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FOREWORD

The Mediterranean is a region of extraordinary promise, where diverse cultures, ecosystems, and economies have flourished for millennia. Today, however, this promise is challenged by the convergence of accelerating environmental degradation, deepening inequalities, and growing climate instability. Yet amidst these pressures lies a clear opportunity: the tools for change exist, and momentum for transformation is building across the region.

This year's volume marks a hopeful and strategic step forward. Building on last year's pioneering analysis of Environmentally Harmful Subsidies (EHS), we now turn to the proactive use of green public finance and economic instruments—powerful levers to align environmental ambition with real-world progress. The stakes are high: climate risks are intensifying, biodiversity is under unprecedented threat, and water scarcity, air pollution, and socio-economic vulnerabilities continue to widen. But so too is the potential for Mediterranean countries to lead the way in forging new models of sustainable, inclusive development.

What sets this report apart is not only its foundation in rigorous, empirically grounded research, but also its scope. It is the first of its kind in the Mediterranean region to explore the role of green and sustainable finance with such depth—directly connecting fiscal instruments to environmental and social outcomes across key sectors. This publication takes the form of an Edited Volume—a format chosen deliberately to reflect the scholarly depth, diversity of perspectives, and methodological rigor of the work. Chapters are self-contained and authored by recognized experts from across the Mediterranean region and are brought together by a coherent editorial structure that ensures thematic consistency and collective relevance. The chapters address pressing issues shared across the region—such as energy transition, biodiversity protection, water scarcity, and air pollution—and explore how specific green tools can provide solutions. From green taxation and carbon pricing to sustainable bonds and nature-based investments, this volume identifies where and how economic tools can generate the greatest impact. It also sheds light on the enabling conditions needed—such as institutional capacity, regulatory coherence, and public trust—for these tools to deliver meaningful change.

While regional in nature, some chapters also delve into national or subnational case studies when applicable. This approach ensures that while we speak to the region as a whole, we also provide actionable insights to support country-level progress. Importantly, the report does not shy away from complexity. It addresses head-on the implementation challenges that countries face, particularly those with constrained fiscal space and asymmetrical governance structures. Drawing on the latest data, literature, and comparative experiences, it offers pragmatic, context-sensitive insights designed to support policymakers in crafting solutions that are both ambitious and feasible.

This work also resonates with the broader global context. As the international community intensifies efforts to achieve the Sustainable Development Goals and deliver on the Paris Agreement, the Mediterranean can position itself as a pioneer—a region capable of translating global ambitions into grounded, region-specific action. Encouragingly, this spirit is already visible: countries across the basin are actively contributing to the revision of the Mediterranean Strategy for Sustainable Development (MSSD), which will soon embed Sustainable Finance among its core priorities.

At the heart of this report lies a simple but urgent premise: that economic and environmental imperatives are no longer separate, but deeply intertwined. Green public finance is not a luxury—it is a necessity. It offers a pathway toward ecological integrity, economic resilience, and greater social justice.

This work is the result of close collaboration with over 20 experts from across the Mediterranean—many from the Southern and Eastern shores—whose dedication to a more just and sustainable future continues to inspire us. We extend our sincere thanks to all contributing authors, and to UNEP/MAP and the Government of France for their steadfast support.

We invite all Mediterranean stakeholders—governments, institutions, investors, civil society, and citizens—to see this report not only as a technical resource but as a shared call to action. With the right policies, grounded in evidence and driven by collective ambition, a thriving and sustainable Mediterranean is within our reach.

Robin Degron (Director, Plan Bleu, France)
Constantin Tsakas (Chief Economist, Plan Bleu, France)

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SHAPING THE MEDITERRANEAN'S FUTURE: GREEN FINANCE AND ECONOMIC TOOLS FOR ADDRESSING ECOLOGICAL AND SOCIO-ECONOMIC CHALLENGES



The Mediterranean region faces a series of interconnected challenges that threaten its future sustainability. Rapid climate change, rising temperatures, and decreasing precipitation are only the beginning of a broader set of environmental pressures, compounded by the region's complex developmental landscape. As underscored by Plan Bleu's SOED2020 report (2020) and MedECC (2020), the Mediterranean is warming at a rate 20% faster than the global average, already reaching temperatures 1.5°C above pre-industrial levels. These changes exacerbate water scarcity, biodiversity loss, pollution, and the destruction of ecosystems, particularly in the region's coastal and urban areas. Additionally, economic disparities between the North and South further hinder the implementation of effective sustainable development policies. The persistence of social inequalities, high youth unemployment, and environmental degradation necessitate comprehensive, region-wide strategies to promote a more resilient, sustainable future.

By 2050, the Mediterranean is expected to face a significantly worse situation, with major transformations in its marine ecosystem, overall ecological degradation, and increasing vulnerability to external factors like climate change and geopolitical/economic shifts

(MED2050 report, Plan Bleu 2025). As the Mediterranean faces ecological decline and socio-economic instability, it is crucial to accelerate the transition to a sustainable development model in order to meet the Sustainable Development Goals (SDGs) and ensure a fair and prosperous future for the region. This requires not only stronger environmental policies but also a realignment of economic and financial mechanisms, ensuring that economic policies support both environmental stewardship and socio-economic well-being.

A key step in this transformation is the gradual phase-out or reorientation of environmentally harmful subsidies (EHS) (Plan Bleu and UNEP/MAP 2024). The next step involves the proactive implementation of green public finances and economic tools (GFET) to drive sustainable change. These tools aim to channel financial resources towards ecologically sustainable projects and support the transition to a green economy by integrating environmental goals into economic planning. They help reduce environmentally harmful subsidies while fostering innovation and sustainable solutions to address ecological and socio-economic challenges. Green public finances encompass a variety of fiscal instruments all aimed at embedding environmental sustainability into the economic fabric of governments.

UNEP/MAP recognizes the critical need to promote economic instruments and sustainable finance within the region. As part of the ongoing revision of the Mediterranean Strategy for Sustainable Development (MSSD) for the 2026-2035 period, a strategic framework that guides sustainability actions in the Mediterranean, UNEP/MAP and Plan Bleu play a key role in ensuring that sustainable finance is meaningfully integrated into the region's future environmental and socio-economic policies. The implementation of GFET in the Mediterranean must be tailored to the region's unique environmental, economic, and social contexts. With a diverse group of countries, ranging from high-income nations in the North to economies with differentiated development paths in the South and East, a one-size-fits-all approach is unlikely to be effective.

Aware of the urgent need to address Green Finance and Economic Tools, Plan Bleu initiated an Edited Volume report to provide insights for Mediterranean decision-makers. In 2024, an open Call for Papers invited researchers to explore Green Finance's role in key sustainability challenges. Thirteen proposals were selected and funded, with drafts that were discussed in a regional workshop in January 2025. These documents form the chapters of the Edited Volume, which truly resembles an encyclopedia of knowledge on the subject, providing a comprehensive and in-depth resource that is both applicable and adaptable to the diverse challenges faced by stakeholders in the region. While the majority focus on regional issues, some address specific countries as case studies, all providing recommendations that are relevant to the Mediterranean's broader context. This «by Mediterraneans, for the Mediterranean» approach offers invaluable insights, ideas, and practices from diverse perspectives.

Among the Key Takeaways:

BROAD RANKING OF SUSTAINABLE FINANCE AND GREEN ECONOMY TOOLS

The **first chapter** offers a comprehensive introduction to the field of Sustainable Finance, with a particular focus on green economy tools and public finance mechanisms across Mediterranean countries. It critically assesses a range of instruments, including environmental taxation, green bonds, carbon pricing, and renewable energy incentives, and evaluates their effectiveness in fostering sustainable economic development and environmental stewardship.

The chapter underscores the considerable regional disparities in the deployment of these tools. The effectiveness of green economic tools in the Mediterranean hinges on strong institutions, political stability, and adequate fiscal capacity. While robust governance enables effective implementation, disparities in institutional strength, economic structures, and political will lead to uneven progress. High-income and politically stable countries are generally better positioned to adopt green finance mechanisms, though this is not always the case, as some developing countries have also successfully implemented such reforms despite facing challenges. In fact, while developed countries have already significantly reduced harmful subsidies, these subsidies remain notably high in many developing countries. Some Southern Mediterranean countries have established stable frameworks and made strides in these areas. Regional cooperation remains essential but is often hindered by geopolitical tensions and fragmented governance.

While high-income countries like France and Italy stand out with the adoption of methods such as green budgeting and ecological taxation, others, such as Morocco and Tunisia, focus on targeted incentives to promote renewable energy and eco-labeling. However, obstacles remain, including limited technical capacities, sometimes fragile governance, and challenges related to regional harmonization, although some national reforms can be implemented without regional harmonization. Successful implementation depends on the strength of institutions, stakeholder involvement, and effective coordination. To enhance the impact of these initiatives, the region needs a shared vision, strengthened capacities, innovative financing, and regional cooperation to better align economic reforms with environmental sustainability goals.

EVALUATING GREEN FINANCE INSTRUMENTS: EFFECTIVENESS OF CARBON PRICING, FITS, AND GREEN BONDS IN THE MEDITERRANEAN ENERGY TRANSITION

The **second chapter** focuses on the role of green finance in supporting the energy transition within Mediterranean countries. It explores how various economic instruments and finance mechanisms can drive climate change mitigation while contributing to the broader goal of transitioning to a low-carbon economy.

Discussions include the effectiveness of tools such as environmental taxation, feed-in tariffs (FiTs), carbon pricing, subsidies, and green bonds. By drawing on econometric analysis and policy evaluations, the chapter highlights how these instruments affect greenhouse gas (GHG) emissions and help facilitate the shift from fossil fuels to renewable energy sources. A key takeaway from the analysis is that green finance, while indispensable, must be embedded within a broader, coherent policy framework to effectively drive the transition. For instance, environmental taxes, though they can reduce GHG emissions, are most effective when accompanied by stringent regulatory measures.

Data for environmentally related tax revenue (% of GDP) for the period 1994-2021 and FiTs (USD) for the period 2000 – 2019 are extracted from the OECD database, whereas per capita GHG emissions (GHGPC) data (tonnes CO2e/year) is extracted from the IEA and Emissions Database for Global Atmospheric Research (EDGAR). The author employs "fixed effects" econometrics modelisation, with Models 1a and 1b examining how total environmental tax revenue (ENVTAX), as a percentage of GDP, affects greenhouse gas emissions per capita (GHGPC). Meanwhile, Models 2a and 2b specifically focus on the impact of taxes related to climate change (CLIMTAX) on GHGPC. Both sets of models show that a 1 percentage point increase in either ENVTAX or CLIMTAX results in a slight decrease (0.01-0.02%) in GHG emissions per capita. This implies that environmental taxes alone may not be set at levels high enough to significantly change behavior, especially if the cost of compliance is lower than the economic benefits of continuing high-emitting activities. However, strict environmental policies may increase the effectiveness of taxes by creating additional pressure to adopt cleaner technologies and practices. In the same analysis, GDP per capita (GDPPC) makes a significant contribution to emissions per capita; i.e. being a wealthier country in average per capita terms implies an increase in the GHG

each person emits on average. To be more precise, a 1% increase in GDPPC leads to a 0.5-0.6% increase in emissions per capita. On the other hand, renewable energy output, REO, contributes to the low-carbon transition significantly as it decreases emissions by 0.005% as REO increases by 1 percentage point. Higher shares of fossil fuel consumption contributes to increasing per capita emissions, as expected.

Feed-in tariffs are another policy tool discussed in this chapter, though they should be approached with caution, as they do not always ensure genuinely "green" outcomes. These tariffs guarantee a stable long-term purchase price for renewable energy, thereby reducing investment risks and encouraging private sector participation in renewable energy projects. However, the analysis highlights that the success of FiTs is not automatic and is more likely to yield positive results when they are supported by a political environment focused on reducing dependence on fossil fuels. Discussions also suggest that these tariffs should support a variety of renewable energy sources, with a particular emphasis on small producers and community-based projects, to promote energy democratization. In general, while FiTs have encouraged private investments, their impact is limited in certain sensitive areas where they may harm biodiversity. They can also encourage equipment imports rather than the development of local industries. Their overall effectiveness should therefore be very much nuanced.

Carbon pricing, whether through carbon taxes or emission trading systems, theoretically aims to internalize the social cost of carbon by reflecting the economic damage caused by CO_2 emissions. However, challenges such as carbon price volatility and the difficulty in accurately determining the true cost of carbon and setting the tax level at that cost limit the effectiveness of these mechanisms. Despite these challenges, the revenue generated from carbon quota auctions has been effectively used in several European Union member states to finance climate-related initiatives, such as renewable energy projects and energy efficiency. In addition to carbon pricing, green finance instruments, including green bonds and green loans, can directly channel investments into low-carbon projects. Green bonds, for example, have seen significant growth since their introduction, although they face criticism related to greenwashing and insufficient climate impact.

Green loans, similarly, are growing in popularity, with varying levels of success across regions. Central banks, particularly in developed countries, are also starting to incorporate green finance into their frameworks, though developing nations face more significant challenges due to economic instability. Multilateral finance initiatives, like the Clean Technology Fund and multilateral development banks (MDBs) such as the European Bank for Reconstruction and Development (EBRD), play a pivotal role in supporting the green transition by providing funding for renewable energy projects and climate initiatives. These financial instruments, when properly aligned with environmental goals, can significantly contribute to the low-carbon transition, though further research is needed to assess their long-term effectiveness in reducing emissions.



Policy Tool/Instrument	Evaluation	Reasoning
Environmental Taxation	Good	Promotes resource efficiency, fosters climate mitigation, encourages innovation, and targets high-emissions sectors effectively if well-designed and policy is highly stringent.
Feed-in Tariffs (FiTs)	Neutral	Can support renewable energy adoption but may fail without coherent energy policies or provisions prioritizing smaller producers/community-based projects. The impacts of FiTs to each renewable resource may differ depending on the country context. Damaging effects on biodiversity, landscapes, and imports
Other Subsidies for Renewable Energy	Good	Supports potentially the growth of infant renewable industries, aids the green transition, and fosters economic sustainability when designed effectively. Damaging effects on biodiversity, landscapes, and imports.
Carbon Tax	Good	Encourages emissions reductions by internalizing environmental costs, fostering a low-carbon economy, and driving innovation in green technologies.
Subsidies for Fossil Fuels	Bad	Anchors fossil fuels in the economic structure, hinders renewable energy development, and reduces fiscal space for green initiatives and development.
Grants/Loans/Bonds for Green Transition	Good	Targets high-emissions sectors like energy and transport, aiding the transition to a low-carbon economy.
Energy Efficiency Investments/Incentives	Good	Reduces energy consumption and emissions while creating economic savings and fostering sustainable development.
Green Reporting and Transparency.	Good	Enhances monitoring of green finance, ensures accountability, and aligns investments with sustainability goals.
Fossil Fuel Subsidy (FFS) Removal	Good	Frees up potential financial resources for green investments and supports climate goals, provided that mechanisms are put in place to protect vulnerable populations.

TABLE 1

Preliminary ranking of the policy measures and economic tools for the energy transition in the Mediterranean

Source: Author's own synthesis

ALIGNING FISCAL POLICY WITH DECARBONISATION GOALS: STRATEGIC APPROACHES FOR MEDITERRANEAN ECONOMIES

For effective climate action, there is a need for coordinating economic and environmental policies. This is the rationale behind the **third chapter** which focuses on the vital role that economic policymakers, particularly Ministries of Economy and Finance, play in shaping decarbonisation pathways that align with climate stabilisation goals. The chapter stresses how economic policymakers must work closely with ministries of environment, energy, agriculture, and transport to assess the fiscal, macroeconomic, and distributional impacts of climate policy. This collaboration is crucial to ensure that the technical aspects of decarbonisation, which are often not immediately apparent to economic policymakers, are fully integrated into economic planning.

The methods for calculating effective carbon prices and fossil fuel subsidies are outlined, with Cyprus serving as a case study, to help policymakers assess the real impact of carbon pricing across sectors. The analysis incorporates current schemes like the EU Emissions Trading System (ETS), excise taxes on fuels, and circulation taxes on vehicles and also considers future changes. A key feature is the concept of the «shadow cost of carbon,» which represents the price needed to achieve decarbonization goals by 2050. The analysis shows that while road transport is taxed adequately, many sectors, like industry, aviation, and shipping, are either under-taxed or untaxed. This creates implicit fossil fuel subsidies, estimated at about 2.5% of the GDP of Cyprus.

The analysis also highlights the importance of understanding the medium and long-term fiscal implications of decarbonisation policies. This is especially relevant as increasing portions of tax revenue are linked to the environmental performance of economic sectors. This is particularly evident with taxes on fossil fuels, which will decrease as sectors like transport shift to electric vehicles. For instance, excise taxes on oil products and annual circulation taxes based on vehicle emissions will gradually shrink, leading to significant fiscal implications. By 2030, public revenues from these sources could experience a gradual decline, although the extent of this decrease remains uncertain, especially in Mediterranean countries heavily dependent on fossil fuels and considering the volatility of oil prices. Nevertheless, this highlights the urgency of adapting fiscal systems in response to the ongoing energy transition. Policymakers must anticipate these changes and consider decoupling tax bases from emissions to maintain fiscal sustainability while continuing to incentivize green transitions.

A set of criteria for prioritising public investments in decarbonisation is also provided. This goes beyond traditional cost-effectiveness assessments and takes a more holistic approach that includes environmental and broader socio-economic considerations, which is critical for economic ministries to make informed decisions. The criteria include measures of GHG emissions savings (Criteria 1), energy efficiency (Criteria 3), and climate resilience (Criteria 6), which ensure that investments deliver substantial environmental benefits. Additionally, the framework assesses economic multiplier effects (Criteria 9), job creation (Criteria 10), and economic resilience (Criteria 15), providing ministries with a broader understanding of how decarbonisation can also drive economic growth and social stability. The approach is highlighted as being applicable to non-EU Mediterranean countries, with the caveat that analyses and inter-ministerial collaboration must be adapted to each country's unique challenges and contexts, such as restricted access to international climate funds or technical expertise.

FINANCING THE RESTORATION OF MEDITERRANEAN MARINE BIODIVERSITY: LEVERAGING THE NATURE RESTORATION LAW AND INNOVATIVE INSTRUMENTS

How can we leverage the Nature Restoration Law (NRL) and what innovative financing instruments for restoring Mediterranean marine biodiversity should we privilege? This is the question that drives the **fourth chapter**, which explains how the NRL establishes explicit targets for restoring key marine habitats and presents an ambitious framework that requires substantial financing from both public and private sources, while also leveraging EU co-financing instruments.

The chapter presents various financing mechanisms and tools that could support the restoration of marine biodiversity in the Mediterranean. Conservation Trust Funds are considered particularly effective due to their long-term financial sustainability, targeted conservation efforts, and scalability. Conservation fees and charges, especially in tourism-heavy areas, have strong revenue-generating potential and can directly support restoration efforts in Marine Protected Areas (MPAs). Blended finance and private sector investment can mobilize private capital for restoration, though their success depends on attractive returns and low risk for investors. Payments for Ecosystem Services (PES) offer direct rewards for conservation efforts and perform well in well-structured, small-scale projects, but face implementation and monitoring challenges. Public subsidies have the potential for large-scale impact if well-designed, but require strong political support to avoid creating perverse incentives. Blue bonds can attract significant funding, particularly for large-scale or transboundary projects, but they demand strong institutional capacity. Finally, although carbon markets and biodiversity credits have significant potential, they are mainly focused on so-called «blue carbon» ecosystems (seagrass beds, macroalgal forests and soft sediments). However, they need to be supported by strict regulatory frameworks to ensure their effectiveness and credibility. It is also worth noting that biodiversity credits exist for other types of ecosystems, including coastal and terrestrial ones, and they too require appropriate regulation.

While these tools offer significant potential, their success is contingent upon their design, the regulatory frameworks in place, and the need for strong governance. The chapter emphasizes that these mechanisms should be part of a comprehensive, integrated policy approach, as their efficiency is highly dependent on their complementarity with other tools.

Ranking	Financing Instrument	Impact	Efficiency	Scalability	Feasibility	Limitation
1	**Conservation Trust Funds**	Long-term support (e.g., MedFund) Depends on the initial funding or its renewal	Targeted use, low leakage	Can expand to wider MPAs	Needs strong governance	Focused on conservation, not restoration
2	**Conservation fees and charges**	High potential via tourism/resource use	Direct if well-targeted	Applicable mainly in tourist MPAs, but also to islands or ports.	Easier than public reform	Depends on visitor flows, needs earmarking
2	**Private investment & blended finance**	Unlocks private capital	Dependent on returns and risk	Expandable with incentives	Limited by regulation, investor interest	Can only complement public funding
2	**Payments for Ecosystem Services**	Rewards conservation	Effective when structured well	Small/local in scale	Complex to monitor and implement	Relies on ecosystem valuation
3	**Public subsidies**	High potential if well-designed	Depends on activity targeted	Aligns with NRL goals	Needs political will	Risk of perverse effects, equity concerns
3	**Taxes**	Generates revenue, indirect restoration support	Efficient if well-designed	Expansion faces resistance	Needs strong political support	Equity and social acceptability challenges
3	**Blue bonds**	Large-scale restoration funding	Efficient but may have risks	Suitable for big/transboundary projects	Requires high capacity and major funders	Greenwashing risk if poorly monitored
4	**Carbon markets & biodiversity credits**	Potential in 'blue carbon' areas	Investor interest, low legitimacy	Dependent on demand	Needs strong science/regulatory frameworks	Early stage, needs alignment with EU/international rules

TABLE 2

Preliminary ranking of financial mechanisms and tools for marine restoration in the Mediterranean

Source: the author's own qualitative assessment.

ENHANCING MEDITERRANEAN IAS MANAGEMENT: FROM PIGOUVIAN TAXES TO PUBLIC-PRIVATE PARTNERSHIPS FOR SUSTAINABLE SOLUTIONS

The **fifth chapter** also addresses biodiversity, but through a more targeted lens: it examines the substantial economic burden caused by invasive alien species (IAS) in the Mediterranean. These species have led to financial losses exceeding $27.3 billion, particularly affecting key sectors such as fisheries, aquaculture, and tourism. Despite these substantial costs, current IAS management approaches remain predominantly reactive, emphasizing control and mitigation rather than prevention. The discussion highlights the potential of economic tools to enhance financial sustainability and improve long-term management effectiveness.

A range of economic instruments are examined as mechanisms to internalize the costs of IAS while incentivizing proactive management. Prevention-focused tools like Pigouvian taxes, tradable permits, and performance bonds have high potential but face challenges in enforcement, particularly in non-EU Mediterranean countries. Adaptation tools such as compensation and subsidies seem more feasible and widely applied, especially under EU funding schemes, but require stable financial support. Notably, direct financial incentives, such as removal subsidies for pufferfish and lionfish, have proven successful in integrating IAS control into commercial fishing activities. Compensation mechanisms for fishers affected by IAS-driven stock declines further illustrate the importance of economic support structures. Liability insurance, while ensuring long-term remediation funding, remains underutilized due to complex liability assessments. Overall, challenges persist, including the difficulty of quantifying invasion risks, enforcing tax policies, and ensuring the long-term sustainability of financial incentives.

Public-private partnerships are identified as a critical yet underutilized opportunity for IAS management. The private sector can also play a vital role by investing in detection and removal technologies, funding control programs, and developing commercial markets for certain invasive species. Gaps remain in funding stability, governance coordination, and policy implementation, particularly in non-EU Mediterranean countries. The chapter underscores the need for stronger financial mechanisms, greater multi-stakeholder engagement, and the integration of economic models into broader conservation frameworks. Strengthening regional cooperation through initiatives such as a dedicated action plan under the Barcelona Convention could provide clear guidelines for tax policies, incentives, and liability schemes.

FINANCING THE SUSTAINABLE USE AND PROTECTION OF MEDITERRANEAN WATER RESOURCES: EVALUATING GRANTS, BANK LENDING, GREEN BONDS, PPPS, AND OTHER INSTRUMENTS

What policies and financing mechanisms necessary for the sustainable use and protection of water resources in the Mediterranean? This is the central question behind **chapter 6**. It highlights key EU strategies such as the Water Framework Directive, the Green Deal, and the Biodiversity Strategy for 2030, and examines their implications for Mediterranean countries. The paper emphasizes the importance of adequate funding for water-related innovations and uses SWOT analysis to assess modern financing alternatives in the region. Case studies, including the crowdfunding platform Zoomaal in Lebanon, are discussed to illustrate the conditions for deploying novel financing approaches. The paper concludes by ranking financial instruments for water management in the Mediterranean, highlighting the varied accessibility, regulatory support, scalability, environmental impact, and investor appeal of each option.

Grants offer moderate ease of access but are highly supported by regulations, making them particularly useful for funding specific sustainability initiatives. They are strongly aligned with environmental objectives, offering significant environmental benefits. However, grants lack scalability due to their dependence on time and budget constraints, and they do not attract significant investor appeal because they do not provide direct returns. Grants are generally one-time funding sources, which limits their capacity for long-term project growth.

Bank lending is moderately accessible with strong regulatory backing, particularly from institutions like the World Bank and the European Investment Bank. These loans provide structured financing with clear terms, which can be helpful for borrowers. While they can support sustainable water projects, bank lending is often limited by restrictive loan terms and interest rates, which make it harder for new water technologies, especially those with long repayment periods, to access financing. The scalability of bank loans is moderate, as they support large projects but sustainability loans still represent a small portion of overall lending. Investor appeal is relatively high due to the predictable financial returns, although the focus on profitability can limit their environmental impact.

Innovation competitions stand out for their high ease of access, as they encourage creativity and provide non-repayable funding to winners. These competitions are particularly useful for funding novel water innovations, and their environmental impact is high. However, the one-time nature of the funding limits scalability, and while regulatory support is moderate, it often comes from NGOs, universities, or corporate sponsors rather than government institutions. Furthermore, public-private partnerships offer moderate ease of access but are highly supported by regulations, particularly in large-scale water projects. These partnerships allow for the mobilization of both public and private finance, making them scalable and highly attractive for investors. The high environmental impact is a key benefit of these partnerships, but there is a risk that the private sector may prioritize profit over long-term sustainability. Nevertheless, investor appeal is high due to the financial returns and risk-sharing mechanisms involved in these arrangements.

Green bonds are a scalable financing option for sustainable water projects, driven by growing ESG investment interest. However, they are hard to access due to high issuance costs and transparency issues, with moderate regulatory support. Meanwhile, blended finance combines multiple funding sources, reducing risks for private investors and benefiting from strong regulatory backing. This approach is scalable and has high environmental impact, attracting investors by mitigating risks with public funds and mobilizing institutional capital for sustainability. Private equity is another tool, which offers scalability for water businesses but is difficult for early-stage innovators to access. While attractive to investors seeking high returns, its profit-driven nature and regional instability can limit its effectiveness. Lastly, crowdfunding provides easy access for small-scale, innovative water projects, with global reach. However, it lacks regulatory support, scalability, and reliability for large projects.

Financial Instrument	Ease of Access	Regulatory Support	Scalability	Environmental Impact	Investor Appeal
Grants	Moderate	High	Low	High	Low
Bank Lending	Moderate	High	Moderate	Moderate	High
Innovation Competitions	High	Moderate	Low	High	Moderate
Public-Private Partnerships	Moderate	High	High	High	High
Green Bonds	Low	Moderate	High	High	Moderate
Blended Finance	Moderate	High	High	High	High
Private Equity	Low	Moderate	High	Moderate	High
Crowdfunding	High	Low	Low	Moderate	Low

TABLE 3

Ranking of financial instruments for water management in the Mediterranean

Source: Author's assessment following SWOT analysis

GREEN BONDS IN THE ENERGY TRANSITION: NEED FOR ADDRESSING REGULATORY FRAGMENTATION, UNCLEAR GREEN CRITERIA, AND INVESTOR AWARENESS CHALLENGES

Green bonds are at the focus of several remaining chapters, including **chapter 7** which evaluates their role in Türkiye's energy transition using a financially extended social accounting matrix (FSAM). The analysis focuses on the economic impact of green bond issuance, highlighting sectoral linkages and financial constraints. The FSAM integrates input-output analysis, financial-real linkages, and green bond issuance data to evaluate systemic impacts across sectors. The findings highlight the importance of the energy sectors in Türkiye's economy. Gas energy, despite being crucial to the system, faces challenges. If removed, it would result in an 18.7% output loss, underlining its critical role in driving demand for industries like metallic manufacturing and supplying inputs to sectors such as construction. In contrast, wind energy, though prioritized in policy, struggles to integrate effectively into the broader economic system. This difficulty reflects the broader structural challenges in Turkey's energy transition, which are noted in the National Energy Plan 2023 that prioritizes renewable energy development while recognizing the need to overcome obstacles, particularly in integrating wind energy. It is also worth noting that the coal sector, in contrast, demonstrates its inefficiency, with production gains of nearly 30% projected in the event of its removal. This heavily subsidized sector—receiving close to 750 million dollars annually—could serve as a key lever for redirecting financial efforts toward more sustainable energy production.

The chapter also examines the financial constraints that limit the effectiveness of green bonds. These constraints reduce output multipliers across all energy sectors, with the average decline ranging from 25-30%. For instance, the multiplier for gas energy drops from 5.87 in a basic social accounting matrix (SAM) to 4.87 in the FSAM, reflecting a reduction in financial system integration. Wind energy experiences an even sharper decline, from 5.70 to 4.44, highlighting the significant financing hurdles that renewables face in Türkiye. These results align with previous studies that have pointed to liquidity constraints as a key barrier to sustainable financing in emerging economies. While green bonds show some improvement across sectors, their overall impact remains limited. For example, the forward linkage for wind energy slightly increases from 0.340 to 0.342, but this improvement is insufficient to drive systemic change. The coal sector shows no change in its multipliers, which aligns with the ongoing phase-out commitment. The limited impact of green bonds reflects several challenges, including regulatory fragmentation, the absence of clear criteria for qualifying green projects, and a lack of investor awareness.

To maximize the effectiveness of green bonds in Türkiye's energy transition, it is suggested to strengthen regulatory frameworks around green finance, increase investments in renewable energy infrastructure, and enhance investor education. Establishing clear and consistent rules to define what qualifies as a "green" investment will help reduce opportunities for greenwashing and, consequently, strengthen investor confidence. Moreover, the expansion and modernization of renewable energy infrastructure will enhance intersectoral linkages and support a more efficient energy system. Finally, increasing investor awareness of the benefits and opportunities of green financial instruments will stimulate demand for sustainable investments. This approach serves as an illustrative example for other Mediterranean countries, which face similar challenges in aligning their financial mechanisms with their renewable energy and sustainability goals—making such strategies highly relevant for broader regional integration and progress toward a greener economy.

THE IMPACT OF GREEN BOND ISSUANCE ON AIR POLLUTION IN THE MEDITERRANEAN: SECTORAL DIFFERENCES, STRATEGIC DEPLOYMENT, AND MATURITY EFFECTS

The **eighth chapter** analyzes the impact of green bond issuance on air pollution in 21 Mediterranean countries from 2012 to 2022. The results show that green bond issuance reduces air pollution, with the maturity and number of green bonds issued having the most significant effect.

The results show that green bond issuance significantly reduces air pollution in both non-polluting and polluting sectors, with a stronger effect in the latter. Specifically, the Green Bond (GB) coefficient for non-polluting sectors is -0.482, while for polluting sectors it is -1.853, indicating a more pronounced reduction in high-emission industries like manufacturing and energy production. Energy intensity (ENER_INT) also has a greater impact on pollution reduction in polluting sectors (0.669) compared to non-polluting ones (0.387). Other factors, such as government intervention and GDP growth, influence pollution levels but vary in significance across sectors.



The analysis of green bond issuance shows a negative coefficient of -0.221, indicating a trend toward reducing air pollution with increased issuance, though the result is not statistically significant. In advanced EU economies like France, Italy, and Spain, large green bond amounts fund various environmental projects, but the direct impact on air quality is not evident. For smaller economies like Cyprus and Greece, more modest issuance may still be effective if targeted properly. In emerging markets like Egypt, Morocco, and Türkiye, the size of green bond issuance alone does not guarantee improvements in air quality. The findings suggest that the strategic deployment of funds—rather than their volume—plays a more crucial role in achieving environmental impact, emphasizing the importance of project selection, implementation efficiency, and fund allocation.

The results also suggest that maturity plays a key role, specifically moderate-maturity green bonds (5-10 years) are the most effective at reducing air pollution, being roughly twice as effective as short- or long-maturity bonds. This optimal timeframe aligns well with renewable energy project cycles and industrial modernization, offering a balance between flexibility and accountability. It is suitable for both advanced economies like France, Italy, and Spain, as well as emerging markets such as Egypt, Morocco, and Türkiye, providing enough time for meaningful implementation while maintaining momentum. Long-maturity bonds (over 10 years) are ideal for major infrastructure projects and long-term climate goals, particularly in emerging Mediterranean economies, though they may face challenges in maintaining efficiency. Short-maturity bonds (under 5 years) work best for quick-implementation projects, particularly in smaller economies.

TOWARDS MEDITERRANEAN-SPECIFIC GREEN BOND GUIDELINES: ADDRESSING LEGAL GAPS AND ENHANCING PROJECT IMPLEMENTATION

The **ninth chapter** highlights the lack of specific legal regulations for green bonds in the Mediterranean, which could limit the adaptation of financial projects to the region's ecological and economic characteristics. Although existing frameworks could serve as references, the absence of local standards may hinder the mobilization of investments tailored to the Mediterranean's specific environmental challenges. While various European and international regulations, both hard and soft law, define what a green bond is and its required characteristics, there are no practical guidelines on how to encourage their development in the Mediterranean region. The creation of Mediterranean-specific guidelines on green bonds could offer several benefits, such as increasing their visibility, making them more attractive, and supporting the implementation of funded projects. Currently, the legal texts aim for harmonization across different legal systems, but this approach does not emphasize the unique characteristics of the Mediterranean region.

The chapter highlights how it is crucial to highlight in a soft law text, such as guidelines, the practical considerations that would be most relevant for Mediterranean countries. The goal of these guidelines is to create a virtuous cycle: by strategically communicating about the projects or activities that businesses wish to finance in the Mediterranean based on the region's needs, the appeal of this financial tool will be enhanced.

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ENERGY TAXES PROMOTE INNOVATION IN ENERGY EFFICIENCY IN ENERGY-INTENSIVE FIRMS WITH VOLUNTARY MANAGEMENT PRACTICES IN SOUTHERN MEDITERRANEAN COUNTRIES

The findings of **chapter 10** highlight the significant role of energy taxation in driving energy-efficient innovation across the private sector in Southern Mediterranean Countries (SMCs), with a particularly strong impact on the retail and service industries.

The analysis confirms that energy taxes can encourage firms to innovate in energy efficiency, particularly for energy-intensive sectors and firms with proactive environmental management practices. Subsample regression results reveal that energy taxes significantly promote innovation in energy efficiency among firms with voluntary energy management practices, especially in industries like metal and machinery manufacturing, where energy costs are a major burden. However, energy taxes have no significant effect on innovation in less energy-intensive sectors. The findings also suggest that energy tax-induced innovation is more effective when firms recognize its environmental benefits, emphasizing the role of environmental awareness.

In manufacturing versus non-manufacturing firms, energy taxes are more impactful for non-manufacturing firms like services and retail, which face fewer operational disruptions when implementing innovations. In contrast, manufacturing firms, due to their capital-intensive production processes, are more constrained in adopting regulatory changes. The results underline that the effectiveness of energy taxes in driving innovation depends on both the sector's energy intensity and the firm's environmental awareness and capacity for innovation.

Overall, the results highlight several implications for policymakers. First, energy taxation serves as an effective tool to accelerate national energy transition strategies in SMCs by encouraging clean energy innovation at the firm level. Second, this market-based instrument (MBI) is particularly effective in promoting energy-efficient production processes within energy-intensive sectors, which are key barriers to the region's decarbonization efforts. Third, the positive impact of energy taxation on eco-innovation is more pronounced in firms that voluntarily manage their energy consumption and are committed to offsetting their negative externalities. Fourth, fostering clean energy innovation at the firm level supports SMCs' commitment to carbon neutrality as part of their pollution control measures. Fifth, unlike non-manufacturing businesses, manufacturing firms are more likely to view energy taxes as a compliance requirement rather than a driver for innovation, unless they consider innovation as a means to reduce their environmental impact.

While energy taxation serves as a valuable policy tool, it must be complemented by broader structural reforms, such as the phased removal or reform of fossil fuel subsidies, the implementation of fiscal incentives, and support for businesses to enhance their technological capacities and access to green financing. Targeted support for small and medium-sized enterprises (SMEs) in strengthening capacities and providing financial assistance is also crucial to overcome barriers to energy efficiency adoption.

Moreover, it should be noted that many energy-intensive sectors benefit from preferential tariffs or tax exemptions, which can sometimes limit the impact of energy taxes and prevent the intended energy innovation incentives from being fully realized. Furthermore, while greenhouse gas emission taxes are more effective when accompanied by strict regulations, certain rules may actually hinder their application, creating contradictions between fiscal and regulatory instruments.

BUILDING A REGIONAL ENERGY HUB IN THE MEDITERRANEAN: LEVERAGING GREEN FINANCE AND RTAS FOR RENEWABLE ENERGY TRADE AND COOPERATION

Energy security and independence are key goals for countries, with the energy sector being the highest carbon emitter, accounting for 40% of global emissions. Yet, renewable energy trade in the Mediterranean remains limited. This is the rationale behind **chapter 11** which argues that to drive the region's energy transition, a regional energy hub (REH) supported by green technologies and green finance could foster collaboration among Mediterranean countries. A Regional Trade Agreement (RTA) focused on renewable energy trade, with the EU's central role and compliance with State Aid Mechanisms for fiscal incentives, is crucial for this model's success.

For the REH to succeed, regional cooperation, particularly in transmission infrastructure investment, is essential. RTAs, like Free Trade or Economic Integration Agreements, can provide the legal framework for this cooperation.

It is suggested that a new institution be established that would be responsible for overseeing the creation of a regional fiscal aid monitoring body. The revenue generated from the introduction of carbon taxes, as well as green fiscal incentives, would be managed by this body. The design of these fiscal incentives must align with the EU State Aid Mechanism to ensure compliance with EU regulations and standards. Key green finance policy tools, such as tax credits, green bonds, and guarantees for future tax incentives, are essential to accelerate the transition. These financial instruments offer stability and incentivize investment in renewable energy, ensuring that green projects are prioritized over fossil fuel investments. Tailoring these instruments to the region's socio-economic contexts will be vital for a smooth and effective energy transition, while ensuring that green finance remains efficient and impactful in supporting long-term sustainability.

TAILORING THE SOCIAL COST OF CARBON IN THE MEDITERRANEAN: REGIONAL VARIATIONS, CARBON TAX SCENARIOS, AND POLICY IMPLICATIONS

What is the optimal Social Cost of Carbon ? The **twelfth chapter** attempts to answer that using an extended Regional Integrated Climate Economics for Mediterranean Region (RICE-MED) model, it measures the Social Cost of Carbon (SCC) for each country, evaluates different carbon tax scenarios, and assesses their implications for emissions reductions and economic performance.

The model used projected carbon costs from 2020 to 2100, providing an overview of the temporal and geographical distribution of climate-related damages. The results show a general upward trend, reflecting the growing economic and social damages due to the increase in greenhouse gas emissions. Southern European countries, such as France, Spain, and Italy, exhibit higher SCC projections, reaching $750–800 per ton of CO_2 by 2100, due to their significant economic activity and emissions. In contrast, North African and Eastern Mediterranean countries,

like Algeria and Egypt, show lower SCC values, ranging from $400 to $600 per ton of CO_2, despite their high vulnerability to climate impacts. Others, such as Greece and Turkey occupy an intermediate position, with SCC projections of $650–750 per ton of CO_2.

The analysis also highlights the sensitivity of SCC to key economic and climate parameters. Climate sensitivity exerts the strongest influence, particularly in regions already facing high temperatures and heatwaves. The discount rate, which determines the weight of long-term climate damages, varies by country depending on their economic stability. The analysis underscores the importance of tailoring carbon pricing policies to specific regional contexts to ensure they are both economically viable and socially equitable. The carbon tax scenarios analyzed in the chapter highlight complex trade-offs between environmental benefits and economic costs across Mediterranean countries. Southern European nations, with diversified economies and strong renewable energy infrastructure, would be better equipped to handle higher carbon taxes. Their industrial bases and alignment with EU climate policies may enable them to lead in decarbonization and adopt ambitious tax strategies. In contrast, North African countries, more reliant on fossil fuels and less diversified, face challenges in implementing higher carbon taxes, at least in the immediate-run. While they have renewable energy potential, a gradual approach is necessary to avoid economic disruption.

Ultimately, successful carbon pricing in the Mediterranean requires addressing social equity. Public acceptance increases when revenues are transparently recycled. In North Africa, carbon tax revenues could fund cash transfers, rural energy access, and subsidies, using existing programs like Egypt's Takaful or Morocco's RAMED. In Southern Europe, carbon pricing can offer co-benefits like home retrofits and green jobs. Tailored approaches should be preferred instead of a unified Mediterranean carbon tax, which would be politically unfeasible due to regional differences in fiscal capacity, energy dependence, and public support for reform.

Regions	Countries	Characteristics	SCC	Plan A: Optimal Tax Scenarios	Plan B: Potential for Aggressive Tax
Eastern Mediterranean	Turkiye	High reliance on coal and natural gas; emerging renewables	650–750 USD/ tCO_2 by 2100	50% SCC progressing to 100%	Moderate; post-2050 or in select sectors
North Africa	Algeria	Largest fossil fuel exporter in the region; high emissions	500–600 USD/ tCO_2 by 2100	50% SCC; gradual move to 100%	No; requires significant diversification and renewable capacity
	Egypt	Energy-intensive industrial base; natural gas reliant	450–600 USD/ tCO_2 by 2100	100% SCC	Moderate; requires enhanced renewable capacity
	Morocco	Renewable energy leader in the region; low emissions	450–500 USD/ tCO_2 by 2100	100% SCC	High; strong renewable base supports implementation
	Tunisia	Moderate fossil fuel use; growing renewables	400–500 USD/ tCO_2 by 2100	50% SCC progressing to 100%	Low; dependent on renewable growth
Southern Europe	France	High reliance on nuclear energy; strong industrial base	750–800 USD/ tCO_2 by 2100	100% SCC with gradual progression	Yes; specific sectors or post-2050
	Greece	Economy in transformation; moderate emissions	600–700 USD/ tCO_2 by 2100	100% SCC; phased approach from 50%	Moderate; dependent on renewable expansion
	Italy	Energy-intensive industries; moderate renewable adoption	650–750 USD/ tCO_2 by 2100	100% SCC; phased approach from 50%	Yes; post-2050 in energy-intensive sectors
	Spain	Growing renewable energy investments; diversified economy	650–700 USD/ tCO_2 by 2100	100% SCC	Yes; feasible with existing renewable infrastructure

TABLE 4
Findings summary
Source: calculations by the authors



CLIMATE CHANGE AND MUNICIPAL FISCAL REVENUES: IMPACTS, SCENARIOS, AND POLICY MEASURES FOR RESILIENCE

The **final chapter** is more local in focus, it explores the potential impacts of climate change on municipal fiscal revenues in Italy, highlighting the essential role municipalities play in local service provision and infrastructure management. Climate change threatens to disrupt their financial stability, which could hinder local redistribution policies and the ability to respond effectively to climate challenges. The chapter presents two main scenarios, optimistic and pessimistic, for municipal fiscal revenues. The optimistic one predicts an overall increase in fiscal revenues for municipalities, with Milan seeing the largest absolute increase of €252,360 and Turin the largest relative increase at 3.5%. The total net gain for all municipalities is estimated at €567 million (in 2005 euros). The Pessimistic Scenario presents a stark contrast, with Catania potentially losing 5% of its revenue, Turin losing over 6%, and Milan losing more than 5%. For all municipalities, the total loss could exceed €1.2 billion. The chapter then outlines several policy measures aimed at mitigating the adverse fiscal impacts of climate change on municipal revenues, providing a roadmap for cities to strengthen resilience while maintaining fiscal stability. One proposed measure is the implementation of Pigouvian taxation, levies designed to reflect the external costs of economic activities that harm society or the environment. In the municipal context, such taxes could target activities contributing to climate change, including carbon emissions and pollution. By internalizing these social and environmental costs, municipalities could generate a steady revenue stream to reinvest in climate resilience initiatives. In this context, tools such as urban tolls, already implemented in several Italian cities, could be explored. This mechanism, which aims to reduce congestion and pollution while generating revenue for municipalities, could be adapted to finance climate change adaptation initiatives.

Another recommendation involves reforming cadastral systems, which are used to assess land and property values for taxation purposes. These systems should be updated to account for climate-related

risks, enabling municipalities to adjust property valuations based on factors such as flood exposure, extreme heat, or drought vulnerability. Such reforms would help align property taxes more closely with actual environmental risks, fostering more equitable taxation and encouraging sustainable land use.
The chapter also advocates for an expansion of climate-related tourist taxes, particularly in destinations that depend heavily on coastal or cultural tourism. This additional revenue could be allocated to fund adaptation measures in tourism-dependent areas, such as flood protection, heat mitigation infrastructure, or conservation efforts. By doing so, municipalities can both mitigate the environmental impact of tourism and create new fiscal space for climate action.

THE ROAD AHEAD

Across the diverse contributions of the edited volume, a set of shared conclusions emerges, underscoring the strategic importance of economic tools and green finance for advancing sustainability in the Mediterranean. First, the progressive phase-out or reform of environmentally harmful subsidies and the alignment of fiscal policy with sustainable development goals are widely recognized as foundational to ecological and economic reform. Second, while a range of green instruments—from carbon pricing to green bonds and conservation trust funds—show significant potential, their effectiveness hinges on strong governance, inter-ministerial coordination, and context-sensitive design. Third, regional disparities in institutional capacity, fiscal space, and regulatory maturity underline the need for tailored approaches, rather than one-size-fits-all solutions. A recurring message is that financial mechanisms must be embedded in coherent policy frameworks and supported by robust monitoring, stakeholder engagement, and long-term commitment. Finally, several contributions emphasize the urgent need to develop a Mediterranean taxonomy of sustainable activities, supported by operational guidelines. Such a taxonomy, tailored to the economic, social, and environmental realities of the Mediterranean basin, would help better direct financial flows toward genuinely sustainable projects in the region. It would clarify the signals sent to investors, reduce the risk of greenwashing, and ensure transitions that are not only fair and effective but also aligned with local specificities—such as resource dependencies, climate vulnerabilities, and economic structures.

A significant shift toward more sustainable economic practices is within reach, provided the right national and regional frameworks are in place and actively supported, enabling green tools to flourish.

Looking ahead, much remains to be done, particularly in areas that require deeper exploration. The integration of private sector involvement and the potential of blended finance are key areas that warrant further research. Additionally, developing a comprehensive Framework and Taxonomy for Sustainable Activities is vital to provide clarity and guide investments effectively. These topics will be further addressed in upcoming reports under the 2026-2027 Program of Work.

This process is ongoing, change is gradual, and while progress has been made, much more is needed to drive the transformation required. Political will, coupled with continued research, collaboration, and innovation, is crucial to ensuring the region's transition to sustainability is not only successful but lasting. Achieving sustainability will demand collective effort, sustained commitment, and coordinated action across all sectors and stakeholders. The ongoing efforts within existing frameworks such as the MSSD can support this transformation, but they must be complemented by continuous momentum and strong political support.

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FAÇONNER L'AVENIR DE LA MÉDITERRANÉE : LA FINANCE VERTE ET LES OUTILS ÉCONOMIQUES POUR RELEVER LES DÉFIS ÉCOLOGIQUES ET SOCIO-ÉCONOMIQUES

La région méditerranéenne fait face à une série de défis interdépendants menaçant sa durabilité future. Le changement climatique rapide, la hausse des températures et la diminution des précipitations ne sont que le début d'un ensemble plus large de pressions environnementales, aggravées par le paysage complexe de développement de la région. Comme le soulignent le rapport RED2020 du Plan Bleu (2020) ainsi que MedECC (2020), la Méditerranée se réchauffe à un rythme 20 % plus rapide que la moyenne mondiale, atteignant déjà des températures supérieures de 1,5°C par rapport aux niveaux préindustriels. Ces changements exacerbent la rareté de l'eau, la perte de biodiversité, la pollution et la destruction des écosystèmes, notamment dans les zones côtières et urbaines. De plus, les disparités économiques entre le Nord et le Sud compliquent davantage la mise en œuvre de politiques efficaces de développement durable. La persistance des inégalités sociales, le chômage élevé des jeunes et la dégradation de l'environnement nécessitent des stratégies globales à l'échelle de la région pour promouvoir un avenir plus résilient et durable.

D'ici 2050, la Méditerranée devrait se retrouver dans une situation bien plus préoccupante, avec des transformations majeures de son écosystème marin, une dégradation écologique générale, et une vulnérabilité accrue face à des facteurs externes tels que le changement climatique et les évolutions géopolitiques/économiques (rapport MED2050, Plan Bleu 2025). Alors que la Méditerranée traverse un déclin écologique et une instabilité socio-économique, il est crucial d'accélérer la transition vers un modèle de développement durable afin de répondre aux Objectifs de Développement Durable (ODD) et assurer un avenir équitable et prospère pour la région. Cela nécessite non seulement des politiques environnementales plus fortes, mais aussi un réalignement des mécanismes économiques et financiers, garantissant que les politiques économiques soutiennent à la fois la gestion de l'environnement et le bien-être socio-économique.

Une étape clé dans cette transformation est l'élimination ou la réorientation progressive des subventions nuisibles à l'environnement (SNE) (Plan Bleu et PNUE/PAM 2024). L'étape suivante consiste en la mise en œuvre proactive des outils économiques et finances publiques vertes et des outils économiques écologiques pour favoriser le changement durable. Ces outils visent à canaliser les ressources financières vers des projets écologiquement durables et à soutenir la transition vers une économie verte, en intégrant les objectifs environnementaux dans la planification économique. Ils contribuent à réduire les subventions nuisibles à l'environnement, tout en favorisant l'innovation et des solutions durables face aux défis écologiques et socio-économiques. Les finances publiques vertes englobent une variété d'instruments fiscaux visant à ancrer la durabilité environnementale dans le tissu économique des gouvernements.

Le PNUE/PAM reconnaît la nécessité cruciale de promouvoir les instruments économiques et la finance durable dans la région. Dans le cadre de la révision en cours de la Stratégie Méditerranéenne pour le Développement Durable (SMDD) pour la période 2026-2035, cadre stratégique qui guide les actions de durabilité en Méditerranée, le PNUE/PAM et Plan Bleu jouent un rôle clé pour veiller à ce que la finance durable soit intégrée de manière significative dans les politiques environnementales et socio-économiques futures de la région. La mise en œuvre des outils économiques et finances publiques vertes en Méditerranée doit être adaptée aux contextes environnementaux, économiques et sociaux uniques de la région. Avec des pays hétérogènes, allant des nations à revenu élevé du Nord aux économies à trajectoire de développement différenciée du Sud et de l'Est, une approche universelle ne sera probablement pas efficace.

Conscient de l'urgence de traiter la finance verte et les outils économiques, Plan Bleu a lancé un rapport «Volume Édité» pour fournir des perspectives aux décideurs méditerranéens. En 2024, un appel à propositions a invité les chercheurs à explorer le rôle de la finance verte face aux grands défis de durabilité. Treize propositions ont été sélectionnées et financées, avec des projets discutés lors d'un atelier régional en janvier 2025. Ces documents constituent les chapitres du Volume Édité, qui s'apparente véritablement à une encyclopédie de connaissances sur le sujet, offrant une ressource complète et approfondie, applicable et adaptable à la diversité des défis qu'affrontent les acteurs de la région. Bien que la majorité se concentre sur des enjeux régionaux, certains abordent des pays spécifiques comme études de cas, fournissant tous des recommandations pertinentes pour le contexte plus large de la Méditerranée. Cette approche « par les Méditerranéens, pour la Méditerranée » offre des perspectives, idées et pratiques précieuses provenant de divers points de vue.



Parmi les points clés:

CLASSEMENT GÉNÉRAL DES OUTILS DE FINANCE DURABLE ET D'ÉCONOMIE VERTE

Le **premier chapitre** propose une introduction complète au domaine de la Finance Durable, en mettant un accent particulier sur les outils de l'économie verte et les mécanismes de finances publiques à travers les pays méditerranéens. Il procède à une évaluation critique d'un ensemble d'instruments, notamment la fiscalité environnementale, les obligations vertes, la tarification du carbone et les incitations aux énergies renouvelables, en examinant leur efficacité pour favoriser un développement économique durable et une gestion responsable de l'environnement.

Le chapitre souligne les importantes disparités régionales dans l'utilisation de ces outils. L'efficacité des instruments économiques verts en Méditerranée dépend fortement de la solidité des institutions, de la stabilité politique et d'une capacité fiscale suffisante. Alors qu'une gouvernance robuste permet une mise en œuvre efficace, les différences en termes de solidité institutionnelle, de structures économiques et de volonté politique entraînent des progrès inégaux. Les pays à revenu élevé et politiquement stables sont généralement mieux positionnés pour adopter les mécanismes de finance verte, bien que ce ne soit pas toujours le cas, certains pays en développement ayant également réussi à mettre en œuvre de telles réformes malgré les défis. En effet, tandis que les pays développés ont déjà considérablement réduit leurs subventions nuisibles, celles-ci demeurent très élevées dans de nombreux pays en développement. Certains pays du Sud de la Méditerranée ont réussi à établir des cadres stables et à réaliser des progrès dans ce domaine. La coopération régionale reste essentielle, mais elle est souvent entravée par des tensions géopolitiques et une gouvernance fragmentée.

Tandis que des pays à haut revenu comme la France et l'Italie se distinguent par l'adoption de méthodes telles que la budgétisation verte (green budgeting) et une fiscalité écologique, d'autres, comme le Maroc et la Tunisie, se concentrent sur des incitations spécifiques pour promouvoir les énergies renouvelables et l'éco-labellisation. Toutefois, des obstacles demeurent, notamment des capacités techniques limitées, une gouvernance parfois fragile et des défis d'harmonisation régionale, bien que certaines réformes nationales peuvent être mises en place sans harmonisation régionale. Une mise en œuvre réussie dépend de la solidité des institutions, de l'implication des parties prenantes et d'une coordination efficace. Pour accroître l'impact de ces initiatives, la région nécessite une vision commune, des capacités renforcées, du financement innovant et une coopération régionale, afin de mieux aligner les réformes économiques avec les objectifs de durabilité environnementale.

QUELLE EFFICACITÉ DE LA TARIFICATION DU CARBONE, DES FITS ET DES OBLIGATIONS VERTES DANS LA TRANSITION ÉNERGÉTIQUE MÉDITERRANÉENNE ?

Le **deuxième chapitre** se concentre sur le rôle de la finance verte dans le soutien de la transition énergétique au sein des pays méditerranéens. Il explore comment divers instruments économiques et mécanismes financiers peuvent stimuler la lutte contre le changement climatique tout en contribuant à l'objectif plus large d'une économie à faible émission de carbone.

Les discussions portent notamment sur l'efficacité des outils tels que la fiscalité environnementale, les tarifs de rachat de l'électricité (Feed-in Tariffs - FiTs), la tarification du carbone, les subventions et les obligations vertes. S'appuyant sur des analyses économétriques et des évaluations politiques, le chapitre met en lumière l'impact de ces instruments sur les émissions de gaz à effet de serre (GES) et leur contribution à la transition des énergies fossiles vers les sources renouvelables. Un enseignement majeur de cette analyse est que, bien que la finance verte soit indispensable, elle doit être intégrée dans un cadre politique cohérent pour conduire efficacement la transition. Par exemple, bien que les taxes environnementales puissent réduire les émissions de GES, elles sont plus efficaces lorsqu'elles sont accompagnées de mesures réglementaires strictes.

Les données relatives aux recettes fiscales environnementales (en % du PIB) pour la période 1994-2021 et aux tarifs de rachat (FiTs, en USD) pour la période 2000-2019 sont extraites de la base de données de l'OCDE, tandis que les données sur les émissions de gaz à effet de serre par habitant (GHGPC, en tonnes de CO_2e/an) proviennent de l'AIE et de la base de données EDGAR (Emissions Database for Global Atmospheric Research). L'auteur utilise un modèle économétrique à «effets fixes», avec les modèles 1a et 1b examinant comment les recettes fiscales environnementales totales (ENVTAX), en pourcentage du PIB, affectent les émissions de gaz à effet de serre par habitant (GHGPC). Les modèles 2a et 2b se concentrent spécifiquement sur l'impact des taxes liées au changement climatique (CLIMTAX) sur les GHGPC. Les deux ensembles de modèles montrent qu'une augmentation de 1 point de pourcentage d'ENVTAX ou de CLIMTAX entraîne une légère diminution (0,01-0,02 %) des émissions de gaz à effet de serre par habitant. Cela implique que les taxes environnementales seules ne sont peut-être pas fixées à des niveaux suffisamment élevés pour modifier de manière significative les comportements, surtout si le coût de la conformité est inférieur aux avantages économiques des activités fortement émettrices. Cependant, des politiques environnementales strictes pourraient accroître l'efficacité des taxes en exerçant une pression supplémentaire pour adopter des technologies et pratiques plus propres. Dans la même analyse, le PIB par habitant (GDPPC) contribue de manière significative aux émissions par habitant ; en effet, être un pays plus riche en termes de PIB par habitant implique une augmentation des émissions de GES par personne. Plus précisément, une augmentation de 1 % du PIB par habitant entraîne une augmentation de 0,5-0,6 % des émissions par habitant. D'autre part, la production d'énergie renouvelable (REO) contribue de manière significative à la transition bas carbone, car elle réduit les émissions de 0,005 % à chaque augmentation de 1 point de pourcentage de REO. Les parts plus élevées de consommation de combustibles fossiles contribuent à augmenter les émissions par habitant, comme prévu.

Les tarifs de rachat de l'électricité constituent un autre outil politique abordé dans ce chapitre, à considérer avec prudence, car ils ne garantissent pas toujours des résultats véritablement "verts". Ces tarifs garantissent un prix d'achat stable à long terme pour l'énergie renouvelable, réduisant ainsi les risques d'investissement et encourageant la participation du secteur privé dans les projets d'énergie renouvelable. Toutefois, l'analyse souligne que le succès des FiTs n'est pas automatique et qu'ils sont plus susceptibles de produire des résultats positifs lorsqu'ils bénéficient d'un environnement politique axé sur la réduction de la dépendance aux énergies fossiles. Les discussions indiquent également que ces tarifs devraient soutenir une variété de sources d'énergie renouvelable, en mettant particulièrement l'accent sur les petits producteurs et les projets communautaires, afin de promouvoir la démocratisation de l'énergie. Aussi, de manière générale, bien que les tarifs de rachat aient encouragé les investissements privés, leur impact est limité dans certaines zones sensibles, où ils peuvent nuire à la biodiversité. Ils peuvent aussi favoriser des importations de matériel et non le développement de filières locales. Leur efficacité doit donc, dans l'ensemble, être considérablement nuancée.

La tarification du carbone, qu'il s'agisse de taxes sur le carbone ou de systèmes d'échange de quotas d'émission, vise, en théorie, à internaliser le coût social du carbone en reflétant les dommages économiques causés par les émissions de CO_2. Cependant, des défis tels que la volatilité des prix du carbone et la difficulté à déterminer précisément le coût réel du carbone et à fixer le niveau de la taxe à ce coût réel, limitent l'efficacité de ces mécanismes. En dépit de ces défis, les recettes générées par les enchères de quotas carbone ont été efficacement utilisées dans plusieurs États membres de l'Union Européenne pour financer des initiatives liées au climat, telles que les projets d'énergies renouvelables et d'efficacité énergétique. En complément de la tarification du carbone, les instruments de finance verte, incluant les obligations et prêts verts, peuvent canaliser directement les investissements vers des projets à faible émission de carbone. Les obligations vertes, par

exemple, ont connu une croissance significative depuis leur introduction, bien qu'elles fassent face à des critiques liées au greenwashing et à un impact climatique insuffisant.

De la même manière, les prêts verts gagnent en popularité avec des niveaux de succès variables selon les régions. Les banques centrales, notamment dans les pays développés, commencent également à intégrer la finance verte dans leurs cadres, bien que les pays en développement rencontrent des défis plus importants en raison de l'instabilité économique. Les initiatives de financement multilatérales, telles que le Fonds pour les Technologies Propres et les banques de développement multilatérales (comme la Banque Européenne pour la Reconstruction et le Développement - BERD), jouent un rôle crucial dans le soutien de la transition verte en finançant des projets d'énergie renouvelable et des initiatives climatiques. Lorsqu'ils sont correctement alignés avec les objectifs environnementaux, ces instruments financiers peuvent contribuer de manière significative à la transition vers une

Outil/Mesure politique	Évaluation	Justification
Fiscalité environnementale	Bonne	Encourage l'efficacité des ressources, favorise l'atténuation climatique, stimule l'innovation et cible efficacement les secteurs fortement émetteurs, à condition que la politique soit bien conçue et rigoureuse.
Tarifs de rachat (FiTs)	Neutre	Peuvent soutenir l'adoption des énergies renouvelables mais risquent d'échouer sans politiques énergétiques cohérentes ou dispositifs favorisant les petits producteurs/projets communautaires. Les effets varient selon le type d'énergie et le contexte national. Effets dommageables sur biodiversité, paysage, importations.
Autres subventions aux énergies renouvelables	Bonne	Soutiennent potentiellement la croissance des filières naissantes, facilitent la transition verte et favorisent la durabilité économique lorsqu'elles sont bien conçues. Effets dommageables sur biodiversité, paysage et importations
Taxe carbone	Bonne	Encourage la réduction des émissions en internalisant les coûts environnementaux, favorise une économie bas carbone et stimule l'innovation dans les technologies vertes.
Subventions aux énergies fossiles	Mauvaise	Maintient les énergies fossiles dans l'économie, freine le développement des renouvelables et réduit les marges budgétaires pour les investissements verts et dans le développement.
Subventions/Prêts/Obligations pour la transition verte	Bonne	Ciblent les secteurs fortement émetteurs comme l'énergie et les transports, facilitant le passage à une économie bas carbone.
Investissements/Incitations pour l'efficacité énergétique	Bonne	Réduisent la consommation d'énergie et les émissions, tout en générant des économies et en soutenant le développement durable.
Transparence et reporting vert	Bonne	Améliorent le suivi de la finance verte, garantissent la responsabilité et alignent les investissements sur les objectifs de durabilité.
Suppression des subventions aux énergies fossiles	Bonne	Libère des ressources financières potentielles pour les investissements verts et soutient les objectifs climatiques, à condition de mettre en place des mécanismes de protection des populations vulnérables.

TABLEAU 1

Classement préliminaire des mesures politiques et outils économiques pour la transition énergétique en Méditerranée

Source : Synthèse de l'auteur

économie à faible émission de carbone, bien que des recherches supplémentaires soient nécessaires pour évaluer leur efficacité à long terme dans la réduction des émissions.

ALIGNER LA POLITIQUE FISCALE AVEC LES OBJECTIFS DE DÉCARBONISATION : APPROCHES STRATÉGIQUES POUR LES ÉCONOMIES MÉDITERRANÉENNES

Pour une action climatique efficace, il est indispensable de coordonner les politiques économiques et environnementales. C'est la logique qui sous-tend le **troisième chapitre**, qui se concentre sur le rôle essentiel joué par les décideurs économiques, en particulier les ministères de l'Économie et des Finances, dans la définition de trajectoires de décarbonisation alignées sur les objectifs de stabilisation climatique. Le chapitre insiste sur la nécessité pour ces responsables de collaborer étroitement avec les ministères de l'Environnement, de l'Énergie, de l'Agriculture et des Transports pour évaluer les impacts fiscaux, macroéconomiques et de répartition des politiques climatiques. Cette coopération est cruciale pour veiller à ce que les aspects techniques de la décarbonisation, souvent moins apparents pour les décideurs économiques, soient pleinement intégrés dans la planification économique.

Les méthodes de calcul des prix effectifs du carbone et des subventions aux énergies fossiles y sont également détaillées, prenant Chypre comme étude de cas afin d'aider les décideurs à mesurer l'impact réel de la tarification du carbone dans différents secteurs. L'analyse intègre des dispositifs actuels comme le Système d'Échange de Quotas d'Émission de l'UE (SEQE-UE), les taxes d'accise sur les carburants et les taxes de circulation sur les véhicules, tout en anticipant les évolutions futures. Une notion clé est celle du « coût d'ombre du carbone », qui représente le prix nécessaire pour atteindre les objectifs de décarbonisation d'ici 2050. L'analyse révèle que, si le secteur du transport routier est correctement taxé, de nombreux secteurs – tels que l'industrie, l'aviation et le transport maritime – restent soit insuffisamment taxés, soit non taxés, induisant ainsi des subventions implicites aux énergies fossiles, estimées à environ 2,5 % du PIB de Chypre.

L'analyse met également en lumière l'importance de comprendre les répercussions fiscales à moyen et long terme des politiques de décarbonisation. En effet, une part croissante des recettes fiscales est liée à la performance environnementale des secteurs économiques. Cette tendance se manifeste particulièrement pour les taxes sur les énergies fossiles, qui diminueront à mesure que des secteurs, notamment les transports, amorcent leur transition vers l'électrification. Par exemple, les taxes d'accise sur les produits pétroliers et les taxes de circulation basées sur les émissions des véhicules devraient diminuer progressivement, avec des implications fiscales notables. D'ici 2030, les recettes publiques issues de ces sources pourraient connaître une diminution progressive, bien que l'ampleur de cette baisse reste incertaine, notamment dans des pays méditerranéens fortement dépendants des énergies fossiles et en tenant compte de la volatilité des prix du pétrole. Cela souligne néanmoins l'urgence d'adapter les systèmes fiscaux face à la transition énergétique en cours. Il convient ainsi que les décideurs anticipent ces mutations et envisagent de dissocier les bases fiscales des niveaux d'émissions afin de maintenir la durabilité financière tout en stimulant la transition verte.

Un ensemble de critères pour prioriser les investissements publics dans la décarbonisation est également présenté. Ces critères vont au-delà de l'évaluation traditionnelle de la rentabilité pour adopter une approche plus globale, intégrant à la fois des considérations environnementales et socio-économiques, ce qui permet aux ministères de l'Économie de prendre des décisions éclairées. Parmi ces critères, on retrouve des indicateurs d'économies d'émissions de gaz à effet de serre (Critère 1), l'efficacité énergétique (Critère 3) et la résilience climatique (Critère 6), garantissant que les investissements génèrent des bénéfices environ

nementaux substantiels. Parallèlement, le cadre évalue les effets multiplicateurs sur l'économie (Critère 9), la création d'emplois (Critère 10) et la résilience économique (Critère 15), fournissant ainsi une vision étendue de la manière dont la décarbonisation peut simultanément stimuler la croissance économique et renforcer la stabilité sociale. Cette approche est aussi applicable aux pays méditerranéens non membres de l'UE, en tenant compte du fait que les analyses et la collaboration inter-ministérielle doivent être adaptées aux défis et contextes spécifiques de chaque pays, tels que l'accès limité aux fonds climatiques internationaux ou aux compétences techniques.

FINANCER LA RESTAURATION DE LA BIODIVERSITÉ MARINE EN MÉDITERRANÉE : EXPLOITER LA LOI SUR LA RESTAURATION DE LA NATURE ET LES INSTRUMENTS INNOVANTS

Comment tirer parti de la Loi sur la Restauration de la Nature (LRN) et quels instruments financiers innovants privilégier pour restaurer la biodiversité marine en Méditerranée ? Voilà la question centrale du **quatrième chapitre**. Ce dernier explique comment la LRN établit des objectifs explicites pour la restauration des habitats marins essentiels et présente un cadre ambitieux nécessitant un financement conséquent de sources publiques et privées, tout en s'appuyant sur des dispositifs de cofinancement de l'UE.

Le chapitre présente divers mécanismes de financement susceptibles de soutenir la restauration de la biodiversité marine en Méditerranée. Les fonds de fiducie pour la conservation figurent parmi les options les plus efficaces en raison de leur viabilité financière à long terme, de leur focalisation sur des actions de conservation ciblées et de leur scalabilité. Les redevances et frais de conservation, notamment dans les zones fortement touristiques, disposent d'un fort potentiel de génération de revenus pouvant directement financer les efforts de restauration dans les aires marines protégées. Le financement mixte, associé à l'investissement privé, peut mobiliser des capitaux privés en faveur de la restauration, à condition que les retours sur investissement soient attractifs et que le risque soit limité pour les investisseurs. Par ailleurs, les paiements pour services écosystémiques (PSE) offrent des incitations directes pour les initiatives de conservation et obtiennent de bons résultats dans des projets de petite envergure bien structurés, même s'ils sont confrontés à des défis en termes de mise en œuvre et de suivi. Les subventions publiques, quant à elles, peuvent avoir un impact à grande échelle si elles sont bien conçues, mais requièrent un soutien politique ferme pour éviter de créer des incitations perverses. Les obligations bleues représentent également une option intéressante pour attirer des financements importants, en particulier pour des projets de grande envergure ou transfrontaliers, bien qu'elles exigent une capacité institutionnelle robuste. Enfin, bien que les marchés du carbone et les crédits de biodiversité aient un potentiel important, ils sont principalement centrés sur les écosystèmes dits de « blue carbon » (herbiers marins, forêts de macroalgues et sédiments meubles), mais ils doivent être accompagnés de cadres réglementaires stricts pour garantir leur efficacité et leur crédibilité. Il convient également de noter que des crédits de biodiversité existent pour d'autres types d'écosystèmes, notamment littoraux et terrestres, et qu'ils nécessitent également une régulation appropriée.

Ces instruments offrent un potentiel considérable, mais leur succès repose avant tout sur leur conception, sur les cadres réglementaires en vigueur et sur la solidité de la gouvernance. Le chapitre souligne qu'ils doivent s'inscrire dans une approche politique globale et intégrée, car leur efficacité dépend largement de leur complémentarité avec d'autres outils.

Rang	Instrument de financement	Impact	Efficacité	Évolutivité	Faisabilité	Limitation
1	Fonds fiduciaires pour la conservation	Soutien à long terme (ex. : MedFund) Dépend du financement initial ou de son renouvellement	Utilisation ciblée, faible déperdition	Extensible à d'autres AMP	Requiert une gouvernance solide	Focalisé sur la conservation plus que sur la restauration
2	Redevances/ contributions à la conservation	Potentiel élevé via le tourisme/l'exploitation des ressources	Direct si bien ciblé	Surtout adapté aux AMP touristiques, mais aussi aux iles ou aux ports	Plus simple que les réformes publiques	Dépend du flux de visiteurs, nécessite une affectation dédiée
2	Investissement privé & financement mixte	Mobilise des capitaux privés	Dépend des rendements et du risque	Extensible avec incitations	Limité par la réglementation et l'intérêt des investisseurs	Ne peut que compléter les financements publics
2	Paiements pour services écosystémiques	Récompense la conservation	Efficace si bien structuré	Limité à petite échelle locale	Complexe à mettre en œuvre et à suivre	Nécessite une valorisation des écosystèmes
3	Subventions publiques	Fort potentiel si bien conçues	Varie selon l'activité ciblée	Aligné avec les objectifs de la NRL	Nécessite une volonté politique	Risque d'effets pervers, enjeux d'équité
3	Taxes	Génère des revenus, soutient indirectement la restauration	Efficace si bien conçue	Extension difficile	Requiert un fort soutien politique	Défis d'acceptabilité sociale et d'équité
3	Obligations bleues	Financement à grande échelle	Efficaces mais avec risques	Adaptées aux projets de grande envergure/transfrontaliers	Nécessitent de fortes capacités et des bailleurs importants	Risques de greenwashing sans surveillance adéquate
4	Marchés carbone & crédits biodiversité	Potentiel pour les zones « carbone bleu »	Intérêt des investisseurs, faible légitimité	Dépend de la demande	Besoin de cadres scientifiques/réglementaires solides	Stade précoce, nécessite alignement avec normes européennes/ internationales

TABLEAU 2

Classement préliminaire des mécanismes financiers pour la restauration marine en Méditerranée

Source : Évaluation qualitative de l'auteur

AMÉLIORATION DE LA GESTION DES EAS EN MÉDITERRANÉE : DES TAXES PIGOUVIENNES AUX PARTENARIATS PUBLIC-PRIVÉ POUR DES SOLUTIONS DURABLES

Le **cinquième chapitre** aborde également la biodiversité, mais sous un angle plus ciblé : il examine le fardeau économique important engendré par les espèces invasives (EAS) en Méditerranée. Ces espèces ont entraîné des pertes financières dépassant 27,3 milliards de dollars, affectant particulièrement des secteurs clés tels que la pêche, l'aquaculture et le tourisme. Malgré ces coûts considérables, les approches actuelles de gestion des EAS restent majoritairement réactives, privilégiant le contrôle et l'atténuation plutôt que la prévention. La discussion met en lumière le potentiel des outils économiques pour améliorer la viabilité financière et renforcer l'efficacité de la gestion à long terme.

Une gamme d'instruments économiques est examinée afin d'internaliser les coûts induits par les EAS tout en incitant à une gestion proactive. Parmi les outils axés sur la prévention, on trouve les taxes pigouviennes, les permis échangeables et les cautions de performance, qui présentent un fort potentiel mais rencontrent des difficultés d'application, particulièrement dans les pays méditerranéens non membres de l'UE. Les dispositifs d'adaptation, tels que les mécanismes de compensation et de subvention, semblent plus réalisables et sont largement appliqués, notamment dans le cadre des programmes de financement européens, mais nécessitent un soutien financier stable. Il est à noter que des incitations financières directes, telles que les subventions pour l'élimination des poissons-globes et des lionfish, se sont avérées efficaces pour intégrer le contrôle des EAS dans les activités de pêche commerciale. De plus, les mécanismes de compensation destinés aux pêcheurs affectés par le déclin des stocks induit par les EAS illustrent l'importance des dispositifs de soutien économique. L'assurance responsabilité, qui pourrait assurer un financement pérenne pour la remédiation, reste toutefois sous-utilisée en raison de la complexité liée à l'évaluation des responsabilités. Globalement, des défis persistent, notamment la difficulté de quantifier les risques d'invasion, de faire appliquer les politiques fiscales, et d'assurer la durabilité à long terme des incitations financières.

Les partenariats public-privé apparaissent comme une opportunité cruciale, mais encore sous-exploitée, pour la gestion des EAS. Le secteur privé peut jouer un rôle déterminant en investissant dans des technologies de détection et d'éradication, en finançant des programmes de contrôle et en développant des marchés commerciaux pour certaines espèces invasives. Cependant, des lacunes subsistent en termes de stabilité de financement, de coordination de la gouvernance et d'application des politiques, particulièrement dans les pays méditerranéens non membres de l'UE. Le chapitre souligne la nécessité de mécanismes financiers plus solides, d'un engagement accru des multiples acteurs et de l'intégration des modèles économiques dans des cadres de conservation plus larges. Renforcer la coopération régionale, par le biais d'initiatives telles qu'un plan d'action dédié sous la Convention de Barcelone, pourrait fournir des lignes directrices claires pour les politiques fiscales, les incitations et les schémas de responsabilité.



FINANCEMENT DE L'UTILISATION DURABLE ET DE LA PROTECTION DES RESSOURCES EN EAU EN MÉDITERRANÉE : ÉVALUATION DES SUBVENTIONS, PRÊTS BANCAIRES, OBLIGATIONS VERTES, PARTENARIATS PUBLIC-PRIVÉ ET AUTRES INSTRUMENTS

Quelles politiques et quels mécanismes de financement sont nécessaires pour l'utilisation durable et la protection des ressources en eau en Méditerranée ? Telle est la question centrale du **sixième chapitre**. Celui-ci met en avant des stratégies clés de l'UE, telles que la Directive-cadre sur l'eau, le Green Deal et la Stratégie Biodiversité 2030, et examine leurs implications pour les pays méditerranéens. Le document insiste sur l'importance d'un financement adéquat pour les innovations liées à l'eau et utilise une analyse SWOT pour évaluer les alternatives de financement modernes dans la région. Des études de cas, dont la plateforme de financement participatif Zoomaal au Liban, illustrent les conditions requises pour le déploiement de nouvelles approches de financement. Le document conclut en classant les instruments financiers pour la gestion de l'eau en Méditerranée, en soulignant l'accessibilité variable, le soutien réglementaire, la scalabilité, l'impact environnemental et l'attrait pour les investisseurs de chaque option.

Les subventions offrent une accessibilité modérée tout en étant fortement soutenues par la réglementation, ce qui les rend particulièrement utiles pour financer des initiatives de durabilité spécifiques. Elles sont étroitement alignées avec les objectifs environnementaux et procurent des bénéfices environnementaux significatifs. Cependant, leur scalabilité est limitée par leur dépendance aux contraintes temporelles et budgétaires, et elles n'attirent pas un fort attrait des investisseurs, n'offrant pas de retours directs. De plus, les subventions sont généralement des sources de financement ponctuelles, limitant leur capacité à soutenir la croissance à long terme des projets.

Le prêt bancaire est modérément accessible et bénéficie d'un soutien réglementaire fort, notamment de la part d'institutions telles que la Banque mondiale et la Banque européenne d'investissement. Ces prêts offrent un financement structuré avec des conditions claires, ce qui peut être avantageux pour les emprunteurs. Bien qu'ils puissent soutenir des projets d'eau durables, leur utilisation est souvent restreinte par des conditions de prêt rigoureuses et des taux d'intérêt, compliquant l'accès au financement pour les nouvelles technologies de l'eau, surtout celles avec de longues périodes de remboursement. La scalabilité des prêts bancaires est modérée, puisqu'ils permettent de financer de grands projets, mais les prêts dédiés à la durabilité restent une part réduite de l'ensemble des financements. Leur attrait pour les investisseurs est relativement élevé en raison de la prévisibilité des retours financiers, bien que la focalisation sur la rentabilité puisse limiter leur impact environnemental.

Instrument financier	Facilité d'accès	Soutien réglementaire	Évolutivité	Impact environnemental	Attractivité pour les investisseurs
Subventions	Modérée	Élevé	Faible	Élevé	Faible
Prêts bancaires	Modérée	Élevé	Modérée	Modérée	Élevée
Concours d'innovation	Élevée	Modéré	Faible	Élevé	Modérée
Partenariats public-privé	Modérée	Élevé	Élevée	Élevé	Élevée
Obligations vertes	Faible	Modéré	Élevée	Élevé	Modérée
Financement mixte (blended finance)	Modérée	Élevé	Élevée	Élevé	Élevée
Capital-investissement	Faible	Modéré	Élevée	Modérée	Élevée
Financement participatif	Élevée	Faible	Faible	Modérée	Faible

TABLEAU 3

Classement des instruments financiers pour la gestion de l'eau en Méditerranée

Source : Evaluation de l'auteur suite à une analyse SWOT

Les concours d'innovation se distinguent par leur grande facilité d'accès, encouragent la créativité et fournissent un financement non remboursable aux lauréats. Ces concours sont particulièrement utiles pour financer des innovations novatrices dans le domaine de l'eau, avec un impact environnemental élevé. Toutefois, leur caractère ponctuel limite leur scalabilité, et si le soutien réglementaire est modéré, il provient souvent d'ONG, d'universités ou de sponsors privés plutôt que d'institutions gouvernementales. Par ailleurs, les partenariats public-privé offrent une accessibilité modérée mais bénéficient d'un fort soutien réglementaire, notamment dans les projets d'eau à grande échelle. Ces partenariats permettent de mobiliser des financements publics et privés, ce qui les rend scalables et très attractifs pour les investisseurs. Leur impact environnemental élevé constitue un avantage majeur, bien que le secteur privé puisse être tenté de privilégier le profit au détriment de la durabilité à long terme. Néanmoins, leur attrait pour les investisseurs est important grâce aux retours financiers et aux mécanismes de partage des risques intégrés à ces accords.

Les obligations vertes représentent une option de financement évolutif pour les projets d'eau durables, soutenue par l'intérêt croissant des investissements ESG. Cependant, leur accès est compliqué en raison des coûts d'émission élevés et des problèmes de transparence, avec un soutien réglementaire modéré. Le financement mixte, quant à lui, combine plusieurs sources de capitaux, réduisant ainsi les risques pour les investisseurs privés et bénéficiant d'un appui réglementaire fort. Cette approche est scalable, offre un impact environnemental élevé et attire les investisseurs en atténuant les risques grâce aux fonds publics et en mobilisant du capital institutionnel en faveur de la durabilité. Le capital-investissement représente un autre outil, offrant une scalabilité pour les entreprises œuvrant dans le secteur de l'eau, mais il est difficile d'accès pour les innovateurs en phase de démarrage. Bien qu'il soit attrayant pour des investisseurs recherchant des rendements élevés, son caractère axé sur le profit et l'instabilité régionale peuvent en limiter l'efficacité. Enfin, le financement participatif (crowdfunding) offre une grande facilité d'accès pour les projets innovants de petite envergure dans le secteur de l'eau, avec une portée mondiale. Cependant, il souffre d'un manque de soutien réglementaire, de scalabilité et de fiabilité pour les projets de grande ampleur.

OBLIGATIONS VERTES DANS LA TRANSITION ÉNERGÉTIQUE : NÉCESSITÉ DE RÉPONDRE À LA FRAGMENTATION RÉGLEMENTAIRE, AUX CRITÈRES VERTS FLOUS ET AUX DÉFIS DE LA SENSIBILISATION DES INVESTISSEURS

Le **chapitre 7** se concentre sur le rôle des obligations vertes dans la transition énergétique de la Turquie, en utilisant une matrice comptable sociale financièrement étendue (FSAM). L'analyse met en lumière l'impact économique de l'émission des obligations vertes, en soulignant les liens sectoriels et les contraintes financières. La FSAM intègre une analyse input-output, des liens financiers-réels et des données sur l'émission d'obligations vertes pour évaluer les impacts systémiques dans différents secteurs. Les résultats démontrent l'importance des secteurs énergétiques dans l'économie turque. Par exemple, l'énergie gazeuse, bien qu'essentielle au système, fait face à de nombreuses difficultés : si elle devait être supprimée, cela se traduirait par une perte de production de 18,7 %, soulignant ainsi son rôle crucial dans la stimulation de la demande pour des secteurs tels que la fabrication métallique et la construction. En revanche, l'énergie éolienne, bien que priorisée par les politiques, peine à s'intégrer efficacement dans le système économique global. Cette difficulté reflète des défis structurels plus larges dans la transition énergétique de la Turquie, comme l'indique le Plan National de l'Énergie 2023, lequel encourage le développement des énergies renouvelables tout en reconnaissant les obstacles, en particulier pour l'intégration de l'énergie éolienne. On peut par ailleurs noter que le secteur charbonnier démontre quant à lui son inefficience, provoquant un gain de production de presque 30% dans le cas où il serait supprimé. Ce secteur, gourmand en subvention (près de 750 millions de dollars par an), pourrait faire figure de levier dans la redirection des efforts financiers vers une production plus durable de l'énergie.

Le chapitre examine également les contraintes financières qui limitent l'efficacité des obligations vertes. Ces contraintes réduisent les multiplicateurs de production dans tous les secteurs énergétiques, avec une diminution moyenne comprise entre 25 et 30 %. Par exemple, le multiplicateur de l'énergie gazeuse chute de 5,87 dans une matrice comptable sociale de base (SAM) à 4,87 dans la FSAM, illustrant une baisse de l'intégration du système financier. L'énergie éolienne connaît une diminution encore plus marquée, passant de 5,70 à 4,44, ce qui met en évidence les obstacles financiers importants auxquels sont confrontées les énergies renouvelables en Turquie. Ces résultats re

joignent les études antérieures qui identifiaient les contraintes de liquidité comme un frein majeur au financement durable dans les économies émergentes. Bien que les obligations vertes apportent certaines améliorations intersectorielles, leur impact global demeure limité. Par exemple, le lien en aval pour l'énergie éolienne augmente légèrement, passant de 0,340 à 0,342, une amélioration insuffisante pour induire un changement systémique. Le secteur charbonnier ne montre aucun changement dans ses multiplicateurs, en adéquation avec les engagements de sortie progressive du charbon. Les résultats mettent en exergue plusieurs défis : la fragmentation réglementaire, l'absence de critères clairs pour qualifier les projets verts et le manque de sensibilisation des investisseurs.

Afin de maximiser l'efficacité des obligations vertes dans la transition énergétique turque, il est suggéré de renforcer les cadres réglementaires liés à la finance verte, d'augmenter les investissements dans les infrastructures d'énergies renouvelables et d'améliorer l'éducation des investisseurs. Établir des règles claires et cohérentes pour définir ce qui constitue un investissement « vert » contribuera à réduire les opportunités d'éco-blanchiment et, par conséquent, à renforcer la confiance des investisseurs. Par ailleurs, l'expansion et la modernisation des infrastructures d'énergies renouvelables amélioreront les liens sectoriels et soutiendront un système énergétique plus performant. Enfin, une meilleure sensibilisation des investisseurs aux avantages et aux opportunités des instruments financiers verts stimulera la demande d'investissements durables. Cette démarche constitue un exemple illustratif pour d'autres pays méditerranéens, lesquels font face à des défis similaires pour aligner leurs mécanismes financiers sur leurs objectifs en matière d'énergies renouvelables et de durabilité, rendant ces stratégies pertinentes pour une intégration régionale plus large et une progression vers une économie plus verte.

IMPACT DE L'ÉMISSION DES OBLIGATIONS VERTES SUR LA POLLUTION DE L'AIR EN MÉDITERRANÉE : DIFFÉRENCES SECTORIELLES, DÉPLOIEMENT STRATÉGIQUE ET EFFETS LIÉS À LA MATURITÉ

Le **chapitre 8** analyse l'impact de l'émission des obligations vertes sur la pollution de l'air dans 21 pays méditerranéens, sur la période allant de 2012 à 2022. Les résultats montrent que l'émission d'obligations vertes contribue à réduire la pollution de l'air, avec un effet particulièrement marqué lié à la maturité et au nombre d'obligations émises.

Les résultats révèlent que l'émission d'obligations vertes réduit significativement la pollution, tant dans les secteurs à faibles émissions que dans ceux à fortes émissions, avec un effet plus prononcé dans ces derniers. Plus précisément, le coefficient associé aux obligations vertes est de -0,482 pour les secteurs non polluants, tandis qu'il atteint -1,853 pour les secteurs polluants, indiquant une réduction plus marquée dans les industries à haute émission, telles que la production manufacturière et énergétique. L'intensité énergétique (ENER_INT) a également un impact plus important sur la réduction de la pollution dans les secteurs polluants (0,669) que dans les secteurs non polluants (0,387). D'autres facteurs, comme l'intervention gouvernementale et la croissance du PIB, influencent les niveaux de pollution, bien que leur degré de signification varie selon les secteurs.

L'analyse des émissions d'obligations vertes montre un coefficient négatif de -0,221, traduisant une tendance à la diminution de la pollution avec l'augmentation des émissions d'obligations, bien que ce résultat ne soit pas statistiquement significatif. Dans les économies avancées de l'UE telles que la France, l'Italie et l'Espagne, de fortes émissions d'obligations vertes financent divers projets environnementaux, mais leur impact direct sur la qualité de l'air n'est pas toujours évident. Pour des économies plus modestes, comme Chypre et la Grèce, une émission plus modeste peut néanmoins être efficace si elle est correctement ciblée. Dans des marchés émergents comme l'Égypte, le Maroc et la Turquie, le volume des émissions d'obligations vertes à lui seul ne garantit pas nécessairement une amélioration de la qualité de l'air. Les résultats suggèrent que le déploiement stratégique des fonds, plutôt que leur volume, joue un rôle crucial dans l'atteinte des impacts environnementaux recherchés, mettant en exergue l'importance de la sélection des projets, de l'efficacité de leur mise en œuvre et de l'allocation judicieuse des fonds.

Par ailleurs, la durée des obligations joue un rôle clé : les obligations vertes à maturité modérée (5 à 10 ans) se révèlent être les plus efficaces pour réduire la pollution de l'air, ayant environ deux fois l'effet des obligations à courte ou longue maturité. Ce délai optimal s'aligne bien sur les cycles de projets d'énergies renouvelables et sur la modernisation industrielle, offrant un juste équilibre entre flexibilité et responsabilité. Il convient aussi bien aux économies avancées (France, Italie, Espagne) qu'aux marchés émergents (Égypte, Maroc, Turquie), fournissant un délai suffisant pour une mise en œuvre significative tout en maintenant la dynamique du projet. Les obligations à longue maturité (plus de 10 ans) sont idéales pour les projets d'infrastructures majeurs et les objectifs



climatiques à long terme, en particulier dans les économies méditerranéennes émergentes, malgré des défis potentiels pour maintenir leur efficacité. Enfin, les obligations à courte maturité (moins de 5 ans) conviennent quant à elles mieux aux projets nécessitant une mise en œuvre rapide, en particulier dans les économies de plus petite taille.

VERS DES LIGNES DIRECTRICES SPÉCIFIQUES AUX OBLIGATIONS VERTES EN MÉDITERRANÉE : COMBLER LES LACUNES JURIDIQUES ET AMÉLIORER LA MISE EN ŒUVRE DES PROJETS

Le **chapitre 9** souligne l'absence de réglementations juridiques spécifiques à la Méditerranée concernant les obligations vertes, ce qui pourrait limiter l'adaptation des projets financiers aux particularités écologiques et économiques de la région. Bien que des cadres existants puissent servir de référence, l'absence de normes locales pourrait entraver la mobilisation d'investissements adaptés aux défis environnementaux spécifiques de la Méditerranée. Alors que diverses réglementations européennes et internationales, en droit contraignant ou souple, définissent ce qu'est une obligation verte et ses caractéristiques requises, il n'existe pas de lignes directrices pratiques pour encourager leur développement dans l'espace méditerranéen.

Le chapitre insiste sur l'importance de mettre en avant, dans un texte de droit souple tel que des lignes directrices, les considérations pratiques les plus pertinentes pour les pays méditerranéens. L'objectif est de créer un cercle vertueux : en communiquant stratégiquement sur les projets ou activités que les entreprises souhaitent financer en Méditerranée en fonction des besoins régionaux, l'attrait de cet instrument financier sera renforcé. Ces lignes directrices spécifiques à la Méditerranée pourraient accroître leur visibilité, les rendre plus attractives et faciliter la mise en œuvre des projets financés. Actuellement, les textes juridiques visent une harmonisation entre différents systèmes juridiques, une approche qui ne prend pas suffisamment en compte les caractéristiques uniques de la région méditerranéenne.

LES TAXES ÉNERGÉTIQUES FAVORISENT L'INNOVATION EN EFFICIENCE ÉNERGÉTIQUE DANS LES ENTREPRISES À FORTE INTENSITÉ ÉNERGÉTIQUE, DOTÉES DE PRATIQUES DE GESTION VOLONTAIRES DANS LES PAYS MÉDITERRANÉENS DU SUD

Les conclusions du **chapitre 10** soulignent le rôle important des taxes énergétiques pour stimuler l'innovation visant à améliorer l'efficience énergétique dans le secteur privé des pays méditerranéens du Sud (SMC), avec un impact particulièrement marqué dans les secteurs du commerce de détail et des services. L'analyse confirme que les taxes sur l'énergie peuvent encourager les entreprises à innover en matière d'efficacité énergétique, notamment dans les secteurs à forte consommation d'énergie et chez les entreprises adoptant de manière volontaire des pratiques de gestion énergétique. Les résultats des régressions sur des sous-échantillons révèlent que ces taxes favorisent significativement l'innovation en efficience énergétique chez les entreprises ayant des pratiques volontaires de gestion de l'énergie – en particulier dans des industries telles que la fabrication de métaux et de machines, où le coût énergétique représente un fardeau majeur. En revanche, ces taxes n'ont pas d'effet significatif sur l'innovation dans des secteurs moins énergivores. Les résultats suggèrent

également que l'innovation induite par la fiscalité énergétique est plus efficace lorsque les entreprises perçoivent clairement ses avantages environnementaux, soulignant ainsi l'importance de la sensibilisation environnementale.

Par ailleurs, la comparaison entre les entreprises manufacturières et non manufacturières met en lumière que l'impact des taxes énergétiques est plus fort dans les entreprises non manufacturières (services, commerce de détail), qui font face à moins de contraintes opérationnelles lors de l'implémentation d'innovations. En revanche, les entreprises manufacturières, en raison de leurs processus de production fortement capitalistiques, sont plus limitées dans leur capacité à adopter les changements réglementaires. En somme, l'efficacité des taxes énergétiques pour stimuler l'innovation dépend à la fois de l'intensité énergétique du secteur et de la sensibilisation environnementale ainsi que de la capacité d'innovation des entreprises.

À l'échelle des implications pour les décideurs politiques, ces résultats indiquent que :

- La taxation énergétique constitue un levier efficace pour accélérer les stratégies nationales de transition énergétique dans les SMC en stimulant l'innovation au niveau des entreprises.
- Cet instrument de marché se révèle particulièrement pertinent pour promouvoir des processus de production énergétiquement efficients dans les secteurs intensifs en énergie, qui représentent souvent des obstacles majeurs à la décarbonisation régionale.
- L'impact positif des taxes énergétiques sur l'éco-innovation est plus marqué dans les entreprises qui gèrent volontairement leur consommation énergétique et qui s'engagent activement à compenser leurs externalités négatives.
- Le soutien à l'innovation en énergie propre au niveau de l'entreprise contribue à l'engagement des SMC en faveur de la neutralité carbone dans le cadre de leurs mesures de contrôle de la pollution.
- Enfin, les entreprises manufacturières risquent de percevoir les taxes énergétiques comme une contrainte de conformité plutôt que comme un moteur d'innovation, à moins qu'elles ne considèrent celle-ci comme un moyen de réduire leur impact environnemental.

Cependant, il est essentiel de compléter la fiscalité énergétique par des réformes structurelles plus larges, telles que la suppression ou la réforme progressive des subventions fossiles à l'énergie, la mise en place d'incitations fiscales et le soutien aux entreprises pour améliorer leurs capacités technologiques et leur accès à des financements verts. Un accompagnement ciblé des petites et moyennes entreprises (PME) en matière de renforcement des capacités et d'assistance financière est également indispensable pour lever les obstacles à l'adoption de l'efficience énergétique.

Aussi, il convient de noter que de nombreux secteurs électro-intensifs bénéficient de tarifs préférentiels ou d'exonérations fiscales, limitant ainsi parfois l'impact des taxes énergétiques et empêchant l'incitation à l'innovation énergétique de se concrétiser pleinement. De plus, bien que les taxes sur les émissions de GES soient plus efficaces avec des réglementations strictes, certaines règles peuvent en réalité limiter leur application, créant ainsi des contradictions entre les instruments fiscaux et réglementaires.

CONSTRUIRE UN HUB ÉNERGÉTIQUE RÉGIONAL EN MÉDITERRANÉE : MOBILISATION DE LA FINANCE VERTE ET DES ACCORDS COMMERCIAUX RÉGIONAUX POUR LE COMMERCE DE L'ÉNERGIE RENOUVELABLE

Le **chapitre 11** présente l'argument selon lequel, pour mener à bien la transition énergétique dans la région, il serait bénéfique de créer un Hub Énergétique Régional (HER) soutenu par les technologies vertes et la finance verte, afin de favoriser la collaboration entre les pays méditerranéens. Actuellement, malgré la nécessité d'une sécurité et d'une indépendance énergétiques – le secteur énergétique étant responsable de 40 % des émissions mondiales – le commerce de l'énergie renouvelable reste limité en Méditerranée. Ainsi, il est proposé de mettre en place un Accord Commercial Régional (ACR) axé sur le commerce de l'énergie renouvelable, en y intégrant un rôle central pour l'UE et en se conformant aux mécanismes d'aides d'État pour les incitations fiscales.

Pour réussir, le HER requiert une coopération régionale étroite, notamment dans l'investissement en infrastructures de transmission. Les ACR, qu'ils soient bilatéraux ou intégrés dans le cadre d'accords d'intégration économique, pourraient fournir le cadre juridique nécessaire à cette coopération. Il est également suggéré de créer une nouvelle institution chargée de superviser la mise en place d'un organe de suivi de l'aide fiscale régionale. Les revenus générés

par l'introduction de taxes carbone, ainsi que par des incitations fiscales vertes, seraient gérés par cet organe. La conception de ces incitations fiscales doit être alignée sur le mécanisme d'aide d'État de l'UE afin d'assurer leur conformité aux normes européennes. Des outils de politique financière verte, tels que les crédits d'impôt, les obligations vertes et les garanties d'incitations fiscales futures, sont essentiels pour accélérer la transition énergétique. Ces instruments financiers offrent stabilité et incitations à l'investissement dans les énergies renouvelables, garantissant ainsi une priorité aux projets verts par rapport aux investissements fossiles. Leur adaptation aux contextes socio-économiques régionaux sera déterminante pour une transition harmonieuse et efficace, tout en assurant que la finance verte reste performante et impactante pour un développement durable à long terme.

ADAPTER LE COÛT SOCIAL DU CARBONE EN MÉDITERRANÉE : VARIATIONS RÉGIONALES, SCÉNARIOS DE TAXE CARBONE ET IMPLICATIONS POLITIQUES

Quel est le coût social optimal du carbone ? Le **chapitre 12** s'attaque à cette question en utilisant un modèle intégré régional (RICE-MED) étendu, permettant de mesurer le coût social du carbone (CSC) pour chaque pays, d'évaluer divers scénarios de taxe carbone, et d'en analyser les implications sur la réduction des émissions et la performance économique.

Le modèle, projetant les coûts du carbone de 2020 à 2100, offre une vue d'ensemble de la répartition temporelle et géographique des dommages liés au climat. Les résultats indiquent une tendance générale à la hausse, reflétant l'accroissement des dommages économiques et sociaux causés par l'augmentation des émissions de gaz à effet de serre. Les pays d'Europe du Sud, tels que la France, l'Espagne et l'Italie, affichent des projections de CSC plus élevées, atteignant entre 750 et 800 dollars par tonne de CO_2 d'ici 2100, en raison de leur activité économique importante et de leurs émissions élevées. À l'inverse, des pays d'Afrique du Nord et du Bassin méditerranéen oriental, comme l'Algérie et l'Égypte, montrent des valeurs de CSC plus faibles, entre 400 et 600 dollars par tonne de CO_2, malgré leur grande vulnérabilité aux impacts climatiques. D'autres pays, tels que la Grèce et la Turquie, occupent une position intermédiaire avec des projections comprises entre 650 et 750 dollars par tonne. L'analyse met également en exergue la sensibilité du CSC aux principaux paramètres économiques et climatiques. La sensibilité climatique exerce la plus forte influence, particulièrement dans les régions déjà confrontées à des températures élevées et à des vagues de chaleur. Le taux d'actualisation, qui détermine le poids des dommages climatiques à long terme, varie d'un pays à l'autre selon leur stabilité économique. Ces résultats soulignent l'importance d'adapter les politiques de tarification du carbone aux contextes régionaux afin qu'elles soient économiquement viables et socialement équitables.

Les scénarios de taxe carbone présentés révèlent des compromis complexes entre bénéfices environnementaux et coûts économiques, variant selon les pays méditerranéens. Les nations d'Europe du Sud, avec des économies diversifiées et de solides infrastructures en énergies renouvelables, seraient mieux armées pour supporter des taxes carbone plus élevées. Leurs bases industrielles et leur alignement sur les politiques climatiques de l'UE leur permettraient de jouer un rôle de leader dans la décarbonisation. En revanche, les pays d'Afrique du Nord, plus dépendants des combustibles fossiles et moins diversifiés, devraient adopter une approche progressive pour éviter des perturbations économiques majeures, malgré leur potentiel en énergies renouvelables.

Pour aboutir à une tarification carbone réussie en Méditerranée, il est impérativement nécessaire de prendre en compte l'équité sociale. L'acceptabilité publique s'améliore lorsque les revenus issus des taxes sont recyclés de manière transparente. En Afrique du Nord, les recettes de la taxe carbone pourraient par exemple financer des transferts monétaires, l'accès à l'énergie en milieu rural ou des subventions, en s'appuyant sur des programmes existants tels que le Takaful en Égypte ou le RAMED au Maroc. En Europe du Sud, ces revenus pourraient être utilisés pour financer des projets tels que la rénovation énergétique des logements, ou la création d'emplois verts. Il est ainsi recommandé d'adopter des approches différenciées plutôt qu'une taxe carbone uniforme à l'échelle méditerranéenne, qui serait politiquement irréaliste au vu des différences régionales en termes de capacité fiscale, de dépendance énergétique et de soutien public aux réformes.

Régions	Pays	Caractéristiques	SCC	Plan A : Scénarios fiscaux optimaux	Plan B : Potentiel pour une taxe agressive
Afrique du Nord	Algérie	Principal exportateur de combustibles fossiles de la région ; émissions élevées	500–600 USD/ tCO2 d'ici 2100	SCC à 50% ; passage progressif à 100%	Non ; nécessite une diversification significative et des capacités dans les renouvelables
	Egypte	Base industrielle énergivore ; dépendance au gaz naturel	450–600 USD/ tCO_2 d'ici 2100	SCC à 100%	Modéré ; nécessite une capacité renouvelable renforcée
	Maroc	Leader en énergie renouvelable dans la région ; faibles émissions	450–500 USD/ tCO2 d'ici 2100	SCC à 100%	Élevé ; base renouvelable solide soutient la mise en œuvre
	Tunisie	Utilisation modérée des combustibles fossiles ; croissance des renouvelables	400–500 USD/ tCO_2 d'ici 2100	SCC à 50% progressant vers 100%	Faible ; dépend de la croissance des renouvelables
Europe du Sud	Espagne	Investissements croissants dans les énergies renouvelables ; économie diversifiée	650–700 USD/ tCO2 d'ici 2100	SCC à 100%	Oui ; faisable avec l'infrastructure renouvelable existante
	France	Forte dépendance à l'énergie nucléaire ; base industrielle solide	750–800 USD/ tCO_2 d'ici 2100	SCC à 100% avec progression progressive	Oui ; secteurs spécifiques ou après 2050
	Grèce	Économie en transformation ; émissions modérées.	600–700 USD/ tCO2 d'ici 2100	SCC à 100% ; approche progressive de 50%	Modéré ; dépend de l'expansion des renouvelables
	Italie	Industries énergivores ; adoption modérée des énergies renouvelables	650–750 USD/ tCO_2 d'ici 2100	SCC à 100% ; approche progressive de 50%	Oui ; après 2050 dans les secteurs énergivores
Méditerranée orientale	Turquie	Forte dépendance au charbon et au gaz naturel ; énergies renouvelables émergentes	650–750 USD/ tCO_2 d'ici 2100	SCC à 50% progressant vers 100%	Modéré ; après 2050 ou dans certains secteurs

TABLEAU 4
Résumé des résultats
Source : Synthèse de l'auteur

CHANGEMENT CLIMATIQUE ET RECETTES FISCALES MUNICIPALES : IMPACTS, SCÉNARIOS ET MESURES POLITIQUES POUR RENFORCER LA RÉSILIENCE

Le **dernier chapitre** se focalise sur les impacts potentiels du changement climatique sur les recettes fiscales municipales en Italie, soulignant le rôle crucial des municipalités dans la fourniture de services locaux et la gestion des infrastructures. Le changement climatique menace de perturber leur stabilité financière, ce qui pourrait entraver la mise en œuvre des politiques de redistribution locale et la capacité à répondre efficacement aux défis climatiques. Le chapitre présente deux scénarios principaux – optimiste et pessimiste – pour l'évolution des recettes fiscales municipales. Dans le scénario optimiste, une augmentation globale des recettes est prévue, avec, par exemple, une hausse absolue notable pour Milan de 252 360 € et une augmentation relative de 3,5 % pour Turin, pour un gain net total estimé à 567 millions d'euros (en euros de 2005). À l'inverse, le scénario pessimiste anticipe des baisses significatives : Catania pourrait perdre 5 % de ses recettes, Turin plus de 6 % et Milan plus de 5 %, avec une perte totale potentielle dépassant 1,2 milliard d'euros.

Plusieurs mesures politiques sont proposées pour atténuer les impacts fiscaux négatifs du changement climatique sur les municipalités. L'une d'elles est la mise en place d'une taxation pigouvienne, visant à intégrer les coûts externes des activités nuisibles à la société ou à l'environnement. Dans le contexte municipal, ces taxes pourraient cibler les activités contribuant au changement climatique, notamment les émissions de carbone et la pollution, générant ainsi une source de revenu destinée à réinvestir dans des initiatives de résilience climatique. Dans ce contexte, l'impact d'outils tels que le péage urbain, déjà mis en œuvre dans plusieurs villes italiennes, pourrait être exploré. Ce mécanisme, qui vise à réduire la congestion et la pollution tout en générant des revenus pour les municipalités, pourrait être adapté pour financer des initiatives liées à l'adaptation au changement climatique.

D'autres recommandations incluent la réforme des systèmes cadastraux utilisés pour évaluer la valeur des biens immobiliers à des fins fiscales, afin d'intégrer les risques liés au climat (inondations, vagues de chaleur, sécheresse) et d'adapter la fiscalité foncière en fonction des risques réels. Par ailleurs, il est suggéré d'élargir l'assiette des taxes touristiques, notamment dans les destinations côtières ou culturelles, afin de financer des mesures d'adaptation telles que la protection contre les inondations, l'installation d'infrastructures de mitigation de la chaleur ou des projets de conservation. Ce faisant, les municipalités peuvent à la fois atténuer l'impact environnemental du tourisme et créer de nouveaux espaces fiscaux pour l'action climatique.

LA VOIE À SUIVRE

À travers la richesse des contributions rassemblées dans ce volume, plusieurs conclusions convergentes se dégagent, mettant en lumière le rôle central des outils économiques et de la finance verte dans la transition vers un développement durable en Méditerranée. En premier lieu, la **suppression ou la réforme progressive des subventions nuisibles à l'environnement, ainsi que l'alignement des politiques fiscales sur les objectifs de développement durable,** apparaissent comme des leviers incontournables de réforme écologique et économique. Ensuite, si les instruments verts – qu'il s'agisse de la tarification du carbone, des obligations vertes ou des fonds fiduciaires pour la biodiversité – offrent un réel potentiel, **leur efficacité dépend fortement d'une gouvernance robuste, d'une coordination entre ministères, et d'une adaptation fine aux réalités locales.** Par ailleurs, les écarts persistants entre les pays de la région en termes de capacité institutionnelle, de marge de manœuvre budgétaire et de maturité réglementaire soulignent **la nécessité d'approches différenciées,** plutôt que de modèles uniformes. Un constat transversal est que les mécanismes financiers ne peuvent produire leurs effets que s'ils s'inscrivent dans des cadres politiques cohérents, assortis d'un suivi rigoureux, d'une implication active des parties prenantes et d'un engagement sur le long terme. Enfin, plusieurs contributions insistent **sur l'urgence de doter la région d'une taxonomie méditerranéenne des activités durables,** accompagnée de lignes directrices opérationnelles. Une telle taxonomie, adaptée aux réalités économiques, sociales et environnementales du bassin méditerranéen, permettrait de mieux orienter les flux financiers vers des projets véritablement durables dans la région. Elle aiderait à clarifier les signaux adressés aux investisseurs, à limiter les risques d'écoblanchiment et à garantir des transitions à la fois justes, efficaces et cohérentes avec les spécificités locales, comme la dépendance à certaines ressources, les vulnérabilités climatiques ou les structures économiques.

Un tournant significatif vers des pratiques économiques plus durables est à portée de main, pour autant que des cadres nationaux et régionaux appropriés soient mis en place et soutenus activement, permettant ainsi aux outils verts de se développer pleinement.

L'avenir recèle encore de nombreux défis, notamment dans des domaines nécessitant une exploration approfondie. L'intégration des acteurs privés et le potentiel du financement mixte sont des pistes essentielles qui méritent une recherche plus poussée. Par ailleurs, l'élaboration d'un cadre et d'une taxonomie complets pour les activités durables est indispensable afin d'apporter de la clarté et d'orienter efficacement les investissements. Ces thèmes feront l'objet de rapports à venir dans le cadre du Programme de travail 2026-2027.

Ce processus est en cours, le changement étant progressif. Malgré des progrès réalisés, il reste encore beaucoup à faire pour impulser la transformation nécessaire. La volonté politique, combinée à une recherche continue, une collaboration étroite et l'innovation, est essentielle pour assurer non seulement une transition réussie vers la durabilité dans la région, mais également sa pérennité. Réussir cette transition nécessitera un effort collectif, un engagement soutenu et une action coordonnée entre tous les secteurs et parties prenantes. Les initiatives en cours, telles que la SMDD, peuvent soutenir cette transformation, mais elles doivent être complétées par un élan continu et un soutien politique fort.

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INTRODUCTION: FROM HARMFUL SUBSIDIES TO GREEN FINANCE AND ECONOMIC TOOLS: CHARTING A SUSTAINABLE COURSE FOR THE MEDITERRANEAN

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1. THE MEDITERRANEAN AT A CROSS-ROADS: BALANCING ENVIRONMENTAL AND DEVELOPMENT CHALLENGES

The Mediterranean region faces an intricate and interwoven set of environmental and developmental challenges, the convergence of which presents threats to its long-term sustainability. Addressing these complexities requires holistic and forward-thinking approaches to policy and governance, including the strategic deployment of virtuous economic tools to drive sustainable transitions and mitigate adverse impacts.

Specifically, as highlighted by UNEP/MAP and Plan Bleu (2020)[1] and MedECC (2020)[2], climate change is accelerating at a pace above the global average, with rising temperatures (the region is warming 20% faster than the global average, with temperatures already 1.5°C above pre-industrial levels), decreasing precipitation, and an increasing frequency of extreme weather events such as droughts, floods, and wildfires. This, in turn, exacerbates water scarcity, a critical issue in many Mediterranean countries, particularly in the South and East, where demand continues to rise while inefficient water use and climate impacts put additional pressure on limited resources. The region's rich biodiversity is also under threat, with habitat destruction, overfishing, pollution, and the spread of invasive species leading to ecosystem degradation. Urbanization and tourism-driven coastal development further intensify environmental pressures, contributing to habitat loss, pollution, and the destruction of marine and terrestrial ecosystems. Marine pollution, particularly from plastics and chemical contaminants, has reached alarming levels, making the Mediterranean one of the most affected seas in the world. Additionally, air pollution in urban areas remains a significant health concern, with emissions from transport, industry, and energy production causing severe respiratory and cardiovascular issues.

Beyond environmental concerns, one must not forget that the Mediterranean also grapples with deep-rooted development challenges (UNEP/MAP and Plan Bleu, 2020). Economic disparities between northern and southern/eastern countries remain stark, influencing investment capacities and the ability to implement sustainable policies. While human development indicators have improved in many countries, persistent social inequalities, high youth unemployment, and low female workforce participation continue to hinder inclusive growth. Population growth, particularly in the South and East, places increasing pressure on infrastructure, services, and natural resources, while migration flows add further complexity to social and economic dynamics. The Mediterranean is also highly dependent on food imports, especially cereals, making it vulnerable to fluctuations in international markets and supply chain disruptions. Political instability and governance challenges in some countries further limit the region's ability to address these pressing issues effectively.

Together, these environmental and development challenges highlight the urgent need for coordinated action at both regional and national levels. Without significant efforts to promote sustainability, resilience, and equitable economic growth, the Mediterranean risks facing further ecological de-

1 United Nations Environment Programme/Mediterranean Action Plan and Plan Bleu (2020). State of the Environment and Development in the Mediterranean. Nairobi.
2 MedECC (2020) Climate and Environmental Change in the Mediterranean Basin – Current Situation and Risks for the Future. First Mediterranean Assessment Report [Cramer, W., Guiot, J., Marini, K. (eds.)] Union for the Mediterranean, Plan Bleu, UNEP/MAP, Marseille, France, 632pp. ISBN: 978-2-9577416-0-1 / DOI: 10.5281/zenodo.7224821

gradation and socio-economic instability in the coming decades. In this context, transitioning towards sustainable development strategies has become increasingly urgent, requiring not only stronger environmental policies but also a fundamental shift in economic and financial mechanisms.

2. THE NEED TO REDUCE ENVIRONMENTALLY HARMFUL SUBSIDIES

A pivotal strategy entails the gradual elimination of environmentally harmful subsidies (EHS) and the reallocation of public financial resources toward green economic instruments that foster sustainability. This realignment ensures that fiscal policies and incentive structures are coherently oriented toward long-term environmental stewardship and socio-economic well-being.

Environmentally harmful subsidies, which support economic activities that deplete resources, drive pollution, and contribute to environmental degradation, are estimated to be 5 to 6 times higher than those that benefit the environment (OECD, 2020)[3]. The 2024 Plan Bleu-UNEP/MAP report highlighted the detrimental effects of EHS in the Mediterranean region. The persistence of EHS creates a vicious cycle, allowing for the expansion of unsustainable activities while jeopardizing the very resources these sectors depend on. This not only threatens the environment but also undermines the long-term economic viability of industries and the livelihoods of local populations.

The report discussed how, in the Mediterranean context, EHS have been particularly problematic in sectors such as fisheries (capacity-enhancing subsidies) and fossil fuels, leading to overexploitation of resources, pollution, and degradation of ecosystems, especially in coastal areas. The conclusions from this report highlight several critical issues and recommendations. Several factors contribute to the persistence of EHS, such as limited information on long-term environmental consequences, diffuse costs and fragmented governance, economic inertia and livelihood dependence, and powerful interest groups opposing reform.

To address these challenges, the report recommended establishing legally binding commitments, prioritizing transparency and data availability, fostering inclusive stakeholder engagement, implementing gradual transitions with compensation measures, and promoting cross-border cooperation. A proposed Euro-Mediterranean EHS Phase-Out and Reform Framework (EHS-MedFRAME) could be used to progressively phase-out EHS, identify compensation measures, ensure a harmonized approach to environmental sustainability, and monitor economic, environmental, and social indicators.

The report also provided sector-specific findings and recommendations for fisheries, energy, water, and tourism. It emphasized the need for regional cooperation and a multi-pronged approach to address the complex challenges facing the Mediterranean region. Moving forward, the report stressed the importance of replacing EHS with «green instruments» that are more environmentally friendly and economically sustainable.

3. EMBRACING GREEN PUBLIC FINANCES AND ECONOMIC TOOLS

Where do we go from there? Building on last year's focus on phasing out EHS, this year's report turns to the proactive implementation of green tools and public finances as a positive force for change. These mechanisms aim to channel financial resources and policy support toward sustainable practices, embedding environmental considerations into economic planning and fostering a resilient, ecologically responsible economy.

Green public finance and economic tools (GFET) are pivotal in aligning economic policies with environmental sustainability goals. These mechanisms encompass a range of fiscal instruments designed to support green investments, address environmental externalities, and incentivize low-carbon and nature-based solutions. They help governments mobilize resources to drive the transition to a sustainable, resilient economy by integrating environmental considerations into financial planning and decision-making.

3 OECD. (2020a). Aperçu général du financement de la biodiversité à l'échelle mondiale, (p. 48). OECD.

3.1 Green Public Finances

Green public finances encompass a suite of fiscal policies and instruments designed to embed environmental considerations within public revenue and expenditure frameworks, ensuring that financial governance aligns with sustainability objectives. Key components include:

- **Environmental Taxation**: Green taxation, or environmental taxation, is a crucial instrument. This involves levying taxes on activities that generate negative environmental externalities, thereby incentivizing businesses and individuals to adopt more sustainable practices. The objective is to internalize environmental costs by incorporating them into market prices (Pigou, 1920[4]; Sainteny, 2010[5]). Examples include carbon taxes, plastic taxes, and pollution charges, designed to internalize environmental costs and encourage sustainable behaviors. The «polluter pays» principle underpins this approach, ensuring that those who contribute to environmental damage bear the financial responsibility. According to Stern (2006)[6], green taxes, such as carbon taxes, drive emissions reductions by increasing the cost of polluting activities, thereby steering investment toward cleaner alternatives. There are over 150 biodiversity-related taxes in OECD countries, generating approximately USD 7.4 billion annually (OECD 2020b)[7]. Overall, green taxes can help finance green projects, reinvest in green infrastructure, and promote social equity measures (Schoder, 2022)[8]. They are shown to contribute to multiple SDGs, such as reducing air pollution (SDG 3), promoting sustainable cities (SDG 11), and supporting decent work (SDG 8) (Heine & Black, 2019[9]; Schoder, 2022; Burns et al., 2021[10]; Timilsina et al., 2021[11]). But while such taxes could be used to «penalize» grey infrastructure in favor of green alternatives, their effectiveness may be constrained by the implementing government's authority and resistance from stakeholders (Baroni, Nicholls, and Whiteoak 2019)[12].
- **Green (and Blue) Bonds:** These are fixed-income instruments specifically designed to finance projects with environmental benefits, such as renewable energy, climate adaptation, and sustainable transportation. Issuers must adhere to recognized frameworks such as the Green Bond Principles (ICMA, 2021)[13] or the EU Green Bond Standard. These financial instruments raise capital for environmentally sustainable projects, unlocking private sector investment in the green transition. However, despite the rapid expansion of this tool, challenges remain. Critics argue that the green finance landscape is fragmented, with a lack of standardized definitions and rigorous monitoring, leading to concerns about greenwashing—where projects are marketed as environmentally sustainable without offering substantive benefits.
- **Green Budgeting:** This approach, championed by institutions such as the OECD, refers to integrating environmental and climate objectives into public financial decision-making, ensuring that government budgets contribute to sustainability goals. It involves green expenditure tagging, environmental fiscal reforms, and climate-related reporting. It supports the integration of environmental considerations into national financial planning, ensuring that fiscal policies are both sustainable and inclusive. France has been a pioneer in this approach, introducing an annual "green budget" assessment of public finances (Degron, 2021)[14].

4 Pigou, A. C. (1920). The Economics of Welfare. Macmillan.
5 Sainteny, Guillaume (2012), « L'écofiscalité comme outil de politique publique », Revue française d'administration publique, no 134,2010/2.
6 Stern, N. (2006). The Economics of Climate Change: The Stern Review. Cambridge University Press. Retrieved from https://www.lse.ac.uk/granthaminstitute/publication/the-economics-of-climate-change-the-stern-review
7 OECD. (2020b). Tracking Economic Instruments and Finance for Biodiversity 2018. OECD Publishing, Paris.
8 Schoder, C. (2022). Regime-dependent environmental tax multipliers: evidence from 75 countries. Journal of Environmental Economics and Policy, 12(2), 124–167. https://doi.org/10.1080/21606544.2022.2089238
9 Heine, Dirk & Black, Simon. (2018). Benefits beyond Climate: Environmental Tax Reform. 10.1596/978-1-4648-1358-0_ch1.
10 Burns, Andrew; Jooste, Charl; Schwerhoff, Gregor. 2021. Climate Modeling for Macroeconomic Policy: A Case Study for Pakistan. Policy Research Working Paper;No. 9780. © World Bank, Washington, DC. http://hdl.handle.net/10986/36307 License: CC BY 3.0 IGO.
11 Timilsina, Govinda; Dissou, Yazid; Toman, Mike; Heine, Dirk. 2021. Carbon Tax in an Economy with Informality: A Computable General Equilibrium Analysis for Cote d'Ivoire. Policy Research Working Paper;No. 9710. © World Bank, Washington, DC. http://hdl.handle.net/10986/35830 License: CC BY 3.0 IGO.
12 Baroni, L., Nicholls, G., & Whiteoak, K. (2019). Grow Green: Approaches to Financing Nature-Based Solutions in Cities.
13 International Capital Market Association (ICMA) (2021). Green Bond Principles.
14 Degron, R. (2021). Les finances publiques vertes en France : entre ambition écologique et réalités socio-fiscales. Revue française d'administration publique, 179, 669-680. https://doi.org/10.3917/rfap.179.0155

3.2 Green Economic Tools

As for green economic tools, they are policy mechanisms designed to align economic activities with environmental sustainability. Such notable instruments include:

- **Carbon Pricing:** A market-based approach to reducing greenhouse gas emissions by assigning a price to carbon. This can be implemented through carbon taxes, where governments set a fixed price per ton of CO_2 emitted, which companies must pay. This approach provides price certainty and encourages businesses to reduce emissions in the most cost-effective way. Examples include Sweden's carbon tax, which is among the highest in the world (in 2025 the tax rate amounts to EUR 134 for most fuels with 100 % fossil content)[15]. Another approach is through **cap-and-Trade Systems (Emissions Trading Systems - ETS)**, where a government sets a cap on total emissions and issues allowances (permits) that companies can trade. Firms that reduce emissions efficiently can sell excess allowances to others. The **EU Emissions Trading System (EU ETS)**, launched in 2005, is the world's largest carbon market, covering sectors like power generation, heavy industry, and aviation.
- **Renewable Energy Incentives (REIs):** These include financial mechanisms such as feed-in tariffs, a guaranteed fixed price paid to renewable energy producers for feeding electricity into the grid, widely used in countries such as Germany. REIs also include production tax credits (tax reductions granted to firms that produce or invest in renewable energy infrastructure), investment subsidies, and renewable portfolio standards to promote clean energy deployment (IRENA, 2020)[16].
- **Eco-labeling:** A voluntary certification system that identifies products meeting specific environmental criteria, helping consumers make informed choices. Examples include the EU Ecolabel and the Blue Angel in Germany. Certification frameworks ensure credibility and transparency in sustainability claims.
- **Natural Capital Accounting (NCA):** This integrates the value of ecosystems and natural resources into national economic planning and corporate decision-making. The **System of Environmental-Economic Accounting (SEEA)**, endorsed by the UN, provides a standardized approach for measuring natural capital.



15 https://www.government.se/government-policy/taxes-and-tariffs/swedens-carbon-tax/
16 IRENA, IEA and REN21 (2020), 'Renewable Energy Policies in a Time of Transition: Heating and Cooling'. IRENA, OECD/IEA and REN21.

BOX 1

Advancing Sustainable Finance : UNEP FI's and UNEP/MAP's key efforts

1. *From Voluntary Principles to Global Impact: The UNEP Finance Initiative*

Facing today's environmental challenges requires global cooperation, both between countries and between the public and private sectors. To establish a channel for dialogue between these two types of players, the United Nations Environment Programme has established a unique partnership between the global financial sector and the United Nations: the UNEP Finance Initiative. Founded in 1992, the UNEP FI today brings together, on a voluntary basis, players from over 85 different countries, including more than 500 banks and insurers, mobilizing some 45% of the world's banking assets and 25% of global insurance premiums, and totalling more than US$170,000 billion involved in the initiative. The first organization to involve the financial sector in sustainability, it aims to promote better application of sustainable development principles at all operational levels in financial institutions through the integration of environmental, social and governance (ESG) criteria into asset management.

Since its inception, UNEP FI has worked to implement global sectoral frameworks developed by leading practitioners.

In 2006, it joined forces with the United Nations Global Compact to launch the Principles for Responsible Investment (PRI), offering investors a proactive approach to integrating ESG factors into their management and decision-making through 6 voluntary principles. These principles are now applied by half of the world's institutional investors, representing US$83,000 billion. This initiative works in conjunction with the Investment Leadership Program (ILP), which brings together small groups of leading responsible investors to incubate initiatives that are considered best practices but too ambitious to be immediately adopted by mainstream investors.

Meanwhile, in 2012, UNEP FI launched the Principles for Sustainable Insurance (PSI), which set out sector-specific guidelines for integrating ESG risks into the life, non-life and health insurance businesses. These principles are now applied by a quarter of the world's insurers.

After institutional investors and insurers, UNEP FI proposed a global framework for the banking sector in September 2019: the Principles for Responsible Banking (PRB). Offering help with impact analysis, target setting and making available a list of best practices, case studies and expert advice, this initiative has been signed by over 345 banks - representing more than half the world's assets - committed to providing an annual report to account for progress. By signing up, banks gain access to the Climate Mitigation Journey, a manual outlining the business skills they need to develop over the coming years to align themselves with the Paris target of 1.5°C global warming and carbon neutrality.

In addition to global sectoral frameworks, UNEP FI conducts in-depth thematic research, defines guidelines and develops communities of practice. It is also a major supporter of the Glasgow Financial Alliance for Net Zero (GFANZ) and coordinates 3 of its largest carbon-neutral initiatives: the Net-Zero Asset Owner Alliance launched in 2019 for investors, the Net-Zero Banking Alliance bringing together players in the banking sector and the Net-Zero Insurance Alliance including the insurance sector, both of which will be launched in 2021.
Finally, UNEP FI plays a key role as an interface between the private sector and political bodies in matters of sustainable finance. By guiding its members through a complex and constantly evolving regulatory landscape, UNEP FI facilitates the convergence of financial interests and global political priorities. Through its Regulatory Implementation Support Program, the initiative informs financial institutions of legislative developments, helps them understand and integrate transparency and compliance requirements, and prepares them to anticipate future regulations. It also acts as a catalyst for public-private dialogue, participating actively in multilateral platforms such as the G20 and the International Platform on Sustainable Finance (IPSF). This strategic positioning enables UNEP FI not only to support the implementation of voluntary commitments by the private sector, but also to fuel the development of more coherent, robust public policies aligned with climate, biodiversity and sustainable development objectives.

2. Revising the MSSD for 2035: Integrating Sustainable Finance and Subsidy Reform

As for the Mediterranean,recent decisions and statements from the UNEP/MAP system highlight the importance of promoting green finance and economic tools and reforms, such as the reduction of environmentally harmful subsidies (EHS), as outlined in key documents like Article 21 of the ICZM Protocol (2009), the Common Regional Framework for Integrated Coastal Zone Management in the Mediterranean (2019), and the UNEP/MAP Medium-Term Strategy 2022-2027.

The reform of EHS is also a core objective of the Mediterranean Strategy for Sustainable Development (MSSD) 2016-2025 and its follow-up. In 2024–2025, UNEP/MAP, in collaboration with Plan Bleu, has taken a major step forward by leading a series of expert working groups as part of the revision process of the MSSD. These groups focus on the intersection of the Ocean Economy and Sustainable Finance, with the goal of introducing robust national and regional actions for the 2026–2035 period to foster the emergence of sustainable finance across the Mediterranean region. Their work aims to assess the current landscape of funding for sustainable transitions, identify best practices for phasing out EHS, and explore existing green finance instruments. This collective effort seeks to better align economic and financial policies with sustainability goals and to strengthen long-term ecological and economic resilience throughout the region.

A new strategic direction is taking shape through this process: the development, by 2035, of a Mediterranean Taxonomy for Green and Sustainable Economic Activities. This shared regional framework would classify eligible activities that contribute to adaptation, mitigation, and resilience, and suggest the most appropriate financial and economic tools to support them, while remaining adaptable to national and local contexts. It could enhance coherence and comparability across countries while allowing for flexibility in implementation. Six concrete national and regional actions have already been identified under this strategic direction, each assigned to specific actors, national governments, local authorities, financial institutions, academia, etc, and paired with indicators to monitor progress and effectiveness.

Once the revised MSSD 2026–2035 is adopted, expected at COP 24 of the Barcelona Convention in Cairo (2–5 December 2025), the key challenge will be its effective implementation. This will require the active participation of all stakeholders: national and local governments, civil society, the private sector, and financial institutions. The ultimate goal is to build a Mediterranean community of practice, where each actor contributes, at their level, to a more sustainable and resilient region.

4. TAILORING THE TOOLS TO THE MEDITERRANEAN CONTEXT

Reports from the World Bank, OECD, and UN Environment (2018)[17] highlight the importance of aligning infrastructure investments with climate goals to achieve a low-carbon, resilient future. They argue that current infrastructure financing mechanisms are insufficient to meet the Paris Agreement targets, urging governments, financial institutions, and the private sector to adopt innovative financial instruments to fund the green transition. Stronger collaboration between the public and private sectors is essential not only to drive green investments but also to facilitate divestment from projects that harm the environment (Calliari et al 2022)[18].

The relevance of green public finance and economic tools in the Mediterranean region is particularly significant due to its vulnerability to climate change, water scarcity, biodiversity loss, and other sustainability challenges. Green public finance can help address these issues by channeling limited resources toward climate-resilient infrastructure and sustainable water management practices. Moreover, it fosters a more resilient, environmentally friendly economy, promoting sustainable practices while supporting long-term economic stability. Green economic tools can reduce carbon emissions, create new markets for sustainable products and services, and drive innovation in the region. By leveraging market-based financing, these tools can bridge the financial gap faced by many green projects.

While the case for implementing GFET is well established, there remain numerous questions, particularly when considering the specificities of the Mediterranean region. A crucial concern is how these tools can be effectively tailored to the distinct environmental, economic, and social contexts found across the region's diverse countries. The region is characterized by a mix of high-income and developing economies, varying political landscapes, and a rich diversity of ecosystems. As such, it becomes clear that a «one-size-fits-all» approach to green economic tools is unlikely to be effective in this context. Instead, there is a pressing need for solutions that are tailored to the specific circumstances and challenges of different Mediterranean regions.
How can green finance and economic tools be designed to account for the region's stark differences in income levels, governance structures, and development stages? For example, while the wealthier nations around the northern Mediterranean coast may have the resources to implement sophisticated green policies and technologies, how can we ensure that developing countries in the southern and eastern Mediterranean are not left behind?

A further layer of complexity arises when considering the specific environmental challenges faced by different Mediterranean sub-regions. For instance, how can green finance and economic tools be adapted to address the pressing issue of water scarcity in southern and eastern Mediterranean countries? Could green bonds, for instance, be used to fund sustainable water management infrastructure, or should targeted subsidies and fiscal policies be prioritized to incentivize the adoption of water-saving technologies?

Another pressing question is the preservation of marine biodiversity along the Mediterranean's extensive coastline. Can the same economic tools effectively protect marine ecosystems while balancing the economic interests tied to tourism, fisheries, and shipping industries? How can we design policies that incentivize sustainable fishing practices, while still supporting the livelihoods of local fishing communities? Can green taxation be leveraged to support marine conservation efforts without undermining industries vital to the region's economy? What role can environmental taxes play in reducing the carbon footprint of the tourism sector, or in encouraging more sustainable practices, without risking adverse socio-economic impacts, such as job losses or reduced economic growth?

The region's diverse political landscape also presents a significant challenge. One should ask, what are the underlying factors that hinder the implementation of green finance mechanisms and sustainability-oriented fiscal policies? Are these challenges more about capacity or political will, and how can these be overcome? How can green finance and economic tools be designed in a way that accounts for varying levels of political will and institutional capacities across different Mediterranean countries? What are the best strategies for fostering cooperation among Mediterranean nations with differing priorities?

Finally, the overarching question is: How can the Mediterranean develop and implement green finance and economic tools that are both effective in achieving environmental goals and fair in ensuring that the transition to a green economy is inclusive and just? What mechanisms can be put in place to ensure that these tools promote equity across the region, reducing disparities between countries and social groups, while also driving progress toward a sustainable future ?

Such questions represent only a fraction of the complexity involved in developing and deploying green public finance and economic tools in the Mediterranean. Rather than relying on generic solutions, the region requires nuanced, context-specific approaches that consi-

17 OECD/The World Bank/UN Environment (2018), Financing Climate Futures: Rethinking Infrastructure, OECD Publishing, Paris, https://doi.org/10.1787/9789264308114-en.
18 Calliari, E., Castellari, S., Davis, M., Linnerooth-Bayer, J., Martin, J., Mysiak, J., Pastor, T., Ramieri, E., Scolobig, A., Sterk, M., Veerkamp, C., Wendling, L., & Zandersen, M. (2022). Building climate resilience through nature-based solutions in Europe: A review of enabling knowledge, finance and governance frameworks. Climate Risk Management, 37, 100450.

der the interplay of economic, environmental, and social factors. The success of these tools in the Mediterranean will depend on how well they are tailored to the region's unique challenges and opportunities, and how effectively they are integrated into national and regional strategies for sustainable development. The need for empirically-backed research and dialogue is clear.

5. BRIDGING KNOWLEDGE AND POLICY: THE PLAN BLEU EDITED VOLUME ON GREEN FINANCE AND ECONOMIC TOOLS

Therefore, recognizing the urgency of addressing the issue, Plan Bleu initiated the production of this new Edited Volume report to better inform decision-makers across the Mediterranean. In 2024, Plan Bleu launched a Call for Papers as an open invitation to Mediterranean researchers, primarily from academia, to explore the complexities of green finance and economic tools. Thirteen paper proposals were selected and funded by Plan Bleu, with each one presented as a chapter in this volume. The chapters provide insights into how best to tailor green finance and economic tools to local contexts. They explore the challenges and opportunities in introducing these tools, highlighting case studies, best practices, and innovations that offer promising solutions to specific challenges. While most chapters offer regional (multi-country) insights, some are also country-specific, providing detailed local/national perspectives and case-studies that are always contextualized for the broader Mediterranean region. All chapters include recommendations that are relevant to the global Mediterranean context. This «by Mediterraneans, for the Mediterranean» approach offers valuable insights, ideas, and practices from a range of perspectives across the region.

The significance of these chapters lies in their collective ability to comprehensively address the potential of green finance and economic tools in the Mediterranean. The report adopts a positive narrative, focusing on the potential for sustainable growth, cross-border collaboration, and the creation of a more resilient Mediterranean economy—one that successfully integrates both environmental sustainability and socio-economic development.
Draft versions of the chapters underwent rigorous review and refinement during the Plan Bleu Regional Workshop on January 29, 2025. This collaborative process aimed to enhance the quality and relevance of each chapter before inclusion in the final report. The workshop provided a valuable platform for authors to receive feedback not only from Plan Bleu but also from a diverse audience, including representatives from the EU, international organizations such as the OECD, and experts in green taxation. Their insights played a crucial role in strengthening the final versions, ensuring that the report offers a comprehensive and well-informed perspective. Additionally, the Plan Bleu team and Bureau conducted an additional peer-review process to further refine the content.

Each chapter delves into a unique facet of the issue, specifically:

Chapter 1. A Comparative Assessment of Green Economic Tools and Public Finance Mechanisms implemented in the Mediterranean Countries : This first chapter aims to conduct a comparative assessment of Green Economic Tools and Public Finance mechanisms in Mediterranean countries. It identifies, reviews, classifies, and compares these tools, informs policymakers about the current state of implementation and offers evidence-based recommendations for a greener future in the Mediterranean.

Chapter 2. Financing the green transition: A synthesis and analysis of green finance tools employed in the Mediterranean region : Historical and contemporary patterns in global greenhouse gas (GHG) emissions, alongside the resulting global warming, highlight the mechanisms, strategies, and policies that have contributed to the ecological crisis affecting both the Earth and humanity. From an economic standpoint, this adverse trajectory can be attributed to a combination of policy instruments, including taxes, subsidies, grants, loans, tax incentives, financial mechanisms, and regulatory frameworks. Conversely, a transition toward sustainability is achievable through targeted policies and economic tools, with green finance serving as a critical mechanism to support the shift to a low-carbon economy. This chapter aims to examine the impacts of environmentally related taxes and feed-in tariffs on climate change in selected Mediterranean countries, analyzed through the lens of economic policy. Additionally, it explores other green finance instruments utilized within the region.

Chapter 3. Helping Economic Policymakers Navigate through Ambitious Climate Policies : Achieving climate stabilization in line with the Paris Agreement requires deep decarbonization across all sectors, making it an economy-wide effort. Ministries of Economy/Finance must be involved in decarbonization planning due to their role in budget preparation, economic incentives, and public investments. However, they often lack the technical expertise to assess the fiscal, macroeconomic, and distributional impacts of climate policy, requiring close collaboration with other ministries like Environment, Energy, Agriculture, and Transport. This chapter

outlines methods that help economic policymakers assess the impacts of low-carbon strategies, including: (a) evaluating carbon rates and fossil fuel subsidies, (b) addressing long-term fiscal challenges, (c) identifying climate-related investments, and (d) prioritizing low-carbon projects. A case study from Cyprus demonstrates these methods, though they apply broadly to Mediterranean countries, including non-EU members, under EU decarbonization frameworks.

Chapter 4. Leveraging the Nature Restoration Law – Innovative Financing Instruments for Restoring Mediterranean Marine Biodiversity : This chapter examines how the EU Nature Restoration Law (NRL) can drive innovative financing for Mediterranean marine biodiversity restoration. Addressing ecological challenges and funding gaps, it explores synergies between Payments for Ecosystem Services (PES), nature-based solutions (NbS), and biodiversity credits linked to blue carbon ecosystems. Redirecting harmful subsidies, leveraging environmental taxes, and integrating tools like blue bonds and blended finance can mobilize resources. Successful examples, including the Mediterranean Blue Carbon Initiative and LIFE Blue Natura, highlight potential pathways while cautioning against greenwashing. Strengthening private-public investment through frameworks like the EU Taxonomy and Green Bonds Regulation can enhance credibility and scale restoration efforts.

Chapter 5. Economic support tools for marine invasive alien species management in the Mediterranean : Invasive alien species (IAS) cause a significant threat to global biodiversity, ecosystem services, and socio-economic stability, with the Mediterranean Sea standing out as the most invaded marine ecosystem globally. This paper reviews the ecological, economic, and management dimensions of IAS in the Mediterranean, highlighting unique challenges due to its semi-enclosed nature, proximity to major introduction pathways, and heightened vulnerability from climate change and anthropogenic pressures. The impacts of IAS are profound, spanning biodiversity loss, ecosystem degradation, and substantial economic costs to sectors like fisheries, tourism, and aquaculture. Key species, including pufferfish, lionfish, and rabbitfish, exemplify the ecological disruptions and financial burdens caused by IAS, with estimated total costs reaching $27.3 billion in the Mediterranean. The reactive nature of IAS management, focusing on control and eradication rather than prevention, results in high expenditures and limited success. Economic tools such as subsidies and compensation schemes are being used to address IAS, with case studies showing the potential for aligning conservation and economic goals. Despite progress, gaps remain in funding, management, and public awareness. Strengthening legislative frameworks and promoting cross-border collaboration are key to improving IAS management in the region.

Chapter 6. EU water policies and innovative financing mechanisms: Developments and future perspectives for the Mediterranean countries : This chapter identifies relevant water policies and assesses their implications for the Mediterranean through SWOT analysis. It systematically reviews modern financing tools and case studies, such as crowdfunding in Lebanon and innovation funding in the North Mediterranean, focusing on technology implementation and regional differences. The chapter evaluates financing alternatives, considering socio-economic and environmental impacts across sectors like agriculture and aquaculture. It provides a critical guide on EU water policies, financing options, and their application to Mediterranean water management, offering insights for policymakers and stakeholders.

Chapter 7. Green Bonds as a Financial Instrument for the Energy Transition: a FSAM approach : This chapter explores the potential of green bonds to accelerate the energy transition, with Tûrkiye as a case study, leveraging key available data. Using a Financially Extended Social Accounting Matrix (FSAM), we analyze the economic and environmental impacts of green bond issuance, with a focus on the Turkish context. The chapter identifies opportunities and challenges in Türkiye's green bond market, including investor awareness, market infrastructure, and regulatory frameworks. By analyzing various policy scenarios, our findings provide policy recommendations to optimize the effectiveness of green bonds in driving renewable energy investments and fostering sustainable development in Türkiye.

Chapter 8. Clearing the Air: Evaluating the Effectiveness of Green Bonds in Reducing Air Pollution in the Mediterranean Region : This paper examines the impact of green bond issuance on air pollution in 21 Mediterranean countries from 2012 to 2022 using panel regression analyses. Unlike previous research focused on financial performance or greenhouse gas emissions, this paper addresses the often-overlooked issue of air pollution. The findings show that green bond issuances lead to measurable reductions in air pollution, with bonds of moderate maturity (5-10 years) and higher issuance volumes being most effective in reducing pollutants like CO2, methane, and nitrous oxide. The impact is more significant in highly polluting sectors. These results have important policy implications for the Mediterranean region, highlighting the need for effective green bond frameworks and regional coordination to enhance sustainable finance and address air pollution.

Chapter 9. Towards Mediterranean green bond guidelines : This chapter highlights the lack of specific Mediterranean legal regulations on green bonds to guide economic players in the region. While international and European laws define green bonds and their characteristics, there is no practical guidance for promoting their development in Mediterranean countries. The creation of Mediterranean guidelines could facilitate their use, especially in addressing pollution. Current legal texts aim to harmonize practices but overlook the potential applications of green bonds in the region. This paper proposes that soft law guidelines could encourage the use of green bonds to support environmentally-friendly economic activities in Mediterranean countries, fostering regional cooperation and environmental protection.

Chapter 10. Does Energy Taxation Matter for Energy Efficient innovations? Evidence from Firms in the Southern Mediterranean Countries : This chapter explores the link between green public finance tools, such as energy taxation, and energy-efficient innovations in 6,952 privately-owned firms across seven Southern Mediterranean Countries. The findings show that energy taxation significantly encourages energy-efficient innovation, particularly in the retail and service sectors. External pressures, such as customer demand for environmental certification, also drive innovation. Firms with strong green capabilities are more likely to innovate in sustainable energy solutions. The results suggest that energy taxation promotes innovation mainly in firms with environmental self-regulation or those in energy-intensive industries. Governments in Southern Mediterranean Countries should implement comprehensive regulatory frameworks that target energy-intensive firms, raise environmental awareness, and support technological capabilities and access to finance.

Chapter 11. Aligning Green Public Finance and Law: Exploring the Possibilities for a Renewable Energy Hub : The chapter argues that, currently, international trade in fossil fuels is well-established, but this is not the case for renewable energy. To facilitate energy transition in the Mediterranean Region, a combination of facilitated cross-border renewable energy trade and fiscal incentives could be effective. The chapter highlights that fiscal incentives, such as subsidies, tax breaks, or green bonds, could play a pivotal role in attracting the necessary investments to develop renewable energy infrastructure. The establishment of a regional trade agreement (RTA) among Mediterranean countries could further facilitate financial flows, ensuring that the energy transition is both economically viable and equitable for



all stakeholders involved. This framework would encourage private sector participation and mobilize finance for green technologies, contributing to a sustainable energy future for the region.

Chapter 12. Social Carbon Cost: Measuring Climate Change's Socio-Economic Impact in the Mediterranean with a Carbon Tax Proposal : This chapter explores the socio-economic impact of climate change in the Mediterranean region and proposes optimal carbon tax strategies tailored to country-specific contexts. Using an extended Regional Integrated Climate Economics for mediterranean region (RICE-MED) model, the chapter measures the Social Cost of Carbon (SCC) for each country, evaluates different carbon tax scenarios, and assesses their implications for emissions reductions and economic performance. Results reveal significant regional differences driven by economic structures, energy profiles, and climate vulnerabilities. While Southern European nations are equipped to adopt higher carbon taxes due to advanced renewable energy systems, North African countries require gradual approaches. The chapter highlights the importance of regional cooperation, harmonized carbon pricing, and shared investments in renewable energy to address shared climate challenges. Its insights aim to guide policymakers toward effective, equitable, and sustainable decarbonization strategies.

Chapter 13. Climate Scenarios for Municipal Fiscal Revenues in Italy : Local authorities, cities, and municipalities are essential yet often overlooked actors in combating climate change. This chapter focuses on the implications of climate change for municipal fiscal revenues in Italy, offering scenarios that highlight potential risks and opportunities, with relevance for all Mediterranean contexts. The analysis reveals that climate change adversely affects municipalities' fiscal bases, such as GDP, land use, and tourism. These impacts threaten the delivery of essential services, redistribution policies, and local economic stability. Using an «open box» modeling approach, this work presents adaptable scenarios that account for demographic and economic shifts, allowing for greater flexibility in planning. Two policy orientations are proposed, a Pigouvian Taxation for Climate Risk and Active Adaptation Measures. This research underscores the urgency for municipalities to act as pivotal agents in climate adaptation, leveraging fiscal tools and international partnerships to address long-term climate challenges.

As we progress through this series of chapters, we embark on a journey aimed at deepening understanding, proposing practical and tailored solutions, and nurturing a collective commitment to a more sustainable and resilient future for the Mediterranean.

CHAPTER 1. REVIEW OF GREEN ECONOMY TOOLS AND PUBLIC FINANCE MECHANISMS IN MEDITERRANEAN COUNTRIES

Authors : Jérémie Fosse, Haiat Jellouli Moaddine



Abstract

This chapter provides an assessment of green economy tools and public finance mechanisms available and implemented in Mediterranean countries. It examines various instruments—from environmental taxation and green bonds to carbon pricing and renewable energy incentives—and evaluates their effectiveness in promoting sustainable economic growth and environmental protection. The study highlights significant regional disparities in the adoption and implementation of these tools, emphasizing the role of institutional capacity, governance structures, and political commitment. Through a review of academic literature, policy documents, and case studies—including country analysis of France, Italy, Spain, Portugal, Morocco, Tunisia, Greece, Croatia, and Türkiye—the paper offers insights and policy recommendations to enhance the integration of green finance and sustainability objectives in public decision-making.

Résumé

Ce chapitre propose une évaluation des outils de l'économie verte et des mécanismes de finances publiques disponibles et mis en œuvre dans les pays méditerranéens. Il examine divers instruments – de la fiscalité environnementale et des obligations vertes à la tarification du carbone et aux incitations aux énergies renouvelables – et évalue leur efficacité à promouvoir une croissance économique durable et la protection de l'environnement. L'étude met en évidence d'importantes disparités régionales dans l'adoption et la mise en œuvre de ces outils, soulignant le rôle déterminant de la capacité institutionnelle, des structures de gouvernance et de la volonté politique. À travers une analyse de la littérature académique, des documents de politique publique et des études de cas – incluant des analyses nationales de la France, de l'Italie, de l'Espagne, du Portugal, du Maroc, de la Tunisie, de la Grèce, de la Croatie et de la Turquie – ce chapitre propose des pistes de réflexion et des recommandations pour renforcer l'intégration de la finance verte et des objectifs de durabilité dans les décisions publiques.

1. INTRODUCTION

In order to contextualize the chapter, the region's main environmental challenges are described, followed by the review of green economic tools, the study's objectives, and the methodological approach adopted.

1.1 Main Environmental Challenges in the Mediterranean

The Mediterranean region faces an array of urgent and interlinked **environmental and development challenges,** stemming from its unique geographical, socio-economic and ecological characteristics[19]. **Climate change** poses an existential threat, with rising air and sea temperatures, more frequent and prolonged droughts, and extreme weather events disrupting natural, social and economic ecosystems and increasingly impacting human livelihoods[20]. In particular, **coastal areas** are increasingly vulnerable to sea-level rise, threatening infrastructure, tourism, and urban populations[21].

Food security, Energy access and **Water scarcity** are critical issues, driven by over-extraction of natural resources, inefficient environmental management systems, and environmental pollution[22]. This impacts agricultural productivity, industrial activity, and access to basic ecosystem services such as clean water or air, particularly in urban, arid and semi-arid parts of the region. At the same time, the Mediterranean's rich **biodiversity**—spanning marine and terrestrial ecosystems—faces significant pressures from habitat destruction, overfishing, invasive species, and pollution. These challenges jeopardize not only environmental health but also key economic sectors— such as agriculture, tourism, or fisheries—along with broader social stability, underscoring the urgency of sustainable solutions.

1.2 Green Economic and Public Finance tools

In this context, environmentally friendly economic tools and public finance mechanisms have emerged as vital instruments for achieving environmental and social sustainability. Such tools have been significantly promoted and implemented to build back better in the aftermath of the pandemic crisis[23]. In Mediterranean countries, the use of such tools have been more limited, except within the European Union[24].

These tools are designed to incorporate environmental considerations into financial and economic decision-making, incentivizing sustainable practices and discouraging harmful ones. For example, environmental taxes penalize activities that contribute to pollution, encouraging industries to adopt greener practices. Green (or blue) bonds mobilize private and public capital for projects that deliver measurable environmental benefits, such as renewable energy infrastructure or biodiversity conservation initiatives.

Other tools, such as carbon pricing, renewable energy incentives, and eco-labeling, further align economic incentives with environmental goals, fostering resource efficiency and low-carbon development. Public finance mechanisms, such as green budgeting and eco-friendly subsidies, help governments reorient spending priorities toward sustainability. Beyond environmental benefits, these tools contribute to job creation, innovation, and equitable economic growth, reinforcing their importance as pillars of sustainable development[25].

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19 Plan Bleu, State of the Environment and Development in the Mediterranean, (2020).
20 MedECC - Mediterranean Experts on Climate and Environmental Change, Summary for Policymakers, 2020.
21 MedECC - Mediterranean Experts on Climate and Environmental Change, Special Report on Climate and Environmental Coastal Risks in the Mediterranean, 2024.
22 MedECC - Mediterranean Experts on Climate and Environmental Change, Special Report Interlinking climate change with the Water – Energy – Food – Ecosystems (WEFE) nexus in the Mediterranean Basin, 2024.
23 World Bank, "Building Back Better" in Practice: A Science-Policy Framework for a Green Economic Recovery after COVID-19, 2021.
24 Eco-union, Towards a Green and Inclusive Recovery, 2021.
25 ILO - International Labour Organization, World Employment and Social Outlook, 2018.

1.3 A Growing Field of Interest for Scholars and Policy-makers

The concept of the Green Economy has garnered increasing attention from policymakers and scholars over the past decade as a strategic approach to harmonize economic growth, social inclusion, and environmental sustainability. It is widely promoted as a pathway to achieving sustainable development by decoupling economic progress from environmental degradation[26].

While some critics argue that the Green Economy may overpromise by assuming that economic growth can be fully aligned with environmental limits[27], it remains a widely endorsed and practical strategy for reducing environmental pollution, fostering innovation, and driving inclusive economic transformation—particularly in the context of global climate and biodiversity goals.

2019	2020	2021	2022	2023	2024
12,8	15,2	18,7	22,3	25,7	40,2

TABLE 1
Number of papers (per thousand) related to "Green Economy" indexed in Google Scholar
Source : Eco-Union

Table 1 serves as an empirical indicator of the growing academic and policy interest in the green economy. The steady increase in the number of indexed papers—from 12.8 in 2019 to 40.2 in 2024—suggests that research in this area has gained significant momentum over recent years. This trend reflects both a surge in scholarly inquiry into sustainable economic practices and an increasing focus on policy adoption by governments and institutions. Essentially, as environmental challenges have become more urgent, both academic communities and policymakers have intensified their efforts to develop and implement environmentally friendly economic tools, which is mirrored in the expanding volume of research literature.

1.4 Research Objective

While Mediterranean countries have made progress in adopting green economic tools and public finance mechanisms, the extent and effectiveness of their implementation vary significantly. Differences in institutional capacity, financial resources, and policy priorities have created a fragmented landscape, with some countries leading in green innovation and others lagging behind.
This chapter aims to provide a comprehensive review of these tools and mechanisms across the Mediterranean region. Specifically, it seeks to:

- Identify and describe the green economic tools and finance mechanisms used in Mediterranean countries.
- Compare their adoption and integration across countries with diverse socio-economic contexts.
- Assess the barriers and enablers of their successful implementation.
- Evaluate their potential environmental and socio-economic impacts at a regional level.

By addressing these objectives, the research intends to bridge critical knowledge gaps and provide actionable insights for policymakers and stakeholders working toward a sustainable Mediterranean future.

1.5 Methodology

To achieve these objectives, the research employs a mixed-methods approach combining **qualitative and quantitative** analyses. A comparative case

26 UNEP, Towards a Green Economy: Pathways to Sustainable Development and Poverty Eradication, 2011
27 IVockel & Higel, Is green growth happening? An empirical analysis of achieved versus Paris-compliant CO2–GDP decoupling in high-income countries, The Lancet Planetary Health, 2023.

study methodology has been adopted, focusing on a diverse set of Mediterranean countries to capture the region's ecological and socio-economic diversity.

Data collection involves a review of policy documents, academic literature, and reports from international organizations such as the United Nations Environment Programme (UNEP), International Labour Organization (ILO) or the Organisation for Economic Co-operation and Development (OECD); but also economic and environmental Think Tanks and Civil Society Organizations (CSO).

This methodology ensures that the research captures the complexity of green economic practices in the Mediterranean, offering a comprehensive basis for comparative analysis and evidence-based recommendations. Through this integrated approach, the study contributes to the broader discourse on aligning economic policies with sustainability goals, charting a path toward a resilient and equitable future for the Mediterranean region.

2. REVIEW OF GREEN ECONOMY AND PUBLIC FINANCE TOOLS

This chapter delves into existing academic research and policy documents concerning green economic tools and public finance mechanisms, with a focus on their applications and impacts within the Mediterranean region and comparable contexts. It explores the theoretical frameworks and empirical evidence to provide a comprehensive understanding of the current state of knowledge in this field.

2.1 Green Economic Tools

Green economic tools encompass a range of policy instruments designed to promote environmentally sustainable practices and internalize environmental costs into economic decision-making. These tools can incentivize sustainable behaviors, discourage environmentally harmful activities, and mobilize financial resources for green investments. This section explores several key green economic tools, including environmental taxation, green bonds, carbon pricing, renewable energy incentives, eco-labeling, and natural capital accounting.

2.1.1 Green Policies

Green Policy instruments are widely used in European Member states and less often in other Mediterranean countries, as per the OECD database on Policy Instruments for the Environment (PINE) Database.

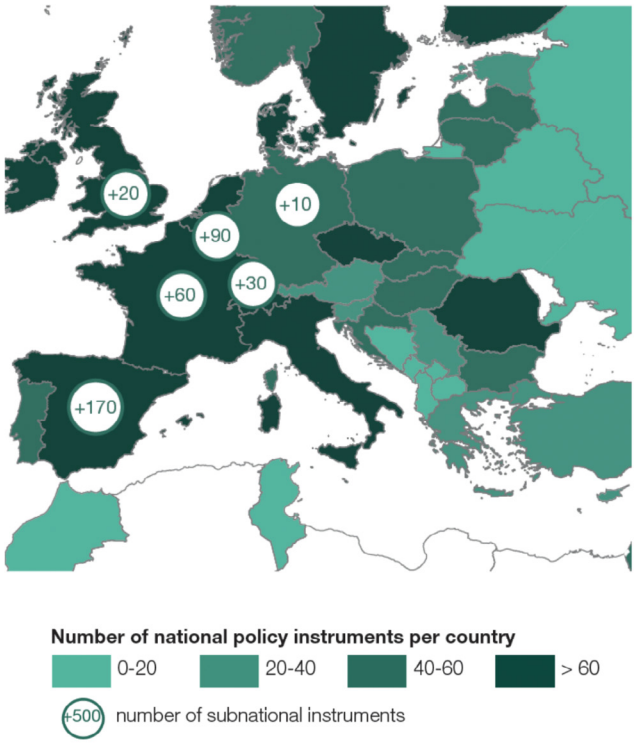


FIGURE.1 *Number of Green Policy instruments per countries (2024)*
Source: OECD, Policy Instruments for the Environment (PINE) Database (2024)

The figures from the OECD PINE database not only highlight the diversity in the number of green policy instruments across countries but also reflect broader trends in policy adoption. **European Member States** tend to employ a wide range of green economy tools, such as carbon pricing, renewable energy incentives, and green budgeting, as part of their comprehensive strategy to support sustainability. In contrast, many **Mediterranean countries outside the EU** have been slower to adopt these instruments, a discrepancy that can be attributed to factors such as limited institutional capacity, differing economic priorities, and fiscal constraints.

In Eastern and Southern Mediterranean countries, there is a noticeable pattern of **lower adoption rates,** where the number of green policy instruments is often fewer compared to their EU counterparts, indicating a significant gap in policy innovation and implementation. Despite this lag, an emerging interest in environmental measures is evident, as many countries are gradually incorporating tools like environmental taxation, green bonds, and renewable energy incentives, particularly as they reform their energy and environmental sectors.

Furthermore, there is a discernible trend towards a policy focus on specific sectors. Several Mediterranean nations are beginning to concentrate their efforts on targeted areas such as water and energy management to address their environmental challenges. However, regional disparities remain pronounced, reflecting differences in economic development, political stability, and the institutional readiness required to integrate sustainability into policy frameworks.

These trends suggest that while academic interest and research output continue to grow, practical policy implementation varies significantly within the region. This emphasizes the need for tailored strategies that address the specific challenges and opportunities present in the Mediterranean context.

2.1.2 Environmental Taxation

Environmental taxation serves as a pivotal green economic instrument aimed at mitigating environmental degradation by internalizing the external costs associated with pollution and resource consumption. By imposing taxes on activities or products that harm the environment, such as carbon emissions or plastic production, these fiscal measures incentivize both producers and consumers to adopt more sustainable practices. The **Organisation for Economic Co-operation and Development** (OECD) emphasizes that environmental taxes are designed to encourage **environmentally friendly choice**s while supporting broader tax policy goals of fair and sustainable economic growth[28]. These taxes can be levied on various environmental domains, including energy products, motor vehicles, waste management, and natural resource usage[29].
A prominent example is the **carbon tax**, which directly charges emitters based on the amount of carbon dioxide they release. The United Nations Handbook on Carbon Taxation for Developing Countries provides comprehensive guidance on designing and implementing such taxes, highlighting their role in reducing greenhouse gas emissions and promoting sustainable development[30]. Similarly, the **World Bank** reports that despite the potential benefits, large gaps in environmental taxation persist globally, with governments spending a record **USD 1 trillion on fossil fuel subsidies in 2022,** underscoring the need for more robust environmental tax policies[31].

Empirical studies further elucidate the impact of environmental taxes. Research demonstrates that environmental taxes positively affect the economic performance and technological innovation of heavily polluting industries, thereby contributing to a greener economy[32]. Additionally, a recent study finds that energy taxes, including CO_2 taxes, significantly reduce energy consumption and intensity, indicating their effectiveness in promoting energy efficiency[33].

However, the implementation of environmental taxes must consider potential **socioeconomic implications.** A study analyzing data from OECD countries reveals that while environmental taxes can effectively reduce environmental harm, they may also exacerbate economic and social inequalities if not carefully designed[34]. Recognizing this risk, several Mediterranean governments have begun

28 OECD - Organisation for Economic Co-operation and Development, Tax and the environment, 2024.
29 OECD - Organisation for Economic Co-operation and Development, Environmental tax, 2021.
30 United Nations Department of Economic and Social Affairs, Environmental Taxation | Financing for Sustainable Development Office, 2024.
31 World Bank, Environmental Taxes, 2025.
32 Zhengyan Wang; Naiping Zhu; Jianuo Wang; Yingyun Hu & Mwansa Nkana, The impact of environmental taxes on economic benefits and technology innovation input of heavily polluting industries in China, 2022.
33 Sackitey, Cogent Economics & Finance. Do environmental taxes affect energy consumption and energy intensity? An empirical analysis of OECD countries, 2023.
34 Edmond Noubissi Domguia, Taxing for a better life? The impact of environmental taxes on income distribution and inclusive education, 2023.

to implement measures to cushion the impact on lower-income households. In **Greece**, for instance, the government has introduced revenue recycling mechanisms where a portion of the revenue collected from environmental taxes is redirected into social programs that provide targeted subsidies to low-income households, helping offset increases in energy bills and transportation costs[35]. Similarly, **Italy** has incorporated complementary social benefits alongside its green taxation policies to support vulnerable sectors and small businesses, ensuring that the burden of transitioning to a greener economy does not disproportionately affect those least able to bear it[36]. In **Spain**, policy frameworks also include targeted support for households affected by higher energy costs, often linked to increased environmental taxes[37].

Environmental taxation represents a critical tool in the transition towards sustainable development in Mediterranean countries. By effectively pricing environmental externalities, these taxes can drive behavioral changes, stimulate green innovation, and generate public revenues that can be reinvested into environmental protection and social equity initiatives. The successful implementation of environmental taxes requires careful consideration of their design and impact, informed by empirical evidence and tailored to specific economic and social contexts.

2.1.3 Green (and Blue) Bonds

While environmental taxation plays a crucial role in shaping sustainable behaviors, complementary financing mechanisms such as green and blue bonds provide the necessary capital to scale up investments in environmental projects.

Green bonds have emerged as a pivotal financial instrument in mobilizing capital for environmentally sustainable projects, facilitating the transition towards a low-carbon economy. A subset of **green bonds**, blue bonds, are specifically targeted towards projects that conserve and restore the world's oceans and marine environments. These debt securities are specifically earmarked to fund initiatives that yield environmental benefits, such as renewable energy installations, energy efficiency improvements, and sustainable waste management systems. The **World Bank**, a pioneer in this domain, has issued over USD 19 billion in green bonds through more than 220 transactions across 28 currencies since 2008, underscoring the growing investor appetite for sustainable investment vehicles[38].

The **International Finance Corporation** (IFC), a member of the World Bank Group, has also been instrumental in advancing the green bond market. By offering green bonds, the IFC enables investors to finance private sector projects that address climate change through climate-smart investments in emerging markets. This approach not only supports environmental sustainability but also fosters economic development in regions most vulnerable to climate impacts[39].

In recent years, the issuance of green bonds has experienced exponential growth. The sixth edition of the IFC-Amundi Green Bond report highlights a **45% increase** in the issuance of green, sustainability, sustainability-linked, and social (GSSS) bonds in emerging markets in 2023 compared to the previous year. This surge reflects a heightened commitment from sovereign, financial, and corporate borrowers to integrate sustainability into their financing strategies[40].

35 IEA - International Energy Agency, National measures against soaring energy prices – Policies - IEA, 2023.
36 Ministero dell'Economia e delle Finanze, Less taxes and more focus on the environment and welfare: the 2020 Budget Law - MEF, 2020.
37 European Commission, Spanish national strategy against energy poverty 2019-2024 | Energy Poverty Advisory Hub, 2019.
38 World Bank, Green Bonds, 2023.
39 International Finance Corporation, Green Bonds | International Finance Corporation (IFC), 2024.
40 International Finance Corporation, Emerging Market Green Bonds 2023, 2024.

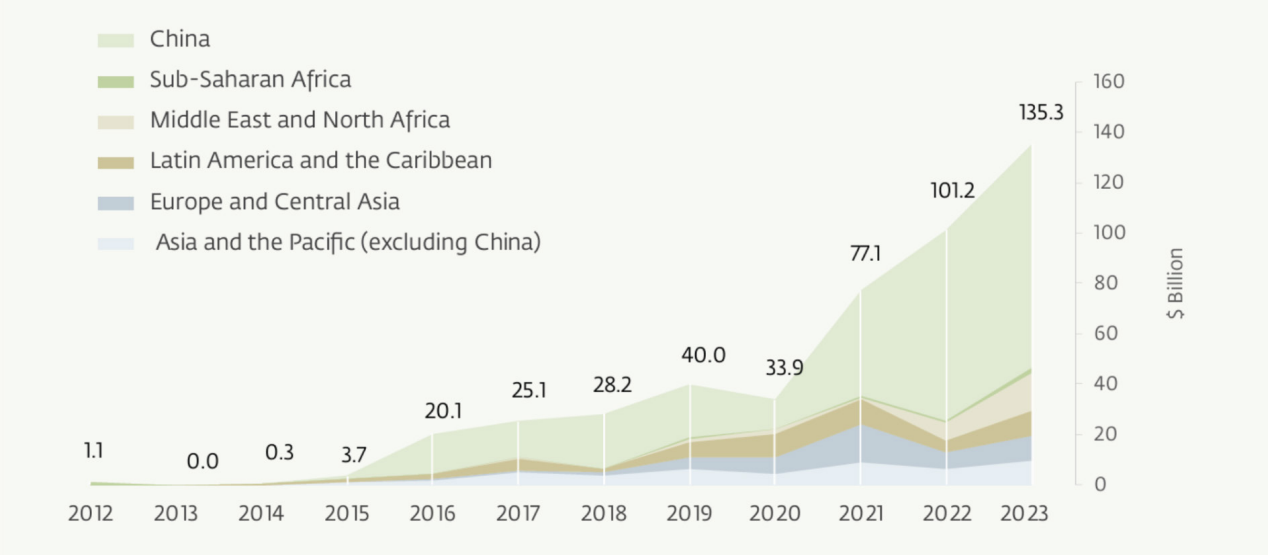


FIGURE.2 *Annual green bond issuance in emerging markets (2012-23)*
Source: Emerging Market Green Bonds (AMundi, AFC, 2024)

However, the proliferation of green bonds has introduced complexities, particularly concerning the standardization of definitions and classifications, commonly referred to as **'taxonomies'**. The International Finance Corporation has emphasized the urgent need to harmonize these taxonomies to attract the necessary funds for the global green transition. Currently, the existence of over 30 different green taxonomies worldwide complicates investment decisions and may hinder the efficient allocation of capital towards sustainable projects[41].

Despite these challenges, innovative developments continue to shape the green bond landscape. For instance, in August 2021, **Egypt**'s Commercial International Bank (CIB) issued the country's first private-sector green bond, with a $100 million investment from the **International Finance Corporation** (IFC). This initiative aims to increase private sector investment in environmentally friendly projects, aligning financial flows with global environmental objectives and setting a precedent for other Mediterranean nations to follow[42].

Green bonds represent an effective mechanism for channeling financial resources into projects that promote environmental sustainability in the Mediterranean region. The rapid expansion of the green bond market signifies a positive shift towards integrating environmental considerations into financial decision-making. Nonetheless, achieving a cohesive and efficient market necessitates addressing challenges related to standardization and transparency. As the market evolves, continued collaboration among international organizations, governments, and private entities will be essential to realize the full potential of green bonds in fostering a sustainable future.

2.1.4 Carbon Pricing

Carbon pricing is a pivotal mechanism in global efforts to mitigate climate change, aiming to internalize the external costs of greenhouse gas (GHG) emissions by assigning a monetary value to carbon emissions. This economic tool incentivizes emitters to reduce their carbon footprint, fostering a transition towards low-carbon technologies and sustainable practices.

There are primarily two forms of carbon pricing: **carbon taxes** and emissions trading systems

41 Libby George, World must urgently streamline green bond 'taxonomies' - IFC, 2025.
42 International Finance Corporation, World Bank Group, IFC Invests in Egypt's First Private Sector Green Bond to Help Boost Climate Finance, Drive Green Growth, 2021.

(ETS). A carbon tax directly sets a price on carbon by levying a tax on the carbon content of fossil fuels or on GHG emissions. Conversely, an ETS, also known as a **cap-and-trade system,** establishes a market-based approach where a limit (cap) is set on total emissions, and entities can buy or sell emission allowances within this cap. The World Bank's **Carbon Pricing Dashboard** provides an up-to-date overview of these instruments globally, highlighting their design attributes, GHG emissions coverage, price, and revenue[43].

The **effectiveness of carbon pricing** in reducing emissions has been substantiated by empirical research. A systematic review and meta-analysis published in Nature Communications assessed the impact of carbon pricing on emissions reductions. The study found that carbon pricing mechanisms have contributed to measurable decreases in GHG emissions, underscoring their role in climate mitigation strategies[44].

Despite its theoretical appeal, the implementation of carbon pricing faces political and economic challenges. While carbon pricing is economically sound, it remains politically contentious. Governments often favor renewable energy strategies over carbon pricing due to the latter's perceived economic impact and the difficulty in measuring its direct benefits[45].

In 2023, global carbon pricing revenues reached a record **$104 billion,** reflecting an increasing adoption of these mechanisms. Notably, over half of the collected revenue was allocated to funding climate and nature-related programs, demonstrating a commitment to reinvest in sustainable initiatives[46].

However, the global landscape of carbon pricing is marked by significant disparities. The **International Monetary Fun**d (IMF) highlights the need for coordinated approaches to address cross-border effects of climate policies and to prevent issues such as carbon leakage, where emissions shift to regions with less stringent regulations. A joint report by five international organizations explores pathways for such coordination, emphasizing the importance of harmonized carbon pricing mechanisms to achieve global climate goals[47].

Carbon pricing stands as a critical instrument in the arsenal against climate change, effectively encouraging emission reductions and promoting sustainable economic practices. While empirical evidence supports its efficacy, the successful implementation of carbon pricing requires careful consideration of political, economic, and social factors. Achieving global climate objectives will depend on the continued evolution and harmonization of carbon pricing policies, ensuring they are both effective and equitable across different jurisdictions.



43 World Bank, Carbon Pricing Dashboard | Up-to-date overview of carbon pricing initiatives, 2024.
44 Döbbeling-Hildebrandt, N., Miersch, K., Khanna, T.M. et al., Systematic review and meta-analysis of ex-post evaluations on the effectiveness of carbon pricing | Nature Communications, 2024.
45 Brooking, The economics—and politics—of carbon pricing, 2018.
46 World Bank, State and Trends of Carbon Pricing 2024, 2024.
47 OECD et al., Working Together for Better Climate Action: Carbon Pricing, Policy Spillovers, and Global Climate Goals, 2024.

BOX 2

Morocco & Tunisia, energy challenges ahead

Morocco[48] and Tunisia[49] have embarked on a transformative journey to reduce energy dependency and tackle climate change by leveraging renewable energy incentives alongside carbon pricing schemes. In Morocco, the government has prioritized the diversification of its energy mix by boosting solar and wind capacity, as outlined in its National Strategy for Sustainable Development 2030. This strategy not only sets ambitious renewable energy targets but also introduces carbon pricing mechanisms designed to internalize environmental costs, thereby encouraging energy efficiency and reducing reliance on imported fossil fuels. The initiative is coordinated by the Ministry of Energy Transition and Sustainable Development, which mobilizes financial, technical, and political resources to drive the transition. Regular monitoring and evaluation processes ensure that progress is tracked and adjustments are made to meet evolving environmental and economic objectives.

Similarly, Tunisia is actively reforming its energy landscape by promoting renewable energy through fiscal incentives and exploring carbon pricing as a market-based tool to curb greenhouse gas emissions. As part of its forthcoming five-year plan (2021–2025), Tunisia aims to stimulate private investment in renewable technologies such as solar and wind power. The Ministry of Regional Development and Planning leads these efforts, ensuring that technical expertise and financial resources are effectively deployed to support the country's green transition. Through ongoing pilot projects and a framework of rigorous monitoring, Tunisia seeks to gradually shift from fossil fuels to a cleaner, more sustainable energy model while addressing the broader challenges of climate change.

Together, the initiatives in Morocco and Tunisia exemplify how North African countries are adopting innovative policy tools to modernize their energy sectors. By integrating renewable energy incentives with carbon pricing schemes, both nations are making strategic strides towards lowering emissions, enhancing energy security, and fostering sustainable economic growth. These complementary approaches not only address immediate energy challenges but also lay the groundwork for long-term environmental resilience and regional cooperation.

48 Carnegie Endowment for International Peace, Just Energy Transitions? Lessons From Oman and Morocco, 2024.
49 Energy Capital & Power, Tunisia's Strategic Push Toward Renewable Energy Growth, 2025.

2.1.5 Green Financial Incentives

Green financial schemes to support environmental actions, such as Renewable energy incentives, are critical policy tools designed to accelerate the adoption of clean energy technologies, thereby reducing greenhouse gas emissions and promoting sustainable development. These incentives encompass a variety of mechanisms, including tax credits, grants, subsidies, and regulatory mandates, each tailored to address specific barriers and opportunities within the renewable energy sector.

Financial schemes play a significant role in encouraging investment in renewable energy projects. For instance, **Germany's feed-in tariff system** guarantees a fixed price for renewable electricity fed into the grid, providing a stable revenue stream for producers. The **EU Renewable Energy Directive** (RED) also sets binding targets for renewable energy consumption, further stimulating investment in this sector. Additionally, the establishment of the **EU electricity market** and the introduction of **Contracts for Difference** (CfDs) and **auction mechanisms** provides further stability and predictability for renewable energy investors, fostering competition and driving down costs[50].

In addition to economic incentives, direct financial support through **grants and loan programs** is provided by various government agencies and financial institutions, such as the **European Investment Bank** and national development banks. These programs aim to stimulate innovation and infrastructure development in the renewable energy sector. Moreover, **countries like Spain and Portugal** have implemented **Renewable Portfolio Standards (RPS),** which mandate that a certain percentage of electricity sold by utilities comes from renewable sources, thereby creating a stable market demand for clean energy[51].

Internationally, organizations such as the I**nternational Renewable Energy Agency (IRENA)** support countries in their transition to sustainable energy futures by serving as platforms for international cooperation and repositories of policy, technology, and financial knowledge on renewable energy.

Despite the availability of these incentives, challenges remain in ensuring **equitable access** to renewable energy benefits. For example, in the **United Kingdom**, schemes have been introduced to offer residents living near renewable power projects, such as wind farms, discounts on their energy bills. This approach aims to address local opposition to renewable installations and distribute the advantages of clean energy more broadly among communities[52].



50 European Parliament Think Tank, Improving the design of the EU electricity market, 2024.
51 IRENA - International Renewable Energy Agency, IRENA – International Renewable Energy Agency, 2022.
52 World Economic Forum, Renewable energy incentives: What different countries offer | World Economic Forum, 2023.

BOX 3

Spain & Portugal, priority on Renewable Energy

Spain[53] and Portugal[54] have taken a proactive stance in accelerating renewable energy adoption by implementing **Renewable Portfolio Standards** (RPS) as a central component of their energy policies. These regulatory frameworks mandate that utility companies source a defined percentage of their electricity from renewable sources, thereby creating a predictable market for clean energy investments. The RPS initiatives in both countries are designed to stimulate innovation, enhance competition within the energy sector, and reduce dependence on fossil fuels—all of which contribute to a more sustainable and resilient energy market.

In Spain, the RPS policy has been integrated into a broader national strategy aimed at meeting ambitious renewable energy targets, as outlined in the country's Sustainable Development Strategy 2030. This approach has not only led to significant growth in renewable energy capacity—particularly in wind and solar—but has also fostered improvements in grid management and energy storage. Regular monitoring by national energy regulators ensures that progress is consistently tracked, and policy adjustments are made as needed to meet evolving market dynamics[55].

Similarly, Portugal has embraced the RPS framework as a means to drive the transformation of its energy sector. The initiative encourages utility companies to increase their share of renewable energy in the national mix, thereby spurring private investments and technological advancements. The Portugal Energy Portal offers detailed insights into current targets, performance indicators, and the overall impact of RPS on market competitiveness. Through periodic evaluations, Portuguese authorities can fine-tune the standards to address emerging challenges and capitalize on new opportunities in renewable energy production[56].

Together, these initiatives in Spain and Portugal exemplify a regional commitment to transforming the energy landscape through robust regulatory measures. By setting clear renewable energy targets and fostering an environment of continuous innovation, both countries are not only advancing their national sustainability goals but also contributing to the broader European energy transition. For more detailed information, you can explore Spain's Sustainable Development Strategy 2030 and the Portugal Energy Portal, which offer comprehensive overviews of the policy frameworks, targets, and monitoring processes underpinning these RPS initiatives.



53 Enerdata, Spain's 2030 NECP: 81% Renewable Power & 43% Energy Efficiency Boost, 2024.
54 João Louro e Costa, Jill de Doet Palmeiro & Francisco Fráguas Mateus, Renewable Energy Laws and Regulations Report 2025 Portugal, 2024.
55 Ministry for Social Rights and the 2030 Agenda, Executive Summary of the Progress Report 2022 of the 2030 Sustainable Development Strategy, 2023.
56 NECP 2030, Portugal: National Energy and Climate Plan 2021-2030 (NECP 2030), 2019.

2.1.6 Eco-labeling

Eco-labeling serves as a **market mechanism** in promoting environmentally sustainable consumer behavior by providing transparent information about the environmental impacts of products and services. These labels aim to bridge the information gap between producers and consumers, enabling informed purchasing decisions that favor ecological preservation. The United Nations Environment Programme (UNEP) emphasizes that eco-labels guide consumer choices by revealing the environmental footprint of products, thereby fostering sustainable consumption patterns[57].

The proliferation of eco-labels worldwide is substantial. The **Ecolabel Index**, a comprehensive global directory, currently tracks 456 eco-labels across 199 countries and 25 industry sectors[58]. This extensive array reflects a growing commitment to environmental transparency. However, the diversity of labels also presents challenges, such as potential consumer confusion and difficulties in assessing the credibility of various certifications. To address these challenges, organizations like the **Global Ecolabelling Network** (GEN) composed of eco-labeling organizations worldwide, aims to improving, promoting, and developing the eco-labeling of products and services[59].

The effectiveness of eco-labels in influencing **consumer behavior** has been the subject of academic scrutiny. A review examined the impact of **front-of-package** (FoP) eco-labeling on food choices. The study found that while eco-labels have the potential to guide consumers toward environmentally friendly products, their effectiveness varies based on design, consumer awareness, and trust in the label[60]. This underscores the need for clear, credible, and well-communicated labeling to maximize impact.

In the European context, the **EU Ecolabel** stands as a prominent voluntary scheme promoting goods and services that demonstrate environmental excellence. Established in 1992, the EU Ecolabel covers a wide range of product groups and is recognized across all EU member states, providing a unified standard for environmental performance[61].

The eco-labeling landscape also faces challenges, including the risk of **«greenwashing,»** where misleading claims about environmental practices can erode consumer trust. The recent **EU directive against greenwashing** aims to enhance transparency and combat misleading commercial practices, thereby improving the reliability of environmental claims and enabling consumers to make informed choices[62]. The credibility of eco-labels through rigorous standards and third-party verification is essential to maintain consumer confidence and drive genuine environmental benefits.



57 UNEP - United Nations Environment Programme, Eco-labelling | UNEP, 2025.
58 Ecolabel Index, Ecolabel Index | Who's deciding what's green?, 2025.
59 Global Ecolabelling Network, Global Ecolabelling Network, 2025.
60 Ornella Tiboni-Oschilewski; Magdalena Abarca; Fabiana Santa Rosa Pierre; Alice Rosi; Beatrice Biasini; Davide Menozzi & Francesca Scazzina, Frontiers | Strengths and weaknesses of food eco-labeling: a review, 2024.
61 European Commission, EU Ecolabel, 2025.
62 European Parliament Think Tank, 'Green claims' directive: Protecting consumers from greenwashing, 2024.

BOX 4

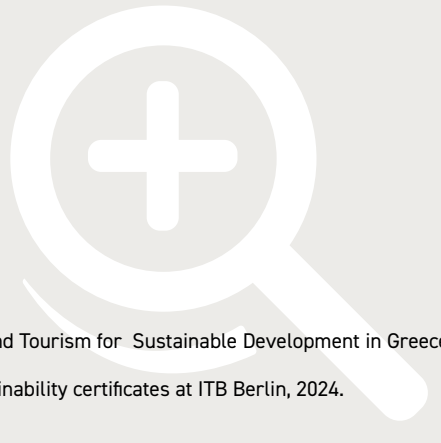
Greece & Croatia, focus on eco-labeling

Greece[63] and Croatia[64] have embraced eco-labeling initiatives as a strategic means to promote sustainable tourism and conserve their rich natural resources. In both countries, the tourism sector represents a critical component of the economy, yet it also poses significant challenges in terms of environmental impact and resource management. Recognizing these dynamics, governments and industry stakeholders have collaborated to introduce eco-labeling schemes that certify tourism-related businesses—such as hotels, resorts, restaurants, and tour operators—for their adherence to rigorous environmental standards.

These eco-labeling initiatives are designed to incentivize sustainable practices by highlighting establishments that minimize their ecological footprint, use energy efficiently, and manage waste responsibly. In Greece, for instance, the eco-labeling program has been integrated into the national tourism strategy, encouraging businesses to adopt green practices that not only reduce environmental degradation but also enhance the overall quality and competitiveness of the tourism offering. This approach not only benefits the environment but also serves as a market differentiator, attracting eco-conscious travelers seeking authentic, low-impact holiday experiences.

Similarly, Croatia has positioned eco-labeling at the forefront of its efforts to modernize the tourism sector. By promoting certified sustainable tourism operators, Croatia aims to protect its pristine coastlines, cultural heritage, and biodiversity. The initiative fosters a sense of accountability among businesses, prompting them to continuously improve their environmental performance and engage in practices that contribute to long-term sustainability. Regular monitoring and evaluation ensure that these eco-labels maintain credibility and truly reflect the environmental benefits they are meant to deliver.

Together, these initiatives illustrate how Greece and Croatia are leveraging eco-labeling not only to drive sustainable tourism practices but also to create economic value through enhanced market competitiveness. By clearly communicating the environmental credentials of tourism businesses, both countries are paving the way for a tourism sector that supports conservation efforts, benefits local communities, and aligns with broader sustainability goals.



63 Directorate for Strategic Planning, Ministry of Tourism of the Hellenic Republic, Circularity and Tourism for Sustainable Development in Greece, 2022.
64 Ministarstvo turizma i sporta Republike Hrvatske, Croatia destinations awarded global sustainability certificates at ITB Berlin, 2024.

2.1.7 Natural Capital Accounting

Natural Capital Accounting (NCA) is a systematic framework that integrates natural assets—such as water, forests, and biodiversity—into national and corporate accounting systems. By quantifying the value of ecosystem services, NCA provides critical data that inform sustainable policy and business decisions. The United Nations' **System of Environmental-Economic Accounting** (SEEA) offers standardized guidelines for implementing NCA, facilitating consistency across applications[65].

The significance of NCA is increasingly recognized by international organizations. The World Bank underscores its role in embedding nature's contributions into policy-making, particularly in developing countries to align development and climate strategies with sustainability objectives[66]. The **European Central Bank** (ECB) also raised concerns on the threat nature loss poses to the global economy and the financial system in particular[67].

In the **corporate sector**, NCA assists businesses in assessing nature-related risks and opportunities. A recent study explores how NCA supports business data needs[68], including disclosures aligned with the **Taskforce on Nature-related Financial Disclosures** (TNF) recommendations.

Despite its advantages, NCA implementation faces challenges, such as **data limitations** and the need for **capacity building**. A report by the Institute for Policy Integrity highlights the necessity for comprehensive data collection and institutional frameworks to effectively integrate natural capital into national accounts[69]. This is a significant barrier for Mediterranean countries that often lack the technical capacity - and sometimes political willingness - to collect and review the necessary information on the state of their economy and environment.

2.2 Green Public Finance

Green public finances encompass the strategic use of government revenue and expenditure to promote environmental sustainability and combat climate change. This involves incorporating environmental considerations into budgetary decisions, public spending, and fiscal policies. By aligning public finances with environmental goals, governments can play a pivotal role in driving the transition toward a green economy. This section explores key aspects of green public finances, including green budgeting, green public spending, green procurement and green subsidies.

2.2.1 Green Public Spending

Green public spending refers to government expenditures specifically allocated toward initiatives that promote environmental sustainability and address climate change. This encompasses investments in renewable energy, energy efficiency, sustainable transportation, conservation of biodiversity, and other projects aimed at reducing environmental impact. By directing public funds toward these areas, governments can stimulate economic growth while fostering a transition to a low-carbon, sustainable economy.

The **International Monetary Fund** (IMF) has analyzed the economic impacts of green public spending, finding that investments in clean energy and biodiversity conservation can yield significant economic returns. However, the extent of these benefits depends on various factors, including the type of investment, policy design, and the economic context. Their research indicates that while many key carbon-neutral or carbon-sink activities can generate more than a dollar's worth of economic activity per dollar spent, outcomes may vary based on implementation strategies and local economic conditions.

65 United Nations, Natural Capital Accounting and Valuation of Ecosystem Services Project, 2025.
66 World Bank, Natural Capital, 2025.
67 ECB - European Central Bank, Nature-related risk: legal implications for central banks, supervisors and financial institutions, 2024.
68 Jane Carter Ingram, Emily J. McKenzie, Kenneth J. Bagstad, John Finisdore, Rayne van den Berg, Eli Fenichel, Michael Vardon, Stephen Posner, Marta Santamaria, Lisa Mandle, Richard Barker and James Spurgeon, Leveraging natural capital accounting to support businesses with nature-related risk assessments and disclosures | Philosophical Transactions of the Royal Society B, 2024.
69 Institute for Policy Integrity, Accounting for Nature's Value, 2024.

This highlights both the potential and the complexities of green public spending as a catalyst for economic recovery and growth[70].

Further supporting this perspective, a recent report reveals that green government investments are demonstrably superior to traditional, non-eco-friendly investment options. According to this study, such investments can be implemented more rapidly, create more jobs, and boost economic growth more effectively than their non-green counterparts[71]. Additionally, a joint analysis by Think Tanks found that, dollar for dollar, investments in clean energy and other green initiatives generally create more short-term jobs than non-sustainable investments. These findings highlight the strong economic potential of green public spending as a tool for recovery and long-term growth[72].

However, challenges remain in scaling up green public spending. A significant hurdle is the **financing gap** for environmental initiatives. For instance, experts estimate that an additional $700 billion per year is essential to halt the decline of global biodiversity and sustain ecosystems. This figure underscores the need for increased public and private investment to meet environmental goals[73].

2.2.2 Green Budgeting

While green public spending ensures financial support for sustainability initiatives, green budgeting plays a crucial role in institutionalizing these commitments by embedding environmental objectives into national fiscal frameworks. By aligning budgetary allocations with environmental objectives, green budgeting aims to ensure that public funds support sustainable development and contribute to the mitigation of climate change.

The Organisation for Economic Co-operation and Development (OECD) defines green budgeting as the use of the budgetary system to promote the alignment of national expenditure and revenue processes with climate and other environmental goals. This involves evaluating the environmental impacts of budgetary and fiscal policies, thereby enhancing transparency and accountability in how public finances address environmental challenges[74].

A report by the European Commission, the OECD and IMF highlights that national budgets play a crucial role in **prioritizing and resourcing governmental policies**, which can significantly impact the economy, environment, and society. Green budgeting integrates climate and environmental objectives into a country's budgetary and public financial management frameworks and practices, helping achieve goals ranging from climate mitigation to biodiversity protection[75].

The International Monetary Fund (IMF) emphasizes the importance of **climate-sensitive management** of public finances, or «green Public Financial Management (PFM).» This approach involves incorporating climate considerations into various stages of the budget cycle, including planning, execution, and reporting, to ensure that fiscal policies effectively address climate-related risks and opportunities[76].

Despite its benefits, implementing green budgeting presents challenges, such as the need for robust data, institutional capacity, and coordination across government agencies. The OECD's 2024 report on green budgeting practices indicates that countries have adopted **multi-initiative approaches**, reflecting differences in climate and environmental policies, resources dedicated to green budgeting, and existing budget frameworks[77].

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70 International Monetary Fund, Nicoletta Batini, By Mario di Serio, Matteo Fragetta, Giovanni Melina & Anthony Waldron, Building Back Better: How Big Are Green Spending Multipliers?, 2021.
71 University of Oxford, New report suggests that a greener recovery from the pandemic will create more jobs, spur long-term growth, and save lives | University of Oxford, 2021.
72 University of Oxford, Green investment works: world-first systematic review shows positive economic outcomes in green government spending | Smith School of Enterprise and the Environment, 2022.
73 The Nature Conservancy, FINANCING NATURE: Closing the Global Biodiversity Financing Gap - Full Report, 2020.
74 OECD, Green Budgeting in OECD Countries, 2024.
75 EC, OECD, IMF, Green Budgeting: Towards Common Principles, 2021.
76 IMF, Climate-Sensitive Management of Public Finances—»Green PFM", 2021.
77 OECD, Green Budgeting in OECD Countries, 2024.

BOX 5

France, a Green Budget leader

France[78] has emerged as a pioneer in the integration of environmental considerations within its fiscal policies through the implementation of its Green Budget and the accompanying 2030 Roadmap. This initiative is designed to evaluate the environmental impact of public expenditures and revenues by systematically identifying which budgetary measures promote or hinder environmental sustainability. The Green Budget, presented as an annex to the annual finance law, serves as a comprehensive report detailing the ecological footprint of state spending, while the 2030 Roadmap sets a strategic framework to meet the nation's sustainable development goals.

At its core, the initiative aims to integrate environmental factors directly into the state's budgeting process, ensuring that public policies are aligned with the broader objectives of the ecological transition. By emphasizing transparency, the government seeks to clearly demonstrate how each financial decision contributes to—or detracts from—its environmental commitments. Quantitative targets include reducing greenhouse gas emissions by 52 percent by 2030 compared to 2005 levels and doubling decarbonization investments to reach an annual target of 110 billion euros. In the long term, the initiative also supports the overarching ambition of achieving carbon neutrality by 2050[79].

The Green Budget was first introduced in 2021 and has since been updated annually, reflecting the dynamic nature of France's environmental and fiscal strategies. Complementing this, the 2030 Roadmap was launched in 2019, outlining a clear set of actions and commitments to be fulfilled by 2030. The implementation of these measures is spearheaded by the Ministry of Economy, Finances and Recovery in conjunction with the Ministry of Ecological Transition, alongside other relevant governmental bodies. These institutions mobilize substantial resources, including financial allocations from the "France Relance" recovery plan—amounting to around 30 billion euros—as well as technical and political assets essential for the initiative's success[80].

Continuous monitoring and evaluation are key features of this initiative. An annual report is published to assess the environmental impact of the state budget, and national indicators have been established to track progress towards the sustainable development goals outlined in the 2030 Roadmap. For more detailed information, official sources such as the French government's budget website and the Agenda 2030 portal provide comprehensive insights into both the conceptual framework and the operational details of the initiative. A conceptual diagram and related imagery further illustrate the strategic vision and practical application of France's Green Budget, underlining the country's commitment to aligning fiscal policy with environmental sustainability[81].

78 SDG Summit 2019, France's Road Map for the 2030 Agenda, 2019.
79 La plateforme des finances publiques du budget de l'État et de la performance publique, Budget Bill 2024 : 4th edition of the Green Budget, 2024.
80 Ministry for Europe and Foreign Affairs, France Relance recovery plan: building the France of 2030, 2020.
81 Iulia Ruxandra Teodoru, Xun Li, Rachel Lee, Hugo Rojas-Romagosa, and Nate Vernon, Deep Dive on the Climate Transition for France in: Selected Issues Papers Volume 2024 Issue 033, 2024

2.2.3 Green Public Procurement

Green public procurement (GPP) leverages the purchasing power of governments to promote environmentally preferable goods and services. By integrating environmental criteria into their procurement processes, governments can stimulate market demand for sustainable products, encourage innovation, and lead by example in promoting sustainable consumption and production patterns. The OECD recognizes GPP as a strategic tool for governments to achieve environmental policy goals while ensuring value for money[82]. The OECD's Sustainable Public Procurement Toolkit provides guidance to policymakers on implementing GPP, emphasizing its potential to drive innovation, reduce environmental impacts, and support sustainable economic growth.

The **World Bank** also highlights the transformative power of GPP in driving markets for sustainable goods and services[83]. By setting clear environmental standards and prioritizing sustainable suppliers, governments can create a ripple effect across the supply chain, encouraging businesses to adopt greener practices. This, in turn, can lead to the development of new markets for eco-friendly products and services, fostering a more sustainable and competitive economy.

In the Mediterranean region, GPP can play a crucial role in addressing environmental challenges such as climate change, water scarcity, and biodiversity loss. For instance, governments can prioritize the purchase of energy-efficient buildings, renewable energy technologies, and sustainable transportation systems. Some countries in Europe (Spain, France, Italy) and North Africa (Tunisia, Morocco) have started to review and reform their public procurement practices. By doing so, they can significantly reduce their environmental footprint and contribute to regional sustainability goals. However, despite its potential, GPP also faces several barriers, including cost premiums on sustainable goods, limited supplier readiness, and the need for stronger regulatory frameworks. Addressing these challenges will be essential to fully unlocking the benefits of green public procurement in the region[84].

2.2.4 Green Subsidies

Green subsidies are financial incentives provided by governments to support environmentally friendly practices and technologies, aiming to accelerate the transition to a sustainable, low-carbon economy. These subsidies can take various forms, including grants, tax incentives, and low-interest loans, targeting sectors such as renewable energy, energy efficiency, and sustainable agriculture.

The **International Monetary Fund** (IMF) acknowledges that green subsidies can be beneficial in addressing **market failures**, particularly when carbon emissions are not adequately priced. By lowering the costs of clean technologies, these subsidies encourage businesses and consumers to adopt less polluting alternatives[85]. However, the implementation of green subsidies is not without challenges. Experts caution that, despite their environmental intentions, such subsidies may have hidden costs. For instance, a recent study suggests that certain subsidies might inadvertently lead to increased emissions or other unintended environmental consequences[86]. Moreover, the international trade implications of green subsidies are complex. The World Bank has examined how the **World Trade Organization** (WTO) regulates environmental subsidies, particularly those related to renewable energy. The analysis indicates that while green subsidies can promote environmental objectives, they must be carefully designed to comply with international trade rules and avoid potential disputes[87].

The phasing out of **Environmentally Harmful Subsidies** (EHS) and the promotion of **Green incentives** serve as a vital policy mechanism for promoting sustainable development and mitigating climate change in the Mediterranean[88]. When thoughtfully designed and implemented, they can effectively address market failures and stimulate the adoption of cleaner technologies and practices. However, it is essential to consider potential hidden costs and trade implications to ensure that these subsidies achieve their intended environmental benefits without adverse side effects.

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82 OECD, Green Budgeting in OECD Countries, 2024.
83 World Bank Group, Green Public Procurement : An Overview of Green Reforms in Country Procurement Systems, 2021.
84 World Bank Group, Green Public Procurement : An Overview of Green Reforms in Country Procurement Systems, 2021.
85 IMF, Europe, And the World, Should Use Green Subsidies Cooperatively, 2023.
86 University of Connecticut, Green Subsidies May Have Hidden Costs, Experts Warn, 2024.
87 World Bank Group, Resuscitating WTO for the Energy Transition, 2024.
88 Plan Bleu & Eco-union. Unraveling the Impact of Environmentally Harmful Subsidies in the Mediterranean, Chapter 1: Measuring Progress and Accountability in Phasing Out Environmental Harmful Subsidies, 2024.

BOX 6

Italy, a frontrunner in green fiscal reform

Italy[89] has implemented an innovative initiative to steer fiscal reforms and promote sustainable investments through its Catalog of Environmentally Harmful and Beneficial Subsidies. This comprehensive tool systematically categorizes public subsidies based on their environmental impact, distinguishing those that contribute to environmental degradation from those that foster sustainable development. By identifying and phasing out harmful subsidies while bolstering green financial support, the catalog plays a critical role in guiding Italy's fiscal policy towards a more sustainable future.

The primary objective of the initiative is to reform fiscal policies by reducing environmentally detrimental subsidies and redirecting public funds towards projects that promote sustainability. By doing so, it enhances transparency and accountability in public spending, setting clear quantitative and qualitative targets—namely, the gradual reduction of harmful subsidies and the increased allocation of resources for environmentally beneficial initiatives. This approach not only facilitates better fiscal management but also supports the country's broader environmental goals.

First introduced in 2017 and updated periodically (with the latest revision in 2022), the catalog is managed by the Italian Ministry of Environment, Land and Sea in collaboration with national agencies responsible for public finance reforms. The initiative mobilizes substantial financial resources through budget reallocations, leverages technical expertise for data collection and subsidy impact assessments, and relies on strong political commitment to drive legislative reforms and stakeholder engagement.

Regular review cycles and public reports are integral to the monitoring process, ensuring that the progress of fiscal reforms is transparently communicated and that the catalog's data is integrated into the national sustainable development monitoring system. This continuous evaluation mechanism helps Italy align its fiscal policies with its environmental objectives, ultimately contributing to a greener, more accountable public finance framework.



89 Ministero dell'Ambiente e della Sicurezza Energetica, Catalogo dei sussidi ambientalmente dannosi e dei sussidi ambientalmente favorevoli, 2024.

BOX 7

Türkiye, green economic tools aligned with green public finance to finance renewable energies

Türkiye has embarked on an ambitious initiative that strategically integrated Sustainable Development Goals (SDGs) with renewable energy financing. Recognizing that achieving long-term economic growth, social inclusion, and environmental protection requires a holistic approach, Türkiye is aligning its policy frameworks with the global SDG agenda. This integration focuses on mobilizing both public and private investments in renewable energy projects, ensuring that financial flows support the country's broader climate and sustainability objectives[90].

At the heart of this initiative is a commitment to diversify the nation's energy portfolio and reduce reliance on fossil fuels. By coupling renewable energy financing with clear SDG targets—such as affordable and clean energy, sustainable industrialization, and climate action—Türkiye is creating an enabling environment for innovation and investment. Financial instruments, including green bonds, public-private partnerships, and tailored credit facilities, are being leveraged to attract capital into the renewable energy sector. This not only accelerates the deployment of renewable technologies like solar and wind but also promotes economic resilience and job creation in emerging green industries[91].

Furthermore, the integration of SDGs into renewable energy financing enhances transparency and accountability. It provides a framework for measuring the environmental and social impacts of investments, ensuring that projects contribute meaningfully to sustainable development. Regular monitoring and evaluation mechanisms have been established to track progress against key performance indicators, thereby facilitating informed policy adjustments and fostering long-term sustainability.

In essence, Türkiye's approach exemplifies a forward-thinking model where strategic financial planning is seamlessly aligned with global sustainability goals, driving the country toward a more resilient and low-carbon future.



90 Reuters, Turkey aims to quadruple wind and solar energy capacity by 2035 | Reuters, 2024.
91 Reuters, Turkey, AIIB signs MoU for $5 billion financing to public sector projects | Reuters, 2025.

3. INSTITUTIONAL, ECONOMIC AND POLITICAL CHALLENGES

The success of green economic tools and public finance mechanisms hinges not only on their design but also on the institutional frameworks and governance structures within which they operate. This section examines the critical role of institutions and governance in shaping the effectiveness and impact of these tools, particularly in the Mediterranean context.

3.1 Institutional and Governance Issues

Institutional frameworks and governance structures play a crucial role in the implementation and success of environmentally friendly economic tools and finance mechanisms. In the context of the Mediterranean, these frameworks are essential for addressing the region's unique environmental challenges, including water scarcity, climate vulnerability, and biodiversity loss, while ensuring policy coherence and effective resource allocation[92].

The Mediterranean region is characterized by a **diversity of governance systems and institutional capacities**. Some countries have well-established regulatory frameworks and enforcement mechanisms, while others face challenges such as weak institutional capacity, political instability, and limited financial resources. This disparity significantly influences the adoption and effectiveness of green economic tools across the region[93]. For example, robust institutions are better equipped to implement policies like carbon pricing, environmental taxation, and green budgeting, ensuring that these tools are effectively aligned with broader sustainability goals.

Governance frameworks also play a critical role in fostering collaboration among stakeholders, including governments, private sectors, and civil society. The **European Green Deal** (EGD) serves as an exemplary model of integrated governance, encouraging Mediterranean countries to harmonize their policies with broader regional and international environmental objectives. However, its influence on non-EU Mediterranean countries faces challenges, such as differences in regulatory frameworks, financial constraints, and varying levels of institutional capacity. Ensuring that the EGD's principles are effectively adapted to these contexts will be key to fostering broader regional cooperation on sustainability[94].

Furthermore, institutional frameworks must ensure **transparency, accountability, and stakeholder engagement** to build public trust and promote policy compliance. The Organisation for Economic Co-operation and Development (OECD) highlights that good governance practices, such as participatory decision-making and clear accountability mechanisms, are essential for the successful implementation of green public finance mechanisms[95].

In addition to regional governance efforts, international organizations such as the United Nations Environment Programme (UNEP) and the World Bank provide technical and financial support to Mediterranean countries, enabling them to strengthen their institutional capacities. For instance, the **UNEP's Mediterranean Action Plan** (UNEP/MAP) focuses on enhancing environmental governance in the region through capacity-building initiatives, environmental policies and the adoption of science-based sustainability frameworks, such as the **Mediterranean Strategy for Sustainable Development** (MSSD).

Despite these efforts, challenges remain in aligning national governance systems with transnational environmental goals. Fragmented policy approaches and inconsistent enforcement mechanisms often hinder the effectiveness of green economic tools. To address these challenges, experts recommend adopting **integrated governance approaches** that consider cross-sectoral linkages and prioritize long-term sustainability[96].

3.2 Economic and Political Factors

The Economic and political factors significantly shape the adoption and implementation of Green Economic Tools and Public Finance mechanisms in

92 Plan Bleu, State of the Environment and Development in the Mediterranean, 2020.
93 Eco-union, The implementation of the Sustainable Development Goals in the Mediterranean, 2017.
94 European Commission, The European Green Deal - European Commission, 2019.
95 OECD, Green finance policies, institutions, tools and governance, 2025.
96 EEA - European Environment Agency, Governance in complexity, 2024.

Mediterranean countries. These factors influence both the capacity of governments to mobilize resources and their political will to integrate environmental objectives into their economic strategies.

The transition to a green economy requires significant **resources**, both from private investors and public policy makers with important implications for employment and living standards. Green **macro-economic policies** - targeting the fiscal, monetary and financial market- are essential in accelerating the transition to strengthen the price signals; mobilize additional public and hybrid funding; and soften the social and labor market impact of the transition for those workers currently still employed in polluting industries[97].

Fiscal transition management is also essential to ensure a smooth path towards a Green Economy. The advancement towards climate neutrality will impact government expenditures and revenues due to climate-related damages and the implementation of mitigation policies. While carbon pricing strategies can initially boost revenues, their long-term success in reducing emissions may lead to lower fiscal income. A recent paper explores the necessity of investments to support the economic transformation towards a net-zero emission future and discusses the varying degrees of fiscal impact across different regions and policy mixes. It stresses the importance of broadening the tax base and incorporating innovative financing strategies to ensure fiscal sustainability during the transition[98]. Notably, some Mediterranean countries, particularly those with limited fiscal capacity and heavy reliance on fossil fuel-related revenues—such as Algeria and Egypt—might face the biggest risks from declining carbon revenues.

From an economic perspective, **national income levels** are a key determinant to advance the Green Economy. High-income countries generally have greater fiscal capacity to invest in green initiatives such as renewable energy subsidies or ecosystem restoration. In contrast, middle- and low-income countries face fiscal constraints that limit such investments, often exacerbated by heavy debt burdens, which compel governments to prioritize short-term expenditures over long-term environmental goals.

Moreover, the **economic structure** of each country plays a crucial role. Economies reliant on tourism or agriculture often have a direct interest in preserving their natural resources, leading them to adopt mechanisms such as eco-labeling or water-efficient technologies. Conversely, nations whose economies depend heavily on resource extraction may resist policies like carbon pricing due to potential economic disruptions.

Political stability and policy continuity strongly influence the success of green initiatives. Politically stable countries are better positioned to design and implement long-term environmental strategies. On the other hand, nations experiencing frequent governance changes or political instability risk seeing their green initiatives interrupted or undermined. Institutional capacity is another critical factor. States with robust mechanisms to enforce environmental regulations, monitor their implementation, and mobilize financial resources are more likely to successfully integrate green economic tools into their policy frameworks. However, weak institutions and a lack of transparency often hinder these efforts, increasing public mistrust in green policies.

Geopolitical dynamics further complicate regional cooperation efforts in the Mediterranean. Shared environmental challenges, such as water scarcity and biodiversity loss, call for transboundary solutions. Although cooperative initiatives, such as joint funding for green infrastructure or regional carbon markets, have emerged, geopolitical tensions and divergent national priorities often impede such efforts. Additionally, the influence of international organizations and foreign donors, such as the European Union or the United Nations Environment Programme (UNEP), is particularly pronounced in middle- and low-income Mediterranean countries. While these actors can play a catalytic role by providing financial and technical support, their involvement sometimes limits national ownership and the adaptation of policies to local contexts.

By considering these various dimensions, it is evident that the economic, fiscal and political disparities among Mediterranean countries profoundly shape their trajectories toward sustainable development. Addressing these factors is essential for designing and implementing effective green economic tools tailored to the region's diverse realities.

97 Frontiers in Climate, Financing the green transition. The role of macro-economic policies in ensuring a just transition, 2023.
98 European Commission, Fiscal Challenges in the Green Transition: A Global Perspective, 2024.

3.3 Strategic Policy Framework Towards Sustainability

The strategic approaches and policy frameworks adopted by Mediterranean countries to foster sustainability are essential to advance a Green Economy. It contributes to integrating environmental considerations into development agendas and the specific policies to achieve sustainability goals.

3.3.1 Mediterranean Level

The **Mediterranean Strategy for Sustainable Development** (MSSD) 2016–2025[99], endorsed by Contracting parties of the **Barcelona Convention** provides a robust regional framework to advance a green and blue economy, emphasizing sustainable development while enhancing social equity and reducing environmental risks. Objective 5 of the MSSD, «Transition towards a green and blue economy,» explicitly highlights the importance of promoting sustainability across multiple sectors, integrating innovative economic models, and ensuring inclusive social progress.

This objective defines the green economy as encompassing r**enewable energy, waste management, and sustainable consumption and production.** Additionally, it incorporates new paradigms such as the **circular economy**, which emphasizes the reuse of resources, the collaborative economy, which fosters shared access to goods and services, and the functional economy, which focuses on delivering services over ownership. By advancing these concepts, the strategy aims to align economic growth with environmental preservation.

Specific actions under this objective include fostering (green and fair) **job creation**, particularly for youth and women, as a means to reduce poverty and promote social inclusion. The strategy also emphasizes the importance of adopting sustainable consumption and production patterns, encouraging environmentally friendly innovation, and integrating sustainability principles into both public and private investment decisions. A central focus is placed on developing **greener and more inclusive markets** that internalize the true environmental and social costs of products and services, thereby addressing externalities and promoting long-term sustainability.

Moreover, the MSSD supports the development of **indicators and metrics** to measure progress in transitioning to a green and blue economy, ensuring that actions are guided by evidence-based policies. It also underscores the critical role of the UNEP/MAP Sustainable Consumption and Production Action Plan for the Mediterranean, which provides a complementary framework for advancing sustainable practices at the regional level. Through these initiatives, the strategy seeks to harmonize economic activity with the ecological and social needs of the Mediterranean region.

3.3.2 Country Level

A Policy assessment was made in 2023 to identify and review the quality and consistency of the National Strategies on Sustainable Development (NSSD) developed by Mediterranean countries in the framework of the 2030 Agenda and the Sustainable Development Goals (SDGs). Despite limitations in terms of data access and accuracy, it can serve as a proxy to compare the ambition and credibility of Green Economy Strategy and Policies endorsed by national governments.

10 Mediterranean countries (Bosnia and Herzegovina, Croatia, France, Greece, Italy, Malta, Montenegro, Morocco, Slovenia and Spain) have a “good” NSSD with clear goals and monitoring indicators. 7 countries (Albania, Algeria, Cyprus, Israel, Monaco, Tunisia and Türkiye) have a “moderate” NSSD due to outdated or incomplete information. Finally, 4 countries (Egypt, Lebanon, Palestine and Syria) have a “weak” NSSD due to a lack of a planning, capacity or monitoring framework.

99 United Nations Environment Programme - Mediterranean Action Plan - Barcelona Convention, Mediterranean Strategy for Sustainable Development (MSSD), 2024.

Country	Green Economy, Sustainability Frameworks and/or National Strategy For Sustainable Development (NSSD)	Comments	Assessment	Justification
ALBANIA	National Strategy for Development and Integration 2015-2020 (NSDI II)	The National Strategy for Development and Integration 2015-2020 (NSDI II) is the core strategic document that combines the EU integration agenda with the country's sustainable economic and social development goals, including its correlation with the sustainable development goals. NSDI III is under preparation with interim nationalized Sustainable Development Goal indicators and targets.	*Moderate*	The current strategy is outdated. Update is underway.
ALGERIA	Several sectoral plans and strategies but no NSSD as such	- National Strategy for the Environment and Sustainable Development (2020-2035) - National Action Plan for Environment and Sustainable Development 2035 (PNAE-DD) - Algerian National Climate Plan (PNC) - Plan d'action MCPD Algérie 2016-2030: 42 Actions pour développer des Modes de consommation et de production durables - programs of energy transition and the development of renewable energies.	*Moderate*	Algeria does not have a formal governmental strategy on the 2030 Agenda, although there are ongoing sectorial policies for agriculture, fisheries, renewable energy or water that take into account sustainability.
BOSNIA & HERZEGOVINA	SDG Framework	The first step in implementing Agenda 2030 in BiH was the creation and adoption of the SDG Framework. This document, developed collaboratively by all levels of government, outlines the development pathways through which BiH aims to contribute to the SDG implementation. Bosnia also has adopted the Development Strategy of the Federation of Bosnia and Herzegovina 2021-2027, which defines public policies and directs the socio-economic development of the territory of FBiH.	*Good*	Strategy adopted in 2021, with provisions related to financing and budget and a comprehensive set of indicators.
CROATIA	National Development Strategy of the Republic of Croatia (NDS 2030)	Previous strategy: Strategy for sustainable development of the republic of Croatia (2009).	*Good*	Not legally binding, but shows commitment to implement the 2030 Agenda and converge to European standards based on the overarching objective to enter the EU. The update is recent, and it also has a specific website.

CYPRUS	Cyprus revised its NSDS in 2010. More recent frameworks include Vision 2035 (adopted 2022), the updated NECP 2021–2030 (2024), and the ESD & Green Transition Strategy 2021–2030.	Cyprus has taken steps beyond the outdated 2010 NSDS, with recent strategies covering long-term sustainability, climate, and education. An SDG Action Plan is under development.	*Moderate*	The current strategy is outdated. Cyprus has yet to adopt a comprehensive policy framework for implementation of the goals in the national context there; however, there are initiatives that promote sustainable development, and an Intergovernmental Commission has been established for the implementation of the SDGs.
EGYPT	Sustainable Development Strategy (SDS): Egypt Vision 2030	Egypt's Sustainable Development Strategy (SDS): Vision 2030 is a comprehensive national agenda launched in 2016 to guide the country's economic, social, and environmental development. Aligned with the UN Sustainable Development Goals, it aims to achieve inclusive growth, social justice, and environmental sustainability by 2030. The strategy emphasizes good governance, innovation, and human capital development, positioning Egypt as a competitive and diversified economy.	*Weak*	Although it presents ambitious plans for Egypt's development, it is vague on the details on how to reach its goals. Moreover, it is more a general development strategy than a specific SD strategy.
EUROPEAN UNION	European Green Deal	Since the adoption of the first EU Sustainable Development Strategy (EU SDS) in 2001, revised in 2006, the EU has strengthened its commitment through the European Green Deal (EGD) launched in 2019. Aiming for climate neutrality by 2050, the EGD places the SDGs at the core of EU policy. Key strategies include Fit for 55, the Circular Economy Action Plan, the Farm to Fork Strategy, and the Biodiversity Strategy. Funding relies on instruments like NextGenerationEU and the EU Taxonomy. Implementation follows an integrated approach at all levels—especially regional and local—monitored through the European Semester.	*Good*	Good integrated whole-of-government approach that places the SDGs at the core of EU policy, legislation and funding, in order that all EU actions and policies contribute to delivering on the SDG.
FRANCE	Roadmap for the 2030 Agenda	France's Roadmap for the 2030 Agenda, adopted in 2019, is the national strategy to implement the UN Sustainable Development Goals (SDGs). It defines six priority challenges and promotes a whole-of-society approach, with clear monitoring tools and cross-sector coordination.	*Good*	Complete framework for policies. The goals are clear and detailed with monitoring indicators. The Roadmap adopted in 2019 complements the strategy.
GREECE	National Strategy for Sustainable and Fair Growth 2030	In May 2018, Greece adopted a National Growth Strategy, consequently updated in May 2019 as the "National Strategy for Sustainable and Fair Growth 2030" fully aligned with the 2030 Agenda for Sustainable Development objectives.	*Good*	It includes 40 key performance indicators relating to SDG implementation.

ISRAËL	Several sectoral plans and strategies but no NSSD as such.	The Parliament is examining ways in which SGD thinking and terminology can be incorporated in the process of preparing legislation, and the Government integrates SDGs in its strategic planning. The Israeli Cabinet approved in 2019 a proposal to integrate the UN's Sustainable Development Goals into Israeli programs. Israel does have a Strategic Plan for Sustainable Development (Government Decision no. 246) that dates back to 2003, prior to Agenda 2030.	*Moderate*	Israel does not have an overall sustainable development strategy enshrined in one document, but incorporates SDGs in several strategic plans and has integrated sustainable development in the country's strategic planning.
ITALY	National Sustainable Development Strategy 2017/2030	The NSDS is an update of the former Environmental Action Strategy for Sustainable Development (2002-2010).	*Good*	Complete and relevant document, set to be periodically updated.
LEBANON	Several sectoral plans and strategies but no NSSD as such.		*Weak*	Lebanon does not have a formal governmental strategy on the 2030 Agenda. The country does have some sectoral plans focused on sustainability, a national committee to oversee the roll-out of the SDGs chaired by the Prime Minister (that includes civil society and private sector representatives), and a parliamentary committee on SDGs.
LIBYA	No NSSD adopted as such	Even if it does not have a proper National Strategy for SD, it published in 2015 a National Action Plan on Sustainable Production and Consumption focusing on the industrial sector (published with the support of the SwitchMed program). There is also a legislative institutional mechanism to monitor the SDGs within the Lebanese parliament. Ministries are also taking into consideration the integration of the SDGs within their planning.	*No data*	
MALTA	Malta's Sustainable Development Strategy for 2050	Malta's first Sustainable Development Strategy was adopted in 2007 with a mandate until 2016. After the completion of this period, the Maltese Government began developing a new strategy, publishing a Vision Document in 2018. On December 9, 2022, Malta launched the Sustainable Development Strategy for 2050 for public consultation. This updated strategy outlines long-term goals to transition to a green and blue economy, promote sustainable urban development, ensure healthy lives and well-being, accelerate digital transformation, and achieve social equity and prosperity.	*Good*	Complete and relevant document, aiming for a longer term (2050), and it is also considered ambitious for its commitment to advance sustainable development in every sector at all levels.

MONACO	Several sectoral plans and strategies but no NSSD as such	Monaco has adopted SD strategies in various sectors, like tourism.	*Moderate*	Monaco does not have a national strategy for sustainable development, but has adopted a number of sectoral strategies to advance the Principality towards sustainability.
MONTENEGRO	National Strategy on Sustainable Development until 2030	The Government of Montenegro adopted the first National Strategy for Sustainable Development (NSSD) in April 2007, together with a corresponding Action Plan (AP) for the period of 2007-2012.	*Good*	Complete and relevant document.
MOROCCO	National Strategy of Sustainable Development 2030	Morocco's National Strategy for Sustainable Development 2030 (SNDD) is a comprehensive framework aimed at guiding the country toward a green and inclusive economy, aligned with the 2030 Agenda for Sustainable Development. The strategy focuses on enhancing governance, promoting a green economy transition, ensuring social equity, and protecting the environment. It includes actions to mitigate climate change, improve resource efficiency, and promote sustainable production and consumption. The strategy also emphasizes international cooperation to share knowledge and resources for sustainable development.	*Good*	Recently updated, with monitoring indicators and covering all sectors.
THE STATE OF PALESTINE	Several sectoral plans and strategies but no NSSD as such	Despite incorporating the principles of sustainable development in some plans, there is no overall SD specific strategy. In 2016, the Palestinian government adopted the "2017-2022 National Policy Agenda: Putting Citizens First" (NPA) that dedicates one of its 3 strategic pillars to Sustainable Development. The NPA has adopted 75 of the SDG targets.	*Weak*	Lack of a comprehensive and unified planning and progress monitoring framework, although there are sectoral plans that have been aligned with SDGs. Lack of up-to-date data on a large number of SDG indicators. Lack of capacity to effectively take action on sustainable development.
SLOVENIA	Slovenian Development Strategy 2030	The Slovenian Development Strategy 2030 is Slovenia's long-term national development framework, aiming to ensure a high quality of life for all citizens. Adopted in December 2017, the strategy outlines five strategic orientations and twelve development goals, aligning closely with the United Nations Sustainable Development Goals (SDGs). It emphasizes balanced and inclusive economic, social, and environmental development.	*Good*	Complete and relevant. In preparation of the strategy, Slovenia worked closely with OECD experts and used relevant OECD tools. It also prepares Development Reports to monitor implementation of the strategy.

SPAIN	Sustainable Development Strategy 2030	Spain is in the process of developing its Sustainable Development Strategy 2030, aligning with the 2030 Agenda. Although the strategy is not yet finalized, Spain has shown commitment through various initiatives and voluntary national reviews. The country has also made progress in its international cooperation policy, ensuring alignment with the SDGs.	*Good*	Complete and relevant, with a recently published Roadmap for implementation.
SYRIA	Strategic Plan "Syria 2030"	In October 2019, the Government issued the Strategic Plan "Syria 2030". This document outlines the Government's guiding policies and implementation framework in line with the 2030 Agenda.	*Weak*	A national strategy has been adopted recently, but the country's capacity to effectively take action on sustainable development is doubtful given its structural challenges on social, economic and political levels.
TUNISIA	National Strategy for the Green Economy (2016-2036)	Tunisia's National Strategy for the Green Economy (2016-2036) aims to harmonize economic, social, and environmental policies for sustainable development. Additionally, the National Strategy for the Development of Green Hydrogen, unveiled in September 2023, outlines plans to export over 6 million tonnes to Europe by 2050.	*Moderate*	Tunisia is working on the National Strategy for the Green Economy (2016-2036), which aims to integrate environmental, social, and economic policies for sustainable development. This strategy focuses on transitioning to a green economy, reducing carbon emissions, and promoting resource efficiency.
TURKEY	Several sectoral plans and strategies but no NSSD as such	Turkey adopted the Eleventh Development Plan (2019-2023), which integrates the Sustainable Development Goals (SDGs) into national policies. The Twelfth Development Plan (2024-2028), approved by the Turkish Parliament in October 2023, is currently in effect. While Turkey does not have a distinct National Sustainable Development Strategy (NSSD), it has established structures for coordinating the implementation of the SDGs, including the National Commission for Sustainable Development to oversee actions by relevant institutions.	*Moderate*	Türkiye integrates SDG action into its National Development Plans and sectoral strategies, and has established a National Sustainable Development Commission to lead the concerted action by all relevant institutions, and actively tracks progress on SDG indicators.

TABLE 2

State of Green Economy Strategies in Mediterranean countries

Source: eco-union

3.3.3 Green Growth Performance

The **Green Growth Index** measures country performance in achieving sustainability targets including Sustainable Development Goals, Paris Climate Agreement, and Aichi Biodiversity Targets for four green growth dimensions: efficient and sustainable resource use, natural capital protection, green economic opportunities and social inclusion. Globally, the scores of almost half of the countries are in the middle range, between 40 and 60 (out of 100). About 50 countries reached a high score between 60 and 80, many in Europe. Meanwhile, 8 countries have very low scores, between 20 and 40, from Africa and Asia. In the Mediterranean, EU member states perform better, followed by Morocco, Israel and Tunisia.

4. STATE OF PLAY IN THE MEDITERRANEAN

The findings of this study provide a comprehensive analysis of the state of Green Economic Tools and Public Finance mechanisms across Mediterranean countries, identifying key trends, success factors, barriers, and potential environmental and socio-economic impacts.

Previous **mapping of Green Economic Tools and Public Finance mechanisms** reveals significant diversity in the adoption and implementation of these instruments across the Mediterranean region. High-income countries, with robust fiscal capacity and established institutional frameworks, tend to lead in implementing sophisticated mechanisms such as green budgeting and eco-taxation. In contrast, lower-income countries, constrained by limited fiscal resources and less diversified economic structures, may benefit from alternative pathways—like blended finance solutions and targeted renewable energy incentives—that are more adaptable to their specific economic and developmental contexts. This interplay between economic structures and the choice of green finance mechanisms underscores the importance of tailoring strategies to suit each country's unique circumstances. **France**, for example, is the first country to implement a «green budget» that systematically evaluates the environmental impact of state spending and revenue policies[100]. Other **emerging nations**, like **Morocco** and **Tunisia**, are increasingly integrating renewable energy incentives and carbon pricing schemes to address their specific challenges, such as energy dependency and water scarcity. However, the effectiveness of these tools depends on several factors influencing their success or failure. Countries with strong institutional frameworks and political stability, such as Spain and Italy, have shown greater capacity to enforce green policies and mobilize resources. Conversely, nations with weaker governance structures, limited fiscal capacity, and conflicting policy priorities struggle to implement and sustain these mechanisms. The variation in economic structures also plays a role; for instance, tourism-dependent economies like **Greece** and **Croatia** are focusing on eco-labeling initiatives to protect their natural resources while maintaining economic growth.

Despite progress, significant **gaps and barriers** to implementation persist. Limited technical capacity and financial constraints remain major obstacles in middle- and low-income countries. The absence of harmonized regulations across the region also complicates cross-border initiatives, such as joint carbon markets or shared investments in green infrastructure. Furthermore, the lack of public awareness and stakeholder engagement often hampers the adoption of environmentally friendly practices, particularly in sectors resistant to change, such as fossil fuel-dependent industries.

The assessment of expected **environmental and socio-economic impacts** highlights the potential of scaling up Green Economic Tools to drive substantial benefits. Increased implementation of green taxation and carbon pricing mechanisms could lead to measurable reductions in greenhouse gas emissions, as demonstrated by France's eco-fiscal reforms. Furthermore, renewable energy incentives and green bonds have shown promise in fostering economic resilience and creating job opportunities in renewable sectors. For example, **Italy**'s catalog of environmentally beneficial subsidies has effectively supported the transition to cleaner energy systems[101].

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100 Ministère de l'Économie, des Finances et de l'Industrie et Ministère chargé du Budget et des Comptes publics, Budget vert : La France est le 1er pays au monde à mesurer l'impact du budget de l'État sur l'environnement, 2020.
101 Ministero dell'Ambiente e della Sicurezza Energetica, Catalogo dei sussidi ambientalmente dannosi e dei sussidi ambientalmente favorevoli, 2024.

The findings underline the urgent need for coordinated regional strategies to address implementation barriers, foster knowledge sharing, and harmonize green finance policies. By addressing these challenges, Mediterranean countries can maximize the potential of Green Economic Tools to achieve sustainable development and environmental protection objectives.

5. POLICY LEARNINGS

T The analysis of Green Economic Tools and Public Finance mechanisms across Mediterranean countries reveals significant variations in approaches, driven by differences in economic conditions, institutional capacities, and policy priorities. While some countries have made notable strides, others face persistent challenges in integrating sustainability into their economic and fiscal frameworks. This section compares these approaches, distills lessons learned, and provides policy recommendations for enhancing the effectiveness of green tools and mechanisms.

A comparative analysis highlights distinct trajectories among Mediterranean countries. **High-income nations**, such as **France** and **Italy**, have adopted advanced mechanisms like green budgeting and comprehensive environmental taxation systems. France's pioneering green budget systematically evaluates the environmental impact of state expenditures, ensuring alignment with climate objectives. Similarly, Italy has developed a detailed catalog of environmentally harmful and beneficial subsidies to guide fiscal reforms. These countries demonstrate how robust institutional frameworks and dedicated resources enable the implementation of complex green finance mechanisms.

In contrast, **middle- and low-income countries**, such as **Morocco** and **Tunisia**, often focus on targeted initiatives like renewable energy incentives and eco-labeling programs. These measures address immediate environmental challenges, such as energy dependency and biodiversity loss, but their scalability is limited by financial constraints and institutional weaknesses. For example, while Tunisia has successfully promoted solar energy adoption through fiscal incentives, the lack of technical capacity and regulatory coherence hinders broader implementation.

Key lessons emerge from these diverse experiences. First, **institutional strength** is a critical enabler of green economic reforms. Countries with clear governance structures, transparency, and accountability mechanisms are better positioned to design and enforce policies. Embedding these policies into robust legal frameworks and independent institutions can help ensure long-term compliance, even in the face of political shifts. Second, **stakeholder engagement** enhances public buy-in and compliance. Successful initiatives, such as Greece's eco-labeling programs for sustainable tourism, demonstrate the importance of involving local communities and businesses in environmental policy development. Maintaining long-term adherence to green policies can also be achieved through ongoing dialogue, participatory decision-making, and regular policy reviews that allow adjustments in response to changing political landscapes. Finally, **cross-sectoral integration** is essential for maximizing impact. Coordinating green tools across sectors—such as energy, agriculture, and transportation—ensures coherence and amplifies their cumulative effects.

To enhance the effectiveness of Green Economic Tools and Public Finance mechanisms in the Mediterranean, several policy recommendations are proposed.

1. **Develop a shared Green Economy vision:** Governments should promote a common vision for a sustainable and green economy in their country. This shared vision should outline the desired future state of the region's economy, encompassing environmental, social, and economic objectives.
2. **Develop a cross-sectoral and multi-stakeholders Green Economy Strategy:** Based on this vision, a comprehensive Green Economy Strategy should be developed, outlining clear targets, actions, and timelines for transitioning towards a sustainable model. This strategy should be inclusive, involving all relevant stakeholders, and should integrate green economic tools and public finance mechanisms into a coherent policy framework.

3. **Strengthen institutional capacity:** Governments should invest in building the technical expertise and administrative capabilities needed to design, implement, and monitor green policies. This includes establishing dedicated

units for environmental economics within finance ministries and enhancing regulatory frameworks.

4. **Promote regional cooperation:** Mediterranean countries should collaborate to harmonize standards and share best practices. For instance, developing a regional green taxonomy would facilitate cross-border investments and streamline the implementation of joint initiatives, such as carbon markets or biodiversity conservation projects.
5. **Expand financial resources:** Addressing fiscal constraints requires innovative funding mechanisms, such as green bonds and blended finance models. Public-private partnerships can also mobilize additional capital while sharing risks between stakeholders.
6. **Enhance stakeholder engagement:** Governments should prioritize participatory approaches, involving civil society, businesses, and local communities in the design and implementation of green policies. Transparent communication about the benefits and trade-offs of green reforms fosters trust and compliance.
7. **Foster innovation and data-driven decision and policy-making**: Investing in research, development, and digital tools can improve the design and evaluation of green policies. For example, adopting natural capital accounting systems provides valuable insights into the economic value of ecosystem services, enabling more informed policy choices.

By adopting these strategies, Mediterranean countries can overcome existing barriers, leverage lessons learned, and scale up the impact of Green Economic Tools and Public Finance mechanisms. This collaborative and adaptive approach will be essential for addressing the region's pressing environmental challenges while fostering sustainable economic growth.



6. CONCLUSION

To This study has provided an assessment of Green Economic Tools and Public Finance mechanisms relevant in the Mediterranean region, highlighting the diversity of approaches, the factors influencing their success, and the barriers to effective implementation. The findings underscore the critical role of these instruments in aligning economic policies with environmental objectives and advancing sustainable development.

A key finding is the significant variation in the adoption and effectiveness of green tools across the region. High-income countries have leveraged their institutional strength and fiscal capacity to implement comprehensive frameworks, including green budgeting and environmental taxation. Conversely, middle- and low-income countries have focused on targeted measures to address pressing environmental challenges. These differences reflect the region's economic and political diversity, which shapes the capacity and priorities of individual nations.

The implications for sustainable development and environmental protection are profound. Green Economic Tools have demonstrated their potential to reduce greenhouse gas emissions, promote renewable energy adoption, and conserve biodiversity, contributing to the resilience of ecosystems and societies. Additionally, these mechanisms can drive economic growth, create jobs, and foster innovation, offering a pathway to a greener and more equitable future for the Mediterranean. However, achieving these outcomes requires addressing persistent barriers, such as limited financial resources, weak institutional capacities, and fragmented policies. Aligning with emerging and existing EU regulatory frameworks, such as the **Carbon Border Adjustment Mechanism** (CBAM) and the **EU Green Taxonomy**, could offer Mediterranean countries opportunities to attract sustainable investment, enhance trade compatibility, and accelerate their green transitions.

Looking ahead, future research should focus on three key areas. First, more detailed **evaluations of the environmental and socio-economic impact**s of specific green tools are needed to build an evidence base that informs policy making. Second, studies on **regional cooperation and policy harmonization**, such as common green taxonomies or transboundary carbon markets, could identify opportunities for collective action. Finally, research should explore innovative **financing mechanisms**, including blended finance and nature-based solutions, to address the funding gaps in sustainable development initiatives.

Moreover, aligning with emerging and existing EU regulatory frameworks—such as the CBAM and the EU Green Taxonomy—could offer Mediterranean countries a structured pathway to harmonize their policies with broader European standards, thereby enhancing market access and fostering deeper regional integration.

By addressing these research and policy gaps and fostering regional collaboration, Mediterranean countries can strengthen their collective capacity to tackle environmental challenges and build a resilient, sustainable future for the region.

CHAPTER 2. FINANCING THE GREEN TRANSITION: A SYNTHESIS AND ANALYSIS OF GREEN FINANCE TOOLS EMPLOYED IN THE MEDITERRANEAN REGION

Author : Sevil Acar



Abstract

Historical and contemporary patterns in global greenhouse gas (GHG) emissions, alongside the resulting global warming, highlight the mechanisms, strategies, and policies that have contributed to the ecological crisis affecting both the environment and human well-being. From an economic standpoint, this adverse trajectory can be attributed to a combination of policy instruments, including taxes, subsidies, grants, loans, tax incentives, financial mechanisms, and regulatory frameworks. Conversely, a transition toward sustainability is achievable through targeted policies and economic tools, with green finance serving as a critical mechanism to support the shift to a low-carbon economy.

This chapter aims to examine the impacts of environmentally related taxes on climate change in selected Mediterranean countries, analyzed through the lens of economic policy. Additionally, the study explores other green finance instruments utilized within the region. The chapter highlights several key findings. First, environmentally-related taxes and climate taxes, while not significantly reducing per capita GHG emissions when applied alone, appear to become more effective when combined with stringent environmental policies. Specifically, based on the results of two sets of models mobilizing OECD data on environment-related tax revenues over the period 1994-2021 and IEA and EDGAR data on GHGPC emissions, a 1 percentage point increase in these taxes leads to a 0.01-0.02% decrease in GHG emissions per capita, with more stringent policies amplifying their impact. This result is supported by two sets of models: ENVTAX, examining how total environmental tax revenues as a percentage of GDP affect greenhouse gas emissions per capita (GHGPC), and CLIMTAX, which focuses on the impact of climate change-related taxes on GHGPC. Both sets of models mobilize OECD data on environment-related tax revenues for the period 1994-2021, and data extracted from the IEA and the EDGAR database on GHG emissions. According to the results, green taxation is all the more relevant when the revenues generated are reinvested in environmental actions, such as climate change mitigation or adaptation.

Additionally, the presence of feed-in tariffs (FiTs) for renewable energy does not significantly affect GHG emissions per capita unless the FiT prices for specific energy sources (e.g., hydro, waste, marine) increase, which then leads to a notable decrease in emissions. In contrast, increases in FiT for biomass energy are associated with higher emissions. Overall, FiTs can promote renewable energy production in an economic environment which also prioritizes a reduction in dependence on fossil fuels and reducing GHG emissions. However, they should be viewed with caution due to potential indirect negative impacts, as they may harm biodiversity in sensitive areas, and can encourage equipment imports over local industry development, among other things.

Experience so far highlights the necessity for both the public and private sectors to actively engage in fostering and advancing green finance.

Résumé

Les évolutions passées et présentes des émissions mondiales de gaz à effet de serre (GES), ainsi que le réchauffement climatique qui en découle, mettent en évidence les mécanismes, stratégies et politiques ayant contribué à la crise écologique qui affecte à la fois l'environnement et la qualité de vie humaine. D'un point de vue économique, cette trajectoire préoccupante résulte d'un ensemble d'instruments de politique publique : fiscalité, subventions, aides publiques, prêts, incitations fiscales, dispositifs financiers ou encore cadres réglementaires. À l'inverse, une transition vers un modèle durable est envisageable grâce à des politiques ciblées et à des outils économiques appropriés, parmi lesquels la finance verte joue un rôle essentiel pour accompagner le passage à une économie bas-carbone.

Ce chapitre se propose d'analyser l'impact des taxes environnementales sur la lutte contre le changement climatique dans plusieurs pays méditerranéens, en adoptant une perspective de politique économique. Il examine également d'autres instruments de finance verte mobilisés dans la région. Plusieurs constats majeurs en ressortent. Premièrement, les taxes environnementales et climatiques, prises isolément, n'entraînent qu'une réduction limitée des émissions de GES par habitant. En revanche, leur efficacité augmente sensiblement lorsqu'elles sont combinées à des politiques environnementales rigoureuses. Ainsi, une hausse d'un point de pourcentage de ces taxes se traduit par une diminution de 0,01 à 0,02 % des émissions par habitant, effet qui s'amplifie en présence de mesures plus contraignantes. Ce résultat est appuyé par deux ensembles de modèles : ENVTAX, examinant comment le total des recettes fiscales environnementales en pourcentage du PIB affecte les émissions de gaz à effet de serre par habitant (GESPC), et CLIMTAX, qui se concentre sur l'impact des taxes liées au changement climatique sur le GESPC. Ces deux ensembles de modèles mobilisent les données de l'OCDE relatives aux recettes fiscales liées à l'environnement pour la période 1994-2021 et les données extraites de l'AIE et de la base de données EDGAR sur les émissions de GESPC. Selon les résultats, la fiscalité verte s'avère donc d'autant plus pertinente que les recettes générées sont réinvesties dans des actions environnementales, telles que l'atténuation du changement climatique ou l'adaptation à ses effets.

Par ailleurs, la mise en place de tarifs de rachat garantis pour les énergies renouvelables n'a pas, en soi, d'effet significatif sur les émissions de GES par habitant, sauf lorsque les tarifs pour certaines sources spécifiques, comme l'hydroélectricité, les déchets ou les énergies marines, sont relevés, ce qui engendre alors une baisse notable des émissions. À l'inverse, une augmentation des tarifs de rachat pour la biomasse est, dans certains cas, associée à une hausse des émissions. Globalement, les tarifs de rachat peuvent favoriser le développement des énergies renouvelables à condition qu'ils s'inscrivent dans un cadre économique qui cherche également à réduire la dépendance aux énergies fossiles et à limiter les émissions de GES. Cependant, ils doivent être envisagés avec prudence en raison de leurs impacts négatifs indirects potentiels, car ils peuvent nuire à la biodiversité dans des zones sensibles et favoriser les importations d'équipements au détriment du développement des industries locales, entre autres.

L'expérience observée souligne enfin la nécessité d'une mobilisation conjointe des secteurs public et privé pour promouvoir et renforcer la finance verte, pierre angulaire de toute stratégie de transition écologique efficace.

1. INTRODUCTION

The primary focus of economic policies worldwide remains sustaining economic growth, yet the adverse impacts of global warming and environmental degradation have already become widespread across many countries. Despite the concerns regarding the unsustainability of current production and consumption patterns, the global community has failed to provide a common and robust response to these concerns against strong economic growth goals. It is observed that resources are used unsustainably as a result of the desire for higher levels of production and consumption as well as for rapid industrialization as part of countries' growth strategies.

Climate change is a pressing reality, scientifically proven and widely acknowledged. As stated by the Intergovernmental Panel on Climate Change (IPCC, 2013), «it is extremely likely that human influence has been the dominant cause of the observed warming since the mid-20th century.» Global greenhouse gas (GHG) emissions from the combustion of fossil fuels have increased extraordinarily since the onset of the Industrial Revolution. In 2022, the majority of global GHG emissions stemmed from carbon dioxide (CO2), largely produced by burning fossil fuels (71.6%). Methane (CH4) accounted for 21% of total emissions, with nitrous oxide (N2O) making up 4.8%, and fluorinated gases (F-gases) comprising the remaining 2.6% (IEA- EDGAR, 2023).

According to the world CO2 emissions statistics (IEA- EDGAR, 2023), GHG emissions released in the whole Mediterranean region were almost at the same level as those emitted by the EU27 countries as of 2022. While global GHG emissions reached 54 billion tonnes of carbon dioxide equivalent (CO2e), emissions in the EU27 and Mediterranean have recently stabilized at around 3.1-3.6 billion tonnes (Figure 1). In the European Union (EU), GHG emissions per capita have been on a downward trend, with countries like Spain, Italy, and France contributing significantly to this decline (IEA- EDGAR, 2023).

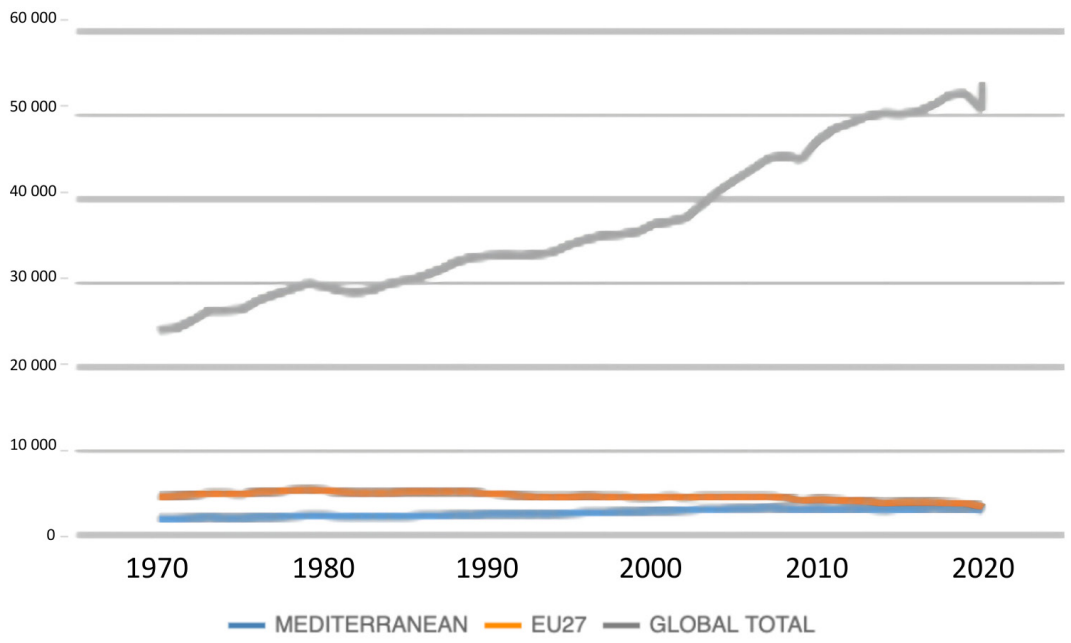


FIGURE.1 *GHG emissions by region (Mt CO2e/year)*
Source: Author's illustration using IEA- EDGAR (2023) data

The U.S. Energy Information Administration (EIA) (2021) reports that world energy-related CO2 emissions were at a level of 34 billion metric tons as of 2020 and are projected to incline considerably throughout the years from 2020 to 2050. Energy-related CO2 emissions are expected to surpass 40 billion metric tons by the year 2050. Taking a glance at their composition reveals that emissions from coal dominate all other sources in 2020 and will continue to be the major contributor to global energy-related emissions up to 2050. Emissions from coal are closely followed by those from liquid fuels. Emissions from natural gas make less than a third of the energy-related emissions throughout the inspected horizon (Figure 2). In addition to the GHG emissions caused by fossil fuel combustion and gas- or coal-fired power plants, there are other external costs of fossil fuel use in terms of environmental and health problems. Fossil fuels bear significant external costs such as creating water, air, and soil pollution and deteriorating public health.

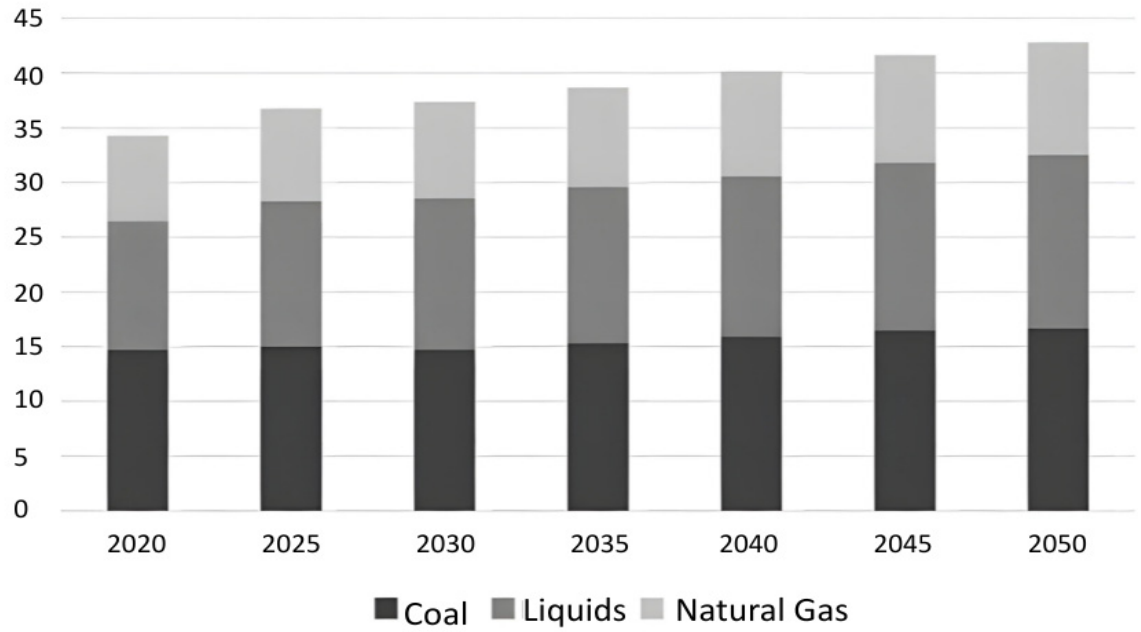


FIGURE.2 *World energy-related CO2 emissions by fuel type (billion metric tons) including projections up to 2050*
Source: U.S. Energy Information Administration (EIA) (2021) Annual Energy Outlook 2021
https://www.eia.gov/outlooks/ieo/tables_side_xls.php

Addressing environmental challenges requires considering the differing circumstances of countries at various stages of development, as they exhibit significant variation in their levels of environmental degradation. Historically, high income countries have had much higher per capita GHG emissions than those of low and middle income countries. The Southern and Eastern Mediterranean countries and the Balkan countries in the Mediterranean are mostly composed of middle-income countries, whereas the EU members in the Mediterranean as well as Israel are mostly high-income countries. From an economic standpoint, the current trajectory of emissions has been a result of a combination of various policy tools such as taxes, subsidies, grants, loans, tax exemptions or reductions, financial instruments, and regulations. Conversely, a shift towards sustainable practices is also achievable through a range of policies and strategies. Green finance represents one of these strategies aimed at facilitating the transition to a low-carbon economy.

This chapter first aims to assess the economic policy implications of environmentally related taxes and feed-in tariffs (FiTs) utilized in Mediterranean countries concerning their impact on climate

change. Second, it seeks to examine other green finance mechanisms employed and shed light on how they correlate with GHG emissions in the region. By doing so, the study seeks to evaluate the role and potential of green finance as a catalyst for advancing the transition to a low-carbon economy in the Mediterranean. This dual focus provides a comprehensive understanding of how economic tools and financial mechanisms can support sustainable development in the region.

The structure of the chapter is as follows: Section 2 undertakes a literature review on the implications of environmental finance policies for climate change outcomes and low-carbon transitions at country level. Section 3 aims to scrutinize the link between the selected finance mechanisms and per capita GHG emissions in Mediterranean states. Section 4 sheds light on the other green finance tools utilized in the region. Finally, Section 5 discusses the results, concludes and provides policy suggestions for the region.

As the EDGAR database used in this chapter reports GHG emissions produced in the region, this information should be borne in mind when interpreting the results. This approach reflects the emissions generated by a country's production activities, rather than the environmental impact of its residents' consumption. Since some of the produced goods may be exported—potentially to other countries within the region—the conclusions drawn should primarily address the production strategies of the countries analyzed. This focus is particularly relevant for this study, as the proposed financial instruments have the potential to shape these production strategies and, consequently, the associated GHG emissions.

2. LITERATURE REVIEW

Environmental taxation and renewable energy subsidies are pivotal tools in financing the transition to a green economy. These mechanisms leverage economic incentives to discourage environmentally harmful practices and foster sustainable development.

2.1 Environmental Taxation and its Role in Emissions Reduction

Second, Environmental taxes, in particular, target activities that generate negative externalities, such as carbon emissions, waste generation, and resource depletion, creating financial disincentives for damaging behavior.

Ma et al. (2018) use the environmental protection tax law in China as a case study to analyze how government tax oversight influences regional sustainable development, emphasizing the need for a robust green tax law system to achieve energy conservation and emission reduction goals while fostering green development. Similarly, Deng et al. (2022) argue that government tax policies play a critical role in shaping green development. Lv and Wu (2024) demonstrate that the reform of taxation systems has led to reduced carbon emissions in regions with stringent government environmental regulations as well as in regions with less stringent regulations in China. Furthermore, this transformation has facilitated regional green development overall. In the same vein, Chen et al. (2023) provide evidence that effective promotion of carbon emissions reduction hinges on leveraging the spatial effects of environmental taxes and carbon emissions in China. They advocate for establishing and enhancing a regional linkage mechanism for carbon emissions reduction, advocating for the inclusion of CO2 within the taxation scope to bolster the positive impact of environmental taxes on reducing carbon emissions. Their research emphasizes the importance of addressing the diverse implementation approaches of environmental taxes to successfully achieve emission reduction objectives. Obobisa and Ahakwa (2024) find that renewable energy consumption, financial development, and environmental taxes contribute to the reduction of CO2 emissions in 25 European countries, while Hao et al. (2021) and Xie and Jamaani (2022) detect a similar effect of environmental taxation on CO2 emissions in G-7 countries (i.e. Canada, France, Germany, Italy, Japan, the United Kingdom and the United States). Khan et al. (2022), He et al. (2023), and Li et al. (2023) discover that environmental taxes and stringent environmental policies effectively decrease emissions in OECD countries. He et al. (2023)

further demonstrate that an increase of one unit in environmental tax revenue per capita leads to a decrease of 0.02% in CO2 emissions across OECD countries. Sarigul and Topcu (2021) as well as Akkaya and Hepsag (2021) detect that environmental taxes and fuel taxes have a negative impact on CO2 emissions in Türkiye.

However, Zhu et al. (2023) critique overly optimistic assumptions, noting that regional disparities in regulations may lead to emissions shifting to jurisdictions with less stringent policies, thereby undermining the overall effectiveness of environmental taxes.

2.2 Renewable Energy Subsidies and Feed-in Tariffs

However Renewable energy subsidies, such as feed-in tariffs (FiTs), represent another policy tool to accelerate the transition to a low-carbon economy. By facilitating the substitution of fossil fuels with renewable energy, they are expected to contribute to emissions reduction. One such measure is feed-in tariffs (FiT), which consists of fixed payments per kilowatt-hour (kWh) established by an administrative authority, typically offered to eligible energy producers. The FiT effectively subsidizes renewable energy generation by covering the difference between the market price of electricity and the tariff's value. Without such subsidies, renewable generators would sell their electricity on the wholesale market, where prices fluctuate based on market conditions at the time of generation. FiTs offer generators a predictable income through a fixed price for their entire output, which acts as a subsidy if this tariff exceeds the wholesale price. This subsidy is quantifiable by comparing FiTs with wholesale prices. Moreover, the certainty provided by the tariff reduces revenue risk associated with fluctuations in wholesale prices. FiTs help accelerate the adoption of renewable energy technologies by guaranteeing renewable energy producers a stable, long-term purchase price for the electricity they produce. This financial incentive provides a predictable revenue stream that reduces investment risks and encourages private sector participation in renewable energy projects. FiTs are expected to facilitate the financing of the green economy by attracting investments in renewable energy infrastructure, such as solar, wind and biomass systems, and encourage the growth of sustainable energy markets.

Nevertheless, as a brief parenthesis, it is important to acknowledge a general but crucial point: some renewable energy sources can have adverse effects, particularly on biodiversity and landscapes, especially when production sites are located within Marine Protected Areas or other Protected Areas. For example, the large-scale installation of solar panels or wind turbines—especially in rural or maritime regions—can lead to habitat fragmentation, disruption of bird migration routes, and soil degradation. FiTs, while promoting investment, can generate negative externalities by indirectly encouraging such developments in ecologically sensitive areas. Moreover, special attention must be given to the conditions under which tools like FiTs are implemented to prevent unintended consequences such as trade imbalances or social injustices. Such mechanisms could encourage energy companies to import solar panel components at the expense of local industry development, drive up land prices thereby putting pressure on agricultural land, or incentivize projects that are not ecologically sustainable—such as water-intensive solar thermal plants in arid zones already facing severe water stress. While a detailed analysis of these potential impacts lies beyond the scope of our current work, it represents a valuable avenue for future research.

There are a range of subsidies granted to renewable energy in many countries. Qi et al. (2023) investigate the temporal alignment of an emissions trading system (ETS) and FiTs for solar and wind energy projects in China, emphasizing the impact of subsidy strategies. Their research indicates that continuous FiT subsidies have a more positive overall effect compared to phasing them out. They highlight that introducing FiT can ease the burden and cost of reducing emissions under the carbon ETS. During the FiT subsidy period, higher subsidy rates correspond to reduced pressure for emission reductions within the carbon ETS framework. Similarly, Lin and Xie (2024) discover that a one-unit increase in FiT subsidies correlates with a 3.4-unit rise in renewable energy investments, based on firm-level data from China. Mardones (2024) demonstrates in the case of Chile that integrating three climate policies—carbon taxes, coal-fired power plant phase-out, and renewable energy subsidies—leads to a significant decrease in GHG emissions, using a computable general equilibrium model and microsimulations.

However, research on the impact of FiTs in the Mediterranean region remains relatively scarce. This study addresses this gap by analyzing available OECD data to examine the green finance policies of Mediterranean countries and their implications for national GHG emissions.

3. DATA AND METHOD FOR ANALYZING THE LINK BETWEEN ENVIRONMENTALLY RELATED TAXES, FITS, AND GHG EMISSIONS IN MEDITERRANEAN COUNTRIES

Making use of the relevant indicator definitions and data, the following research questions are answered in this section:

- Which countries in the Mediterranean region tax the production or consumption of environmentally related goods and services more highly in the region?
- Does environmental taxation make a significant difference in per capita GHG emissions in the region?
- Which energy source is supported more by the FiT incentives in the region?
- Does the type of renewable energy source subsidized make a significant difference in per capita GHG emissions in the region?

Section 3.1 undertakes a thorough review of environmentally related taxes and FiTs provided to renewable energy in the Mediterranean countries, whereas Section 3.2 explores the links between these policies and per capita GHG emissions in the region using an econometric approach.

3.1 Environmentally Related Taxes and FiTs in the Mediterranean

Environmentally related taxes play a crucial role for governments in influencing the prices of goods and services. The OECD Environmentally Related Tax Revenue Database (ERTR) classifies taxes according to their environmental impact, using a structured method to compile revenue specifically from environmentally related taxes. This includes detailed categorization by tax-base types such as energy, transport, pollution, and resources, across 22 environmental domains. ERTR is constructed by 1) focusing on taxes on GHG emissions from different activities by splitting tax revenues into two subcategories: the energy-related part (recorded as an energy tax) and the non-energy-related part, such as certain GHG emissions from landfills or agriculture (recorded as a pollution tax), and 2) introducing four «memo items» to enhance the relevance of the accounts for policy work: (i) certain land taxes, (ii) taxes on oil and natural gas extraction, (iii) taxes on the resource rent (profit taxes only) and (iv) elevated VAT levied on environmentally related tax bases (OECD, 2023). The OECD notes that tax-base categories are distinct from each other but domains can overlap. Therefore, in the current chapter, only the environmentally related tax revenue (% of GDP) indicator is used without combining revenues across domains to avoid potential double counting[102].

As shown in Figure 3, in 2019, Croatia, Slovenia, and Greece led the Mediterranean region in the share of GDP allocated to environmental taxes, covering areas like carbon emissions, waste generation, and resource depletion. Conversely, countries from the South Mediterranean such as Morocco and Egypt appear to have allocated a smallest proportion of their GDP to environmental taxation. When considering tax revenue per capita (measured in 2015 USD PPP), Slovenia, Italy, Croatia, and Greece rank as the highest tax-collecting countries (OECD, 2023).

102 For robustness checks, we employ the environmentally related tax revenue in the domain of climate change (% of GDP) as the main independent variable in two model specifications in Section 3.2.

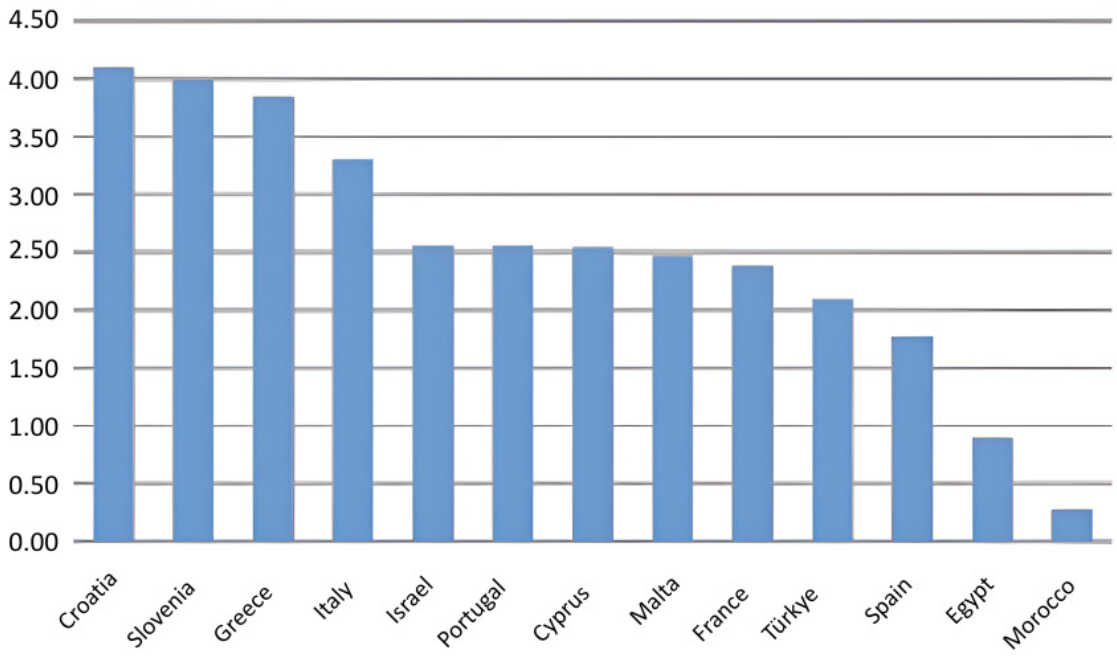


FIGURE.3 *Environmental taxation (% of GDP) in the region, 2019*
Author's illustration using OECD (2023) data

According to the "Environmental Policy: Renewable energy feed-in tariffs" database of the OECD (Edition 2021), FiTs are widely used policies designed to promote the expansion of renewable electricity capacity. These market-driven economic tools generally provide long-term agreements that ensure a fixed price per kilowatt-hour (kWh) for electricity supplied to the grid from a specified energy source. OECD (2022) reports both the mean FiT prices (in USD) and the length of power purchase agreements (in years) for each renewable source supported. The length of agreements ranges between 10 and 25 years. In the Mediterranean region, almost every country has implemented a FiT policy, except for Malta and Morocco. As a small island nation, Malta has limited land and natural resources, making large-scale renewable energy deployment difficult. Solar and wind are the most viable options, but land scarcity and high population density restrict the deployment of large solar farms or wind projects. This explains why it may not be preferred to implement a FiT policy in Malta. While Morocco has abundant solar and wind resources, its focus has historically been on large-scale centralized renewable projects such as Noor Ouarzazate (one of the world's largest solar power plants)[103]. The government may view FiT policies as less compatible with its central development strategy. Besides, FiT policies often require long-term subsidies or guaranteed purchase agreements, which can be a burden on national budgets or lead to higher energy prices for consumers. For countries like Morocco, where affordability and energy access are priorities, FiTs might not be the optimal choice. Also, competitive bidding or auctions for renewable energy projects, which allow investors to control costs better compared to FiTs, can attract large-scale investors by providing a predictable framework in countries like Morocco.

Based on Figure 4, the number of countries adopting FiTs in the Mediterranean region reached a total of 13 in year 2012 and afterwards started to decline. As of 2019, there were only three countries (France, Italy, and Türkiye) in the region that provided FiT support to one or more renewable resources. Among them, FiTs in France were the highest, with 0.094 USD/kWh to small hydro, 0.16 USD/kWh to waste, and 0.14 USD/kWh to marine power in 2019. Historically, some countries provided higher FiT prices to solar power per kWh of electricity (e.g. Cyprus and Greece) while countries such as Türkiye provided the lowest prices (OECD, 2022). Feed-in tariffs in Türkiye also benefit from local content premiums depending on the renewable energy technology[104].

103 https://ouarzazate.city/noor-ouarzazate-solar-power-station/
104 Türkiye also advances renewable energy through YEKAs (Renewable Energy Resource Areas), which are legally designated zones aimed at fostering substantial renewable electricity capacity and promoting localization in renewable energy technologies.

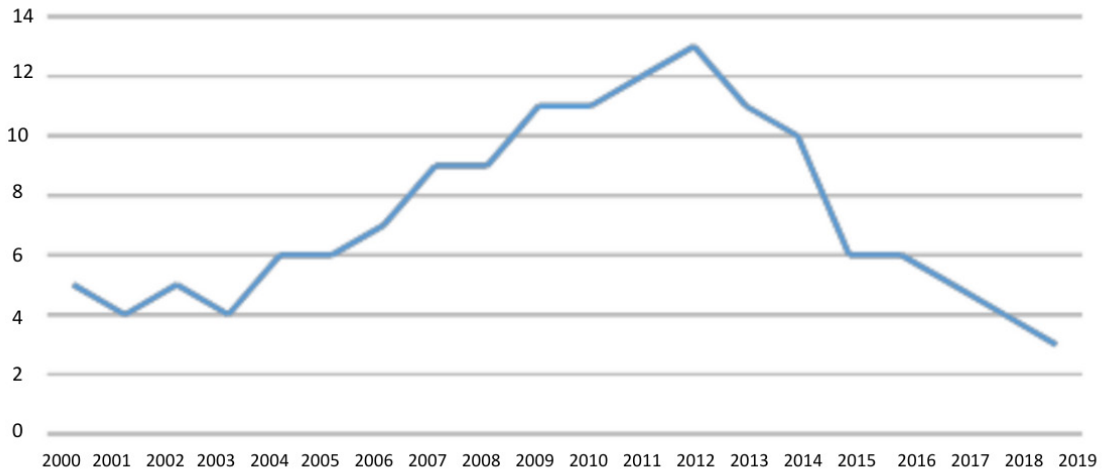


FIGURE.4 *Environmental taxation (% of GDP) in the region, 2019*
Source : Author's illustration using OECD (2023) data

The FiT mechanism (in Turkish, YEKDEM) for renewable energy sources was introduced in Türkiye in 2011. The mechanism includes solar PV, wind, battery storage, geothermal, biomass, and others. Higher tariff rates may be applied to facilities built using domestically produced equipment. All feed-in tariffs are adjusted on a quarterly basis, using an escalation mechanism tied to the producer price index, consumer price index, and the exchange rates for the US dollar and Euro. As of March 1, 2025, the prices presented below are the updated YEKDEM prices based on the type of facility.

Type of Renewable Energy-Based Generation Facility	YEKDEM Price [TRY kuruş/kWh]	Local Content Support [TRY kuruş/kWh]
Hydroelectric power plant with reservoir	271.14	54.24
Run-of-river hydroelectric power plant	254.18	54.24
Land-based (onshore) wind power plant	199.58	54.24
Offshore wind power plant	271.14	72.38
Geothermal power plant	380.38	54.24
Landfill gas / by-products from waste tires	199.58	54.24
Biomethanation	325.74	54.24
Thermal disposal (municipal/industrial/agricultural waste)	254.03	40.62
Solar power plant	199.58	54.24
Integrated storage plant (wind/solar)	235.38	72.38
Pumped-storage hydroelectric power plant	380.38	72.38
Wave or current energy-based generation plant	254.18	72.38

TABLE 1
Author's illustration using OECD (2022) data
Source : EPİAŞ (2025, April)

Figure 5 shows the decline in countries offering FiT support for renewable energy sources from 2012 to 2019. In 2012, the peak year, 10 countries supported solar, 11 wind, and 10 small hydro, among other resources. By 2019, this had dropped to just 1 for solar, 2 for wind, 2 for small hydro, and 1-2 for other resources. This decline can be attributed to several factors: As solar and wind technologies became more cost-competitive (IRENA, 2024), the need for FiTs decreased. Many countries also shifted from FiT schemes to competitive auctions, which reduce costs through competition (Mathieu & Valenzuela, 2024). Additionally, governments increasingly favored alternative support mechanisms like tax credits, subsidies, and green certificates, which offer more flexibility and lower costs (del Rio & Linares, 2014). Countries like Italy, Spain, France, Greece, Morocco, Tunisia, and Egypt have adopted such market-based approaches to encourage renewable investment while reducing financial burdens on public budgets and consumers.

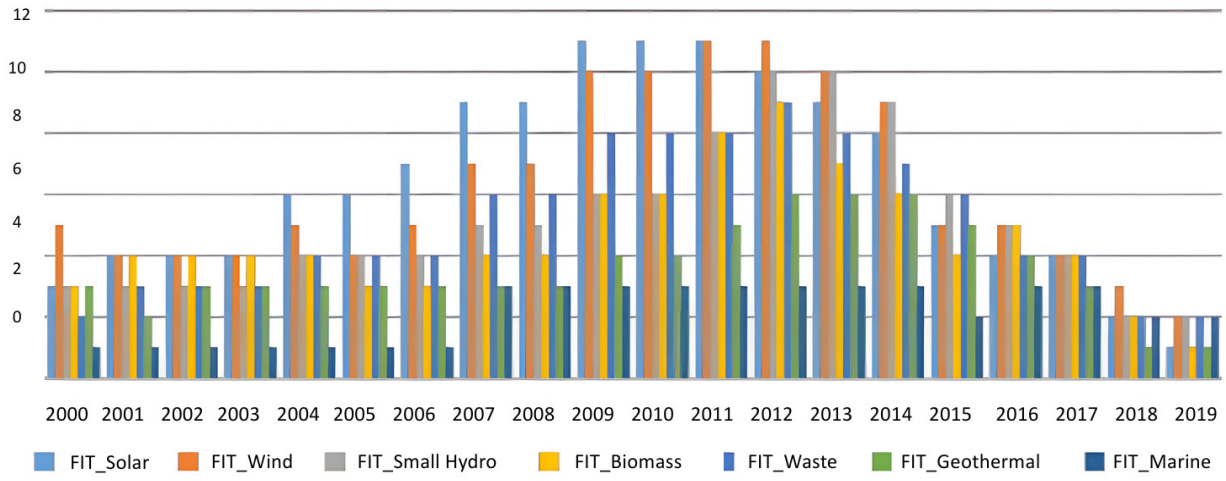


FIGURE.5 *Number of countries with FiTs with respect to source*
Source : Author's illustration using OECD (2022) data

3.2 Environmental Policy and GHG Emissions Link in the Mediterranean

This section examines the causal relationship between greenhouse gas (GHG) emissions per capita and two key environmental policy tools in the Mediterranean region. Specifically, it analyzes:

- The effect of environmentally-related taxes on GHG emissions from 1994 to 2021.
- The effect of Feed-in Tariffs (FiTs) on GHG emissions from 2000 to 2019.

The analysis uses panel data methods to explore these relationships.

The data for environmentally related tax revenue (% of GDP) for the period 1994-2021 and FiTs (USD) for the period 2000 – 2019 are extracted from the OECD database, whereas per capita GHG emissions (GHGPC) data (tonnes CO2e/year) is extracted from the IEA and Emissions Database for Global Atmospheric Research (EDGAR) constructed by Crippa et al. (2023). GHG emissions in the IEA-EDGAR database include CO2 (fossil only), CH4, N2O and F-gases and are aggregated using Global Warming Potential (GWP) values from IPCC AR5 (GWP-100 AR5). GDP per capita (purchasing power parity-adjusted, constant 2021 international USD), renewable electricity output (% of electricity production) and fossil fuel energy consumption (% of total) are used as control variables in explaining per capita emissions in each country. Economic expansion is positively correlated with increased energy consumption, which, in turn, elevates GHG emissions, particularly in countries that predominantly depend on fossil fuel-based energy infrastructures. The generation of renewable electricity (REO) is anticipated to mitigate per capita GHG emissions, whereas fossil fuel energy consumption (FOSSIL) is projected to have the opposite effect, contributing to increased emissions. A higher proportion of

renewable energy sources in electricity generation directly diminishes emissions attributed to fossil fuel combustion. Renewable energy technologies, including solar, wind, and hydroelectric power, do not produce carbon emissions during their energy conversion processes, thereby reducing overall emission intensity. Concurrently, the declining levelized cost of electricity (LCOE) for renewable energy technologies promotes their broader adoption, further enhancing their potential to mitigate emissions.

In order to test whether policy stringency plays a role and affects the effectiveness of environmental taxation, the OECD Environmental Policy Stringency Index (EPS) is used in several equations as well (Kruse et al., 2022). The EPS index is a country-specific and internationally comparable measure of the stringency of environmental policy ranging from zero (least stringent) to six (most stringent). The index covers the years from 1990 to 2020, across 40 countries and 13 policy instruments, focusing on climate change and air pollution mitigation policies[105].

The econometric analysis is conducted using panel data analysis methods. The econometric analysis uses panel data, which tracks the same countries over multiple years. This allows for the analysis of both cross-country variations and time-series trends. Panel data helps control for individual differences between countries, ensuring that the relationship between environmental policies and emissions is not obscured by other factors. The panel structure of the data used in this study enables to examine the effects of environmentally related policies on GHG emissions per capita both on a country level and over a time span (1994-2021). Panel data analysis facilitates the control of individual heterogeneity by allowing for the examination of variation and involving less linear correlation between variables. The model can be expressed as follows:

$$y_{it} = \alpha + X_i'\beta + u_{it}$$

In yit $t = 1, \ldots, T$, where the vector of independent variables, is the coefficient vector of independent variables, and u_{it} is the composite error. In the current analysis, heteroskedasticity-corrected standard errors are estimated using the robust estimator of the covariance matrix proposed by Arellano, which take into account both heteroskedasticity and autocorrelation. By incorporating country-fixed effects (to control for time-invariant unobserved heterogeneity) and time-fixed effects (to capture global shocks like economic crises or climate agreements), our methodology helps mitigate confounding. Furthermore, the inclusion of fixed effects helps mitigate omitted variable bias. Additionally, our regressions might suffer from reverse causality, which implies that higher GHG emissions per capita might drive policy responses, rather than environment/climate policies influencing emissions. This issue can be handled by using lagged independent variables to ensure that the explanatory variables precede the outcome (GHG per capita), reducing simultaneity bias. Models 1a.i to 2b.ii in the Appendix present the results of the regressions with lagged values of renewable electricity output, fossil fuel consumption, and environment/climate policies, which provide similar results to those presented in Table 1. To maintain a broader dataset without omitting data for any given year, we base our interpretations on the results presented in Table 1.

Table 1 presents the fixed effects estimation results in four separate models that include two environmental tax categories as explanatory variables[106]. Model 1a and 1b integrates the effects of total environmental tax revenue (ENVTAX) (at all tax bases as a % of GDP) on the natural logarithm of GHGPC, whereas Models 2a and 2b integrate the effects of environmental tax revenue in the domain of climate change (CLIMTAX) (as a % of GDP). Models 1a and 2a include REO, renewable electricity output (% of electricity production), whereas Models 1b and 2b include FOSSIL, fossil fuel energy consumption (% of total) as well as EPS in interaction with the tax variables.

Models 1a and 2a reveal that an increase in the share of country-level environmental tax revenue or climate-related tax revenue in GDP does not significantly affect GHG emissions per capita in the region. Once these two tax variables enter the equation in interaction with environmental policy stringency (EPS), taxation decreases GHG emissions significantly (Models 1b and 2b). A 1 percentage point increase in ENVTAX or CLIMTAX leads to a net decline of 0.01-0.02% in GHGPC. This implies that environ-

105 The structure of the EPS, its components and the index construction can be accessed in the related 2022 OECD working paper: https://doi.org/10.1787/90ab82e8-en
106 Fixed effects is a statistical technique that controls for variables that are constant within each entity (such as a country), but vary between entities. It allows us to estimate the impact of variables that change over time (e.g., tax revenues) while accounting for unobserved characteristics that could differ between countries but do not change over time (such as institutional frameworks). In simpler terms, it helps isolate the effects of changes in specific variables by controlling for other factors that might influence the results.

	Model 1a LNGHGPC	Model 1b LNGHGPC	Model 2a LNGHGPC	Model 2b LNGHGPC
Variable	**Coefficient (Standard error)**	**Coefficient (Standard error)**	**Coefficient (Standard error)**	**Coefficient (Standard error)**
LNGDPPC	0.60*** (0.09)	0.51*** (0.05)	0.61*** (0.09)	0.50*** (0.05)
REO	-0.005*** (0.001)		-0.005*** (0.001)	
FOSSIL		0.02*** (0.002)		0.02*** (0.002)
ENVTAX	-0.004 (0.012)	-0.03** (0.012)		
CLIMTAX			0.0009 (0.011)	-0.03** (0.01)
EPS		-0.03*** (0.012)		-0.04*** (0.009)
EPS*ENVTAX		0.01*** (0.003)		
EPS*CLIMTAX				0.02*** (0.002)
constant	-4.06 (0.91)	-4.65*** (0.38)	-4.15*** (0.91)	-4.60*** (0.43)
time dummies	Yes	Yes	Yes	Yes
observations	350	175	352	176
LSDV R-squared	0.96	0.98	0.96	0.98
Robust standard errors in parentheses *** p<0.01, ** p<0.05, * p<0.1				

TABLE 2
Fixed effects estimation results for Environmental and Climate Taxation

mental taxes alone may not be set at levels high enough to significantly change behavior, especially if the cost of compliance is lower than the economic benefits of continuing high-emitting activities. However, strict environmental policies increase the effectiveness of taxes by creating additional pressure to adopt cleaner technologies and practices. Besides, taxes often work best when paired with complementary policies, such as emissions standards, renewable energy mandates, or energy efficiency incentives. Policy stringency likely reflects the existence of such measures that enhance the impact of taxation by providing multiple, reinforcing mechanisms to reduce emissions. In the absence of strict enforcement, tax policies may be missed or fail to achieve their intended effect. Strict policies are more likely to include robust enforcement measures that ensure that taxes are effectively implemented and their behavioral objectives are achieved (see the country examples such as France and Italy, where EPS has risen during the investigated time period and per capita GHG emissions are on a considerable decline).

To sum up, **environmental taxation, alone, while an effective tool for internalizing the environmental costs of economic activities, may fail to significantly accelerate the low-carbon transition** due to several limitations such as insufficient tax rates, policy design flaws, economic and political resistance, regressive impacts on low-income populations, and the risk of carbon leakage. Additionally, taxation alone cannot fully address the structural and behavioral changes needed for a

low-carbon economy without complementary measures like subsidies, infrastructure investments, and stringent regulations. When combined with strict environmental policies, taxation becomes more effective and leads to measurable emissions reductions. This suggests that strict regulations increase the impact of taxes by encouraging cleaner technologies and discouraging high-emitting activities. **To maximize its impact, environmental taxation should be integrated into a broader policy framework that addresses these challenges holistically by including renewable energy subsidies, infrastructure investments, and regulatory enforcement.** In addition, earmarking tax revenues for climate action (such as financing renewable energy projects and energy efficiency programs) can increase their effectiveness. Targeting high-emitting sectors specifically rather than broad-based taxes can also lead to more significant reductions.

In the same analysis above (Table 1), GDP per capita makes a significant contribution to emissions per capita; i.e. being a wealthier country in average per capita terms implies an increase in the GHG each person emits on average. To be more precise, a 1% increase in GDPPC leads to a 0.5-0.6% increase in emissions per capita. On the other hand, renewable energy output, REO, contributes to the low-carbon transition significantly as it decreases emissions by 0.005% as REO increases by 1 percentage point. Higher shares of fossil fuel consumption, FOSSIL, contributes to increasing per capita emissions, as expected.

Table 2 presents the results of fixed effects analyses examining the factors influencing emissions across four different models. Each model focuses on how different types of Feed-in Tariffs (FiTs) affect emissions.

- Models 3a and 3b analyze whether simply having a FiT policy (FIT_DUMMY) in place in a given country and year impacts emissions.
- Models 4a and 4b go a step further by examining the specific FiT prices offered for different renewable energy sources, including solar, wind, hydro, biomass, waste, geothermal, and marine energy.

Additionally, these models differ in the control variables they include:

- Models 3a and 4a control for economic activity (log of GDP per capita, LNGDPPC) and renewable electricity output (REO).
- Models 3b and 4b instead control for economic activity (LNGDPPC) and fossil fuel consumption (FOSSIL).

This approach allows us to compare the effects of having FiT policies versus the specific price incentives they provide, while also accounting for key economic and energy-related factors.

Models 3a and 3b reveal that **providing feed-in-tariffs (i.e. the presence of a FiT scheme to any renewable source) alone does not significantly affect GHG emissions per capita in the region.** FiTs might be effective in promoting renewable energy but face limitations such as high financial burdens, inefficiencies in targeting emerging technologies, market distortions, and grid integration challenges. By guaranteeing fixed prices, FiTs can potentially distort energy markets, discouraging competition and innovation. Over-reliance on FiTs may also slow the transition to market-based mechanisms like auctions or competitive pricing, which can drive cost efficiencies in renewable energy deployment. Policy instability and regional disparities can further hinder their effectiveness, while their focus on electricity generation often neglects other critical sectors like transportation or industry. Additionally, the long timeframes for renewable infrastructure development may delay significant emission reductions. **To enhance their impact, FiTs need to be part of a broader strategy that includes grid modernization, energy storage, carbon pricing, and measures to ensure equity and regional inclusivity.**

Once the FiT prices (USD per kWh) to each renewable source are accounted for (Models 4a and 4b), 1 USD increase in FiT prices provided to hydro, waste and marine power decreases GHG emissions per capita significantly (Model 4a). The coefficients of FiTs to waste and hydro appear to be significant in Model 4b as well, once FOSSIL is used as a control variable. On the other hand, a 1-USD increase in FIT_BIOMASS increases GHGPC by around 0.3%.

The difference in the impacts of FiT prices on GHG

emissions reductions among renewable energy sources in Mediterranean countries can be attributed to several factors: The first one is related to the baseline energy mix. Hydro, waste, and marine power often displace high-emission, base-load energy sources like coal or oil-fired plants, leading to more substantial reductions in GHG emissions. On the other hand, solar, wind, and geothermal may replace less carbon-intensive energy sources, such as natural gas, or contribute to intermittent gene-

	Model 3a LNGHGPC	Model 3b LNGHGPC	Model 4a LNGHGPC	Model 4b LNGHGPC
Variable	**Coefficient (Standard error)**	**Coefficient (Standard error)**	**Coefficient (Standard error)**	**Coefficient (Standard error)**
LNGDPPC	0.64*** (0.10)	0.78*** (0.05)	0.62*** (0.11)	0.79*** (0.05)
REO	-0.005*** (0.001)		-0.005*** (0.001)	
FOSSIL		0.01*** (0.003)		0.01*** (0.003)
FIT_DUMMY	-0.0007 (0.003)	0.0009 (0.003)		
FIT_SOLAR			-0.01 (0.03)	-0.004 (0.014)
FIT_WIND			0.02 (0.04)	0.005 (0.024)
FIT_HYDRO			-0.11** (0.05)	-0.07* (0.04)
FIT_BIOMASS			0.27* (0.15)	0.20 (0.13)
FIT_WASTE			-0.09*** (0.03)	-0.04** (0.02)
FIT_GEOTHERMAL			-0.02 (0.09)	-0.07 (0.08)
FIT_MARINE			-0.08** (0.04)	-0.0006 (0.04)
constant	-4.71*** (1.07)	-7.26*** (0.38)	-4.45*** (1.19)	-7.14*** (0.37)
time dummies	Yes	Yes	Yes	Yes
observations	280	231	280	231
LSDV R-squared	0.96	0.99	0.96	0.99
Robust standard errors in parentheses *** p<0.01, ** p<0.05, * p<0.1				

TABLE 3
Fixed effects estimation results for FiTs

ration that doesn't fully offset fossil fuel dependency. Second, hydro, waste-to-energy, and marine power typically have higher capacity factors (i.e., they generate electricity more consistently) compared to solar and wind, which are intermittent and dependent on weather conditions. Consistent generation ensures a more stable replacement of fossil fuel-based energy, resulting in greater GHG reductions. Geothermal energy has high reliability but may have limited implementation due to geological constraints in Mediterranean countries (for example, in countries like Algeria, Egypt, and Morocco, geothermal has limited implementation due to the absence of significant tectonic activity). Third, in regards to infrastructure needs, hydro, waste, and marine power are often integrated into existing grid systems more effectively, leading to immediate and sustained reductions in emissions; whereas solar and wind power may face challenges like curtailment due to grid constraints or a lack of storage solutions, reducing their net impact on emissions. Fourth, hydro, waste, and marine projects often involve large-scale installations that can significantly impact national energy mixes. On the contrary, solar and wind installations in Mediterranean countries may be smaller-scale (Türkiye being an exception in this regard), distributed systems that individually contribute less to GHG reductions.

FiT prices provided to biomass energy might inadvertently trigger an increase in GHG emissions per capita in Mediterranean countries due to several factors: To begin with, if biomass feedstocks (e.g., wood, agricultural residues, or organic waste) are sourced unsustainably, such as through deforestation or overharvesting, the carbon released during combustion may exceed the carbon sequestered during the biomass's growth cycle, leading to a net increase in GHG emissions. Besides, transportation and processing of biomass can also generate significant emissions, particularly if local supply chains are not well-developed. Furthermore, older or poorly maintained biomass power plants may operate with low energy conversion efficiencies, resulting in higher emissions per unit of energy produced (for instance, the biomass power plants in Greece (Alatzas et al., 2019), Türkiye (Ocak and Acar, 2021), and Italy (Moliner et al., 2021) still use older combustion technologies or are not optimized for efficiency). Incomplete combustion of biomass can release methane, carbon monoxide, and black carbon, all of which are potent contributors to global warming.

In the same analysis (Table 2), GDP per capita makes a significant contribution to emissions per capita by leading to a 0.6-0.8% increase in GHGPC as a result of 1% increase in GDPPC. A 1 percentage point increase in FOSSIL triggers GHGPC by 0.01%. On the other hand, as in Models 1a and 2a, renewable energy output, REO, contributes to the low-carbon transition significantly as it decreases emissions by 0.005% as REO increases by 1 percentage point.

4. HOW TO FINANCE THE LOW-CARBON TRANSITION THROUGH OTHER TYPES OF GREEN FINANCE?

4.1 Maximizing the Impact of Carbon Pricing and Efficient Use of Auction Revenues

One of the major policy solutions put forward to tackle the problem of increasing GHGs is carbon pricing via either establishing carbon markets or levying carbon taxes. Both embody the motivation of putting a price on carbon in line with its social cost (i.e. in order to internalize the externality caused by CO2 emissions). From the perspective of economists working in the field of climate change, the social cost of carbon refers to the impact of carbon emissions on consumption (Nordhaus, 2014). The resulting value is interpreted as the cost of carbon to humanity. Simply put, the social cost of carbon is an estimate of the economic harm caused by emitting one extra ton of CO2 into the atmosphere. This includes damages like rising sea levels, more frequent floods, reduced agricultural productivity from droughts, and destruction of infrastructure. It is measured in monetary terms to show how much these negative effects cost society (Tietenberg and Lewis, 2018: 54). However, the value that comes out of this calculation is a value that may not necessarily correspond to the real cost of carbon. Besides, as it is a present value calculation, both the timing of the emission reduction and the discount rate play a significant role (Tietenberg and Lewis, 2018: 54). Due to these difficulties in estimating the real cost of carbon, carbon taxes as well as emissions trading systems that operate around the world fall short of mitigating GHG emissions by a considerable level.

Prices realized in carbon markets such as the EU Emissions Trading System (EU ETS) or the Western Climate Initiative (WCI) vary depending on market factors and understate the true cost of carbon. Besides, carbon prices that prevail in the corresponding markets are highly volatile, which is not desirable by utilities and industries that are in need of credible price signals if they are going to base long-term investments on these prices (ERCST, 2021: 27). Figure 6 displays the volatility in average annual allowance prices in the EU ETS versus the quantity of verified emissions in the system. Apparently, there is a noticeable decline in verified emissions especially in the years where average annual EUA prices are on a rise; however, it can be stated that the EU ETS has not performed well in considerably mitigating GHG emissions. For instance, between 2018 and 2019, verified emissions declined by 9%, whereas EUA prices increased by 60%. In addition, prices have approached zero several times (e.g. in 2007) since the scheme's inception, and the allowance price has failed to reflect the marginal cost of emissions reductions.

EU member countries in the Mediterranean are subject to the EU ETS carbon prices as well. Yet, it is difficult to assess the impact of the carbon trading system on their GHG emissions at a macro level. Sector and firm level studies are needed to detect the emissions impacts of the EU ETS. Martin et al. (2016) confirm that most of the abatement in Phase I (2005-2007) took place in the EU15 region, that includes five Mediterranean countries (France, Greece, Italy, Portugal, and Spain, namely) rather than in Eastern European countries. The authors also

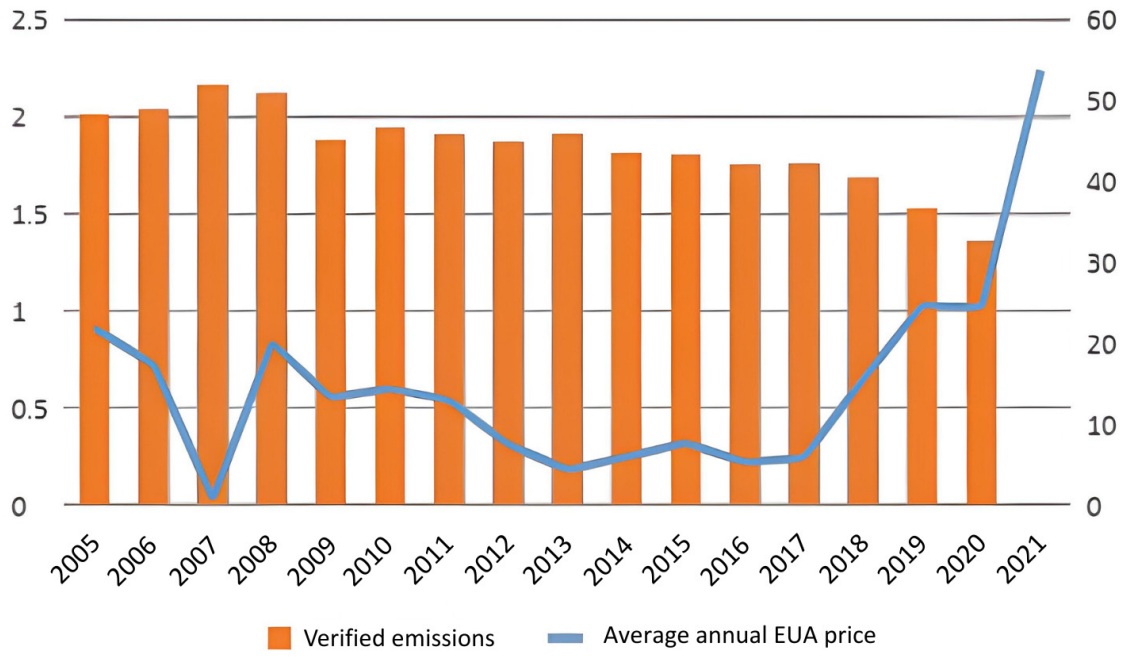


FIGURE.6 *Average annual EUA prices (Euro/ton) and verified emissions (billion tons CO2e)*
Source: EU Emissions Trading System Data Viewer & Ember-Climate Carbon Price Viewer

put forward that there is significant evidence of an emissions decline by industrial firms during Phase II (2008-2012) based on firm-level data in France. On the other hand, according to a study by Pellerin-Carlin and Vangenechten (2022), the only sector that has significantly reduced its emissions under the EU ETS is the electricity sector, which is not offered free allowance rights. Compared to the level in 2013, when the third phase of the EU ETS started, the electricity sector achieved a 27.7% emission reduction in 2019, while this rate was limited to a 2.1% reduction in other ETS sectors.

Yet, one of the successes of the EU ETS scheme has been the fact that revenues from the auctioning of allowances accrue to Member States in the EU ETS with the condition that at least 50% of revenues should be used for climate- and energy-related purposes. In 2019, 77% of their revenues were spent on domestic and international climate-related purposes, in line with the condition (ICAP, 2021). Moreover, between 2013 and 2022, 76% of the revenues from auctioning was spent on climate, renewable energy and energy efficiency related purposes (EEA, 2023). Following Germany and Poland, Spain

generated the third-highest revenue, while Malta and Luxembourg accrued the least. Among the EU member states in the Mediterranean, France, Greece, Portugal, Croatia, Slovenia, Cyprus, and Malta allocated nearly all their auctioning revenues to climate change and energy-related initiatives in 2022. Italy, however, directed only half of these revenues toward climate-friendly purposes in the same year (EEA, 2023).

4.2 Expanding Green Finance: Green bonds, Green Central Banking and Green Loans

While carbon taxes and emissions trading systems create financial incentives to reduce GHG emissions, broader green finance instruments (such as green bonds and loans) serve as complementary tools by directly channeling investment into low-carbon projects and sustainable initiatives. Together, these financial mechanisms play a crucial role in mobilizing capital for climate action.

Despite its popularity, there is still no clear and generally accepted definition of 'green finance'. Lindenberg (2014) proposes a three-legged definition of green finance: The first leg is financing public and private green investments (including preparatory and capital costs) in the fields of environmental goods and services (such as water management and conservation of biodiversity and landscapes) and preventing, minimizing and compensating damages to the environment and climate (such as energy efficiency). The second one is financing public policies that incentivize the implementation of environmental mitigation or adaptation projects and initiatives (for example, feed-in tariffs for renewable energies). The third leg comprises of the financial system components that deal specifically with green investments, such as the Green Climate Fund or financial instruments for green investments (e.g. green bonds and structured green funds), including specific legal, economic and institutional framework conditions. As for the third leg, green financial products such as green bonds, green loans and sukuk have been on the market for some time now. The Climate Bonds Initiative (CBI) defines green bonds as those that are issued to fund projects with positive environmental and/or climate benefits and highlights that the proceeds from these bonds are earmarked for green projects. CBI (2022) calculates that between the issuance of the first green bond in 2007 and the year 2020, the average annual growth rate of climate bonds was around 95%. Furthermore, as of 2020, the proceeds were allocated to investments mainly in the following sectors: energy, buildings, and transport (see Figure 7). Out of the total of 1.3 trillion USD equivalent of green bonds issued since 2007, these three sectors received the top shares cumulatively (36%, 28%, and 18%, respectively) among other sectoral investments. Yet, green bonds are criticized for being a new form of greenwashing and for raising capital for investments that in fact have minimal positive climate impact. For instance, there have been many projects such as large hydropower utilities that have been partially financed by such bonds despite the fact that hydro dams are well-known for their damaging effects for the ecosystems surrounding them. Moreover, several oil and gas companies generated money via green bonds to finance their energy efficiency projects, which only served the survival of the fossil fuel-based energy systems (Rajwanshi, 2019). Although some are "provided based on the borrower's environmental, social and governance (ESG) score or overall sustainability achievements such as emission reductions" (Hussain, 2020), similar criticisms are valid for green loans as well.

Apart from the failure to channel money for really climate-positive impacts, the distribution of these loans is not equal across the developed and developing world. According to IFC (2021), developing countries account for only 1.6 billion USD of the estimated 33 billion USD in green loans. Hence, green financial instruments carry the potential to become buckets that further fuel the climate crisis. Monitoring transparent reporting standards is crucial and reporting should be designed to support green thinking from a business perspective.

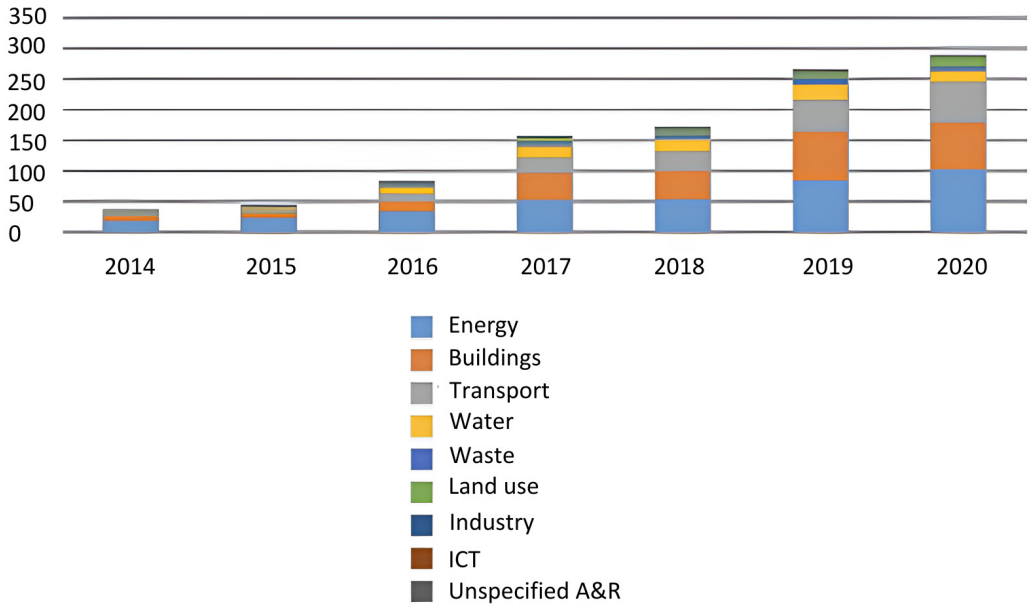


FIGURE.7 *Sectoral use of proceeds from climate bonds (issued billion USD)*
Source: Climate Bonds Initiative (CBI, 2022)

The green bond market in the Mediterranean region shows significant differences. In the Northern Mediterranean, including countries like France and Italy, the market is well-developed with numerous issuances supporting various environmental projects. Conversely, the Southeast Mediterranean has only recently entered the green bond market, with Egypt making a significant advancement in 2020 by issuing the Middle East and North Africa (MENA) region's first sovereign green bond (Hussain, 2022). Before that, in 2016, the Turkish Industrial Development Bank (TSKB) launched the Central & Eastern Europe, Middle East and Africa (CEEMEA) region's first Green/Sustainable Bond (TSKB, 2017). These pioneering initiatives are crucial for setting a precedent and encouraging other issuers to enter the market.

Apart from their price stability targets, central banks have started to utilize their power in order to stimulate a low-cost investment environment which provides opportunities low-carbon projects. The changing targets and regulatory frameworks of especially developed country central banks and the European Central Bank (ECB) are good examples of how a low-carbon economy could be promoted via the ease of green finance. However, emerging country central banks and banking systems in general are highly trapped with huge debts or deficits, which would necessitate much stronger efforts and international funding in such countries' transition to a greener economy. Yet, there are attempts to adopt green banking in the developing Mediterranean countries. Egypt is such an example whose Central Bank introduced guidelines (in 2021) for sustainable finance based on six principles: developing essential capabilities and knowledge, promoting sustainable finance, engaging stakeholders, managing climate change risks, integrating sustainability principles into internal operations, and reporting (American Chamber of Commerce in Egypt, 2023).

In this context, the banking sector emerges as a pivotal component in the financial mechanisms designed to support the transformation of various industries in alignment with climate change policies. It serves as a critical intermediary in channeling capital to the real economy, with bank loans functioning as primary instruments for facilitating this process on a global scale. The Loan Market Association (LMA) defines green loans as credit instruments specifically designed to finance or refinance, either fully or partially, new or existing eligible green projects. While the scale of green loans varies significantly between countries, their popularity is growing globally, with amounts reaching 56.8 billion USD in the US, 13 billion USD in the UK, 1.4 billion USD in Italy, and 1.3 billion USD in Ireland as of 2021 (World Bank, 2021).

4.3 The Key Role of Multilateral Finance Initiatives

Multilateral climate funds as well as multilateral development banks (MDBs) have a significant role in fueling the low-carbon transition as well. One example that the Mediterranean countries also benefited from is the Clean Technology Fund (CTF), which allocated 100 million USD alongside 500 million USD from the World Bank to support the development of small-scale hydroelectric and wind energy facilities in Türkiye, as well as to advance industrial-scale energy efficiency initiatives through the Industrial Development Bank of Türkiye and the Development Bank of Türkiye. Following the successful deployment of its initial 500 million USD loan, the World Bank approved an additional 500 million USD loan in November 2011. This initiative has facilitated the installation of 960 megawatts (MW) of renewable energy capacity, resulting in energy savings of 2,100 teracalories (Tcal) and an annual reduction of 3.3 million tons of CO2e in GHG in Türkiye (Fosse et al., 2017).

Among multilateral development banks, the European Bank for Reconstruction and Development (EBRD) stands out prominently. In 2023, the EBRD allocated over €6.5 billion to green financing, representing 50% of its total investment portfolio for the year (Bitsadze, 2024). Türkiye is one of the major recipients of EBRD funds, getting almost half of the total investments in climate finance from the EBRD in 2015 (Fosse et al., 2017). The EBRD has outlined its strategic priorities for Türkiye for the 2024–2029 period, with a primary focus on accelerating the green economy transition and supporting Türkiye in achieving its climate objectives (EBRD, n.d.). In Türkiye, environmental projects also receive funding from institutions such as the Council of Europe Development Bank, the French Development Agency, and the German Industrialization Fund.

Bos and Thwaites (2021) break down how much each developed country received from public climate finance (i.e. multilateral climate finance flows through multilateral institutions and channels other than MDBs) between 2013 and 2018. Their database published by the World Resources Institute includes the developed countries of the Mediterranean region as well (Figure 8). Accordingly, Greece, Portugal and Spain received hardly any multilateral climate finance inflows, whereas France got access to the highest inflows in the Mediterranean, both in the pre- and post-Paris agreement periods (Figure 8).

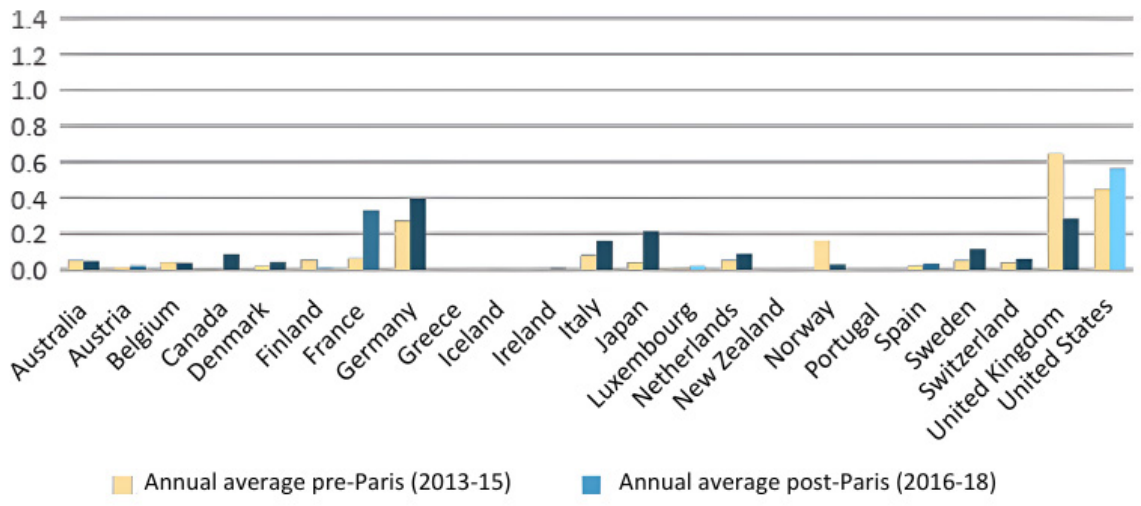


FIGURE.7 *Multilateral climate finance inflows (excluding MDBs) by country, annual average pre– and Post–Paris Agreement*
Source: Bos and Thwaites (2021), World Resources Institute.

On the other hand, the same database also reveals that, historically, France and Italy have been the Mediterranean countries to which the highest MDB climate finance outflows were allocated (Bos and Thwaites, 2021).

Assessing the impact of these green finance tools on emissions reduction in the region requires detailed long-term time series data, which was not available for the current study.

5. CONCLUSION AND POLICY RECOMMENDATIONS

Table 3 below summarizes the findings of the current analysis regarding the effects of selected policy measures on climate change mitigation in the Mediterranean region. The first two rows are supported by the econometric analysis in Section 3.2, whereas the row for 'Subsidies for Fossil Fuels' is backed by another Plan Bleu (2024) report that includes an evaluation of FFS in terms of their impacts on climate change in the Mediterranean region by Acar (2024). The rest of the findings in Table 3 is derived from the discus-

Policy Tool/Instrument	Evaluation	Reasoning
Environmental Taxation	Good	Promotes resource efficiency, fosters climate mitigation, encourages innovation, and targets high-emissions sectors effectively if well-designed and policy is highly stringent.
Feed-in Tariffs (FiTs)	Neutral	Can support renewable energy adoption, under conditions that do not adversely affect biodiversity, landscapes or imports (on which FITs may otherwise have damaging effects), but may fail without coherent energy policies or provisions prioritizing smaller producers/ community-based projects. The impacts of FiTs to each renewable resource may differ depending on the country context.
Other Subsidies for Renewable Energy	Good	Supports potentially the growth of infant renewable industries, aids the green transition, and fosters economic sustainability when designed effectively, i.e. under conditions that do not adversely affect biodiversity, landscapes (and hence tourism) or imports (on which they may otherwise have damaging effects).
Carbon Tax	Good	Encourages emissions reductions by internalizing environmental costs, fostering a low-carbon economy, and driving innovation in green technologies (like other taxes on motor fuels and combustibles).
Subsidies for Fossil Fuels	Bad	Anchors fossil fuels in the economic structure, hinders renewable energy development, and reduces fiscal space for green initiatives and development.
Grants/Loans/Bonds for Green Transition	Good	Targets high-emissions sectors like energy and transport, aiding the transition to a low-carbon economy.
Energy Efficiency Investments/ Incentives	Good	Reduces energy consumption and emissions while creating economic savings and fostering sustainable development.
Green Reporting and Transparency	Good	Enhances monitoring of green finance, ensures accountability, and aligns investments with sustainability goals.
Fossil Fuel Subsidy (FFS) Removal	Good	Frees up potential financial resources for green investments and supports climate goals, provided that mechanisms are in place to protect disadvantaged groups.

TABLE 4

Synthesis of the policy measures under scope

Source : Author's own synthesis

sions in Section 4. The scope of the investigation is limited to a few policies due to data availability for the region.

Green taxation significantly matters, on condition that environmentally related tax proceeds are earmarked for environmental purposes such as climate mitigation and adaptation. Revenues from environmental taxes can be strategically allocated to finance renewable energy projects, energy efficiency programs, sustainable infrastructure, and research and development in green technologies. In addition, such taxes can support subsidies or grants for clean energy adoption, offsetting transition costs for businesses and households. By internalizing environmental costs into market prices, environmental taxation may not only promote resource efficiency, but also encourage innovation and investment in sustainable industries, thereby accelerating the transition to a low-carbon, green economy. Sectoral targeting in environmental taxation also matters. Environmental taxes need to be designed in a way to target the most emissions-intensive sectors effectively instead of being broadly applied. When combined with stringent policies that focus on high-impact areas (e.g., heavy industry, transportation), the interaction may drive more substantial emissions reductions. FiTs are a policy mechanism designed to accelerate the adoption of renewable energy technologies by guaranteeing renewable energy producers a stable, long-term purchase price for the electricity they produce. This financial incentive provides a predictable revenue stream that reduces investment risks and encourages private sector participation in renewable energy projects. However, as observed through the econometric analysis, the implementation of FiTs does not always guarantee the acceleration of a low-carbon transition. FiTs can promote renewable energy production in an economic environment which also prioritizes a reduction in dependence on fossil fuels and reducing GHG emissions. When there are contradictory energy policies in place, FiTs may not end up with the desired outcomes they are meant to lead to. On the one hand, subsidies to renewable energy can be justified as they support infant renewable energy industries in the early stages of their development and spread. On the other hand, continuing to subsidize fossil fuels anchors them to the economic structure, hinders the development of renewable energy, and reduces the fiscal space available to support green technologies and mitigation actions. Besides, the FiT policy needs to be designed to include provisions that prioritize smaller producers or community-based projects, and democratize energy production and distribution.

Experience so far highlights the necessity for both the public and private sectors to actively engage in fostering and advancing green finance. Central banks and regulatory authorities hold the influence to steer market dynamics towards greener practices and ensure their consistent implementation. Development banks and financial institutions play a crucial role in broadening the scope of green financial activities. State support is indispensable during the early stages of green finance, primarily through incentives and regulations. Public efforts to promote transparency and consistency in green reporting are essential; without them, monitoring green finance becomes challenging, leaving the system more susceptible to misuse. Reporting on the 'use of proceeds' is a critical component of green finance. Achieving this requires transparent disclosures from the private sector, aligned with environmental, social, and economic sustainability standards. Although still evolving, 'mixed finance'—the collaboration of public and private funding within the same project—is crucial for unlocking the growth potential of green finance. This approach also enables the public and private sectors to mutually benefit from shared experiences.

Through environmental taxation and other mechanisms, including those described in Section 4, green finance plays an important role in facilitating the transition to a low-carbon economy. Once implemented appropriately, these tools support the implementation of the EU taxonomy on green investments to boost sustainable finance, specifically the objectives of climate change mitigation, pollution prevention and control, and protection and restoration of biodiversity and ecosystems. Besides, there are social implications of any green finance measure that are discussed in the current study. These

social impacts include, but are not limited to, job creation (or unemployment), energy access and affordability, social equity, public health benefits, education and awareness. The necessity of a holistic program in financing the solutions to combat the climate crisis is clearly seen. Therefore, a macro perspective, which is not content with monetary policy and finance alone, but evaluates all the policy tools of the macro economy together, is the prerequisite for the fight against the climate crisis. In this context, it is desirable to support green finance policies and monetary tools with green fiscal policies such as fossil fuel subsidy (FFS) removal, carbon tax, energy efficiency investments and incentives, tax incentives for green investments, and renewable energy investments and incentives. It is necessary to channel financial flows in a way that supports a just transition. For instance, there will be groups who will be negatively affected by FFS removal. The finances that will be freed upon the removal of wasteful subsidies can be earmarked in order to support these disadvantaged groups.

To sum up, in Mediterranean countries, green finance tools alone may lack the necessary scope, enforcement, or complementary measures to drive significant GHG reductions. However, when coupled with stringent environmental policies and paired with coherent energy policies that do not favor fossil fuels, these tools are more likely to be applied effectively, target key sectors, and trigger systemic changes, thereby significantly decreasing emissions. This interplay underscores the importance of integrating green finance instruments within a comprehensive and coherent environmental policy framework.

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APPENDIX: RESULTS WITH LAGGED INDEPENDENT VARIABLES TO CONTROL FOR REVERSE CAUSALITY

Model 1a.i: Fixed-effects, using 340 observations

Included 14 cross-sectional units

Time-series length: minimum 7, maximum 27

Dependent variable: LNGHGPC

Driscoll-Kraay standard errors, bandwidth 2

	Coefficient	Std. Error	Z	p-value	
const	−4.85016	1.03627	−4.680	<0.0001	***
LNGDPPC_1	0.648141	0.0973863	6.655	<0.0001	***
REO_1	−0.00312508	0.00132005	−2.367	0.0179	**
ENVTAX_1	0.000995021	0.0138419	0.07188	0.9427	
dt_2	0.308512	0.0498327	6.191	<0.0001	***
dt_3	0.309750	0.0514360	6.022	<0.0001	***
dt_4	0.329389	0.0445898	7.387	<0.0001	***
dt_5	0.309596	0.0447315	6.921	<0.0001	***
dt_6	0.299474	0.0438286	6.833	<0.0001	***
dt_7	0.286325	0.0439159	6.520	<0.0001	***
dt_8	0.252781	0.0409915	6.167	<0.0001	***
dt_9	0.255511	0.0391831	6.521	<0.0001	***
dt_10	0.245582	0.0405402	6.058	<0.0001	***
dt_11	0.248853	0.0364703	6.823	<0.0001	***
dt_12	0.239021	0.0323418	7.390	<0.0001	***
dt_13	0.217568	0.0324023	6.715	<0.0001	***
dt_14	0.211417	0.0267609	7.900	<0.0001	***
dt_15	0.171484	0.0275122	6.233	<0.0001	***
dt_16	0.119722	0.0245236	4.882	<0.0001	***
dt_17	0.149510	0.0238144	6.278	<0.0001	***
dt_18	0.141956	0.0184980	7.674	<0.0001	***
dt_19	0.119385	0.0221821	5.382	<0.0001	***
dt_20	0.0807659	0.0220443	3.664	0.0002	***
dt_21	0.0797566	0.0154613	5.158	<0.0001	***

dt_22	0.0676104	0.0134597	5.023	<0.0001	***
dt_23	0.0407659	0.0120879	3.372	0.0007	***
dt_24	0.0614797	0.00873743	7.036	<0.0001	***
dt_25	0.00841535	0.0101187	0.8317	0.4056	
dt_26	−0.0145169	0.00341372	−4.253	<0.0001	***
dt_27	−0.0900089	0.00435822	−20.65	<0.0001	***

Mean dependent var	1.905796	S.D. dependent var	0.388619
Sum squared resid	2.202401	S.E. of regression	0.086113
LSDV R-squared	0.956982	Within R-squared	0.574618
Log-likelihood	374.2585	Akaike criterion	−662.5170
Schwarz criterion	−497.8723	Hannan-Quinn	−596.9131
rho	0.878862	Durbin-Watson	0.269723

Robust test for differing group intercepts -

Null hypothesis: The groups have a common intercept

Test statistic: Welch F(13, 105.5) = 78.1684

with p-value = P(F(13, 105.5) > 78.1684) = 5.91961e-48

Model 1b.ii: Fixed-effects, using 175 observations

Included 8 cross-sectional units

Time-series length: minimum 21, maximum 22

Dependent variable: LNGHGPC

Driscoll-Kraay standard errors, bandwidth 2

	Coefficient	Std. Error	Z	p-value	
const	−5.61298	0.507608	−11.06	<0.0001	***
LNGDPPC_1	0.611586	0.0582633	10.50	<0.0001	***
FOSSIL_1	0.0153694	0.00227852	6.745	<0.0001	***
ENVTAX_1	−0.0116666	0.00800425	−1.458	0.1450	
EPS	−0.0127776	0.0183685	−0.6956	0.4867	
EPSxENVTAX	0.00736324	0.00368507	1.998	0.0457	**
dt_2	0.185632	0.0333864	5.560	<0.0001	***
dt_3	0.173573	0.0325016	5.340	<0.0001	***
dt_4	0.184289	0.0306581	6.011	<0.0001	***
dt_5	0.174832	0.0292114	5.985	<0.0001	***
dt_6	0.165875	0.0285438	5.811	<0.0001	***
dt_7	0.166540	0.0268465	6.203	<0.0001	***
dt_8	0.140782	0.0239959	5.867	<0.0001	***
dt_9	0.156881	0.0231603	6.774	<0.0001	***
dt_10	0.148283	0.0217435	6.820	<0.0001	***
dt_11	0.154110	0.0189991	8.111	<0.0001	***
dt_12	0.134345	0.0164992	8.142	<0.0001	***
dt_13	0.108286	0.0156208	6.932	<0.0001	***
dt_14	0.102083	0.0137630	7.417	<0.0001	***
dt_15	0.0574731	0.0130517	4.404	<0.0001	***
dt_16	0.00358196	0.0127176	0.2817	0.7782	
dt_17	0.0369049	0.0118537	3.113	0.0018	***
dt_18	0.0345650	0.00904975	3.819	0.0001	***
dt_19	0.0260393	0.00795416	3.274	0.0011	***
dt_20	−0.00581244	0.00701280	−0.8288	0.4072	
dt_21	−0.0118427	0.00327409	−3.617	0.0003	***
dt_22	0.0273996	0.00173608	15.78	<0.0001	***

Mean dependent var	2.100198	S.D. dependent var	0.228692
Sum squared resid	0.272226	S.E. of regression	0.043940
LSDV R-squared	0.970086	Within R-squared	0.849982
Log-likelihood	317.4526	Akaike criterion	−566.9053
Schwarz criterion	−459.3025	Hannan-Quinn	−523.2585
rho	0.516854	Durbin-Watson	0.911586

Robust test for differing group intercepts -

Null hypothesis: The groups have a common intercept

Test statistic: Welch F(7, 71.1) = 192.715

with p-value = P(F(7, 71.1) > 192.715) = 1.38018e-43

Model 2a.i: Fixed-effects, using 340 observations

Included 14 cross-sectional units

Time-series length: minimum 7, maximum 27

Dependent variable: LNGHGPC

Driscoll-Kraay standard errors, bandwidth 2

	Coefficient	Std. Error	Z	p-value	
const	−4.96675	1.06796	−4.651	<0.0001	***
LNGDPPC_1	0.655059	0.0996257	6.575	<0.0001	***
REO_1	−0.00289276	0.00140209	−2.063	0.0391	**
CLIMTAX_1	0.00898503	0.0121977	0.7366	0.4614	
dt_2	0.340095	0.0517530	6.572	<0.0001	***
dt_3	0.336426	0.0536665	6.269	<0.0001	***
dt_4	0.354648	0.0461467	7.685	<0.0001	***
dt_5	0.334964	0.0466739	7.177	<0.0001	***
dt_6	0.324429	0.0452864	7.164	<0.0001	***
dt_7	0.311989	0.0453846	6.874	<0.0001	***
dt_8	0.280419	0.0430449	6.515	<0.0001	***
dt_9	0.282260	0.0411084	6.866	<0.0001	***
dt_10	0.271945	0.0424603	6.405	<0.0001	***
dt_11	0.274160	0.0380182	7.211	<0.0001	***
dt_12	0.264302	0.0338740	7.802	<0.0001	***
dt_13	0.243354	0.0340628	7.144	<0.0001	***
dt_14	0.237355	0.0284398	8.346	<0.0001	***
dt_15	0.197036	0.0293492	6.714	<0.0001	***
dt_16	0.145663	0.0263946	5.519	<0.0001	***
dt_17	0.173862	0.0255069	6.816	<0.0001	***
dt_18	0.163767	0.0201271	8.137	<0.0001	***
dt_19	0.142489	0.0237905	5.989	<0.0001	***
dt_20	0.103497	0.0236779	4.371	<0.0001	***
dt_21	0.100245	0.0163711	6.123	<0.0001	***
dt_22	0.0876516	0.0140966	6.218	<0.0001	***
dt_23	0.0603985	0.0135044	4.472	<0.0001	***

dt_24	0.0802961	0.00985703	8.146	<0.0001	***
dt_25	0.0279384	0.0112848	2.476	0.0133	**
dt_26	0.00450957	0.00424428	1.063	0.2880	
dt_27	−0.0706289	0.00408288	−17.30	<0.0001	***

Mean dependent var	1.908262	S.D. dependent var	0.386402
Sum squared resid	2.138419	S.E. of regression	0.084853
LSDV R-squared	0.957751	Within R-squared	0.584511
Log-likelihood	379.2703	Akaike criterion	−672.5406
Schwarz criterion	−507.8960	Hannan-Quinn	−606.9367
rho	0.875734	Durbin-Watson	0.274043

Joint test on named regressors -

Test statistic: F(3, 26) = 74.3967

with p-value = P(F(3, 26) > 74.3967) = 6.90656e-13

Robust test for differing group intercepts -

Null hypothesis: The groups have a common intercept

Test statistic: Welch F(13, 106.0) = 78.1179

with p-value = P(F(13, 106.0) > 78.1179) = 4.30059e-48

Model 2b.ii: Fixed-effects, using 176 observations

Included 8 cross-sectional units

Time-series length = 22

Dependent variable: LNGHGPC

Driscoll-Kraay standard errors, bandwidth 2

	Coefficient	Std. Error	Z	p-value	
const	−5.66794	0.558416	−10.15	<0.0001	***
LNGDPPC_1	0.617714	0.0629746	9.809	<0.0001	***
FOSSIL_1	0.0150990	0.00225822	6.686	<0.0001	***
CLIMTAX_1	−0.0109749	0.00911326	−1.204	0.2285	
EPS	−0.0238152	0.0119267	−1.997	0.0458	**
EPSxCLIMTAX	0.0125143	0.00247545	5.055	<0.0001	***
dt_2	0.196854	0.0305365	6.447	<0.0001	***
dt_3	0.181696	0.0299400	6.069	<0.0001	***
dt_4	0.191491	0.0280176	6.835	<0.0001	***
dt_5	0.182390	0.0265565	6.868	<0.0001	***
dt_6	0.172934	0.0257355	6.720	<0.0001	***
dt_7	0.175079	0.0249926	7.005	<0.0001	***
dt_8	0.148849	0.0222588	6.687	<0.0001	***
dt_9	0.164925	0.0213978	7.708	<0.0001	***
dt_10	0.156461	0.0203336	7.695	<0.0001	***
dt_11	0.164021	0.0181497	9.037	<0.0001	***
dt_12	0.145041	0.0164344	8.825	<0.0001	***
dt_13	0.119217	0.0161645	7.375	<0.0001	***
dt_14	0.110780	0.0143901	7.698	<0.0001	***
dt_15	0.0677945	0.0132385	5.121	<0.0001	***
dt_16	0.0127151	0.0129515	0.9817	0.3262	
dt_17	0.0433177	0.0124104	3.490	0.0005	***
dt_18	0.0404892	0.00898774	4.505	<0.0001	***
dt_19	0.0311951	0.00817294	3.817	0.0001	***
dt_20	−0.00236661	0.00739222	−0.3201	0.7489	
dt_21	−0.00972173	0.00353763	−2.748	0.0060	***
dt_22	0.0278587	0.00158301	17.60	<0.0001	***

Mean dependent var	2.099509	S.D. dependent var	0.228221
Sum squared resid	0.259400	S.E. of regression	0.042741
LSDV R-squared	0.971541	Within R-squared	0.857064
Log-likelihood	324.0152	Akaike criterion	−580.0305
Schwarz criterion	−472.2340	Hannan-Quinn	−536.3088
rho	0.489893	Durbin-Watson	0.964457

Joint test on named regressors -

Test statistic: F(5, 21) = 194.601

with p-value = P(F(5, 21) > 194.601) = 7.57204e-17

Robust test for differing group intercepts -

Null hypothesis: The groups have a common intercept

Test statistic: Welch F(7, 71.5) = 154.961

with p-value = P(F(7, 71.5) > 154.961) = 1.36125e-40

CHAPTER 3. HELPING ECONOMIC POLICYMAKERS NAVIGATE THROUGH AMBITIOUS CLIMATE POLICIES

Author : Theodoros Zachariadis



Abstract

Achieving climate stabilisation in line with the Paris agreement is an economy-wide endeavour because deep decarbonisation, on the road to net zero greenhouse gas emissions by mid-21st century, is impossible without interventions in all aspects of economic and social life. Ministries of Economy / Finance must be involved in the design of decarbonisation pathways because they are responsible for budget preparation and implementation, economic incentives and policy reforms, and public investments. This involvement is crucial for integrating green public finances and economic tools to mobilise resources for sustainable development initiatives. However, economic policymakers are not familiar with technical aspects that are essential to evaluate the fiscal, macroeconomic, and distributional impacts of climate policy. For this purpose, they need to collaborate closely with environment, energy, agriculture, and transport ministries. This chapter describes a suite of methods that can provide valuable insights for economic policymakers when they assess the economic impacts of low-carbon strategies, which are not immediately evident to Economy/Finance Ministries and require cooperation between different public authorities. These methods involve detailed exploration of national data for: (a) the assessment of effective carbon rates and fossil fuel subsidies across the economy; (b) the medium- and long-term fiscal challenges associated with decarbonisation; (c) the identification of climate-related investments and future investment needs; and (d) the prioritisation of low-carbon investments with an explicit set of criteria. We present them as a specific case study, their application in the Republic of Cyprus – although most of them have been implemented in different countries as well. Although the general policy orientation in our case studies is the EU decarbonisation framework, the work presented is essentially conducted at national level and therefore our approach is equally relevant for Mediterranean non-EU Member States as well.

Résumé

La stabilisation du climat, conformément aux objectifs de l'Accord de Paris, requiert une transformation de l'ensemble de l'économie. Une décarbonation profonde, visant la neutralité carbone d'ici le milieu du XXI$_2$ siècle, est en effet impossible sans des interventions dans tous les domaines de la vie économique et sociale. Les ministères de l'Économie et des Finances jouent un rôle central dans l'élaboration des trajectoires de décarbonation, puisqu'ils sont responsables de la préparation et de l'exécution des budgets, des incitations économiques, des réformes de politique publique et des investissements publics. Leur implication est essentielle pour intégrer la finance publique verte et les instruments économiques afin de mobiliser les ressources nécessaires aux initiatives de développement durable. Cependant, les décideurs économiques ne maîtrisent pas toujours les aspects techniques indispensables à l'évaluation des impacts fiscaux, macroéconomiques et redistributifs des politiques climatiques. Il est donc crucial qu'ils collaborent étroitement avec les ministères en charge de l'environnement, de l'énergie, de l'agriculture et des transports. Ce chapitre présente un ensemble de méthodes permettant d'éclairer les décisions des responsables économiques lorsqu'ils évaluent les effets économiques des stratégies bas-carbone, qui ne sont pas toujours immédiatement perceptibles pour les ministères de l'Économie et des Finances et nécessitent une coopération interinstitutionnelle. Ces méthodes s'appuient sur une analyse approfondie des données nationales pour : (a) évaluer les taux effectifs de taxation du carbone et les subventions aux énergies fossiles dans l'ensemble de l'économie ; (b) identifier les défis fiscaux à moyen et long terme liés à la décarbonation ; (c) recenser les investissements climatiques existants et les besoins d'investissement futurs ; (d) établir des critères explicites pour hiérarchiser les investissements bas-carbone. Nous illustrons ces approches à travers une étude de cas appliquée à la République de Chypre, bien que ces méthodes aient également été mises en œuvre dans d'autres pays. Si notre cadre d'analyse s'inscrit dans la stratégie européenne de décarbonation, l'approche retenue est avant tout nationale et demeure ainsi tout aussi pertinente pour les États méditerranéens non membres de l'UE.

1. INTRODUCTION

The Achieving climate stabilisation in line with the Paris agreement is an economy-wide endeavour. European countries are increasingly acknowledging this, since the climate-related policies of the European Green Deal involve actions in essentially all economic sectors – energy, agriculture, mobility, industrial emissions, waste management, buildings, etc. Non-European countries are also gradually recognizing the need for whole-of-government approaches because deep decarbonisation, on the road to net zero greenhouse gas emissions by mid-21st century, is impossible without interventions in all aspects of economic and social life. In the Mediterranean, the integration of sustainable public finances and innovative mechanisms is also essential to ensure funding for sustainable development across the region.

As a result, Ministries of Economy/Finance must be involved in the design of decarbonisation pathways. As explained in a recent World Bank blog post, these ministries are key because, among other actions, they are responsible for budget preparation and implementation, they propose incentives and policy reforms, and can promote green public investments (Kristensen et al., 2022). In addition to policy design, Ministries of Economy/Finance can spearhead the development of green economic tools, such as tax incentives for renewable energy, subsidies for nature-based solutions, and the issuance of green bonds to fund critical infrastructure projects. In response to this need, the Coalition of Finance Ministers for Climate Action[107] brings together fiscal and economic policymakers from over 90 countries, supported by the World Bank and the International Monetary Fund.

However, economic policymakers are not familiar with technical aspects that are essential to evaluate the fiscal, macroeconomic, and distributional impacts of climate policy, such as techno-economic assessments of low-carbon technologies, energy and emission projections, or the

106 https://www.financeministersforclimate.org/

evolution of energy prices as a function of different technological mixes. For this purpose, they need to collaborate closely with environment, energy, agriculture, and transport ministries.

This chapter describes a number of pragmatic approaches that can provide valuable insights for economic policymakers when they assess the economic impacts of low-carbon strategies. We focus on aspects that are not immediately evident to Economy/Finance Ministries and require cooperation between different public authorities. These approaches investigate the following policy questions:

(a) What are the actual effective carbon prices across the national economy? Which sectors are underpriced (or unpriced), and in which ones are carbon emissions effectively subsidised?
(b) How can decarbonisation policies affect the medium- and long-term public finances? Which fraction of economy-wide tax revenues depends on greenhouse gas emissions, and how will these be affected if emissions decline in the near future?
(c) What is the actual level of climate-related investments across the economy, and what is the size of future investment needs to head to climate neutrality?
(d) What criteria should we use to prioritise public investments for decarbonisation while keeping in mind broader Sustainable Development Goals and respecting real-world constraints?

The above questions have several common features:

- They must be addressed by Economy/Finance Ministries but cannot be resolved by policymakers in these Ministries alone, because they require input from other authorities that are more familiar with technological questions.
- They require an in-depth look into actual data (e.g. excise tax levels by sector and fuel, exemptions, transition periods, conditions under which public investments are granted, etc.); top-down economic or energy models cannot provide sufficient granularity to investigate these questions.
- They are often overlooked in the public debate because recommendations from both international organisations and academic researchers are too generic since they seldom delve into country-specific details that are necessary for realistic and meaningful decarbonisation policies.

Addressing these policy questions not only helps chart effective decarbonisation strategies but also ensures that public finances are optimised to mobilise resources for sustainable development projects, particularly in Mediterranean countries, where socio-economic challenges demand innovative and inclusive financial solutions.

The approaches to address the above questions are presented in this chapter in a case study – their application in support of climate policies of the Republic of Cyprus – although most of them have also been implemented in other countries. Cyprus is chosen as a case study because it represents a small, Mediterranean EU Member State actively pursuing the EU-wide decarbonisation roadmap to achieve climate neutrality by 2050, in line with the European Climate Law that was adopted by EU leaders in 2021. Its reliance on carbon-intensive sectors, geographical constraints, and ongoing policy changes provide a clear example of how national-level strategies can address the challenges of decarbonisation while aligning with broader regional frameworks. At the same time, the methods described in each section depart from an EU-specific approach and are presented in a way that can be suitable for other Mediterranean countries as well, to assist policymakers in designing actionable strategies for informed decision-making in an era of ambitious decarbonisation. Many nations in the region face similar structural challenges, such as reliance on carbon-intensive sectors, climate vulnerability, and evolving policy landscapes, which makes the lessons drawn from this case study highly relevant both for EU and non-EU Mediterranean countries.

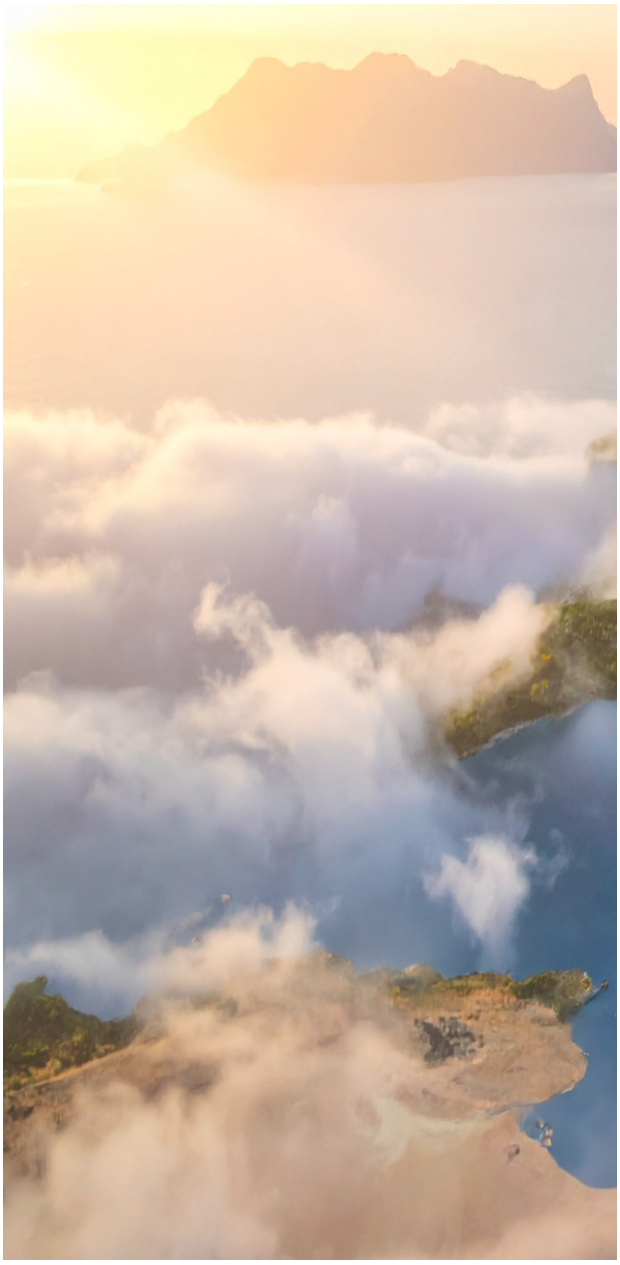
2. EFFECTIVE CARBON RATES ACROSS A NATIONAL ECONOMY

Environmental taxation is a main ingredient of decarbonisation policies, along with adoption of green subsidies, removal of fossil fuel subsidies, and legislation mandating the achievement of green targets or the abolishment of polluting technologies. Direct or indirect schemes of carbon taxation are increasingly being implemented worldwide, such as direct carbon taxes, emissions trading systems, fuel taxes, vehicle taxes based on carbon emissions of vehicles, etc. At the same time, many of these taxes are politically difficult to implement. This leads to discussions about 'fair' taxation schemes, compensation to vulnerable households and firms, and the existence of environmentally harmful subsidies.

In order to understand the scope and level of carbon taxation in an economy, one needs to map the emission levels by sector with the corresponding effective carbon tax/pricing rates. This section attempts to shed light on this topic, by laying out explicitly the different kinds of taxes and pricing schemes on greenhouse gas emissions (to be called effective carbon taxes/prices/rates in the rest of this document) that exist in the Cypriot economy. Our work is based on analysis carried out by the OECD (2023) and in European countries (Vollebergh et al., 2023; Brink et al., 2024) and adapts it to the Cypriot case in more detail than the OECD analysis provides. We map the major current taxes and prices that relate to greenhouse gas (GHG) emissions, their strictness (i.e. the effective tax rate by economic sector and fuel), and their scope (i.e. the amount of emissions that they cover). We also show how the carbon tax landscape is expected to change by the end of this decade, in view of new rules coming into force in the frame of more ambitious climate policies.

2.1 Emissions

Table 1 shows the GHG emissions of Cyprus as available in a recent officially available report for the reference year 2021. For the sake of the analysis in this section, only carbon dioxide (CO2) emissions (not those of other GHGs) will be addressed, since these are the emissions of interest to the energy system and are the most frequently addressed in national discussions about carbon taxation. (Section 3 below will include all GHG emissions in its considerations). Moreover, only taxes that are specifically addressing fossil fuel emissions are included; therefore, our assessment does not include Value Added Tax nor horizontal taxes or charges such as the green levy that is charged to every consumer of electricity to finance a special fund for investments in renewable energy and energy efficiency, regardless of the origin of electricity.



Sector	Sector	All GHG emissions
Power generation	3077.7	3087.6
Industry in ETS - Energy	386.4	394.7
Industry in ETS - Processes	897.0	897.0
Other industry - Energy	135.6	136.0
Other industry - Processes	5.0	380.8
Road transport	2033.3	2046.3
Petrol - Cars & light trucks	961.3	967.4
Petrol - Motorcycles	16.6	16.8
Diesel - Light trucks	799.0	804.2
Diesel - Heavy trucks & Buses	250.6	252.2
LPG	1.4	1.4
Other fossil fuels	4.3	4.4
Other national transport	3.0	4.9
Buildings	383.4	394.8
Agriculture - Energy use	84.7	85.2
Agriculture - Other	0.3	626.2
Other energy	22.9	23.1
Waste	0.0	662.6
Intl. Aviation	554.9	559.1
Intl. Shipping	800.4	810.1
Total	**8381.7**	**10103.3**
Total energy-related	**7482.4**	**7541.7**
Total without bunkers	**7026.4**	**8734.1**

TABLE 1

GHG emissions from fossil fuel use in Cyprus in 2021 (kt CO2-equivalent)

Source : 2023 National Inventory Report of Cyprus submitted to the UNFCCC (Republic of Cyprus, 2023a). The table does not include emissions/sinks due to land use, land use change and forestry.

2.2 Effective Carbon Prices: the Need to Expand Carbon Taxation to Currently Exempt Sectors

To assess the effective carbon rate (in Euros per tonne of CO2) in each economic sector, the following current taxation/pricing/charging schemes were taken into account:

- The EU Emissions Trading System (ETS), applicable to power generation and the non-metallic minerals industry (cement and ceramics plants).
- Excise taxes on all fuels, based on Directive 2003/96/EC that was transposed to national Law 91(I)/2004, which has been amended several times since then.
- The system currently in force to calculate annual circulation tax of passenger cars and light trucks on the basis of their type-approval CO2 emissions, according to Law 47(I)/2019.

As the policy landscape is expected to change considerably in the coming years, we also mapped the emissions versus the expected future carbon rates, which include, in addition to existing legislation, the expansion of the existing ETS to aviation and shipping; the introduction of ETS2 – the new Emissions Trading System covering fuels used in buildings, road transport, and light industry to be effective EU-wide from 2027; and the phase-out of free ETS allowances in heavy industry because of the phase-in of the Carbon Border Adjustment Mechanism as foreseen in Regulation (EU) 2023/956.

Table 2 presents the effective carbon rates based on the regulatory regime that was in force by the end of year 2023, mapped on the officially reported energy-related CO2 emissions in the Cypriot economy of year 2021 (which totalled 7482 kilotons as shown in Table 1). Figure 1 illustrates the same information in graphical form, presenting – sector by sector – the cumulative energy-related CO2 emissions on the horizontal axis and the respective effective carbon rates on the vertical one. It is evident that:

- Road transport bears most of the carbon tax burden, mainly due to the excise tax on automotive fuels. This picture is similar in most European countries and reflects the historically high fuel taxation in this sector. It must be stressed, however, that such taxation is considered to be justified because the use of motor vehicles is the cause of several adverse effects (i.e. external costs) in addition to greenhouse gas emissions. Air pollution, noise, congestion, and accidents are typical externalities associated with vehicle use, especially in cities. In fact, despite impressive technological improvements in engines and fuels, "air pollution is the single largest environmental health risk in Europe and a major cause of premature death and disease" according to the European Environment Agency and the World Health Organisation (EEA, 2023a) – and motor vehicles contribute to most emissions of air pollutants in cities.
- A significant portion of total CO2 emissions remain untaxed today. This includes all emissions of industries subject to the EU ETS, 51% of emissions from non-ETS industry (since only the use of gas oil is taxed but not the use of fuel oil and LPG), 35% of emissions in buildings (again, because only gas oil and a cleaner version -kerosene- are taxed), most emissions from aviation, and all emissions from shipping. In total, about ¾ of total CO2 emissions are taxed, or 88% of emissions if those from international bunkers (aviation and shipping) are not accounted for.
- Importantly, Figure 1 also shows the 'shadow cost of carbon', which assesses the implicit cost of all emission reduction measures in order to stay in line with the EU's overall decarbonisation goals according to the European Investment Bank's guidelines (EIB, 2020). This shadow cost – currently at around 130 Euros per tonne of CO2 – reveals that only road transport (which accounts for 24% of total CO2 emissions and 20% of total GHG emissions in Cyprus) is taxed at levels that can be considered sufficient to meet decarbonisation goals and in line with the environmental damage it causes. Hence, 76-80% of emissions are taxed at lower than

adequate levels or are not taxed at all[108] . In fact, the yellow-coloured area of the graph provides an indication of the magnitude of implicit fossil fuel subsidies in the Cypriot economy. This area corresponds to more than 700 million Euros per year in 2023, or about 2.5% of national GDP, and is considerably higher than the estimate of fossil fuel subsidies in Cyprus by the European Environment Agency (EEA, 2023b). However, the definition of such subsidies is different and depends on the benchmark used to calculate them. In our case, the benchmark is the 'appropriate' price that would be necessary to enable deep decarbonisation by 2050; any effective carbon price below that benchmark can be considered an implicit subsidy.

- This amount is pretty high in comparison to many other estimates but is still quite lower than the subsidies in Cyprus estimated by the International Monetary Fund[109] , which accounts for all external costs from the use of fossil fuels and estimates subsidies of over 1 billion Euros in 2023 (IMF, 2023)[110] .

The issue of fossil fuel subsidies merits a more extensive discussion, which is out of the scope of this chapter. In any case, the above findings can help policymakers as well as tax and environmental professionals identify the scope, strictness, and gaps in current carbon taxation across the Cypriot economy, and understand the inconsistent approach pursued between different economic sectors and different fuels with regard to their carbon price treatment.



108 Although the shadow cost of carbon is not identical with the external cost of GHG emissions, EIB's value of 130 Euros (at 2016 prices) is similar to a recent assessment of the external GHG cost by CE Delft (2023), according to which the central estimate of GHG externality is 130

109 It must be noted that there are different definitions of fossil fuel subsidies, e.g. by the OECD, the International Energy Agency, the International Monetary Fund, and the World Trade Organisation.

110 See IMF (2023). Note that the implicit subsidy calculated by IMF specifically on climate change related externalities, which is the topic of this report, is lower than the subsidy estimate we provide here, due to the fact that the benchmark carbon price used by IMF to calculate these subsidies is around $60 per tonne of CO2, whereas we use a benchmark price of 130 Euros per tonne. However, total implicit fossil fuel subsidies for Cyprus are estimated at around $1.2 billion – much higher than in this report – because fossil fuel prices and charges do not account for all external costs of fossil fuels such as congestion, air pollution etc.

	CO2 emissions in 2021 (kt)	Effective CO2 price today (€/t CO2)	Comments
Power generation	3078	85.0	Approximate average ETS price in 2022-23. Zero fuel excise tax (art. 44 of Law 91(I)/2004).
Industry			Free ETS allowances up to 2025. From 2026 onwards, with CBAM operation, allowances will be gradually auctioned up to 100% auctioning in 2035.
Industry subject to ETS	386	0.0	Zero excise tax for all fuels used in cement industry (art. 44 of Law 91(I)/2004). Plus, all fuel oil used in industry is not subject to excise tax nor to VAT (Annex I of the same Law).
Industry out of ETS - Gas oil	67	27.8	Only gas oil consumption is currently taxed (€74.73/1000 litres); use of fuel oil and LPG are exempt of fuel taxes
Industry out of ETS - Fuel oil	24	0.0	
Industry out of ETS - LPG	44	0.0	
Road Transport			
Petrol - Cars & light trucks	961	235.2	- Fuel excise taxes: €429/1000 litres for petrol, €400/litre for automotive diesel, €125/1000 kg for LPG. - Annual road tax based on CO2 emissions for post-2019 registered cars and light trucks
Petrol - Motorcycles	17	188.4	
Diesel – Cars & Light trucks	799	200.8	
Diesel - Heavy trucks & Buses	251	148.7	
LPG	1	41.9	
Other fossil fuels	4	148.7	
Other national transport	3	0.0	Fuels used for domestic aviation and navigation
Buildings			
Gas oil	251	27.8	Only gas oil consumption is currently taxed (€74.73/1000 litres); use of fuel oil and LPG are exempt of fuel taxes
Fuel oil	8	0.0	
LPG	125	0.0	
Agriculture	85	2.1	Agricultural gas oil excise tax: €21/1000 litres
Other energy	23	0.0	Zero fuel excise tax for military use (art. 28 of Law 91(I)/2004)
International Aviation			
Subject to ETS	233	12.8	15% of ETS allowances are auctioned, for intra-EU flights only. Assume 58% of flights not included* (estimate).
Not subject to ETS	322	0.0	
International Shipping			No fuel tax currently, and no participation in ETS
Subject to ETS	560	0.0	No ETS allowances are auctioned today. Assume that emissions to be part of ETS later this decade account for 70% of all sales of maritime fuel in Cyprus (estimate).
Not subject to ETS	240	0.0	

TABLE 2

Energy-related CO2 emissions and current effective carbon rates by sector (status as of end 2023, without VAT, ignoring temporary reductions in excise taxes decided by the government until March 2024)

Source : https://www.transportenvironment.org/challenges/planes/price-of-flying/aviation-in-the-ets/

** «The carbon market is limited to intra-EEA flights and fails to include long-haul flights in the pricing scheme. As a result, 58% of Europe's aviation CO2 emissions will remain unaccounted for.»*

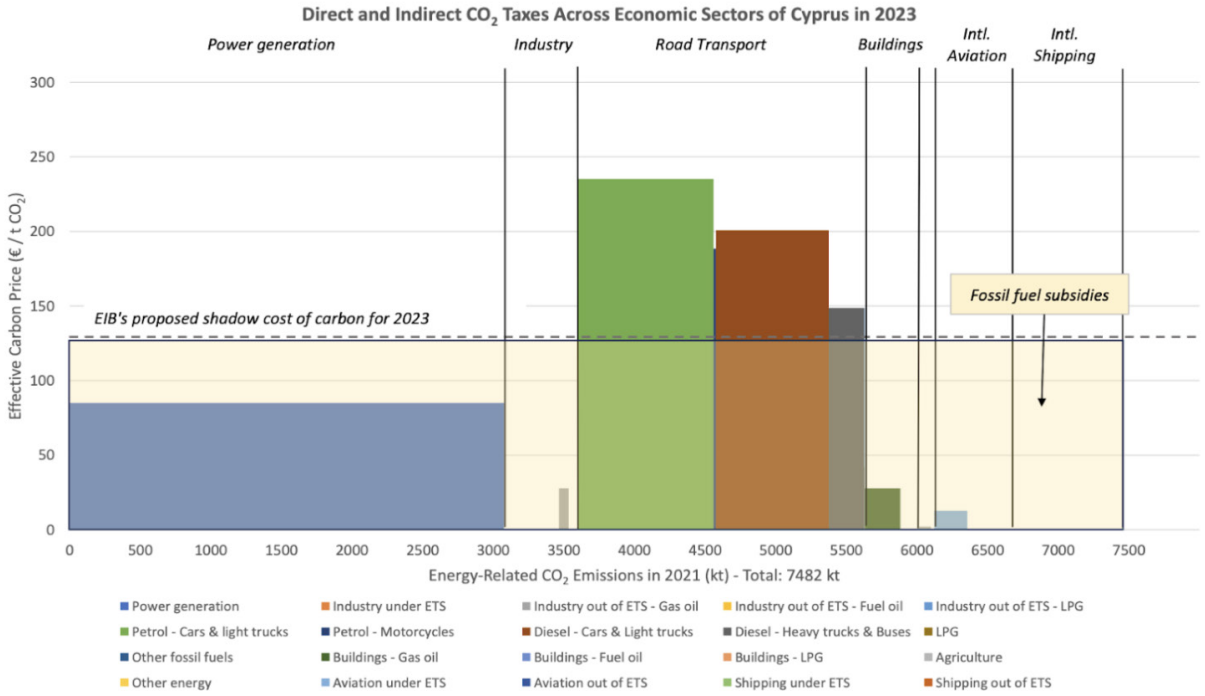


FIGURE.1 *Energy-related CO2 emissions and current effective CO2 prices by sector (status as of end 2023, without VAT, ignoring temporary reductions in excise taxes decided by the government until March 2024)*

As mentioned above, Table 2 and Figure 1 depict the current situation. However, implementation of the European Green Deal and the "Fit-for-55" package will change the landscape considerably in the next few years. Therefore, Table 3 shows the effective carbon rates that are expected to be in place towards the end of this decade – expressed in today's Euros. Figure 2 illustrates the information of Table 3. Note that our assessment does not assume any change in ETS price as this depends on several factors that are difficult to predict. Similarly, the ETS2 price shown in Table 3 follows the expectations of the European Commission according to the ETS2 Impact Assessment. Future carbon rates are mapped on the 2030 emissions, as projected to change in line with the draft revised National Energy and Climate Plan (NECP) that was submitted in July 2023.

Compared to the current status that was displayed in Figure 1, Figure 2 shows that thanks to the new EU policies almost all emissions of the Cypriot economy will be addressed by a carbon tax or carbon pricing scheme before the end of this decade. The only sector for which no clear taxation prospect exists – as far as energy-related emissions are concerned – is agriculture, plus the part of the aviation and shipping emissions that are not covered by the expanded ETS (all non-intra-EU flights and 50% of the ship voyages out of the EU).

Since, according to the EIB's assessment, the shadow cost of carbon must continuously increase to help decarbonise the European economy, and the proposed value is €250 per tonne of CO2 in 2030, it is evident from Figure 2 that only the effective carbon rates of road transport reach these levels; most of the other sectors are expected to be charged at considerably lower levels. This also depends on the evolution of ETS allowance prices, which have been assumed to remain at €85 in this assessment; if the ETS price increases in the near future the effective pricing levels of many sectors will approach the 'appropriate' ones. It must be emphasised, however, that the shadow cost of carbon does not indicate

an optimal economy-wide carbon tax level. It corresponds to the level of carbon tax that would be necessary if no other decarbonisation measures were taken. In reality, even if a direct carbon tax might be more efficient, a multitude of carbon emission abatement policies are implemented, such as subsidies for renewable energy deployment, bans of new internal combustion engines and fossil fuel powered boilers, grants for energy renovations or the purchase of electric cars, etc. In other words, it is not necessary for all sectors to be directly taxed at the levels implied by the shadow cost of carbon. Still, this cost provides a benchmark against which effective carbon rates can be compared.

Finally, it is worth noting that non-energy-relate emissions, which correspond to ¼ of total GH emissions in Cyprus as shown in Table 1, ar essentially untaxed. These span mainly acros three sectors: agriculture and livestock emis sions, waste, and industrial processes. There fore, although Figure 2 indicates that most ener gy-related emissions are on track to be charge at non-negligible levels by 2030, one should no forget the need to include non-energy emission in the tax system as well. This topic will also be mentioned in section 3 below.



	CO2 emissions in 2021 (kt)	Effective CO2 price by 2030 (€/t CO2)	Comments
Power generation	3078	85.0	Uncertain evolution of ETS prices up to 2030
Industry			
Industry subject to ETS	386	42.5	Assuming half of ETS allowances to be auctioned by 2030 as foreseen in the CBAM Regulation.
Industry out of ETS - Gas oil	67	77.8	Continuation of existing excise taxes + ETS2, assuming that ETS2 will lead to €50 allowance prices by 2030, in line with European Commission's guidelines.
Industry out of ETS - Fuel oil	24	50.0	
Industry out of ETS - LPG	44	50.0	
Road Transport			
Petrol - Cars & light trucks	961	285.2	Continuation of existing excise taxes + ETS2, assuming that ETS2 will lead to €50 allowance prices by 2030, in line with European Commission's guidelines.
Petrol - Motorcycles	17	238.4	
Diesel – Cars & Light trucks	799	250.8	
Diesel - Heavy trucks & Buses	251	198.7	
LPG	1	91.9	
Other fossil fuels	4	198.7	
Other national transport	3		
Buildings			
Gas oil	251	77.8	Continuation of existing excise taxes + ETS2, assuming that ETS2 will lead to €50 allowance prices by 2030, in line with European Commission's guidelines.
Fuel oil	8	50.0	
LPG	125	50.0	
Agriculture	85	2.1	No change foreseen; ETS2 will not include fuel used in agriculture.
Other energy	23		
International Aviation			
Subject to ETS	233	85.0	100% of ETS allowances are auctioned, for intra-EU flights only. Assume 58% of flights not included (estimate).
Not subject to ETS	322	0.0	
International Shipping			No fuel tax currently, and no participation in ETS
Subject to ETS	560	85.0	100% of ETS allowances are auctioned, for all intra-EU voyages and 50% of extra-EU voyages. Assume that these account for 70% of all sales of maritime fuel in Cyprus (estimate).
Not subject to ETS	240	0.0	

TABLE 3

Energy-related CO2 emissions in 2021 and expected effective carbon rates by sector by 2030, without VAT

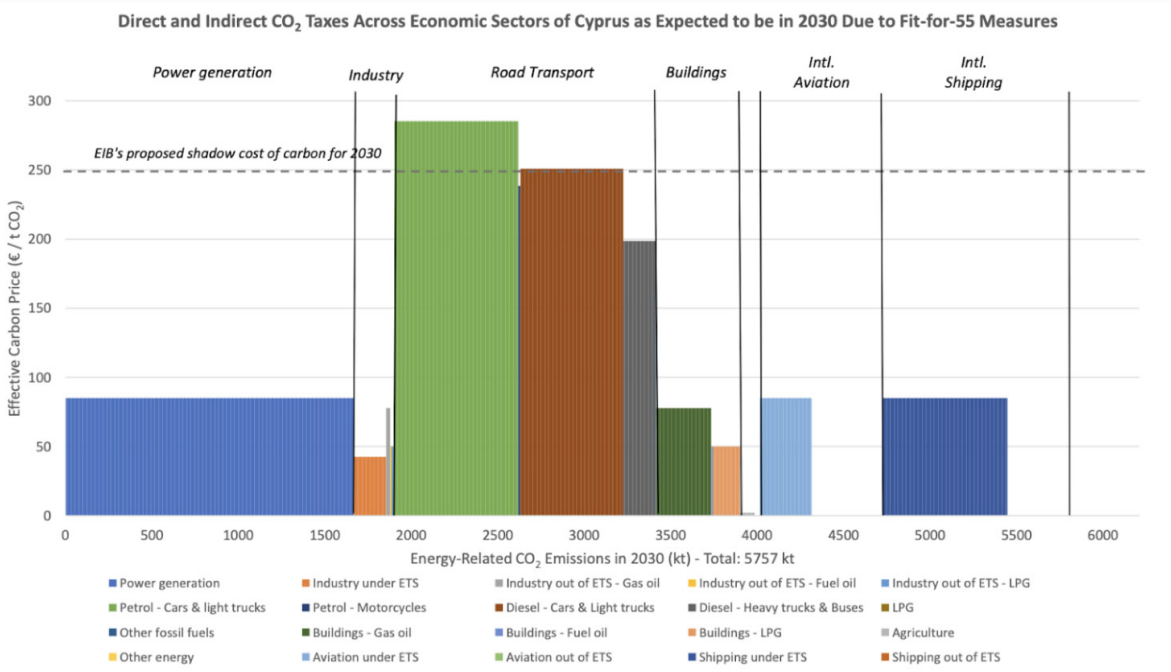


FIGURE.2 *Energy-related CO2 emissions and expected effective carbon prices by sector by 2030, without VAT*

3. FISCAL OUTLOOK OF DECARBONIZATION: RETHINKING CARBON TAXES AND REVENUE STREAMS

Several of the tax bases that generate substantial public revenues are directly or indirectly linked to greenhouse gas emitting activities. This means that, as GHG emissions fall as countries transition to a net zero economy, receipts generated from these emissions-linked taxes or pricing schemes will be affected, mostly leading to a decrease in tax revenues.

This section draws on an analysis conducted by the UK Office for Budget Responsibility (Todd et al., 2023), in an attempt to identify risks to public revenues associated with decarbonisation of the economy. Here we perform a similar analysis for the Cypriot economy, to understand some of the fiscal risks of the net zero transition and thereby to assist the Ministry of Finance in monitoring the implications of the transition for public finances.

In theory, t**he more emissions are directly linked with a tax base the more appropriate the price signal to economic actors that gives economic incentives for decarbonisation. However, as the economy decarbonises and emissions decline, the tax base gradually shrinks, which can lead to diminishing tax receipts.** For example, the electrification of motor vehicles will gradually reduce consumption of fossil fuels and therefore decrease the revenues from excise taxes on oil products. Similarly, since current annual circulation taxes are mainly calculated on the basis of a vehicle's direct carbon emissions, there is a zero charge for electric vehicles. This means that, from some point onwards, it is desirable to decouple the tax base from emissions in order to reduce the sensitivity of public finances to decarbonisation and thus to sustain an acceptable level of tax revenues.

Table 4 provides a mapping between GHG emissions and their tax bases. **As far as energy-related emissions are concerned, it turns out that 74% of them directly map onto tax bases, and therefore onto tax revenues.** Auctioning of allowances for fossil-fuelled power generation is directly linked with the GHG emissions of power plants; essentially all emissions of road transport are proportional to the fuel consumed by

vehicles – which is the base for fuel excise taxes; 49% of light industry's and 64% of buildings' emissions are proportional to the amount of gas oil burned, which is the base for the corresponding excise tax; and a small amount of aviation's emissions is also participating in the ETS and has a direct link to the amount of allowances purchased through auctioning.

On the other hand, **26% of energy-related emissions are not related to a tax base: those of cement and ceramic plants are almost unpriced** as these installations still receive most of their ETS allowances for free, and fuel excise taxes do not apply to heavy industry; oil products other than gas oil (i.e. fuel oil and LPG) used in light industry and the residential and commercial sector have a zero excise tax; and the most part of aviation's emissions (and all emissions of shipping) are charged neither through a fuel excise tax nor through auctioning of emission allowances in the ETS.

The picture is reversed when it comes to non-energy emissions, which come from industrial processes (mainly the use of fluorinated gases in industry and production of CO2 in the cement plant), methane emissions of plant and livestock farming, and waste management: there seems to be no link between any tax base and 74% of these emissions, whereas the only indirect link can be found in the way that waste is charged, which is roughly proportional to the amount of waste generated and therefore can be indirectly related to the amount of methane emissions generated. **Adding up energy and non-energy emissions, 55% of total GHG emissions are directly or indirectly mapped onto a tax base.**

As mentioned in Section 2, it is instructive to look into the changing carbon pricing policies towards the end of this decade, as a result of the "Fit-for-55" package. Therefore, Table 5 displays the same mapping as expected to change by 2030. The introduction of ETS2 and the further inclusion of aviation and maritime emissions in ETS is expected to increase the direct linkage between GHG emissions and a tax base. **As a result, 78% of total emissions (and 89% of energy-related emissions) are projected to map directly onto a tax base by 2030.**



Energy-related GHG emissions	Emissions in 2021	Emissions directly linked with tax base		Emissions indirectly linked with tax base		No link between emissions and tax base		Comments
	(kt)	(kt)	(%)	(kt)	(%)	(kt)	(%)	
Power generation	3088	3088	100%	0	0%	0	0%	Auctioned ETS allowances apply to all GHG emissions of power generation
ETS Industry	395	0	0%	0	0%	395	100%	Most ETS allowances are currently provided for free
Non-ETS Industry	136	67	49%	0	0%	69	51%	Only gas oil consumption is currently taxed; use of fuel oil and LPG are exempt of fuel taxes
Road Transport	2046	2033	99%	13	1%	0	0%	Fuel taxes directly linked with CO2 emissions; annual circulation tax direclty linked with emissions only in the case of cars & light trucks; non-CO2 GHG emissions are indirectly linked as the tax base is fuel consumption.
Buildings	395	251	64%	7	2%	136	35%	
Agriculture	85	85	99%	1	1%	0	0%	Fuel tax on agricultural gas oil
Domestic navigation & aviation & Other energy	28	0	0%	0	0%	28	100%	Zero fuel excise tax for military use (art. 28 of Law 91(I)/2004) & zero fuel excise tax for domestic shis and flights
International Aviation	559	35	6%	0	0%	524	94%	15% of ETS allowances are auctioned, for intra-EU flights only. Assume 58% of flights not included*.
International Shipping	810	0	0%	0	0%	810	100%	No fuel tax currently
Total energy-related GHG emissions	**7542**	**5559**	**74%**	**21**	**0%**	**1962**	**26%**	

Non-energy-related GHG emissions	Emissions in 2021	Emissions directly linked with tax base		Emissions indirectly linked with tax base		No link between emissions and tax base		
	(kt)	(kt)	(%)	(kt)	(%)	(kt)	(%)	
ETS Industry - Process emissions	**897**	**0**	**0%**	0	0%	897	100%	ETS allowances are currently provided for free
Non-ETS Industry - Process emissions	**381**	**0**	**0%**	0	0%	381	100%	Mainly F-gases, which are not taxed
Agriculture	**626**	**0**	**0%**	0	0%	626	100%	No taxes on agriculture & livestock (mainly methane) emissions
Waste	**663**	**0**	**0%**	663	100%	0	0%	Landfill or municipal waste tax varies by region and is usually calculated roughly proportionally to the household size, which indirectly relates to the amount of waste produced by that household. In some cities, pay-as-you-throw schemes are applied, which link directly emissions with the tax base - but they are currently a small fraction of total waste production.
Total non-energy-related emissions	**2567**	**0**	**0%**	**663**	**26%**	**1904**	74%	
All GHG emissions	**10108**	**5559**	**55%**	**684**	**7%**	**1962**	**38%**	

TABLE 4

Linkage of GHG Emissions of Cyprus with Tax Bases – Today's Status

Energy-related GHG emissions	Emissions in 2021	Emissions directly linked with tax base		Emissions indirectly linked with tax base		No link between emissions and tax base		Comments
	(kt)	(kt)	(%)	(kt)	(%)	(kt)	(%)	
Power generation	3088	3088	100%	0	0%	0	0%	Auctioned ETS allowances apply to all emissions of power generation
ETS Industry	395	197	50%	0	0%	197	50%	Assuming half of ETS allowances to be auctioned by 2030 as foreseen in the CBAM Regulation.
Non-ETS Industry	136	136	100%	0	0%	0	0%	All fuel use in light industry to be included in ETS2
Road Transport	2046	2046	100%	0	0%	0	0%	Fuel taxes directly linked with CO2 emissions; annual circulation tax direclty linked with emissions only in the case of cars & light trucks; non-CO2 GHG emissions will also be directly linked due to inclusion of road transport in ETS2.
Buildings	395	395	100%	0	0%	0	0%	All fuel use in buildings to be included in ETS2
Agriculture	85	85	99%	1	1%	0	0%	Fuel tax on agricultural gas oil
Domestic navigation & aviation & Other energy	28	0	0%	0	0%	28	100%	Zero fuel excise tax for military use (art. 28 of Law 91(I)/2004)
International Aviation	559	235	42%	0	0%	324	58%	100% of ETS allowances are auctioned, for intra-EU flights only. Assume 58% of flights not included.
International Shipping	810	567	70%	0	0%	243	30%	100% of ETS allowances auctioned, for all intra-EU and 50% of extra-EU voyages. Assume that these account for 70% of all maritime fuel sold in Cyprus.
Total energy-related GHG emissions	**7542**	**6748**	**89%**	**1**	**0%**	**793**	**11%**	

Non-energy-related GHG emissions	Emissions in 2021	Emissions directly linked with tax base		Emissions indirectly linked with tax base		No link between emissions and tax base		Comments
	(kt)	(kt)	(%)	(kt)	(%)	(kt)	(%)	
ETS Industry - Process emissions	897	448	50%	0	0%	448	50%	Assuming half of ETS allowances to be auctioned by 2030 as foreseen in the CBAM Regulation.
Non-ETS Industry - Process emissions	381	0	0%	0	0%	381	100%	Mainly F-gases, for which no clear outlook exists about their potentual future taxation
Agriculture	626	0	0%	0	0%	626	100%	No taxes on agriculture & livestock (mainly methane) emissions foreseen so far; ETS2 will not include these emissions.
Waste	663	663	100%	0	0%	0	0%	Assume that pay-as-you-throw schemes will be applied for the large majority of waste production in Cyprus.
Total non-energy-related emissions	**2567**	**1111**	**43%**	**0**	**0%**	**1456**	**57%**	
All GHG emissions	**10108**	**7860**	**78%**	**1**	**0%**	**2248**	**22%**	

TABLE 5

Linkage of GHG Emissions of Cyprus with Tax Bases – Expected Status in 2030

Some observations are in order:

- Purchase of allowances from Cypriot firms participating in the ETS does not need to take place from auctions held in Cyprus – they can purchase allowances from any auction taking place around Europe. This means that, strictly speaking, national emissions from ETS installations may not lead to national revenues. However, since many thousand installations across Europe participate in the ETS, and some of them will indeed purchase allowances from those auctioned in Cyprus, the continued operation and expansion of the ETS will lead to public revenues.
- In theory, the more emissions are directly linked with a tax base the more appropriate the price signal to economic actors that gives economic incentives for decarbonisation. However, as the economy decarbonises and emissions decline, the tax base gradually shrinks, which can lead to diminishing tax receipts. For example, the electrification of motor vehicles will gradually reduce consumption of fossil fuels and therefore decrease the revenues from excise taxes on oil products. Similarly, since the current annual circulation tax is calculated on the basis of a vehicle's carbon emissions, there will be a zero charge for electric vehicles. This means that, from some point onwards, it is desirable to decouple the tax base from emissions in order to reduce the sensitivity of public finances to decarbonisation and thus to sustain an acceptable level of tax revenues.

The above is illustrated in Figures 3 and 4. Figure 3 focuses on excise taxes on oil products and depicts the evolution of the tax base (fuel sales) and the corresponding tax receipts. Since 2014, when excise taxes were set at today's levels shown in the last column of Table 2 (with temporary reductions at some points in time), revenues have changed almost proportionally to fuel sales. With the advent of low- and zero-emitting cars (i.e. hybrid and battery electric ones), especially after 2025, although this proportionality will remain, the tax base will start diminishing substantially, hence tax receipts will decline as well. Compared to the years 2019 and 2021, when annual revenues were around 360 million Euros, these are projected to gradually fall to 288 million in 2030, thereby reducing public revenues by about 214 million Euros in total during the five-year period 2026-2030, or by 254 million if VAT is included. The only revenue corresponding to a 'fuel tax' for electric vehicles is the VAT charged on the electricity consumed by these vehicles, but since electric cars are much more efficient than conventional ones, these receipts are expected to be low and cannot counterbalance the revenue loss from reduced fuel sales.

Figure 4 focuses on annual circulation taxes paid by motor vehicles. Here, the tax base is the number of licensed vehicles every year. Since the end of 2019, the annual circulation tax of passenger cars and light trucks is calculated on the basis of their type-approval CO2 emissions. This applies to newly registered vehicles in Cyprus (whether registered as new or used vehicles). As a result, essentially all hybrid, plug-in hybrid, and battery electric cars and light trucks in the Cypriot market pay very low or zero annual circulation tax (since there were almost no vehicles of these technologies before 2019); and conventional vehicles, the most recent of which also have increasingly lower fuel consumption and carbon emissions, will pay lower circulation taxes than older vehicles leaving the market. Thus, for passenger cars, whereas annual vehicle tax revenues were stable between 70 and 75 million Euros/year in 2014-2021, revenues are projected to decline to less than 50 million Euros by 2030, leading to a cumulative fall in revenues of about 95 million Euros from 2024 to 2030, the decline being stronger after 2030. On the other hand, revenues from the annual circulation taxes of trucks and buses are less sensitive to electrification of the vehicle stock because, in contrast to light trucks, the annual tax paid for heavy trucks and buses does not depend on carbon emissions. Therefore, receipts are expected to decrease only slightly – from 26-30 million Euros annually in recent years to 25 million Euros by 2030.

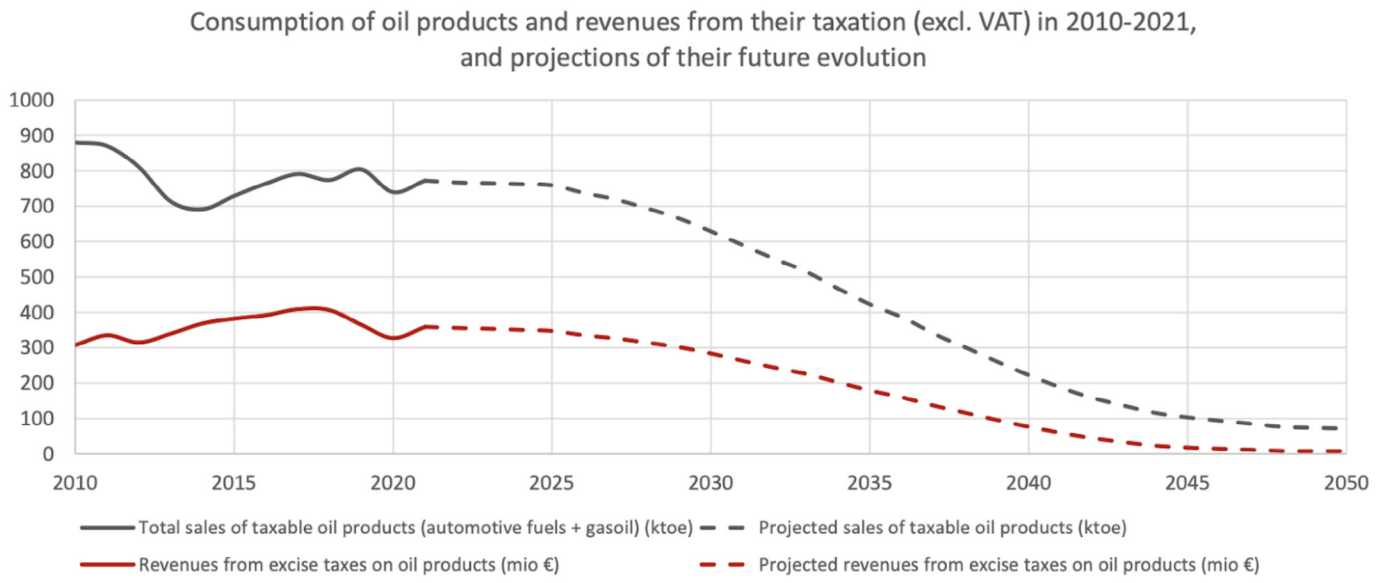


FIGURE.3 *Tax base (sales of oil products in Cyprus) and tax revenues: past evolution and future outlook*
Source of past data: Eurostat energy balances for Cyprus (for fuel consumption) and Cystat online public finance data (tax and social contribution receipts 1995-2021).
Source of projected figures: Detailed energy, transport and emission projections available in the draft revised National Energy and Climate Plan of Cyprus of July 2023 (Republic of Cyprus, 2023); and author's calculations.
ktoe: thousand tonnes of oil equivalent (an energy unit).

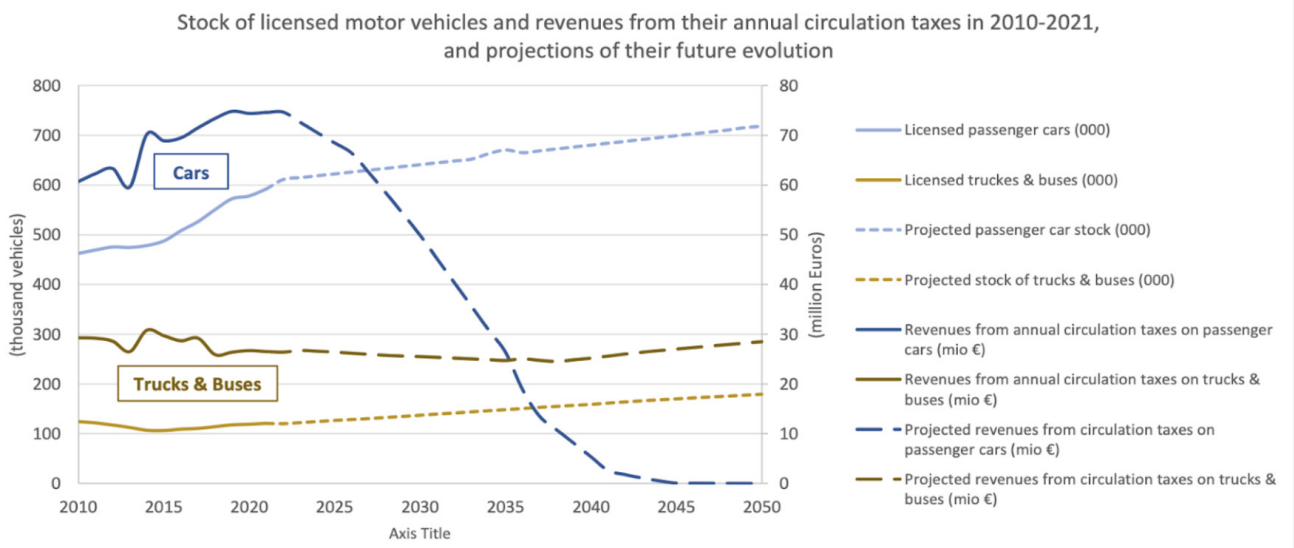


FIGURE.4 *Tax base (stock of vehicles in Cyprus) and tax revenues: past evolution and future outlook*
Source of past data: Statistical Abstract 2020-2021 of Cyprus (for vehicle stock) and Cystat online public finance data (tax and social contribution receipts 1995-2021).
Source of projected figures: Detailed energy, transport and emission projections available in the draft revised National Energy and Climate Plan of Cyprus of July 2023 (Republic of Cyprus, 2023); and author's calculations.
ktoe: thousand tonnes of oil equivalent (an energy unit).

4. ALIGNING INVESTMENTS WITH EU DECARBONIZATION GOALS: ASSESSING NEEDS, GAPS AND FUNDING STRATEGIES

The identification of climate-friendly investments is necessary for ensuring the alignment of national policies of EU member states with the EU-wide decarbonisation goals. There is a range of EU-wide legislative provisions that have to be met through careful planning of green investments – for example, the Energy Union Governance Regulation (EU) 2018/1999, the European Climate Law (Regulation (EU) 2021/1119), the Effort Sharing Regulation (ESR) (EU) 2023/857, the Energy Efficiency Directive EU/2023/1791, the Energy Performance of Buildings Directive EU/2024/1275, the Regulation (EU) 2023/851 for emission standards of cars and vans, etc. These legal texts are the outcome of initiatives that followed the European Green Deal that was adopted by EU leaders in December 2019, with the aim to address all environmental challenges of Europe in a socially just way.

To enable directing investments to the economic activities most needed for the green transition in line with the European Green Deal, the so called "EU Taxonomy" was created and consolidated in a legal text (Regulation (EU) 2020/852), which constitutes a common classification system for sustainable economic activities with the aim to scale up sustainable investments in Europe. For this purpose, it is crucial to identify i) the kind of investments that can be classified as green; ii) the necessary financial amounts that must be directed to such investments; iii) an assessment of the fraction of these amounts that must be supported by public funds' and iv) an understanding of how much of these amounts are additional to "business as usual" green investments, i.e. those that would happen anyhow irrespective of Europe's climate stabilisation ambition.

In its recent report "Towards EU climate neutrality", the European Scientific Advisory Board on Climate Change noted that estimates of climate investment needs "are based on a variety of sources with different scopes and levels of granularity. Currently, there is insufficient information available on the investments required to fund the transition towards climate neutrality. There is also a lack of available indicators to track progress at the sectoral level. This knowledge gap is mainly due to the lack of a harmonised methodology for identifying and estimating climate-related investment needs". Based on this finding, the Board recommended that "The EU should strive for a more granular and accurate overview of required and actual investments in climate mitigation to monitor and assess progress" (ESABCC, 2023).

In an attempt to address this policy gap, this section outlines the method followed to assess current investments and future investment needs in the two scenarios of the revised NECP of Cyprus (WEM – With Existing Measures – and WAM – With Additional Measures). This method has been presented in the impact assessment (chapter 5) of the revised NECP that was submitted to the European Commission in December 2024 (Republic of Cyprus, 2024). We combine:

- Detailed bottom-up information of current and planned investments, associating them with the five different Energy Union dimensions and allocating them in relation to the two main emission abatement categories (sectors subject to ETS and ESR respectively); and
- Top-down projections and cost-optimal simulations of our energy systems models, augmented by other assessments of non-energy-related GHG emissions.

Figure 5 describes the steps followed in this procedure. An assessment of current investments and further needs, prepared by the author, is described in detail in the NECP; here we summarise this approach. Since public policies and measures play a key role in setting the regulatory scene and mobilising private investments, the assessment starts by mapping the main green public investments that have already been planned through EU and international funds and the national budget. Next, similar investments that are indirectly and/or partially related to the NECP are included. Then the additional invest-

ments planned by the government for the near future are assessed, as well as the additional investments that are considered crucial for achieving the energy and emissions trajectory shown in the NECP. Finally, we build on the previous bottom-up analysis and combine it with top-down energy and emissions model simulations, thereby providing a detailed summary of the additional public and private investment needs. Table 6 displays a summary of these aggregate needs and Figure 6 shows their allocation by type of measure and by source of funds; for a detailed breakdown of these investments, the reader is referred to chapter of 5 of the revised NECP of Cyprus.

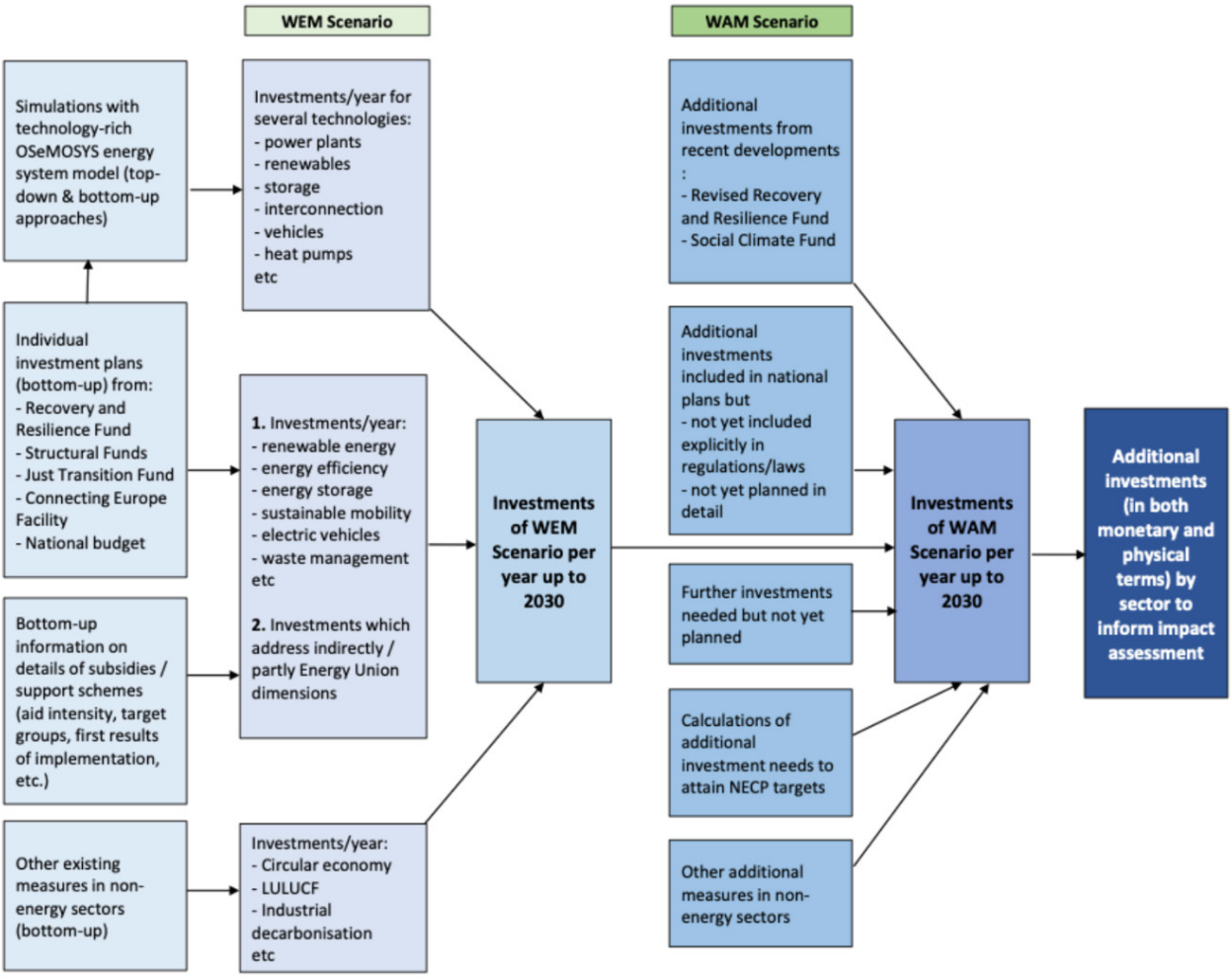


FIGURE.5 *Outline of the methodology to assess investments and investment needs in the NECP scenarios*

Evidently, all these financial resources that must be committed by the end of this decade (representing a significant portion of the GDP of Cyprus) are not merely intended to reach some broad goals of the NECP. They will also contribute to broader socioeconomic goals, such as economic development, job creation, and improved public health due to better air quality in urban areas. Chapter 5 of the Cyprus NECP provides an assessment of all these impacts, which are expected to be clearly beneficial to social welfare. In summary, a slight increase of the order of 0.5% is expected in economic output and employment (NECP section 5.2.1), and a reduction in premature deaths due to air pollution accompanied by a reduction in pollution-induced economic damages (NECP section 5.2.4), without compromising social equity (NECP section 5.2.2) and with a minimum impact on public finances (NECP section 5.2.1.5). As we have demonstrated when assessing post-pandemic economic recovery measures (Zachariadis et al., 2023), some green investments are clearly more friendly to job creation and economic growth than the conventional mix of public expenditures. These considerations provide a more holistic view of investment needs and put them in a broader economic and social perspective, illustrating that environmental and socio-economic considerations can be aligned with a view to improving a country's sustainability on many fronts at the same time.

Total Investments in the NECP of Cyprus by Type (€ mio)	Public Funds	Total Funds
Energy Efficiency	18	36
Promotion of Renewables	1066	2701
Promotion of Renewables + energy Efficiency	858	1353
Natural Gas Infrastructure	101	272
Promotion of Sustainable Mobility	885	1135
Promotion of Electirc Vehicles	61	273
Waste Management	70	100
Economy-wide Investments with Partial/Indirect Climate Impact	465	500
Total	**3523**	**6370**

Total Investments in the NECP of Cyprus by Source of Funds (€ mio)	Public Funds	Total Funds
EU Recovery and Resilience Facility	477	994
EU Structural Funds 2021-2027	271	321
EU Just Transition Plan (current + additional measures)	275	566
EU Connecting Europe Facility	758	2172
EU Social Climate Fund 2026-2030	100	125
Additional Necessary Funds for Energy Renovations of Buildings	300	500
Sustainable mobility investments from national budget	763	1013
Energy efficiency investments in industry	18	36
Specific grants scheme for emission reduction in enterprises	25	42
Waste management measures	70	100
EU funded measures with partial / indirect green impact	465	500
Total	**3523**	**6370**

TABLE 6
Summary of investment needs up to 2030 to achieve the goals of the Cyprus NECP

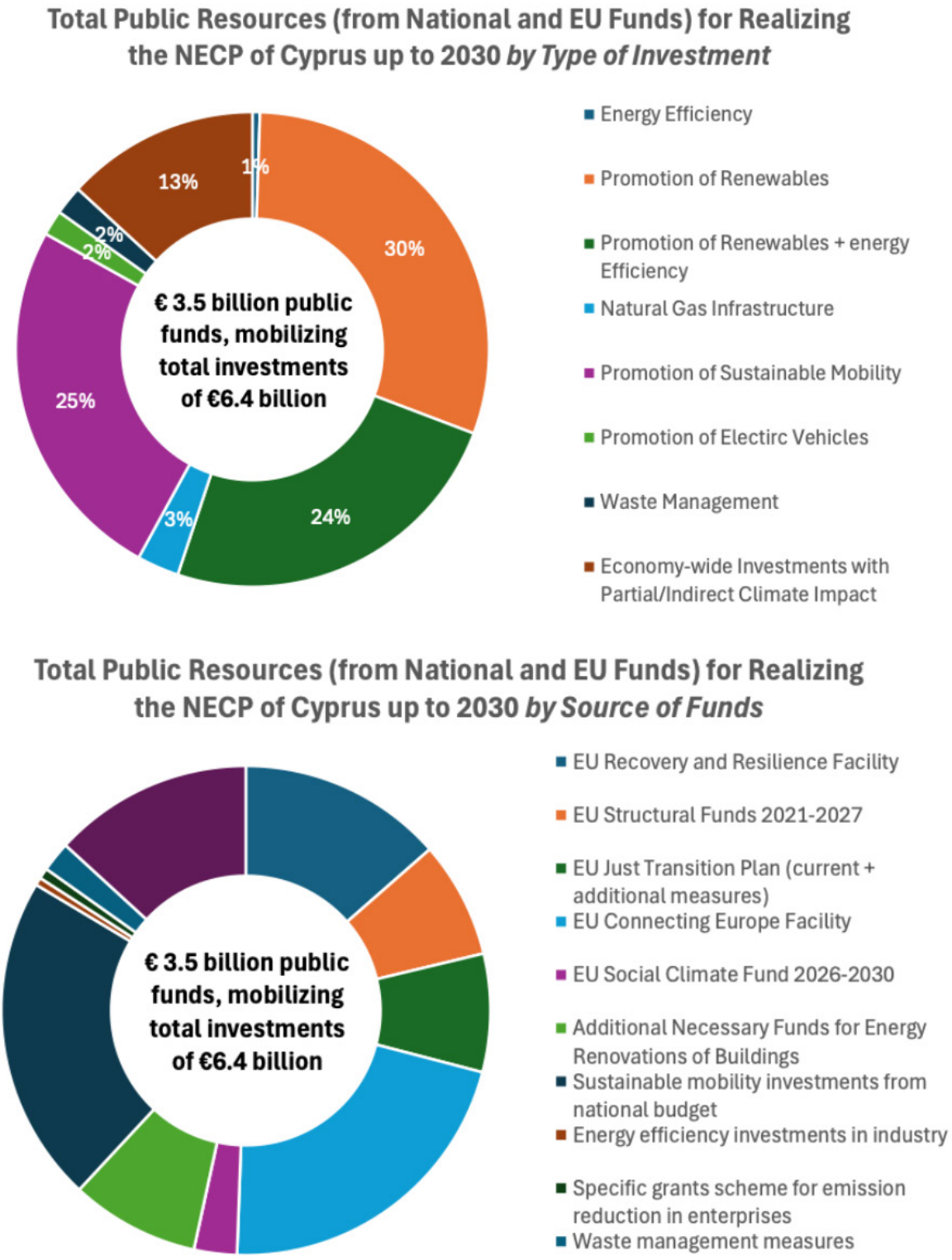


FIGURE.6 *Allocation of investment needs up to 2030 to achieve the goals of the Cyprus NECP*

5. CRITERIA FOR THE ALLOCATION OF PUBLIC FUNDS TO INVESTMENTS CONTRIBUTING TO NATIONAL CLIMATE GOALS

In the coming years, significant resources will be available to EU Member States to implement climate-related policies and measures. These resources will come from a) the revenues of the auctions of greenhouse gas emissions allowances, b) green levies paid e.g. by electricity, c) the current and new EU budget (Multiannual Financial Frameworks 2021-2027 and 2028-2034), e.g. Cohesion Funds, the Regional Development fund, etc. In non-EU countries, such resources could come from national budgets, green taxes/levies, reduction of fossil fuel subsidies, and/or different forms of financing from development aid or multilateral development banks.

In any case, and irrespective of the national circumstances, there is a need to prioritise individual green measures that will be funded by limited financial resources. While energy, environment, and transport ministries have accumulated some experience on which types of projects may be effective in each country's context, they may lack an overview about the broader socio-economic impact of such measures. Again, this is a typical case where Economy/Finance Ministries must be involved – and senior economic policymakers need the knowledge to make such decisions. In an effort to define a transparent methodology for the selection of the projects to be financed, this section proposes a set of criteria that looks into the broader sustainability objectives of a country.

A first – though partial – approach is to focus on carbon emissions abatement only. If a country wants to focus exclusively on fulfilling its goals to reduce greenhouse gas emissions, it can decide to allocate the available funds to projects based on two criteria:

- The cost-effectiveness ratio of each project, in terms of reducing emissions: the higher the indicator "tons of CO2-equivalent reduced per million Euro of investment», the more preferable a project becomes.
- The total emission reduction potential during the life of the investment or up to a predetermined year, e.g. until 2050.

By combining the above two criteria, priority will be given to investments that will reduce emissions at the lowest cost, but which will also be compatible with national emission reduction targets in 2030 and 2050. This will avoid considering myopically the cost-effectiveness criterion only, which may lock the country in a high-emissions path for many years. For example, a replacement of oil-fired boilers in industry with gas boilers can reduce CO2 emissions at a low cost per ton of CO2, which passes the cost-effectiveness test – but if the boiler has a lifetime of 25-30 years, the investment is not compatible with the goal of zero emissions in 2050, so it should not be supported.

Despite the simplicity of the analysis proposed above, it has to be reminded that deep decarbonisation is an economy-wide endeavour that must be addressed with a whole-of-government approach and inevitably interacts with broader Sustainable Development Goals. Therefore, to consider the wider impacts of green investments for the economy and society, multiple criteria need to be applied; these should be based on both cost-effectiveness and energy/emission saving potential, as well as other criteria related to reducing energy poverty, the possibility of stimulating economic development and employment, etc. Such an approach will shed light into synergies and trade-offs between different sustainability objectives and will lead to better informed decisions.

With these considerations in mind, we propose here a list of multiple (up to sixteen) criteria that can provide a holistic assessment of green investments. The list originated from the World Bank (Hammer and Hallegatte, 2020), we then adapted it to Cypriot conditions (Zachariadis et al., 2023) and can be further adapted to particularities of other countries. Table 7 presents these criteria, categorised to those related to environmental or energy impacts and those indicating broader socio-economic impacts. Of these sixteen criteria, some are quantitative (e.g. criterion 1: tons of CO2eq per million Euro of investment) and others are qualitative (e.g. criterion 6: contribution to climate resilience). For each quality criterion, a scale can be set, e.g. zero to 3. Negative values should also be possible.

This list brings transparency and sufficient information to recognise complementary or conflicting impacts of different green investments. Examples of such synergies and trade-offs are the following:

- A solar photovoltaic park that occupies agricultural land will receive a high score in criteria 1, 2, 5 and 12, but a zero or potentially negative score in criteria 8 and 15. Same with a wind farm that is built on a naturally sensitive or protected area.
- Energy renovations in residential buildings can receive a high score in criteria 1-4, 6 and 12, and can be growth and jobs enhancing, i.e. also get high scores in criteria 9 and 10. If they focus specifically on energy-poor households they can receive a high score in an additional criterion (11). At the same time, if they are difficult to implement because of labour shortages or limited administrative capacity they may not be fast enough to help achieve the climate neutrality goal of 2050 and hence they may score low in criterion 5.
- Subsidies for purchases of electric vehicles contribute to energy savings and reduce air pollution, hence will score high in criteria 3, 4 and 7. Their contribution to greenhouse gas emission abatement (and thus the score in criteria 1, 2 and 5) depends on the carbon intensity of power generation in that country or region. If the country has no automotive industry and only imports vehicles, the impact on growth and jobs (criteria 9 and 10) may be neutral or slightly negative (because electric vehicles may need less maintenance and therefore less activity in this economic sector). If the country produces motor vehicles, the score in criteria 9, 10 and 14 will depend on the readiness of the national industry to shift to electric vehicle production.
- A carbon tax or a removal of fossil fuel subsidies scores highly in almost all energy and environmental criteria 1-7. To the extent that they are accompanied with measures to alleviate the impact on poor households (or not) it may score neutrally (or negatively) in criterion 11. However, social acceptance (criterion 16) may be a crucial decision criterion in this case and can be influenced by broader political considerations.
- The buildup of electric railways can receive high scores in criteria related to growth, employment and infrastructure 9, 10 and 13 and can also lead to energy savings (3,4) and possibly to economic resilience (15). To what extent it contributes to savings of greenhouse gas and air pollutant emissions (criteria 1,2,5,7) depends on the emission intensity of power generation. If railway construction and land uptake endangers ecosystems, it will have a low score in criterion 8 (or the measure may be abandoned if it does not comply with environmental legislation).
- Restoration of a wetland may be a nature-based solution with positive impact on carbon absorption, hence can receive a good score in criteria 1, 5 and 6 and – depending on the abatement potential – also in criterion 2. It will also have a positive impact for ecosystems protection (criterion 8). It will probably have a neutral effect on energy-related criteria 3,4,12. The impact on the other socio-economic criteria will depend on the specificities of the measure and the region in which it will be implemented.

Evidently, decisions on the allocation of public funds to green investments cannot be a purely technocratic approach; broader social and political considerations will need to be made by decision makers. The criteria of Table 7 provide a solid evidence base that can be used by public authorities as shown in the examples above, while final decisions will be made on the basis of each one's importance. For this purpose, a weighting factor can be set by criterion, which is left to the discretion of policy makers. In this way, scientific evidence can inform policymaking without intervening in the political decision-making process.

At the same time, decisions do not take place in a policy void. While the quantitative and qualitative assessment on the basis of the criteria of Table 7 will be weighted by policymakers, final decisions will have to be made in combination with other national policies that are in place. In the case of EU countries, it has to be reminded that all financing must comply with EU legislation, as defined by the European Commission's climate-proofing guidelines (European Commission, 2021). This includes:

- Achieving the 2030 and 2050 emission reduction targets (this is addressed by considering criterion 5 in Table 7);
- The "Energy Efficiency First" principle defined in the Energy Efficiency Directive EU/2023/1791 (this is covered through criterion 4);
- "Do No Significant Harm Principle" of the EU Taxonomy Regulation (EU) 2020/852, which defines environmental objectives that must be met before an investment can proceed.

Because the evaluation with these sixteen criteria can become too complex, two or three groups of criteria can be defined and used. For example, in addition to legally binding criteria 4 and 5, it is necessary to consider criteria 1 and 2 in case of climate-related investments, or criteria 2 and 3 for energy-related actions.

	No.	Short name	Explanation	Related SDGs
Environmental impact	**1**	GHG emissions	CO2eq emission savings (tn): - per million Euros total investment or - per million Euros of public funds	13
	2	GHG abatement potential	Total lifetime CO2eq emission savings that can be achieved with this intervention up to 2030/2050 (tn)	13
	3	Energy	Energy savings (ktoe): - per million Euros total investment or - per million Euros of public funds	7
	4	Energy Efficiency First*	Consistency with the 'Energy Efficiency First' Principle as described in EU legislation (article 3 of Directive (EU) 2023/1791)	7
	5	Consistency with Paris Agreement and EU climate objectives*	Is the intervention consistent with a credible GHG emission reduction pathway in line with the EU's climate targets for 2030 and climate neutrality by 2050? Does it provide the technical means to better integrate or employ low-carbon technologies or strategies (for instance, through improvements to transmission and distribution infrastructure, public transit infrastructure, sidewalks or bike lanes, or by promoting denser urban development) that may yield climate benefits in 2030 and beyond?	13, 15
	6	Climate Resilience	Does it improve the adaptive capacity of the country, i.e. the ability to reduce negative impacts (such as adapting buildings to improve resilience to extreme temperature)?	13
	7	Air pollution	Change in emissions of air pollutants: - NOx - PM10 / PM2.5 - SO2	11, 12
	8	Other Environmental Impact	Other environmental impact of this measure (on nature, water resources, land productivity, biodiversity etc)	3, 6, 15
Economic / social impact	**9**	Economic multiplier	Economic output generation (million €) per million Euros invested	8
	10	Jobs	Employment generation (persons) per million Euros invested	8
	11	Affordability/Poverty	Is there a risk that vulnerable households or firms will incur high costs due to the measure?	1, 10
	12	Energy security	Does the intervention increase national energy security?	7
	13	Infrastructure & Productivity	Will the intervention improve local economic productivity through access to better, more reliable infrastructure services?	9
	14	R&D and innovation	Can the intervention spur R&D or innovation in the specific technologies?	9
	15	Economic Resilience	Does the intervention improve socio-economic resilience, that is, the ability of the population to cope with and recover from shocks?	1, 8, 10, 11
	16	Social acceptance	Is the measure socially acceptable? Can it contribute to social objectives?	1, 10

TABLE 7

List of assessment criteria for green projects to be supported by public funds and their relation to UN Sustainable Development Goals (SDGs)

*Included in the "Technical guidance on the climate proofing of infrastructure in the period 2021-2027" (European Commission, 2021).

Because Although Ministries of Economy/Finance must be involved in the design of decarbonisation pathways as these require whole-of-government approaches, economic policymakers are not familiar with technical aspects that are essential to evaluate the fiscal, macroeconomic, and distributional impacts of climate policy. For this purpose, they need to collaborate closely with environment, energy, agriculture, and transport ministries. This chapter has described several methods that can provide insights for economic policymakers when they assess the economic impacts of low-carbon strategies, which are not immediately evident to Economy/Finance Ministries and require cooperation between different public authorities.

In summary, we first demonstrated a method to calculate the actual effective carbon prices applied across a national economy with the aid of detailed energy, environmental, and price data; this sheds light into the actual level of carbon subsidies and prices by economic sector (which is not immediately evident to non-experts) and puts the discussion about carbon pricing in the proper perspective. Then, we used the same detailed datasets to explore the impact of decarbonisation policies on public finances, so that economic authorities can become aware of the medium-term challenges, especially at a time when an increasing part of tax revenues are linked with the environmental performance of each economic sector. We also presented a granular approach to accurately assess the level of economy-wide climate-related investments and the additional investment needs to align with climate stabilisation goals; this is possible if one utilises both top-down energy/economy modelling work with detailed bottom-up information. Finally, we listed a set of criteria that economic authorities can use to prioritise public investments for decarbonisation; this goes beyond the conventional (and sometimes myopic) cost-effectiveness assessments and adopts a holistic approach that encompasses both environmental and broader socio-economic considerations 0 which is exactly the role of Economy/Finance Ministries.

We presented this pragmatic approach as a specific case study in the Republic of Cyprus, which represents a small Mediterranean country pursuing the EU-wide roadmap to achieve climate neutrality by 2050. Inevitably, the general policy background in this chapter was the EU decarbonisation framework since Cyprus is an EU member state. However, the policy challenges that Cyprus faces in view of its dependence on oil imports, its reliance on carbon-intensive sectors and its geographical constraints, are equally relevant for Mediterranean non-EU Member States as well, provided that tailor-made analyses that are suitable for each country's circumstances are conducted and suitable collaboration avenues between public authorities within each country are pursued.

Despite the similarities, non-EU Mediterranean countries may face additional challenges in implementing frameworks such as those presented in this chapter. For example, non-EU nations may have less access to international funds for climate-friendly investments; they may lack sufficiently reliable data at the detail required for such assessments; and their public authorities may be faced with constraints in technical expertise and in the administrative capacity to apply similar frameworks and implement their plans.
Apart from the issues mentioned above, limited coordination among ministries is a common challenge in governmental authorities, irrespective of a country's governance system and level of economic development. However, as nations engage in more ambitious climate change mitigation strategies in combination with inevitable measures for adapting to a changing climate, Ministries of Economy/Finance must take a front position and enhance inter-ministerial collaboration for addressing these challenges. The adoption of a wide-ranging climate policy framework (such as that of the EU but adapted to the specificities of non-EU nations) and the building of institutional capacity in Mediterranean countries for a whole-of-government approach to climate policy will enable the implementation of methods such as those proposed in this chapter and can improve the effectiveness of economic and environmental policy at the same time.

Acknowledgement

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CHAPTER 4. LEVERAGING THE NATURE RESTORATION LAW – INNOVATIVE FINANCING INSTRUMENTS FOR RESTORING MEDITERRANEAN MARINE BIODIVERSITY

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Abstract

This chapter examines how the recently adopted Nature Restoration Law (NRL) can catalyse necessary reforms by governments and the adoption of innovative financing mechanisms to support marine biodiversity restoration in the Mediterranean. The NRL sets explicit targets for restoring key marine habitats and requires Member States to develop National Restoration Plans (NRPs) detailing both restoration actions and financing strategies. Given the law's high level of ambition, Member States will need to scale up financing for restoration from both public and private sources, while leveraging EU co-financing instruments.

To achieve this, the chapter advocates for an integrated policy mix, ensuring a complementary and diversified financing approach while minimising trade-offs. Key recommendations include:

- Identifying and phasing out harmful subsidies, using this process as a foundation for legal and financial reforms.
- Reforming tax systems and introducing fiscal incentives for marine conservation, while ensuring fairness for lower-income groups.
- Harnessing innovative financing tools, such as payments for ecosystem services, carbon markets and biodiversity tools in relation to blue carbon ecosystems, conservation fees and charges for MPA management, and conservation trust funds – all examined in the Mediterranean context for their feasibility and limitations.
- Mobilising private sector investment through blended finance mechanisms and blue bonds, while ensuring alignment with both climate and biodiversity objectives.
- Safeguarding against greenwashing and unintended ecological risks by implementing strong monitoring, verification and accountability measures.

The chapter also provides a preliminary ranking of these financing mechanisms based on their impact, efficiency, scalability and feasibility in the Mediterranean context, offering decision-makers a practical guide for developing marine restoration financing strategies. It concludes with tailored recommendations for both EU Member States implementing the NRL and non-EU Mediterranean countries under the Barcelona Convention, highlighting actionable steps to enhance marine restoration financing and governance.

Résumé

Ce chapitre examine comment la récente adoption de la Loi sur la Restauration de la Nature (LRN) peut catalyser les réformes nécessaires par les gouvernements et l'adoption de mécanismes de financement innovants pour soutenir la restauration de la biodiversité marine en Méditerranée. La LRN fixe des objectifs clairs pour la restauration des habitats marins essentiels et oblige les États membres à élaborer des Plans Nationaux de Restauration (PNR) qui détaillent à la fois les actions de restauration et les stratégies de financement.

Compte tenu de l'ambition élevée de cette loi, les États membres devront augmenter le financement de la restauration à la fois par des sources publiques et privées, tout en exploitant les instruments de cofinancement de l'UE. Pour atteindre ces objectifs, ce document préconise une approche intégrée des politiques, assurant une complémentarité et une diversification des sources de financement tout en minimisant les compromis. Les principales recommandations sont les suivantes :

- Identifier et éliminer les subventions nuisibles, en utilisant ce processus comme base pour des réformes juridiques et financières.
- Réformer les systèmes fiscaux et introduire des incitations fiscales pour la conservation marine, tout en veillant à l'équité pour les groupes à faibles revenus.
- Mettre à profit des outils de financement innovants, tels que les paiements pour services écosystémiques, les marchés du carbone et les instruments de biodiversité en lien avec les écosystèmes de carbone bleu, les frais de gestion des Aires Marines Protégées (AMP) et les fonds de conservation, tous examinés dans le contexte méditerranéen pour évaluer leur faisabilité et leurs limites.
- Mobiliser les investissements du secteur privé à travers des mécanismes de financement mixte et des obligations bleues, tout en garantissant leur alignement avec les objectifs climatiques et de biodiversité.
- Se prémunir contre le greenwashing et les risques écologiques imprévus en mettant en place des mesures rigoureuses de surveillance, de vérification et de responsabilisation.

Le chapitre propose également un classement préliminaire de ces mécanismes de financement en fonction de leur impact, de leur efficacité, de leur évolutivité et de leur faisabilité dans le contexte méditerranéen, offrant ainsi aux décideurs un guide pratique pour développer des stratégies de financement pour la restauration marine. Il se conclut par des recommandations spécifiques destinées aux États membres de l'UE mettant en œuvre la LRN et aux pays méditerranéens non membres de l'UE dans le cadre de la Convention de Barcelone, soulignant des actions concrètes pour améliorer le financement et la gouvernance de la restauration marine.

1. INTRODUCTION

1.1 Mediterranean Marine Biodiversity: Threats and Protection

Because The Mediterranean Sea is a global hotspot of marine biodiversity, hosting 11% of all marine species within less than 1% of the global marine area. This exceptional diversity is however under severe pressure from multiple anthropogenic stressors. Overfishing is a critical threat, as 80% of assessed fish stocks are overexploited. Pollution, particularly from plastic and chemical contaminants, further degrades marine ecosystems, while invasive species disrupt native biodiversity. Coastal development, driven by intense urbanisation and infrastructure projects, leads to habitat loss, while climate change amplifies these pressures through rising sea temperature, acidification and deoxygenation, exacerbating ecosystem stress and reduce resilience to other pressures[111] . As a result, populations of key species, such as mammals, have declined by 41%[112] .

111 Rodríguez-Rodríguez, D. and Abdul Malak, D. (2022).
112 Gomei, M., et al. (2019).

Marine Protected Areas (MPAs) are a cornerstone of Mediterranean marine conservation efforts, covering 9.5% of the sea basin, with 1,280 designated MPAs primarily concentrated in the North-Western region. However, the effectiveness of this protection remains limited. Only 0.11% of the Mediterranean Sea benefits from legally stringent reserves, and only 0.03% is covered by fully protected areas. The lack of effective management further undermines conservation outcomes: while 84% of designated MPA areas have a managerial authority (rising to 97% in the Western Mediterranean), only 2.48% of the basin is covered by an MPA with an active management plan, and a mere 1.27% is covered by MPAs that effectively implement their management plans [113].
Despite progress – MPA coverage in the Mediterranean doubled between 2007 and 2019[114] - protection coverage and efficiency remain largely insufficient to meet international biodiversity commitments. Global targets, such as Target 3 of the Global Biodiversity Framework[115], and regional commitments under the EU Biodiversity Strategy for 2030[116], call for 30% or marine areas to be protected, with at least 10% under strict protection in the EU. The current MPA network falls far short of these goals, necessitating both an expansion in coverage and significant improvements in management effectiveness.

Beyond biodiversity protection, **MPAs play a critical role in maintaining vital ecosystem services,** including food provision, water purification, coastal protection, carbon sequestration and recreation. However, their ability to deliver these services is increasingly compromised by anthropogenic pressures. Safeguarding and restoring ecosystem services back to health is therefore imperative to ensure their continued provision[117]. MPAs also function as sentinel observatories for monitoring ecosystem changes and contribute locally to ecological improvement. Properly managed MPAs can foster habitat recovery, replenish fish stocks and enhance biodiversity resilience[118], and are therefore crucial tools supporting the goals and targets of the NRL.

The NRL provides a framework for addressing these challenges by mandating ecosystem restoration alongside conservation. The NRL defines restoration as the process of actively or passively assisting ecosystem recovery to improve biodiversity, structure and function. Active restoration involves direct interventions such as habitat replanting or coral transplanting, while passive restoration focuses on reducing pressures to allow ecosystem to recover – an approach that aligns closely with effective MPA management, which restricts harmful activities. In this paper, both active and passive restoration measures are considered within the scope of 'restoration', including the role of MPAs as key restoration tools. Conservation and restoration are indeed inherently complementary: while conservation prevents further degradation, restoration seeks to reverse past damage. Ensuring that MPAs are efficiently managed and financially supported is therefore essential for restoring degraded ecosystems, making MPAs an important instrument for achieving the NRL's objectives in the Mediterranean.

1.2 Financing and Restoring Marine Biodiversity in the Mediterranean: Challenges and Opportunities

Marine biodiversity conservation and restoration faces a critical financing gap. The NRL's impact assessment estimates that restoring most of its targets across the EU will require an annual investment of €8.2 billion from 2022 to 2030, but this figure does not include the costs of marine ecosystem restoration, due to insufficient data[119]. While a precise funding gap for marine ecosystems has yet to be quantified at the EU or Mediterranean level, available evidence suggests that these costs will be substantial. Active marine restoration measures are particularly expensive, with reported costs ranging from US$80,000 and $1.6

113 Ibid.
114 Rodríguez-Rodríguez, D. and Abdul Malak, D. (2022).
115 Conference of the Parties to the Convention on Biological Diversity (2022).
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118 Eli, A.A., Raimi, M.O. and Amachree, D. (2025).
119 Commission Staff Working Document (2022).

million per hectare, depending on the ecosystem type (e.g., coral reefs, seagrass meadows, mangrove forests, salt marshes and oyster reefs)[120]. Despite these high upfront costs, restoration yields significant ecological and economic returns and largely outweighs the initial costs [121]. Nevertheless, the costs of restoring ecosystems back to health will only increase as pressures on ecosystems and habitats harms the delivery of ecosystem services. The more degraded an ecosystem is, the more expensive it will be to restore it, and restored ecosystems provide less benefits than untouched ecosystems. Proactive investment is therefore critical to avoid increasing future costs and ensure the continued provision of essential ecosystem services, enabling economic returns that exceed initial costs.

A key aspect of marine conservation in the Mediterranean is the effective financing of Marine Protected Areas (MPAs), which remain largely underfunded. A 2015 study estimated the financing gap for effective management of Mediterranean MPAs at approximately €700 million annually, with €458 million required for seven EU countries (Croatia, Cyprus, France, Greece, Italy, Slovenia, and Spain)[122]. Due to this chronic underfunding, many MPAs exist as 'paper parks', offering little actual conservation benefits. As the NRL's targets put increasing pressure on Member States to finance conservation and restoration measures, the cost of establishing and managing MPAs becomes a critical concern. In 2018, the average annual cost per MPA was US$2.3 million[123], but this investment is modest compared to the scale of Mediterranean tourism revenues. In 2012, international tourism generated €190 billion in the region[124], showing that even a small portion of this economic activity could easily cover the funding needs for effective marine conservation and restoration, benefiting both the environment and the socio-economic landscape in the long term.

Currently, MPA funding relies primarily on public sources, accounting for over 50% of support, with additional contributions from self-generated revenues (e.g., user fees) and international finance, such as Official Development Assistance, the Global Environmental Facility, and the EU LIFE Programme[125]. Private sector investment remains a minor contributor to marine conservation. While public funding is crucial, innovative financing tools offer opportunities to diversify revenue sources for biodiversity protection and restoration.

The Nature Restoration Law (NRL) presents a significant opportunity to restore Mediterranean marine biodiversity, imposing legally binding restoration targets and requiring Member States to detail financing strategies in their National Restoration Plans (NRPs). This provides a strong policy driver to increase investment in marine restoration, improving MPAs, habitat quality, biodiversity, and ecosystem resilience. Non-EU Mediterranean countries, though not bound by the NRL, should also pursue financing reforms to meet targets under the Global Biodiversity Framework (GBF) by 2030.

Drawing on available data and literature (Section 2), this paper explores the NRL's key provisions, highlighting opportunities for financing reforms in Member States and the adoption of innovative financial mechanisms. Section 3 covers the NRL's legal requirements, including targets for restoring marine habitats and financing strategies in NRPs. Section 4 examines public reforms (Section 4.1) and potential funding increases from both public and private sources (Sections 4.2 and 4.3). Section 4.4 emphasizes the need for an integrated policy approach, and Section 4.5 provides a preliminary ranking of reforms and tools to guide policymakers. Finally, Section 5 offers recommendations for both EU and non-EU Mediterranean countries, detailing steps for efficient reforms, increased investment, and NRL implementation.

120 Bayraktarov, E., et al (2016).
121 Commission Staff Working Document (2022).
122 Binet, T., Diazabakana, A. & Hernandez, S. (2015a).
123 Binet, T., Diazabakana, A. & Hernandez, S. (2015a).
124 GRID-Arendal, Tourism in the Mediterranean countries. Based on Plan Bleu, elaborated from World Bank and UNWTO (2012). Available at: https://www.grida.no/resources/5894.
125 Ibid.

2. METHODOLOGY

2.1 Data Extraction

A search conducted on the UNEP-WCMC, Funding Ecosystem Restoration in Europe database[126] using the filters 'ecosystem' (marine neritic, marine coastal/supratidal, marine intertidal, marine oceanic, artificial aquatic) and 'countries' (Mediterranean coastal countries) identified 32 marine ecosystem restoration projects in the Mediterranean, with a total funding of €80 million (including ongoing and completed projects). The aim of the search was to have an overview of the funding sources of such projects, and to identify potentially interesting examples to be highlighted in case studies in the paper. The search identified the following funding sources:

- 25 EU-funded projects, including 21 from the LIFE Programme (for a total of €27 million), 2 from the EU Horizon 2020 Programme (for a total of €9 million) and one from the European Maritime and Fisheries Fund (for €1.5 million).
- 2 government-funded projects, for a total of €13,5 million.
- 1 foundation-funded project, for a total of €2.6 million.
- 1 privately funded project, for a total of €30,000.
- 3 were funded by a blend of government, EU and private funds, for a total of €6 million.

A search conducted on the Policy Instruments for the Environment (PINE) database[127]using the filters 'instrument type (environmentally beneficial subsidies, taxes and fees, and tradable permits and offsets), 'countries' (Mediterranean coastal countries) and 'domain' (fisheries, biodiversity and ocean) identified 43 active economic instruments. Not all are linked to restoration measures, but they provide useful insights into the tools used by Mediterranean countries to incentivise ocean and biodiversity protection. The search identified the following instruments:

- 5 labelled 'environmentally beneficial subsidies', which are relevant for the analysis and potential case studies in Section 4.1.1.
- 33 labelled 'taxes and fees', which are relevant for the analysis and potential case studies in Section 4.1.2.
- 3 labelled 'tradable permits and offsets', which identified transferable quotas, but which will not be studied in the paper.

A search using the European Maritime and Fisheries Fund (EMFF)[128] using the filters 'countries and regions' (Mediterranean countries) and 'topics' (environmental monitoring and restoration) was inconclusive, as only one relevant project was extracted from the database: the AFRIMED project, which received €1,486,111 from the EU fund to improve restoration of macroalgal forests [129].

To strengthen the study's validity and provide a more comprehensive picture, local projects were also explored, with a view to identifying case studies for the different financing tools analysed in Section 4 of the paper. Relevant organisations were contacted to obtain more information about their project or initiative. An interview was conducted with a representative of the MedFund, a Conservation Trust Fund (CTF) in the Mediterranean (see Section 4.2.4). The search for local projects revealed difficulties in obtaining data on such projects. Global databases provide valuable information but often lack granularity at the local level and may not always capture on-the-ground realities. There is therefore a need to fill these gaps, and to identify the relevant organisations who can play a role in this initiative (see Section 5.2.).

2.2 Literature Review

A systematic literature review was conducted to find the relevant data and knowledge to answer the paper's research question: how can innovative financing instruments be leveraged through the implementation of the Nature Restoration Law (NRL) to restore marine biodiversity in the Mediterranean? Search tools (i.e., Google Scho-

126 UNEP-WCMC, Funding Ecosystem Restoration in Europe, https://restorationfunders.com/ecosystem-restoration.
127 OECD, Policy Instruments for the Environment (PINE) database, https://oecd-main.shinyapps.io/pinedatabase/.
128 European Maritime and Fisheries Fund, https://emff-datahub.eismea.eu/#.
129 AFRIMED, Project overview, http://afrimed-project.eu/?page_id=599.

lar) and websites of relevant organisations (i.e., OECD, MedPan, WWF Mediterranean, Plan Bleu), were used to find and extract the relevant information. The EUR-Lex website was also used for access to the final text of the NRL. Relevant grey and scientific literature are referenced in each section below.

2.3 Ranking of Financial Tools

Each financing instrument analysed in Section 4.1 to 4.3 in this paper was assessed to provide a ranking to guide policymakers in Section 4.5. They were assessed according to the following criteria:

- Impact: the potential of the financing tool to generate significant and measurable positive outcomes for marine ecosystem restoration, includes its ability to support large-scale restoration projects, enhance ecosystem resilience and contribute to long-term conservation objectives.
- Efficiency: the cost-effectiveness of the instrument in achieving restoration targets, considering how well resources are or can be allocated, the level of financial leakage, and the degree to which funding reaches on-the-ground restoration activities.
- Scalability: the ability to expand the mechanism across different levels within the Mediterranean region, including its adaptability to various national policies and legal frameworks, as well as its potential to mobilise additional funding at scale.
- Feasibility: the ease with which the instrument can be implemented, considering political, economic and institutional constraints. This includes factors such as regulatory barriers, institutional capacity, market readiness, and social acceptance.

The assessment was qualitatively scored across the four criteria using a three-tiered scale:

- High (3 points): the financing instrument strongly meets the criterion, demonstrating high potential for effectiveness.
- Moderate (2 points): the instrument meets the criterion but with some limitations or challenges.
- Low (1 point): The instrument has significant barriers or weaknesses in meeting the criterion.

The total score for each mechanism was calculated by summing the points assigned across all four criteria, leading to a composite ranking of financing instruments (Tables 3 and 4).

The policy ranking was informed by a combination of existing literature, case studies (see Section 2.1. and 2.2.) but is mostly based on expert judgment from the paper's author. This ranking aims to provide a preliminary assessment of financing instruments – it remains exclusively qualitative in nature and does not assess all financing tools available for financing nature restoration. It does not include a quantitative analysis, due to data limitations on financial flows and restoration outcomes, and complexities in quantifying the criteria assessment. Further work could incorporate data and stakeholder consultations to refine the ranking and validate the findings. Moreover, the assessment is done at the Mediterranean level, without taking into considerations major institutional, legal and societal differences. The assessment may also be further refined at the national level.

3. THE NATURE RESTORATION LAW: A MILESTONE FOR MARINE ECOSYSTEM RESTORATION IN THE EU

3.1 Legal and Policy Background for Biodiversity Conservation and Restoration

The conservation and restoration of Mediterranean marine biodiversity is regulated at the international, regional and national levels. All countries can designate MPAs and implement restoration measures at the national level, but some international laws and policies aim to scale up these efforts.

Firstly, all Mediterranean countries are parties to the Convention on Biological Diversity (CBD), which aims to conserve biological diversity[130] and requires Parties to develop National Biodiversity Strategies and Action Plans (NBSAPs) outlining how they are achieving the goals of the CBD. In December 2022, Parties to the CBD adop-

130 Convention on Biological Diversity of 5 June 1992 (1760 U.N.T.S. 69).

ted the Global Biodiversity Framework (GBF)[131], a voluntary agreement with 23 action-oriented goals for protecting biodiversity by 2030. Notably, Target 2 aims to restore 30% of degraded marine ecosystems, and Target 3 aims to conserve 30% of marine areas. Importantly, Target 19 requests countries to mobilise US$200 billion per year for biodiversity from all sources, to bridge the biodiversity funding gap.

Secondly, at the regional level, different laws and policies provide for conservation targets in the marine realm. The EU Habitats[132] and Birds Directive[133] are critical pieces of legislation for conservation, as it protects key marine species and habitats and requires Member States to designate Natura 2000 areas for certain protected habitats and species. The EU's Marine Strategic Framework Directive[134] and Maritime Spatial Planning Directive[135] contribute to the promotion of marine biodiversity conservation and the sustainable use of marine resources. The former aims to achieve good environmental status for EU marine waters, and the latter aims to promote the sustainable use of marine resources through maritime spatial planning. Moreover, the EU Biodiversity Strategy to 2030[136] (EU BDS) includes a non-binding target to conserve 30% of marine areas, including 10% of strict protection. Recently, the adoption of the NRL[137] further complemented the framework by setting ambitious legal targets for restoring degraded ecosystems (see Section 3.2).

Outside the EU framework, the Specially Protected Areas and Biological Diversity (SPA/BD) Protocol of the UN regional Convention for the Protection of the Marine Environment and the Coastal Region of the Mediterranean (Barcelona Convention) is a key piece of legislation for marine conservation in the region. It provides for the protection and sustainable use of marine and coastal biodiversity in the Mediterranean and promotes the establishment of a network of marine and coastal protected areas and the conservation of endangered or threatened species and habitats.

Both the Barcelona Convention and the GBF serve as crucial frameworks for aligning biodiversity conservation efforts and ambition across Mediterranean countries. Although the GBF is not legally binding, it strengthens the objectives and implementation of the Barcelona Convention and has been instrumental in generating political momentum for biodiversity conservation and scaling up its financing. It has also played a key role in engaging both public and private actors in its implementation. At the resumed COP16 in Rome in February 2025, countries adopted a Strategy for Resource Mobilisation, an important milestone in the implementation of Target 19 of the GBF[138]. It outlines concrete mechanisms and tools to mobilise funding for biodiversity, including leveraging public and private investment, including blended finance, reforming harmful subsidies and significantly increasing domestic finance for biodiversity.

3.2 The NRL's Legal Objectives for Restoration and Identification of Financing Sources

Outside The NRL sets binding targets for restoring 20% of seas by 2030 and all ecosystems needing restoration by 2050, including specific marine ecosystem goals under Article 5. Member States must adopt National Restoration Plans (NRPs) by 2026, detailing restoration areas, measures, and financing strategies. This legal framework mandates countries to explore increased financing for restoration. Key provisions include marine restoration targets, NRP requirements, financing needs assessments, identification of negative subsidies, and estimating co-benefits of restoration measures.

Article 5 outlines marine restoration targets for protected habitats, aiming for 30% restoration by 2030, 60% by 2040, and 90% by 2050. These targets ensure no significant deterioration of restored areas and mandate the re-establishment of listed habitat types to improve connectivity and habitat quality.

131 Conference of the Parties to the Convention on Biological Diversity (2022).
132 Council Directive 92/43/EEC of 21 May 1992 on the conservation of natural habitats and of wild fauna and flora.
133 Directive 2009/147/EC of 30 November 2009 on the conservation of wild birds.
134 Directive 2008/56/EC of 17 June 2008 establishing a framework for community action in the field of marine environmental policy.
135 Directive 2014/89/EU of 23 July 2014 establishing a framework for maritime spatial planning.
136 European Commission (2020).
137 Regulation (EU) 2024/1991 of 24 June 2024 on nature restoration and amending Regulation (EU) 2022/869.
138 Convention on Biological Diversity (2025).

Meanwhile, article 15 requires Member States to assess the socio-economic and climate co-benefits of restoration measures, creating incentives for restoration based on economic valuation and ecosystem services. It also mandates an assessment of financing needs, identifying public and private funding sources. Additionally, the identification of negative subsidies affecting restoration efforts is necessary, marking a first step toward subsidy reform.

Under Article 15(3)(u), Member States must assess their financing needs for implementing the restoration measures and identify public and private financing sources and co-financing opportunities through EU funding instruments. This provision is crucial, as it compels Member States to explore a diverse range of financial tools to support their restoration measures. Indeed, Mediterranean countries face structural challenges in securing adequate financing for marine biodiversity restoration. The NRL's restoration targets will require significant financial commitments, particularly in the context of underfunded MPAs, which already face challenges in securing stable and long-term funding for effective management. Mediterranean countries of the EU can capitalise on this legal requirement by strategically leveraging public and private mechanisms. Public funding sources include national budgets and EU sources, including the EU's LIFE Programme and the European Maritime, Fisheries and Aquaculture Fund (EMFAF), which provide financial support for restoration initiatives. Given the scale of restoration needs, these funds must be completed by additional public financing and private sector engagement.

Article 15(3)(v) requires identifying subsidies negatively impacting marine ecosystems, such as fuel subsidies for industrial fishing or coastal infrastructure development. While this does not mandate direct subsidy reform, it lays the groundwork for financial restructuring aligned with restoration goals.

Lastly, under Articles 15(3)(r) and 15(3)(s), Member States must estimate the restoration measures' co-benefits for climate change mitigation and their socio-economic impacts and benefits. The high potential of blue carbon ecosystems to store and capture carbon is crucial to that regard. Seagrass beds, macroalgal forests and soft sediments deliver such services and are often referred to as 'blue carbon' ecosystems. They are included in Annex II and therefore are explicitly targeted by restoration measures under Article 5.

4. FINANCING MECHANISMS AND TOOLS FOR THE RESTORATION OF MARINE ECOSYSTEMS

This section analyses the different financing mechanisms and tools which are either already used in the Mediterranean region and which could be scaled up for financing marine biodiversity restoration or innovative tools implemented in other marine contexts and that have the potential to be replicated in the Mediterranean region.

Section 4.1. explores the need for reforming subsidies (4.1.1.) and taxes (4.1.2.) for supporting the implementation and financing of the NRL's restoration measures and discusses opportunities to use Maritime Spatial Planning processes (4.1.3.). Section 4.2. delves into innovative financing tools, including Payments for Ecosystem Services (4.2.1), carbon markets and biodiversity credits (4.2.2.), conservation fees and charges (4.2.3.) and Conservation Trust Funds (4.2.4.). Finally, Section 4.3. builds a rationale for leveraging private sector finance, through investments and blended approaches (4.3.1.) and blue bonds (4.3.2.).

Section 4.4. provides a preliminary ranking of these financial tools and public reforms, to guide policy- and decision-makers in prioritising such tools. However, it is crucial to mention the many synergies and overlaps between the financing instruments studied in this section, which call for a recommendation to use them as part of an integrated policy mix (see Section 4.5.).

4.1 Reforming Existing Public Policy Tools

This section focuses on the role of governments to push public reforms in relation to beneficial subsidies and tax reliefs (4.1.1.), environmental taxes (4.1.2.) for aligning economic activities with biodiversity objectives and reducing pres-

sures on ecosystems. It also explores the need to leverage Maritime Spatial Planning processes for restoration measures and for identifying the relevant actors to contribute to restoration measures, both financially and for their implementation (4.1.3.)

4.1.1 Beneficial Subsidies and Tax Reliefs

Reforming harmful subsidies is essential for effective biodiversity conservation and restoration. Subsidies, whether direct payments, service charge reductions, or tax exemptions[139] [140], are intended to support economic activities but can often harm the environment. Redirecting harmful financial flows toward biodiversity-positive outcomes is therefore crucial.

The impact of harmful subsidies on marine restoration efforts

Harmful subsidies undermine marine restoration by supporting activities that damage habitats, deplete fish stocks, or cause pollution[141]. For instance, subsidies for industrial fishing or coastal development can worsen overfishing and habitat loss[142]. Between 2014 and 2020, Mediterranean countries allocated nearly €2.7 billion to fisheries, much of it likely detrimental to marine ecosystems[143]. Only €1 billion went to beneficial subsidies, such as enforcement and data collection, and a mere 4% supported Marine Protected Areas (MPAs). Ambiguous subsidies, which require complementary measures to be effective, amounted to €443 million[144].

Climate-related subsidies also play a role: fossil fuel subsidies increase emissions that contribute to ocean acidification and pollution. Without aligning climate and biodiversity subsidies, restoration financing risks being inefficient or counterproductive. The NRL requirement for Member States to identify harmful subsidies is thus a key opportunity for targeted reform.

Opportunities for redirecting subsidies toward restoration initiatives

Integrating subsidy reviews into National Restoration Plans (NRPs) allows countries to eliminate harmful subsidies and reallocate funds to restoration-friendly efforts, such as compensation schemes for small-scale fishers or payments for ecosystem services. One example is the western Mediterranean demersal stock agreement, which compensates fishers for conservation actions[145].

The NRL offers a framework to justify national subsidy reforms, helping governments build a case for repurposing harmful incentives in line with restoration goals. Although Article 15(3)(v) does not mandate reform, it provides a strong legal and financial rationale for shifting subsidies toward nature-positive investments. This shift would enhance the effectiveness of marine restoration efforts and ensure greater policy coherence across biodiversity, climate, and fisheries governance[146].

Some Mediterranean countries already apply environmentally beneficial subsidies. According to the PINE database, seven such instruments have been identified in Mediterranean OECD countries[147]. France, for example, offers property tax reliefs linked to protected areas—an approach that could be adapted to marine restoration. Globally, instruments like the GBF's Target 18 and the 2022 WTO Agreement on Fisheries Subsidies (not yet ratified) aim to reduce harmful incentives and promote sustainable practices.
Countries can also build on international commitments and agreements, such as Target 18 of the GBF which aims to reduce biodiversity-harmful incentives by at least $500 billion per year and to scale up positively. Other promising initiatives include the World Trade Organisation Agreement on Fisheries Subsidies, adopted in 2022, to prohibit harmful subsidies such as those supporting illegal, unreported and unregulated

139 European Commission (2021).
140 Oosterhuis, F.H. (2011).
141 Rimin (2024).
142 OECD (2022).
143 Gomei, M., et al. (2024).
144 Ibid.
145 Council Regulation (EU) 2025/219.
146 Plan Bleu and UNEP/MAP (2024).
147 OECD, Policy Instruments for the Environment (PINE) database.

fishing, fishing on overfished stocks and fishing on unregulated high seas. The Agreement is not operational at this point, as not enough members have endorsed it[148].

Challenges in Reforming EHS

Subsidy reform faces definitional, political, and social hurdles. The lack of a common definition for harmful subsidies hampers classification, while political resistance[149] and the socio-economic role of sectors like fisheries and tourism complicate change[150] [151]. Public backlash[152], as seen with France's yellow vests movement[153], illustrates the need for transparent, phased reforms with social safeguards[154].

Despite these challenges, identifying and reforming harmful subsidies is vital for effective marine biodiversity restoration. The NRL provides a practical entry point to advance this agenda in the Mediterranean.

4.2 Environmental Taxation

Environmental taxation serves as a powerful policy tool for adjusting, redirecting or modifying economic behaviour to enhance environmental protection. By imposing an additional cost on the use of natural resources or the emission of pollutants to reflect their negative environmental externalities, they create incentives for producers and consumers to adopt biodiversity-aligned practices[155]. However, despite their potential, environmental taxes currently constitute only a small share of government revenue in the EU, with the majority linked to energy taxation. Since taxation remains a national competence in the EU, decisions on environmental taxes are made at national or local level[156].

The role of biodiversity-related taxes in marine restoration

Biodiversity-related taxes specifically target activities that negatively impact ecosystems. For such taxes to be effective, a portion of the entirety of the revenue generated must be used for conservation efforts through a process known as 'earmarking'. This approach enhances the legitimacy and impact of these fiscal tools while promoting long-term environmental benefits.

In the context of marine conservation and restoration, tourism-related taxes could for example serve as a key financing mechanism. A tourist tax applied to visitors of MPAs could be directly, or at least partly, allocated to fund MPA management costs or finance part of the restoration measures in affected ecosystems. Taxes can also be combined with user fees to create more tailored financing mechanisms as part of a broader policy mix (see Sections 4.2.3 and 4.5).

While biodiversity-taxes are often applied to pesticides, fertilisers, and forest management, there are some examples of taxation instruments linked to marine resources. An analysis of the PINE database identified 33 biodiversity-related taxes and fees in Mediterranean OCED countries. It is important to note that the database includes both taxes and fees in this category, with fees analysed separately in Section 4.2.4. The search identified the following marine-related taxes, categorised by type and description in Table 1 below.

Spain provides interesting examples related to pollution control and mitigation and has provided details on the earmarking of the different revenues collected. These examples demonstrate the variability of taxes and of the natural resource or activity that can targeted by such an instrument, depending on national contexts and frameworks.

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148 World Trade Organisation, Agreement on Fisheries Subsidies. Available at: https://www.wto.org/english/tratop_e/rulesneg_e/fish_e/fish_e.htm#:~:text=The%20WTO%20Agreement%20on%20Fisheries,of%20the%20world's%20fish%20stocks.
149 Plan Bleu and UNEP/MAP (2024).
150 Gomei, M., et al. (2019).
151 Roditis, M., et al. (2023).
152 Belgioioso, M. and Newman, E. (2025).
153 Plan Bleu and UNEP/MAP (2024).
154 See for example Droste, N. et al (2024), Belgioioso, M. and Newman, E. (2025) and Mahdavi, P. et al (2025).
155 OECD (2021).
156 Remeur, C. (2020).

	Type of tax	Country	Earmarking
Taxes on maritime transport and ports, or other types of transport	Harbour tax on ship owners	Albania	Not specified
	Tax on fisheries use for fishing companies or fishermen	Albania	Not specified
	Boat tax	Croatia	Not specified
	Tax on ship management services	Cyprus	Not specified
	Annual tax on plaisance boats	France	Conservation of MPAs
	Tax on maritime transport	France	Protected natural areas to finance coastline preservation
	Dock dues	France	Conservation of MPAs
Pollution control and environmental protection taxes	Marine pollution taxes	Greece	Revenues go to the Blue Fund
	Tax on coastal wastewater discharges	Spain	95% earmarked for financing environmental expenditure programmes and 5% for a fund for environmental catastrophes
	Tax on wastewater discharges into the sea	Spain	Earmarked for sanitation actions, improving the quality of sea waters and minimising the pollution produced by discharges from land to sea in certain autonomous communities
Resource-specific taxes	Tax on seafood and aquaculture	France	Not specified
	Tax on caging bluefin tuna	Malta	Not specified
Fuel and aviation taxes	Fuel excise tax	Montenegro	Not specified
	Tax due by airlines and shipping in Corsica and overseas departments	France	Not specified

TABLE 1

Examples of marine-related taxes in Mediterranean countries

Source: OECD PINE database.

Equity considerations in environmental taxation and other challenges

When designing and implementing environmental taxes, it is essential to consider their equity implications, particularly for lower-income communities and sectors that are heavily reliant on marine resources. In the Mediterranean region, many small-scale fishers and coastal communities dependent on tourism activities often have limited financial capacity to absorb additional costs. Poorly designed tax policies risk disproportionately burdening these groups, potentially leading to resistance and social backlash.

To ensure social acceptance and fairness, such taxes should avoid placing undue financial strain on low-income households or stakeholders. Where necessary, they should be complemented by compensatory mechanisms, such as reinvesting tax revenues into local livelihoods or designing progressive tax structures that mitigate potential socio-economic impacts. Well-designed fiscal reforms can play an important part in addressing environmental problems while strengthening social inclusion and growth.

Environmental taxation suffers from the perception that they can cause economic damage, particularly in less developed countries with stronger development needs. Such perception is misguided, as research demonstrates the positive economic impacts of environmental taxation[157]. Another challenge is on the scope of environmental taxes, which focus heavily on energy and pollution, and much less so on biodiversity and ecosystems. They therefore focus more on the source of pollution or harm to ecosystems, rather than their actual restoration. When the latter exist, as shown by Table 2, they are highly localised. They would need to be broader and taken at a higher level for an effective implementation of an NRP. As for public subsidies, tax reform relies highly on political willingness, which is often lacking.

157 Heine, D. (2002).

Another challenge lies in the vulnerability of taxes to political changes, as demonstrated by the Balearic Sustainable Tourism Tax. Introduced in 2000, the tax aimed to generate €72 million annually by charging tourists €0.5-2 per night, with funds earmarked for conservation in high-traffic areas. While the initiative faced opposition from various political, business, and tourism sectors, it successfully raised €60 million during its implementation.

However, following a change in government, the tax was repealed, and the associated foundation, which had directed some of the funds to environmental projects, was dissolved. This experience underscores the critical importance of securing long-term legislative and institutional support to ensure the continuity and effectiveness of such measures in fostering conservation efforts[158].

Fiscal reform and environmental taxes should be seen as useful tools for implementing the NRL and financing its measures, as well as for contributing to other international commitments like the GBF. Integrating environmental taxation into national and regional policy frameworks can create a more coherent and effective approach to restoration financing as of an integrated policy mix.



158 Binet, T., Diazabakana, A., Laustriat, M., Hernandez, S. (2015b).

4.1.3 Maritime Spatial Planning

Maritime Spatial Planning (MSP) integrates financial mechanisms into marine management, aligning public activities with biodiversity restoration. By mapping marine users, their activities, and ecological pressures, MSP helps balance conservation with economic interests. Under the Maritime Spatial Planning Directive (MSPD), EU Member States were required to develop national maritime plans by 2021[159]. However, biodiversity conservation, particularly establishing MPAs within MSP processes, remains a challenge.

Ecosystem-based MSP manages maritime activities while ensuring biodiversity conservation and human well-being. In the Mediterranean, where economic activities like tourism, fisheries, and transport pressure biodiversity, MSP can help integrate restoration into existing governance[160]. The polluter-pays principle can be applied through MSP by linking maritime activities' environmental impacts to targeted financial instruments, such as marine pollution taxes or user fees.

MSP can also foster private sector involvement in restoration by linking sectors' responsibility for biodiversity degradation to specific financial obligations. By mapping degraded areas like seagrass meadows in NRPs, MSP can direct private sector investments, such as carbon market initiatives or blue bonds, to support restoration efforts.

Furthermore, MSP serves as a strategic tool for prioritising restoration activities and aligning them with national and regional strategies, such as the NRL. While the NRL doesn't explicitly mention MSP, it provides a regulatory framework that can guide the designation of MPAs and restoration efforts. However, most MSP processes fail to prioritise conservation, with governance and financial barriers hindering effective implementation[161] [162].

Non-EU Mediterranean countries are encouraged to integrate spatial planning into their marine governance, in line with the GBF's Target 1 for conservation and sustainable use. Though global MSP initiatives are growing, harmonised methodologies remain scarce. To maximise MSP for marine restoration financing, coordination between spatial planning authorities and financial actors is essential. Integrating MSP into restoration strategies requires political commitment, policy coherence, and enhanced capacity.

4.2 Implementing and Scaling Up Innovative Financing Mechanisms

This section explores a range of innovative financing mechanisms that can be used for financing marine restoration efforts under the NRL and beyond, including payments for ecosystem services (PES) (4.2.1.), carbon markets and biodiversity credits (4.2.2.), conservation fees and charges (4.2.3.) and conservation trust funds (4.2.4.).

4.2.1 Payments for Ecosystem Services

Payments for ecosystem services (PES) refer to voluntary transactions between users (beneficiaries) and providers of ecosystem services, under which financial incentives are provided in exchange for actions that maintain or enhance ecosystem service delivery[163]. These agreements are conditional, relying on adherence to resource management practices to maintain or enhance ecosystem service delivery. It is rooted in the user- or beneficiary-pays principle and on the premise that ecosystem services have a quantifiable economic value which can be leveraged to incentivise investment in conservation and restoration activities[164]. PES schemes can offer monetary benefits to lower-income groups, including fishers or coastal communities, in return for their engagement in conservation or restoration activities[165]. As such, they present a promising instrument to target biodiversity degra-

159 European Climate, Infrastructure and Environment Executive Agency, What's next on Maritime Spatial Planning? 15 March 2024. Available at: https://cinea.ec.europa.eu/news-events/news/whats-next-maritime-spatial-planning-2024-03-15_en.
160 Manea, E., Agardy, T. and Bongiorni, L. (2023).
161 Manea, E., Agardy, T. and Bongiorni, L. (2023).
162 Galparsoro, I., et al (2025).
163 Wunder (2015).
164 Forest Trends (2010).
165 Ibid.

dation while promoting ecological stewardship, fostering economic empowerment and addressing poverty[166]. Importantly, PES can be financed by both public and private sources, making them a flexible tool that effectively complement regulatory approaches analysed in Section 4.1.

A difficult yet emerging application of PES in the marine environment

While PES schemes have been widely used for terrestrial ecosystems, their application in the marine environment faces unique challenges, including the transboundary nature of marine ecosystem services, the absence of clear property rights, and limitations in data availability which complicate the valuation and monitoring of services. Additionally, many critical marine ecosystem services, such as carbon storage and sequestration, flood risk reduction and sediment capture[167], are not directly marketed, which complicates the demonstration of a business case for marine PES[168]. This calls for the further development of tailored marine PES schemes which promote conservation outcomes and provide cost savings and income to relevant stakeholders, alongside strong institutional governance and enforcement mechanisms[169], which remain weak in certain Mediterranean countries.

Despite these challenges, PES schemes in marine contexts have emerged globally, demonstrating their feasibility and variability. For example, Tanzania's Marine Legacy Fund has a PES programme which derives revenues from commercial fishing licences, marine ecotourism revenue sharing and oil and gas taxation to finance community-based efforts conservation and operational expenses[170]. In Mexico, local communities receive financial support for protecting whale habitats[171], further demonstrating the schemes' potential to align conservation with local development. Such schemes can also compensate local fishers for lost revenues caused by conservation measures, such as no-take zones or seasonal fishing closures, creating strong incentives for their participation in conservation and restoration efforts[172].

Despite its potential, PES implementation in the marine context faces structural challenges, particularly due to data gaps. The effectiveness of these schemes depends on robust research and monitoring of ecosystem services, yet data availability in coastal and marine environments is more limited compared to terrestrial ones. Additionally, marine restoration efforts can be disrupted by environmental events, such as sea-level rise or marine heatwaves, which are exacerbated by climate change and could undermine the delivery of ecosystem services and the effectiveness of PES initiatives[173]. Finally, identifying and isolating specific ecosystem services for PES remains complex, as many marine services are interconnected and difficult to separate[174]. Addressing these challenges requires continued investment in research, governance and policy innovation to fully harness the potential of PES in marine restoration efforts.

Application of PES schemes in the Mediterranean

In the Mediterranean, PES schemes could play an important role in restoring marine ecosystems, namely blue carbon ecosystems like seagrass beds which have significant carbon storage and sequestration potential. As research continues to qualify the value of these services[175], PES schemes could incentivise their restoration[176]. Moreover, given the region's strong tourism sector, PES could be designed as user fees, a subset of PES (see Section 4.2.3.) to fund marine restoration

166 Matzdorf, B., Sattler, C. and Engel, S. (2013).
167 Iyer et al. (2018).
168 Friends of Ocean Action (); OCTO (2014).
169 Matzdorf, B., Sattler, C. and Engel, S. (2013).
170 OCED, Payments for ecosystem services programmes, https://www.oecd.org/en/publications/ocean-policies_17318a16-en/payments-for-ecosystem-services-programmes_540de426-en.html.
171 Ibid.
172 Mohammed, E.Y. (2012).
173 Phelps, J. and Friess, D. How viable are payments schemes for 'blue carbon'? Forest News, 25 March 2015. Available at: https://forestsnews.cifor.org/27533/paying-for-ecosystem-services-the-future-for-coastal-and-marine-landscapes?fnl=.
174 Lau, W.W.Y. (2013).
175 For example, see Campagne et al. (2015); Scanu et al. (2022); El Zrelli et al. (2023).
176 UNEP (2020).

efforts. Such mechanisms could be instrumental in implementing the NRL by generating co-financing for restoration projects, empowering local stakeholders and mobilising private sector contributions through the valuation of ecosystem services.

A notable example of PES-like mechanisms within the EU is the compensation payments provided for legal restrictions in Natura 2000 areas, designated under the Habitats and Birds Directives. While typically PES incentivise measures beyond legal requirements, such payments can enhance the social acceptance of conservation regulations, particularly in developing countries[177]. Under the NRL, Member States may need to restrict activities or rights on marine ecosystems, such as limitations on fishing or tourism activities. In such cases, PES mechanisms could be structured as compensation payments, either to offset revenue losses induced by the regulatory measures, or to incentivise alternative activities that contribute to marine restoration, which would apply well to the Mediterranean context. To avoid long-term dependency on these payments, however, compensation should be gradually phased out, ensuring communities transition to sustainable economic alternatives.

4.2.2 Carbon Markets and Biodiversity Credits

The growing recognition of synergies between biodiversity conservation and climate change mitigation has led to increasing interest in financing tools that specifically target blue carbon ecosystems. These ecosystems serve as important carbon sinks by sequestering and storing significant amounts of carbon. The NRL highlights their restoration by requiring Member states to indicate the measures that generate climate mitigation co-benefits. Consequently, certain financing mechanisms are targeted to support the conservation and restoration of ecosystems which bring specific mitigation benefits.

The role and limitations of carbon markets

Regulatory and voluntary carbon markets have been developed both in the EU and globally, with growing private sector interest in carbon credits as companies seek to offset their emissions. However, while carbon markets can channel private investment into conservation, challenges related to credibility, additionality and verification persist. Experiences from voluntary carbon markets, which showed that more than 90% rainforest offset credits do not lead to effective carbon reductions[178], underscore the need for robust methodologies to ensure that blue carbon projects genuinely contribute to climate goals rather than serving as greenwashing tools.

Biodiversity credits: A new financial instrument

Regulatory Beyond carbon markets and credits, emerging tools such as biodiversity credits and certificates aim to generate private investment for biodiversity conservation and restoration. While there is no agreed definition of a biodiversity credit, it refers to instruments that create a market for units of biodiversity protection and restoration. They are based on certificates that represent a measured and evidence-based unit of positive biodiversity outcome that is durable and additional compared to what would have occurred otherwise[179]. While examples of biodiversity credits are limited, with none applied to the marine environment, the European Commission has recently proposed the development of 'nature credits'. Inspired the Emissions Trading Scheme, these credits could allow businesses, governments, and organisations to earn and trade credits for conservation or restoration actions[180]. No formal proposal has been introduced yet, but it may be developed soon and could apply to marine ecosystems.

At the global level, frameworks for high integrity biodiversity credit markets have been developed by the International Advisory Panel on Biodiversity Credits and introduced at COP16 of the Convention on Biological Diversity in Cali in Oc-

177 Matzdorf, B., Sattler, C. and Engel, S. (2013).
178 Greenfield, P. Revealed: more than 90% of rainforest carbon offsets by biggest certifier are worthless, analysis show. The Guardian, 28 January 2023. Available at: https://www.theguardian.com/environment/2023/jan/18/revealed-forest-carbon-offsets-biggest-provider-worthless-verra-aoe.
179 Biodiversity Credit Alliance (2024).
180 European Commission (2024).

tober 2024[181]. The guidelines refer to biodiversity credits as having great potential to support the financial mobilisation targets of the GBF and to provide the means to deliver both positive outcomes for biodiversity and foster the equitable distribution of benefits from biodiversity use. It also highlights their potential to use private finance for projects with positive biodiversity outcomes but limited financial results by valuing biodiversity actions and outcomes[182].

Challenges and safeguards

Despite their potential, the development of biodiversity credits cause concern among civil society and conservation NGOs, as the instrument could follow a similar trajectory as voluntary carbon credits[183], allowing companies to purchase credits without addressing harmful impacts in their activities and supply chains and to brand emission offsetting without verifying their efficiency.

To ensure effectiveness, any biodiversity or carbon market-based instrument must adhere to rigorous scientific standards, including following agreed methodologies, demonstrating additionality rather than assuming it, avoiding ecological trade-offs, ensuring independent verification of positive outcomes and detecting non-compliance in the long term[184].

Additionally, certain limits must be also acknowledged in relation to the narrative around blue carbon conservation and restoration, which should not be framed as a 'silver bullet' for addressing climate change, as is often the case. Communication around such measures must be balanced in relation to the myriads of efforts that must be implemented to achieve this[185]. The NRL's approach, which puts an emphasis on the restoration of blue carbon ecosystems by acknowledging climate mitigation as a co-benefit, strikes a prudent balance. It helps mobilise both public and private financial support for both biodiversity and climate goals, while maintaining realistic expectations.

Existing initiatives and future opportunities in the Mediterranean

Several initiatives in the Mediterranean, including EU-funded LIFE projects, aim to showcase the climate mitigation co-benefits of restoring blue carbon ecosystems and explore financing models for their conservation (Table 2). Given the prevalence of blue carbon coastal ecosystems in the Mediterranean like Posidonia meadows, the results of these projects should guide the development of financing mechanisms at the national level.

Mediterranean Blue Carbon Initiative[186]	Platform focused on mitigating climate change through scientific research, conservation and restoration of coastal and marine ecosystems in the region
LIFE Blue Natura project[187]	One of the project's objectives is to explore and promote existing initiatives to finance conservation projects and the restoration of habitats of blue carbon sinks within policies for the mitigation of and adaptation to climate change, with particular attention to carbon offsetting markets
LIFE SeaForest project[188]	One of the project's actions is to allow local businesses and parks to purchase carbon credits that reduce their CO2 emissions, therefore helping to improve carbon sinks generated by Posidonia Oceanica.

TABLE 2

Overview of EU projects and initiatives on blue carbon ecosystems in the EU
Source: desktop research, including on the LIFE project database.

181 International Advisory Panel on Biodiversity Credits (2024).
182 Ibid.
183 Civil society statement on biodiversity offsets and credits (2024).
184 zu Ermgassen, S., et al. (2025).
185 Johannessen, S.C. and Christian, J.R. (2023).
186 Mediterranean Blue Carbon Initiative. Available at: https://www.medbluecarbon.org/.
187 LIFE, Blue Natura. Available at: https://life-bluenatura.eu/en/home/
188 LIFE, SeaForest. Available at: https://www.seaforestlife.eu/en/

Beyond the Mediterranean, international initiatives such as Australia's Blue Carbon Accelerator Fund provide valuable learnings. This fund supports blue carbon restoration and conservation projects in developing countries, with a strong focus on private sector involvement[189].

Policy integration and next steps

The implementation of the NRL could incorporate carbon certification mechanisms for blue carbon projects in the Mediterranean, to facilitate and incentivise access to voluntary markets. Additionally, the EU's proposed nature credits could offer promising avenues for biodiversity financing and be incorporated into NRPs, provided strong safeguards are in place.

Member States should also consider linking carbon-based financial tools and credits with climate strategies, including National Energy and Climate Plans (NECPs) at the EU level, and Nationally Determined Contributions (NDCs) at the global level under the Paris Agreement. Countries are already encouraged to integrate blue carbon ecosystems into these plans to achieve their climate commitments[190], and now need to integrate such ecosystems into their NRPs. As the NRL puts a strong emphasis on policy coherence with climate policies, such opportunities for alignment for financing opportunities must be leveraged.

With careful design and implementation, carbon markets and biodiversity credits can contribute meaningfully to marine restoration and climate mitigation efforts, if they are backed by strong scientific, regulatory, and ethical frameworks.

4.2.3 Conservation Fees and Charges

Conservation fees and charges derive from the user-pays principle, a variation of the polluter-pays principle, which states that users of natural resources should bear the cost associated with their consumption or degradation. They may be levied on consumptive uses (e.g., fishing and hunting) and non-consumptive uses tied to tourism and recreation (e.g., hiking, diving)[191]. By charging users of public goods for the benefit they receive, these serve as sustainable financing mechanisms for MPAs, generating ongoing revenue to support conservation efforts. Common types include special use permits, entrance/access fees, boat fees, concessions, etc[192].

Scaling up conservation fees schemes in the Mediterranean

Mediterranean region, with its significant tourist activity, offers great potential for expanding conservation fee schemes to co-finance restoration activities. For these schemes to be successfully implemented and scaled up, several key conditions must be met: 1) alignment with national and regional legislation and governance frameworks, 2) ensuring equity by minimising impacts on low-income and local communities, 3) transparency around the measure and the explicit earmarking of funds for conservation or restoration efforts and 4) conducting willingness-to-pay studies to understand consumer perspectives and enhance the scheme's acceptability[193].

Challenges and considerations

Conservation fees and charges come with challenges that must be carefully addressed. First, they are highly vulnerable to fluctuations in tourism, as demonstrated during the COVID-19 pandemic, where a decline in visitors affected funding streams. However, lower tourist activity also reduced pressure on ecosystems, revealing a complex balance. Fees and charges are also limited by inadequate institutional frameworks, as local authorities may lack the mandate or administrative capacity to implement and manage such fees. Moreover, in some cases collected funds may not be properly earmarked for conservation efforts, reducing the schemes' effectiveness. There is also a risk natural areas become

189 Blue Carbon Accelerator. Available at: https://bluenaturalcapital.org/bcaf/.
190 The Blue Carbon Initiative (2023).
191 Kettunen et al. (2017).
192 Iyer et al. (2018).
193 Ibid; MedPan (2024).

commercialised, shifting away from conservation objectives[194], or that measures lead to habitat fragmentation by fencing off areas to facilitate fee collection[195]. Finally, fees and charges may affect cultural values, as in certain countries, nature is regarded as a public good, and charging access fees may be perceived as unjust or inappropriate. Additionally, lower-income communities may be disproportionately affected if fees restrict access to areas they depend on for income, cultural practices, or recreation.

Existing examples and lessons learned

Various examples of conservation fees and charges that are based on marine resources and activities exist in the Mediterranean and beyond. In Mediterranean marine reserves, the Porquerolles Island national park in France[196] and the Miramare Marine Reserve in Italy have implemented access fees to collect revenues. It is important that the revenues collected through these instruments are used for conservation purposes or for the management of MPAs for example, to allow self-financing. An interesting example at the national level is that of Croatian national parks, which charge entry fees to visitors and earmark revenues for nature protection. Part of the fees are retained by the park itself, and another part goes to the Parks of Croatia fund[197]. The Brijuni National Park in Croatia has been financially independent for several years mostly through tourism income, from park entrance fees, accommodation in hotels owned by the park and diving and kayaking activities[198]. Such model functioned by 'branding' the MPA and the activities, an interesting example showing possibilities for cooperating with private actors. In Ireland, a recreational angling license for Atlantic salmon allocates 50% of collected fees to a fund supporting conservation projects[199], demonstrating the feasibility of fees on consumptive use with conservation finance benefits.

The MedPan programme conducted an experiment on entry fees with four MPAs: Sibenik-Knin in Croatia, Karaburun-Sazan National Park in Albania, Katić in Montenegro and Gökova in Turkey, exploring the mechanism's potential to generate funding. A willingness-to-pay survey revealed a positive response from tourists, who were willing to pay fees to enter an MPA if they knew the funds directly support marine conservation[200]. This highlights the importance of clear communication with visitors and transparency about the use of funds, as well as the support for such initiatives[201].

Policy implications and future directions

Given the substantial revenues generated by tourism in the region, a lot of which depend on healthy marine environments, conservation fees and charges can be strategically scaled up to finance MPA management and restoration under the NRL. They can serve as complementary funding sources alongside public and EU funds, promoting self-sufficiency for MPAs. Conservation fees and charges could also provide an income source for MPAs through fishing licences, providing enough resources are directed to patrolling and enforcing regulations. Experience in the Cres-Losinj MPA in Croatia showed that promoting the conservation of flagship species such as bottlenose dolphins in this case could be used to gather greater support for the MPA and to encourage the implementation of visitor fees in support of conservation measures for these species[202].

These examples provide practical models to incorporate conservation fees into NRL-aligned restoration efforts, demonstrating scalability and the importance of transparent and participatory approaches.

194 MAVA (2018).
195 NaturaConnect factsheet
196 Plan Bleu and UNEP/MAP (2023)
197 Bellamy (2017).
198 Binet, T., Diazabakana, A., Laustriat, M., Hernandez, S. (2015b).
199 NPWS (2019).
200 MedPan (2024).
201 Tonin, S. (2018).
202 Binet, T., Diazabakana, A., Laustriat, M., Hernandez, S. (2015b).



4.2.4 Conservation Trust Funds

Conservation Trust Funds (CTFs) are private, independent legal entities that provide grant funding from philanthropy and government funds for conservation projects. They include varied financial arrangements and act as a bridge between donors and organisations implementing conservation measures[203]. They are well suited to finance large MPAs and projects not aiming to generate profits. A few CTFs focus primarily and explicitly on marine and coastal conservation, such as the Mesoamerican Reef Fund, which focuses entirely on a reef ecosystem spanning four countries[204].

The MedFund: a case study

In the Mediterranean, the MedFund was launched in 2015 as a joint initiative by the Foundation Albert II of Monaco Foundation, the government of Monaco and Tunisia, and MedPan. It is the first CTF dedicated to MPAs in the Mediterranean, to address the funding gap for MPAs in the region, particularly in Southern and Eastern Mediterranean countries where financial resources for marine conservation are limited, and to specifically target management activities which are often not covered by EU co-financing. The MedFund operates as an endowment fund: it raises capital from diverse sources – philanthropic foundations, international donors, and governments – which is then invested, with the generated interest used to provide long-term grants to NGOs and national MPA management authorities. To receive funding, MPAs must be officially designated or in the process of being established, have a management plan, and possess an operational management entity[205].

A key feature of the MedFund is its focus on strengthening MPA governance and management. It currently supports the management costs of twenty MPAs, through a funding model

203 Bath et al., (2020).
204 MARFUND, available at: https://marfund.org/en/.
205 MedFund, available at: https://themedfund.org/.

consisting of three five-year phases: 1) an initiation phase, which provides initial structural funding to MPAs; 2) a consolidation phase, during which MPAs gain greater autonomy in managing finances and operations; and 3) a self-sufficiency phase, to gradually withdraw support from the fund to reach financial independence. The MedFund had initially tested short-term funding models, providing two-year grants to evaluate the financial management capacity of MPA authorities and local NGOs before committing to long-term funding. To enhance MPA financial sustainability, the MedFund also supports research into self-financing mechanisms, such as user fees and environmental levies.

A 2024 evaluation by the Fonds Français pour l'Environnement Mondial highlighted the MedFund's effectiveness in improving MPA governance and management[206]. The report found that the initiative had successfully enhanced beneficiary MPAs' management efficiency. However, challenges remain, including the full achievement of the fund's capitalisation objectives and its capacity to mobilise new large-scale financing on the long-term. Additional efforts are required to ensure its financial viability, and to attract varied financing sources. Overall, the evaluation points to the high potential long-term impact of the structure for Mediterranean MPAs. The evaluation also recommends expanding the list of beneficiary countries to enlarge its scope and attract new donors, to increase crowdfunding targets and to focus efforts on sustainable revenues[207]. This shows that the establishment of CTFs requires significant initial capital and strong governance structures.

Linking CTFs to restoration goals and the NRL

While the MedFund does not directly support restoration actions, it indirectly supports restoration by ensuring efficient MPA management. Since 2022, it has prioritised financing MPAs that include at least one no-take zone[208], a strict protection measure that significantly boosts marine biodiversity[209].

If the NRL recognises well-managed MPAs as a form of passive restoration, CTFs like the MedFund can play a crucial role in advancing restoration objectives. The NRL can be used as a leverage for raising funds for MPAs and encourage managers to implement restoration measures in their MPAs, as in some cases active restoration actions are needed to reverse ecological harm. Furthermore, aligning MedFund financing with EU and global conservation policies, such as the GBF's Target 3 aiming to protect 30% of land and sea by 2030, could unlock additional funding opportunities. Countries in the Mediterranean will have to collaborate to reach both the NRL's and the GBF's ambitious targets, and CTFs are an effective approach to do that.

4.3 Harnessing Private Sector Finance for Marine Restoration

The following sections analyse the potential of private sector investment and blended finance (Section 4.3.1.) as well as blue bonds (Section 4.3.2.) to channel financing flows towards restoration measures for marine biodiversity in the Mediterranean, identifying barriers and obstacles to their scaling up.

4.3.1 Private Sector Actors, Financial Institutions and Blended Finance

The role of private sector actors and financial institutions in marine ecosystem restoration

While private finance should not be the primary source for conservation and restoration funding, it plays an increasingly important complementary role in achieving biodiversity protection objectives. Businesses, banks and financial institutions are increasingly recognising their dependency on healthy ecosystems services and the economic risks associated with their degradation[210]. Some are also starting to integrate biodiversity considerations into their corporate social responsibility strategies and environmental social and governance frameworks. While

206 Fonds Français pour l'Environnement Mondial (2025).
207 Ibid.
208 Interview conducted with a MedFund representative on 13 December 2024.
209 Sala, E. and Giakoumi, S. (2018).
210 Dutch Central Bank (2020); Svartzman, R., et al. (2021).

this integration reflects a growing commitment to sustainable practices, private sector engagement remains largely limited, partly due to challenges in data collection and availability[211]. Without sufficient information on biodiversity-related risks, financial institutions and businesses may struggle to incorporate these concerns into their decision-making processes. This underscores the need for greater private sector investments in supporting government initiatives that enhance data collection, conservation and restoration efforts[212].

Financial institutions and investment banks also play an important role in advancing marine ecosystem restoration. While the NRL does not explicitly mandate the alignment of private financial flows with its targets, it is in the best interest of these institutions to invest in nature positive activities that mitigate financial risks associated with ecosystem degradation. Such alignment however is mandated by Target 15 of the GBF. Governments can further incentivise financial institutions to do so through public mechanisms such as subsidies or tax reliefs (see Section 4.1.), or regulatory frameworks that encourage investments in biodiversity conservation, such as the EU Taxonomy[213].

Private actors can support marine ecosystem restoration in multiple ways. They can directly invest in projects that enhance biodiversity and align with ecosystem restoration efforts. However, private investments are typically directed toward activities with high financial returns, whereas biodiversity investments are often perceived as high-risk with low profitability.

Blended finance: a public-private approach

Blended finance is another mechanism used for mobilising private investment in conservation. It involves combining public and private funding through financial instruments such as equity, debt, grants and guarantees to attract additional investment. The rationale behind blended finance is that public funding can help de-risk nature-based investments, making them more attracted to private investors.

Despite its potential, blended finance faces several barriers. Private actors are often discouraged by administrative and reporting complexities, low returns, and the need for further securities. To overcome these challenges, governments and development banks must implement strategic risk mitigation measures, such as guarantees and concessional financing. Moreover, effective blended finance initiatives require robust governance structures that oversee project pipelines and facilitate collaboration between public and private stakeholders.

Blended finance has been implemented for marine conservation outside the Mediterranean region. For instance, the social enterprise Blue Finance MPAs in Belize (Turneffe Atoll[214]) and the Dominican Republic combined grants and debt to fund early-stage investments in MPAs. Revenues generated from eco-tourism fees and sustainable fisheries can create tangible returns for investors, while ensuring the MPA's financial sustainability. Moreover, the Global Fund for Coral Reefs is a 10-year blended finance initiative aiming to de-risk impact investments by leveraging grants and private sector funding for coral reef conservation and restoration[215].

Opportunities for blended finance in the Mediterranean

Currently, there are no major blended finance initiatives for marine conservation in the Mediterranean, despite the region's significant blue economy sectors which depend on healthy marine resources. To unlock such opportunities, a strong regional framework is needed to incentivise private actors to invest in projects with lower profit potential and public funding to mitigate the projects' risks.

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211 World Bank Ground (2020).
212 European Environment Agency (2023).
213 Regulation (EU) 2020/852 of 18 June 2020 on the establishment of a framework to facilitate sustainable investment.
214 Case study, Blended finance for MPAs, https://www.wwf.org.uk/sites/default/files/2022-07/case_study_lended_finance_MPAs.pdf.
215 Global Fund for Coral Reefs, http://globalfundcoralreefs.org/wp-content/uploads/2021/07/UPDATED-GFCR-BROCHURE-JULY-2021.pdf.

While such a framework does not yet exist at the Mediterranean level, existing institutions such as the European Investment Bank and the Global Environment Facility could play a role in supporting blended finance operations. These initiatives can also be fostered by involving development financing institutions such as national promotional banks and institutions (NPBIs) in Mediterranean countries[216]. These institutions, which are commissioned by national or regional authorities to conduct financial, promotional and development activities, serve semi-public interests and are therefore well-positioned to support blended projects.

Linking private sector investment for both biodiversity and climate

Addressing the intertwined crises of climate change and biodiversity loss requires an approach that acknowledges their interdependence. This approach must also be taken when thinking of financing measures that can tackle both crises jointly. In the framework of the NRL, this means ensuring that restoration efforts yield both biodiversity outcomes and carbon sequestration benefits. It also means identifying potential trade-offs between climate and biodiversity measures, such as how the development of renewable energy can harm biodiversity habitat. Public and private finance should work in tandem to achieve this dual objective while avoid trade-offs, and leverage synergies with climate adaptation, mitigation and biodiversity conservation.

However, despite growing recognition of these linkages, financial flows targeting biodiversity remain critically underfunded compared to climate change, and integrating the two domains is an essential part of closing the funding gap. Biodiversity policies often aim to achieve policy coherence with climate policies, as demonstrated in the NRL's requirements to Member States to identify synergies with climate policies and demonstrate the climate co-benefits of chosen restoration measures. The GBF's attempt to link the two is less striking, as its Target 8 is quite weak and difficult to measure.

To effectively incentivise private sector investment in marine ecosystem restoration while simultaneously addressing climate change, a strategic mix of financial mechanisms, policy incentives, and risk-reduction measures is essential.

First, businesses and financial institutions must recognise the financial risks posed by climate change and biodiversity loss. Both crises threaten economic stability, supply chains, and their long-term profitability[217]. Raising awareness and integrating these risks into corporate financial decision-making, through the help of initiatives such as the Taskforce on Nature-related Financial Disclosures for example, can help demonstrate the urgency of proactive investment in both climate and conservation action[218].

Second, appropriate instruments must be identified and leveraged. The mechanisms analysed in this paper, including PES, carbon and biodiversity credits and blended finance mechanisms, provide viable pathways for mobilising private capital for restoration. These tools can help de-risk investments and make restoration projects more attractive to investors while generating measurable environmental and financial returns. Third, a balanced regulatory approach is crucial. While regulatory frameworks play a key role in engaging private actors in restoration and financing efforts, they must be carefully designed to avoid political pushback. Recent EU-level experiences highlight these challenges, as illustrated by the European Commission's Omnibus package which seeks to simplify corporate sustainability reporting and EU Taxonomy requirements adopted under the Green Deal. This has demonstrated how political opposition, backed by private interests, can undermine binding sustainability measures.

Finally, a clear regional strategy for private sector involvement in conservation is needed in the Mediterranean. Given the region's unique economic and ecological characteristics, as well as strongly felt impacts of climate change, a tailored roadmap for engaging private actors in financing both biodiversity conservation and climate miti-

216 EIB (2023).
217 Dutch Central Bank (2020); Svartzman, R., et al. (2021).
218 Kedward, K., Ryan-Collins, J. and Chenet, H. (2022). .

gation and adaption would provide much-needed guidance. Such a strategy should outline specific investment opportunities, risk-mitigation frameworks, public-private partnership models, and legal requirements, to enable governments to create the right conditions for private sector participation.

4.3.2 Blue (and Resilience) Bonds

Blue bonds and resilience bonds to unlock investment for marine conservation and climate resilience

Blue bonds are innovative financial instruments designed to borrow money from investors for marine conservation projects. They can be issued by public or private entities, and the proceeds are invested in conservation projects with clear positive benefits and potential financial returns[219].

Resilience bonds are particularly relevant for climate adaptation. These bonds finance projects enhancing ecosystem resilience, thereby reducing future financial costs associated with climate change impacts, such as natural disasters or ecosystem degradation. Given the co-benefits between ecosystem restoration and climate adaptation[220], resilience bonds represent a promising tool to fund nature-based solutions[221] as could be identified by Member States in their NRPs.

Blue and resilience bonds hold significant potential for financing large-scale marine conservation initiatives, including MPA management by generating economic revenue through conservation fees and sustainable fisheries and defensive natural infrastructure to increase coastal resilience and protect coastal communities[222]. Although less common than traditional grey infrastructure investments, their potential is growing, especially as part of blended finance approaches (see Sections 4.3.1.). These financing models are closely linked and can be used as part of the same policy mix to incentivise private sector engagement, while aiming to reduce risks for private investors to invest in nature positive activities.

Relevant examples of blue bonds

Several countries outside the Mediterranean have successfully implemented blue bonds, such as the Republic of Seychelles which issued a blue bond for financing activities in marine conservation and sustainable fisheries. It raised US$15 million from international investors to support the expansion of MPAs and improve fisheries governance[223]. Moreover, the Nature Conservancy's Blue Bonds for Ocean Conservation programme includes notable examples in Belize and Barbados[224].

In the Mediterranean, Türkiye issued its first blue bond alongside green bond issuance, aimed at addressing climate change. It did not specifically target marine conservation[225], but this highlights a gap that could be filled in future occurrences.

Overcoming challenges to scaling up blue bonds

Despite their potential, blue (and resilience) bonds face several challenges. First, such projects may have unintended negative environmental impacts, which must not be overlooked. Second, clear and informed key performance indicators need to be designed to fuel investor confidence and long-term environmental outcomes. Since the return on investment is based on the project's success, there are possibilities that underperformance will lead to limited financial returns[226]. Finally, as investors seek investments with low financial risk, government and private scrutiny of financial investments and tools is required to ensure they contribute to positive environmental impact to avoid greenwashing and ensure credibility.

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219 World Bank (2018) Sovereign Blue Bond Issuance: Frequently Asked Questions. Available at: https://www.worldbank.org/en/news/feature/2018/10/29/sovereign-blue-bond-issuance-frequently-asked-questions.
220 International Institute for Sustainable Development (2023).
221 The UNESCO Courier, Financing natural resilience : a new wave. 24 January 2018. Available at: https://courier.unesco.org/en/articles/financing-natural-resilience-new-wave.
222 March (2023).
223 Seychelles launches world's first sovereign blue bond, October 2018, https://www.worldbank.org/en/news/press-release/2018/10/29/seychelles-launches-worlds-first-sovereign-blue-bond.
224 Blue Bonds : an audacious plan to save the world's ocean, July 2023, https://www.nature.org/en-us/what-we-do/our-insights/perspectives/an-audacious-plan-to-save-the-worlds-oceans/.
225 ICF Invests in Türkiye's First Blue Bond, Alongside Green Bond Issuance, to Address Climate Change, October 2024, https://www.ifc.org/en/pressroom/2024/ifc-invests-in-t-rkiye-s-first-blue-bond-alongside-green-bond-issuance-to-address-climate-change.
226 March (2023).

The future of blue bonds in the Mediterranean

Blue bonds align well with Mediterranean-specific challenges, as community involvement in projects linked to the sustainable management of natural resources is crucial. Ensuring the participation of artisanal fishers and local businesses for example can enhance both long-term sustainability and project legitimacy.

The EU regulatory framework can also support the scaling up of blue bonds in the region. The EU Taxonomy and Green Bonds Regulation[227] provide a robust regulatory framework for issuing and managing blue and resilience bonds, enabling transparency, credibility and investor confidence. While the Regulation sets a voluntary standard for green bonds, such bonds are governed by rigorous criteria for eligible projects. In the context of marine conservation and restoration in the Mediterranean, the Green Bonds Regulation can influence the uptake of blue bonds aligned with such objectives, by bolstering investor confidence and identifying these activities as potential sources of investments. These activities can and should be identified by Member States when drafting their NRPs as funding sources for their restoration measures.

4.4 Overlaps and Synergies between Financing Mechanisms: Toward an Integrated Policy Mix for Marine Restoration

The most effective approach to financing marine restoration in the Mediterranean does not rely on a single instrument, but rather on a complementary mix of mechanisms that reinforce, and sometimes build on, one another. Different financial tools such as the ones analysed in Section 4 can be designed to work together, creating synergies that enhance their overall impact while reducing potential inefficiencies or conflicts. A well-designed integrated policy mix ensures revenues are reinvested into restoration and that harmful subsidies do not undermine restoration efforts, and that private capital are aligned with conservation goals.

For example, user fees can generate dedicated funding for local conservation efforts but may not be sufficient to cover the upfront costs of large-scale restoration projects. This is where CTFs can play a crucial role, by pooling long-term capital from diverse sources. PES can also intervene where ecosystem services are mapped and monitored, by generate revenue streams to support restoration of ecosystems. Revenues from user fees or taxes could be reinvested into PES programmes for example, to allow local stakeholders to be compensated from their restoration efforts by targeting polluting activities or economic flows mapped under maritime spatial plans.

However, these synergies can only be efficient if financial mechanisms are carefully designed to complement rather than undermine each other. For example, the effectiveness and equity of environmental taxes improves when combined with public investments toward the same objectives. Therefore, taxing activities harmful to marine ecosystems should be coupled with reinvestment in marine restoration and climate adaptation. Otherwise, such taxes risk being perceived as punitive rather than corrective[228]. Similarly, private finance and blended finance models must align with public policies and address their activities' potential harm to marine ecosystem.

Ultimately, integrating climate and biodiversity finance requires a policy shift that prioritises systemic reforms. Phasing out environmentally harmful subsidies, implementing taxes that target harmful activities and scaling up privately financed solutions by aligning public and private capital with restoration objectives are essential in leveraging the NRL to its full potential. Without these changes, financial resources will continue to flow toward activities that undermine restoration efforts and delay progress on both climate and biodiversity targets.

The NRL provides an opportunity to establish this policy coherence by mandating strategies to holistically plan for combining financial instruments, coordinating with the relevant ministries and organisations, to work towards effective funding frameworks for marine restoration.

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227 Regulation (EU) 2023/2631 on European green bonds and optional disclosures for bonds marketed as environmentally sustainable and for sustainability-linked bonds.
228 Heine (2020).

4.5 Ranking Financing Mechanisms and Tools for Marine Restoration in the Mediterranean

This section provides a preliminary ranking of the public reforms and financing tools analysed in Section 4 based on their impact, efficiency, scalability and feasibility, to help policymakers prioritise the most promising approaches and selecting the most appropriate strategies for marine restoration. The ranking is based on a multi-criteria assessment incorporating four dimensions: impact, efficiency, scalability and feasibility in the Mediterranean region. A more detailed explanation of the methodology used can be found in Section 2.3. These criteria were selected to provide a balanced view of each financing tool's potential to support marine ecosystem restoration efforts effectively. The results can be found in Table 3, with a description of the assessment of each criterion for each mechanism and tool and of broader limitations of the instrument. Table 4 provides the detailed scoring used for the assessment.



Ranking	Financing instrument	Impact	Efficiency	Scalability	Feasibility	Limitation
1	Conservation Trust Funds	Proven long-term support for conservation and restoration (e.g., MedFund) Depends on the initial funding or its renewal	Funds are managed for targeted conservation, reducing financial leakage	Can be expanded to cover larger ecosystem and highly protected marine areas	Requires strong governance, which can be a challenge in certain Mediterranean countries	Only covers conservation so far, not restoration measures specifically
2	Conservation fees and charges	High revenue generation in the region linked to tourism and resource use	If well-targeted, can directly fund restoration and conservation	Applicable mainly to designated MPAs with tourist activity, but also to islands or ports.	Easier to implement compared than certain public reforms	Depends on visitor flows and requires strong earmarking
2	Private sector investment and blended finance	Mobilises untapped potential of private capital for restoration	Success depends on potential financial returns and low risks for investors	Potential to be expanded with appropriate incentives and structures	Limited by regulatory frameworks and investor willingness	Private sector investment can only complement public financing sources for restoration
2	Payments for Ecosystem Services	Directly rewards conservation efforts	Strong performance when well-structured, but often small and local projects	Depends on local economic conditions	Complex to implement and monitor	Depends on the valuation of ecosystem services, which can be complex
2	Public subsidies	Effectiveness depends on subsidy design, but strong potential to drive meaningful change	Efficiency depends on activity targeted and should avoid creating perverse incentives	Large potential well aligned with restoration goals and directly driven by the NRL	Requires strong political support, which is currently lacking	Important equity consideration to bear in mind for the Mediterranean region
3	Taxes	Can generate long-term revenue for restoration, but does not directly drive restoration measures	Well-targeted and designed environmental taxes can be efficient, but are often limited in scope	Political and social resistance may limit expansion	Governments must drive political action while navigating economic and equity concerns	Important equity consideration to bear in mind for the Mediterranean region; high potential to target sources of harm
3	Blue bonds	Can mobilise large-scale funding for marine restoration	Potential efficiency but also risks of unintended negative environmental impacts	Suitable for financing large-scale and transboundary projects, less suitable for smaller local projects	Requires strong institutional capacity and large funders	Risk of greenwashing if projects are poorly designed and monitored
4	Carbon markets and biodiversity credits	Potential to drive impact but limited to 'blue carbon' ecosystems	High investor interest but lacks legitimacy, concerns from conservation NGOs	Growth potential but depend on demand	Requires strong regulatory and scientific monitoring frameworks, definitions and frameworks still in early stages	To be handled with caution and with close attention to emerging international and EU frameworks and safeguards

TABLE 3

Preliminary ranking of financial mechanisms and tools for marine restoration in the Mediterranean

Source: the author's own qualitative assessment.

Financing instrument	Impact	Efficiency	Scalability	Feasibility	Total score	Rank
Conservation Trust Funds	3	3	3	2	11	1
Conservation fees and charges	2	3	2	3	10	2
Private sector investment and blended finance	3	2	3	2	10	2
Payments for Ecosystem Services	3	3	2	2	10	2
Public subsidies	3	2	3	2	10	2
Taxes	2	3	2	2	9	3
Blue bonds	3	2	2	2	9	3
Carbon markets and biodiversity credits	2	2	2	2	8	4

TABLE 4
Scoring used for the assessment in Table 3
Source: the author's own qualitative assessment.

The following conclusions can be drawn from the assessment:

- Conservation Trust Funds emerge as one of the most effective instruments, due to their long-term financial sustainability, targeted conservation funding, and scalability, and the example of the MedFund providing a case study of the tool's feasibility in the region.
- Conservation fees and charges, blended finance, PES and public subsidy reform rank highly, offering strong impact and scalability but requiring careful structuring and design.
- Carbon markets and biodiversity credits and taxes score slightly lower, as they require regulatory adjustments and face challenges linked to social acceptance.
- All these mechanisms and tools must be designed as part of an integrated policy mix, as their efficiency depends on the complementarity with other tools (see Section 4.4.).

5. RECOMMENDATIONS FOR MEDITERRANEAN COUNTRIES AND INSTITUTIONS FOR SCALING UP FINANCING FOR MARINE BIODIVERSITY RESTORATION

The This section outlines key recommendations relevant for both EU and non-EU Mediterranean countries to boost biodiversity financing, reform harmful practices, and align economic activities with marine conservation goals. Among the recommendations:

- EU Member States should design ambitious National Restoration Plans (NRPs) that go beyond ticking regulatory boxes—plans that integrate restoration targets with solid financing strategies. This means identifying co-benefits, calculating investment needs, and phasing out harmful subsidies, using guidance like WWF's. All countries should map ecosystems in need of restoration and consider establishing no-take zones to give marine ecosystems space to regenerate and thrive.
- Restoration efforts should be consistent with broader biodiversity commitments. EU Member States should link their NRPs with their National Biodiversity Strategies and Action Plans (NBSAPs), ensuring coherence across national and international agendas. Non-EU countries should also adopt ambitious NBSAPs that explicitly address marine restoration and financing. UNEP/MAP can play a key role here by coordinating a regional restoration strategy that bridges EU regulations and global biodiversity goals.
- Reforming public financial tools is essential. Countries must identify subsidies that harm marine ecosystems and commit to phasing them out—building on existing initiatives like GBF Target 18 and WTO rules. They should adopt fiscal reforms that encourage conservation, such as green taxes and targeted tax relief, while ensuring these measures are socially equitable. Maritime Spatial Planning should be used as a practical tool to coordinate restoration efforts and identify actors who can contribute to their financing.
- Innovative financing must move from pilot to scale. Countries should expand the use of payments for ecosystem services (PES), develop incentives for restoring blue carbon ecosystems, and work toward standardised and transparent biodiversity credit systems. Conservation fees—if well-designed and socially accepted—can fund long-term marine protection. Countries should also support conservation trust funds like MedFund and help their MPAs meet eligibility criteria. A Mediterranean registry for innovative financing tools would help track success and foster collaboration.
- The private sector must become a key partner in restoration. Businesses and financial institutions need to integrate biodiversity into their risk and investment decisions, aligning with frameworks like the Science-Based Targets for Nature (SBTN) and TNFD. Governments should work with financiers to reduce risks and make restoration projects more investable. Blended finance tools should be scaled up, backed by public funds or multilateral banks. A regional platform could help govern and coordinate private investment in marine conservation.
- Strong accountability systems are vital. Countries should adopt clear performance indicators for finance tools—like carbon and biodiversity credits or blue bonds—to assess what's working. Transparent reporting must become the norm, and private actors should commit to third-party audits to ensure their contributions to restoration are real and impactful.

- Restoration efforts must be inclusive and coordinated. Financing tools should align with broader climate plans—such as NECPs and NDCs—to tap into synergies around adaptation and resilience. Cross-border cooperation is key, given that marine ecosystems don't follow national boundaries. Countries should invest in marine biodiversity monitoring, share data across borders, and involve a wide range of stakeholders—including communities, scientists, and NGOs—in designing and implementing NRPs. A whole-of-government approach will be crucial to align ministries and maximise impact.
- Equity must be at the heart of all reforms. New financing tools and fiscal changes must be designed with care to avoid placing undue burdens on vulnerable communities. Instead, they should be used to actively include and benefit local stakeholders—for example, through PES schemes or community-based blue bonds that reward conservation efforts.
- UNEP/MAP has a central role to play in supporting Mediterranean marine restoration. It should help coordinate stakeholder engagement to identify regional priorities and funding gaps, commission research on barriers to private investment, and facilitate regional dialogue on innovative finance solutions. Its leadership can ensure alignment and ambition across the region.

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CHAPTER 5 . ECONOMIC SUPPORT TOOLS FOR MARINE INVASIVE ALIEN SPECIES MANAGEMENT IN THE MEDITERRANEAN

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Abstract

The economic burden of invasive alien species (IAS) in the Mediterranean is substantial, with financial losses exceeding $27.3 billion across key sectors such as fisheries, aquaculture, and tourism. Despite these costs, current IAS management strategies remain predominantly reactive, focusing on control and mitigation rather than prevention. Efforts to mitigate IAS impacts require substantial financial investment, making the exploration of financial mechanisms for prevention and control crucial. This chapter critically examines the role of economic tools in addressing IAS impacts, emphasizing their potential to enhance financial sustainability and long-term management effectiveness.

This chapter discusses how a range of economic instruments, including subsidies, compensation schemes, taxation, tradable permits, and performance bonds, offer mechanisms to internalize the costs of IAS while incentivizing proactive management. Direct financial incentives, such as removal subsidies for pufferfish and lionfish, have demonstrated success in aligning economic and ecological objectives by integrating IAS control into commercial fishing activities. Compensation mechanisms for fishers affected by IAS-driven stock declines further highlight the importance of economic support structures. Meanwhile, taxation models, such as Pigouvian taxes on high-risk activities (e.g., ballast water discharge, ornamental species trade), aim to reduce IAS introductions at their source. However, challenges remain, including the difficulty of quantifying invasion risks, enforcing tax policies, and ensuring the long-term sustainability of financial incentives.

Public-private partnerships represent a critical yet underutilized opportunity for IAS management. The private sector can contribute through direct funding mechanisms, investment in detection and removal technologies, and the development of commercial markets for certain invasive species. By transforming IAS into economically viable resources, such as through targeted fisheries, food markets, or industrial applications, economic tools can shift IAS management from a financial liability to a sustainable opportunity.

Despite these advancements, gaps persist in funding stability, governance coordination, and policy implementation, particularly in non-EU Mediterranean countries. Strengthening financial mechanisms, ensuring multi-stakeholder engagement, and integrating economic models into broader conservation frameworks are essential for improving IAS management outcomes. This chapter underscores the necessity of adaptive, market-based economic strategies to create a resilient financial and policy framework that simultaneously supports biodiversity conservation and economic stability in the Mediterranean region.

Resumé

Les espèces exotiques envahissantes (EEE) représentent un fardeau économique considérable en Méditerranée, avec des pertes financières estimées à plus de 27,3 milliards de dollars dans des secteurs clés comme la pêche, l'aquaculture et le tourisme. Pourtant, les stratégies actuelles de gestion des EEE restent majoritairement réactives, privilégiant le contrôle et l'atténuation des effets plutôt que la prévention. Or, la lutte contre ces espèces nécessite des investissements financiers conséquents, rendant indispensable l'exploration de mécanismes économiques permettant d'améliorer la prévention et la gestion durable des EEE. Ce chapitre analyse le rôle des outils économiques dans la lutte contre les EEE et leur capacité à renforcer la viabilité financière et l'efficacité des actions menées sur le long terme. Divers instruments économiques sont mobilisables, notamment les subventions, les mécanismes de compensation, la fiscalité, les permis échangeables ou encore les cautions de performance. Ces dispositifs permettent d'internaliser les coûts liés aux EEE tout en encourageant une gestion proactive. Par exemple, des incitations financières directes, telles que des subventions pour l'élimination du poisson-lion ou du poisson-ballon, ont démontré leur efficacité en intégrant la lutte contre ces espèces aux activités de pêche commerciale. De même, des mécanismes de compensation pour les pêcheurs affectés par la diminution des stocks halieutiques contribuent à amortir les impacts économiques des invasions biologiques. Par ailleurs, des taxes environnementales, inspirées du principe pigouvien, pourraient être appliquées aux activités à risque, comme le rejet des eaux de ballast ou le commerce d'espèces ornementales, afin de limiter les introductions d'EEE à la source. Toutefois, plusieurs défis persistent, notamment l'évaluation des risques d'invasion, l'application effective des taxes et la pérennisation des incitations financières.

Les partenariats public-privé constituent une opportunité encore largement sous-exploitée dans la gestion des EEE. Le secteur privé pourrait jouer un rôle clé, que ce soit par des mécanismes de financement direct, des investissements dans les technologies de détection et d'éradication, ou encore le développement de débouchés commerciaux pour certaines espèces envahissantes. En valorisant ces espèces – par exemple à travers la pêche ciblée, les marchés alimentaires ou des applications industrielles – il est possible de transformer la lutte contre les EEE d'un fardeau économique en une opportunité durable.

Malgré ces avancées, des lacunes subsistent, notamment en matière de financement, de coordination des politiques et de gouvernance, en particulier dans les pays méditerranéens non membres de l'UE. Pour améliorer la gestion des EEE, il est essentiel de renforcer les mécanismes financiers, d'encourager une coopération multi-acteurs et d'intégrer les outils économiques dans des stratégies de conservation plus larges. Ce chapitre souligne ainsi la nécessité de mettre en place des approches économiques flexibles et fondées sur le marché afin de garantir un cadre financier et politique résilient, capable de concilier la préservation de la biodiversité et la stabilité économique en Méditerranée.

1. INTRODUCTION

The degradation of natural ecosystems is occurring at an alarming rate, primarily due to human activities. Biodiversity loss is accelerating, threatening the stability of ecological systems that provide essential services such as food production, water purification, and climate regulation. The current extinction rate exceeds historical averages, with approximately one million species at risk unless urgent conservation measures are implemented (IPBES, 2019). Among the key drivers of biodiversity decline, habitat destruction, climate change, pollution, and biological invasions are particularly impactful. These factors often interact, compounding pressures on ecosystems and intensifying the loss of native species (Díaz et al., 2019). One of the most pressing threats to marine biodiversity is the introduction and spread of invasive alien species (IAS). These species, whether introduced intentionally or unintentionally, often disrupt native ecosystems by outcompeting indigenous species, altering food webs, and degrading habitats. The ecological consequences of biological invasions extend to economic and societal dimensions, affecting industries such as fisheries, aquaculture, and tourism (Simberloff et al., 2013). Marine invasions are primarily facilitated by global trade and transportation networks. Ballast water discharge, biofouling on ship hulls, and accidental releases through aquaculture are among the most common pathways for marine IAS (Molnar et al., 2008).

Shipping alone is responsible for a significant portion of global IAS introductions. The International Maritime Organization (IMO) estimates that approximately ten billion tonnes of ballast water are transported worldwide each year, potentially carrying thousands of marine organisms across ecosystems (IMO, 2008). With increasing globalization and maritime traffic, the risk of biological invasions is expected to rise, with models predicting a 36 percent increase in bio-invasion rates by 2050, particularly for invertebrate species in European waters (Seebens et al., 2020).

Once established, IAS are difficult and costly to manage. The Mediterranean Sea, with its high connectivity and extensive shipping activity, has experienced a significant influx of non-indigenous species (NIS). The expansion of the Suez Canal in 2016 has further facilitated the spread of thermophilic species from the Indo-Pacific, intensifying ecological and economic challenges (Galil et al., 2017). These introductions are reshaping marine food webs, leading to competition with native species, habitat degradation, and financial losses across multiple industries.

This chapter evaluates the economic implications of IAS in the Mediterranean, focusing on their impact on key industries and financial burdens associated with control measures. It further explores economic support mechanisms, including compensation schemes, subsidies, and market-based incentives, assessing their effectiveness in mitigating losses. The research also highlights policy gaps and proposes strategies for integrating ecological and economic considerations into IAS management.

2. MEDITERRANEAN SEA UNDER BIOLOGICAL INVASION

The Mediterranean Sea is the most invaded marine ecosystem globally, with nearly 1,000 non-indigenous species (NIS) recorded, around 63% of which have entered through the Suez Canal (Katsanevakis et al., 2013; Galil, 2008). This phenomenon, known as "Lessepsian migration," has been influenced by the canal's progressive ex-

pansions, including the 2016 enlargement, which has facilitated the entry of thermophilic species from the Indo-Pacific. Originally inaugurated in 1869, the canal was intended to shorten maritime trade routes between Europe and Asia. Over time, its dimensions have significantly increased, enhancing its strategic role. Beyond its economic significance, the canal has also played an unanticipated role in altering regional marine biodiversity by linking two ecologically distinct bodies of water, the Red Sea and the Mediterranean.

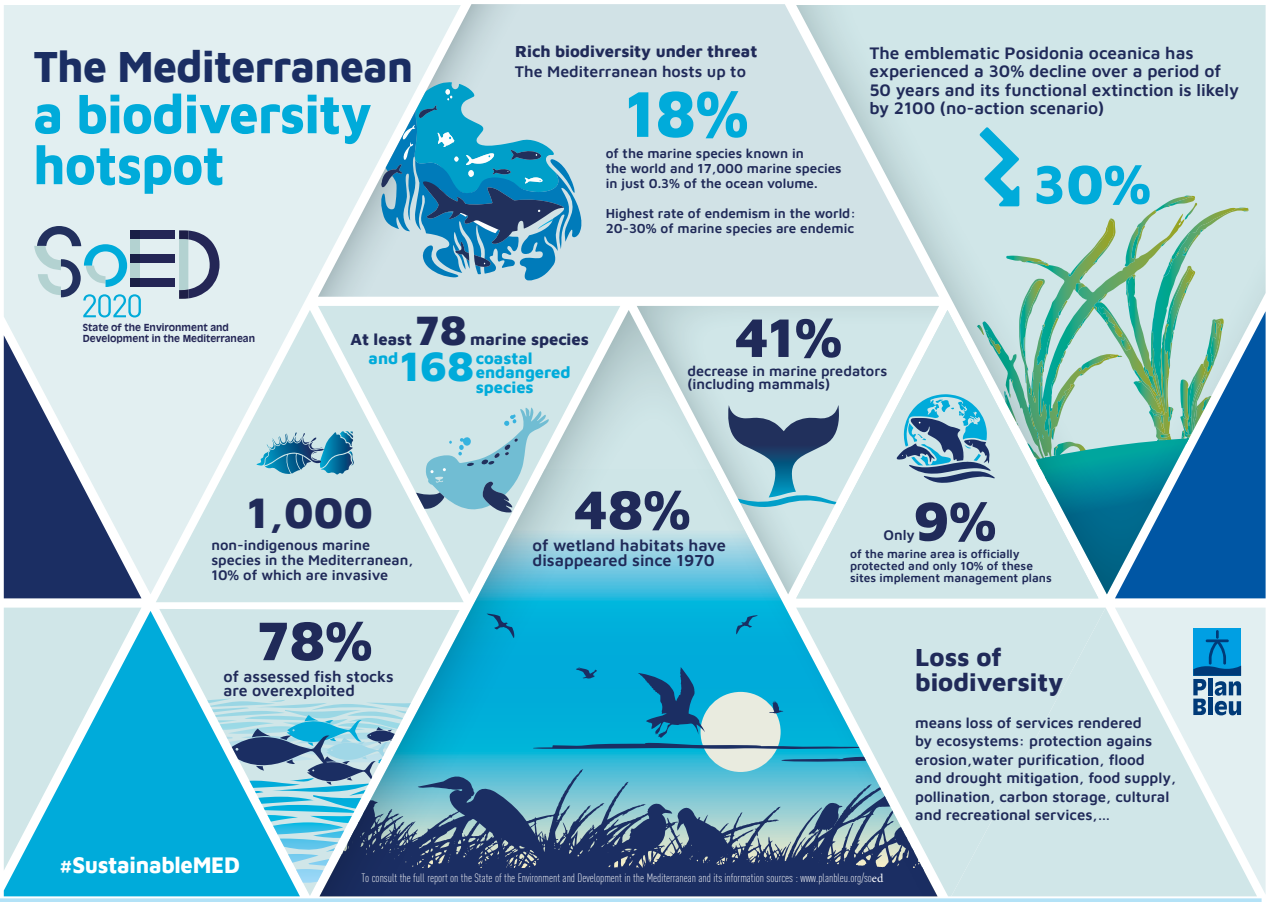


FIGURE.1 *Biodiversity status and threats in the Mediterranean (SoED, 2020)*

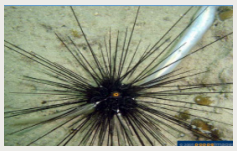
Despite challenges such as the length of canal, initial shallowness, and variations in temperature, salinity, and turbidity, the seawater-fed Suez Canal facilitated a predominantly one-way migration of species from the Red Sea and Indo-Pacific into the Mediterranean. The Eastern Mediterranean, specifically the Levantine Basin, is the region most impacted by invasive species due to its proximity to the canal and favorable conditions for tropical species. Here, non-indigenous species dominate the ichthyofauna, comprising 29% of fish production in some areas like Cyprus (Michailidis et al., 2019).

The Eastern Mediterranean is characterized by higher temperatures and salinity compared to the western basin, largely due to the limited influence of the cooler, less saline Atlantic waters entering through the Strait of Gibraltar. Some studies also point to the construction of the Aswan Dam in the 1970s,

which significantly reduced freshwater input from the Nile, as a contributing factor to rising salinity in the eastern basin. This shift may have eased environmental barriers for Indo-Pacific species, facilitating their establishment. Today, coastal marine communities at depths of up to 30–40 meters in the Eastern Mediterranean are largely dominated by these non-indigenous species (Hüseyinoğlu et al., 2024), while native and endemic species are increasingly in decline. Although the western basin has remained comparatively less affected, warming waters are enabling the gradual spread of thermophilic species such as the dusky grouper (Epinephelus marginatus) (Azzurro et al., 2017). This westward expansion underscores both the adaptability of Indo-Pacific species and the growing influence of climate change on marine biodiversity patterns.

Today, among the worst impactful marine IAS in the Mediterranean are the rabbitfish, lionfish, pufferfish, and various others, each having a severe impact on its ecological balance (Table 1). In terrestrial and freshwater systems, the invasion is less prominent but still significant, particularly in wetlands and river deltas. However, marine ecosystems bear the majority of the impact, with invertebrates (e.g., mollusks and decapods) and fishes being the most represented groups (Zenetos et al., 2020; Galil, 2008). Other significant pathways include ballast water discharge, biofouling on ship hulls, and the aquarium trade (Molnar et al., 2008; Flagella & Abdulla, 2005).



Species	Common name	Native Region	Introduction Pathway	Ecological Impact	Economic Impact
 **Panama. Copyright: © Diane Littler (littlerd@si.edu) (AlgaeBase)**	Caulerpa taxifolia Toxic algae	Unknown (likely aquarium trade)	Aquarium trade	Displaces native seagrass meadows, reduces biodiversity	Affects fisheries and coastal ecosystem services
 **Philippines,by Poppe, Guido and Philippe (SealifeBase)**	Diadema setosum Long-spined sea urchin	Indo-Pacific	Lessepsian migration	Overgrazes seagrass meadows and algal beds, degrades habitat	Reduces nursery grounds for commercially valuable fish
 **Pakistan, by Muhammad Moazzam Khan (SealifeBase)**	Penaeus semisulcatus Green tiger prawn	Indo-Pacific	Ballast water, aquaculture	Competes with native crustaceans, reduces biodiversity	Affects native benthic organisms important for fisheries
 **©Prof. Bella Galil/via Wikimedia Commons - CC BY-SA 3.0 (CABI)**	Rhopilema nomadica Nomadic jellyfish	Indo-Pacific	Suez Canal	Forms large blooms, destabilizes planktonic food webs	Harms coastal tourism due to painful stings
 **Greece, by Robert Partner (FishBase)**	Lagocephalus sceleratus Pufferfish	Red Sea	Lessepsian migration	Competes with native fish, preys on valuable shellfish, damages fishing gear	Damages fishing gear, reduces shellfish populations
 **Papua New Guinea, by Robert Partner (FishBase)**	Plotosus lineatus Striped eel catfish	Indo-Pacific	Lessepsian migration	Displaces native species, alters benthic communities	Risks to fishers due to venomous spines

 **Egypt, by Robert Partner (FishBase)**	Pterois miles Lionfish	Indo-Pacific	Aquarium releases, Lessepsian migration	Preys on native fish and invertebrates, disrupts food webs	Affects fisheries, venomous spines deter predation
 **Greece, by Roberto Pillon (FishBase)**	Siganus luridus & S. rivulatus Rabbitfish	Red Sea	Suez Canal, Lessepsian	Overgrazes native algal forests, transforms habitats into barren areas or invasive algae fields	Reduces biomass, affects biodiversity and ecosystem health

TABLE 1
Overview of the worst impactful marine IAS in the Mediterranean

3. ECONOMIC IMPACT OF IAS IN THE MEDITERRANEAN

Biological invasions impose significant economic burdens on Mediterranean economies, affecting fisheries, aquaculture, tourism, and infrastructure. Unlike terrestrial invasions, where physical containment is often possible, marine IAS are exceptionally challenging to control due to the fluid nature of oceanic environments. Once established, invasive populations can spread rapidly, leading to long-term financial consequences. The total economic cost of IAS in the Mediterranean has been estimated at 27.3 billion dollars, with realized costs amounting to 3.6 billion dollars over the past three decades (Kourantidou et al., 2021). These costs arise primarily from damages rather than proactive management investments, highlighting the reactive nature of IAS control efforts. The difficulty in eradicating marine IAS leads to persistent and escalating costs, with financial losses accumulating across sectors.

Fisheries and aquaculture:

IAS have severely impacted Mediterranean **fisheries**, both by reducing native fish stocks and by damaging fishing gear. Predatory and competitive species such as the toxic pufferfish (Lagocephalus sceleratus) and herbivorous rabbitfish (Siganus spp.) have caused significant disruptions in commercial fisheries (Zenetos et al., 2022). These species compete with native fish for food and habitat, while also preying on commercially valuable species. The pufferfish, in particular, poses additional risks due to its toxicity, leading to a decline in market demand for affected fish stocks. Fishers face increased costs from gear damage, reduced catch volumes, and lower market prices, all of which contribute to financial instability in coastal fishing communities (Kleitou et al., 2022).

Aquaculture also faces major challenges due to IAS. Invasive crustaceans and mollusks, such as the green tiger prawn (Penaeus semisulcatus), disrupt farmed species by competing for food and habitat. Biofouling by invasive macroalgae and mollusks further complicates aquaculture operations, increasing maintenance costs for infrastructure and water filtration systems (Kourantidou et al., 2021). These pressures necessitate economic support mechanisms to offset losses and sustain the livelihoods of those dependent on Mediterranean fisheries and aquaculture.

Tourism and coastal infrastructure:

The Mediterranean's **tourism** industry, one of the largest contributors to regional economies, has also suffered from IAS-related impacts. Invasive macroalgae and jellyfish blooms reduce the aesthetic and recreational value of coastal areas, leading to declining visitor numbers and financial losses for tourism-dependent businesses (WWF, 2021; Galanidi et al., 2023). The invasive jellyfish (Rhopilema nomadica), originally from the Indo-Pacific, has proliferated in the eastern Mediterranean, deterring beachgoers and forcing municipalities to invest in costly management interventions such as protective nets and removal programs (Katsanevakis et al., 2014).

Similarly, invasive macroalgae such as (Caulerpa taxifolia), introduced via the aquarium trade, have spread extensively across Mediterranean **coastlines**, altering natural habitats and diminishing the attractiveness of diving and snorkeling sites. This degradation affects businesses reliant on marine ecotourism, further compounding economic losses (Katsanevakis et al., 2014).

Regional economic disparities:

The **economic burden of IAS is unevenly distributed across the Mediterranean**. The eastern Mediterranean, particularly the Levantine Basin, incurs the highest costs due to its proximity to the Suez Canal and environmental conditions that favor thermophilic species (Katsanevakis et al., 2014). The western Mediterranean has historically been less affected, but rising sea temperatures have facilitated the westward spread of IAS, gradually increasing their economic footprint. Countries such as France, Spain, and Italy report higher financial losses, partly due to well-documented case studies and stronger reporting infrastructure. In contrast, North African nations such as Libya report fewer documented costs, likely due to gaps in data collection rather than a lower degree of biological invasion (Kourantidou et al., 2021).

Financial challenges:

Efforts to mitigate IAS impacts require substantial **financial investment**. Control measures such as invasive species removal, habitat restoration, and monitoring programs demand continuous funding. The economic burden is further amplified by the absence of long-term funding structures, leading to gaps in IAS management efforts (Tsirintanis et al., 2022; de Carvalho-Souza et al., 2024).

Despite the financial burden, e**conomic incentives** for IAS control remain underdeveloped. The current approach to IAS management is largely reactive, with most expenditures directed toward damage mitigation rather than prevention. There is an urgent need for economic support tools, including financial compensation for affected industries and subsidies for proactive control measures. Strengthening cross-border collaboration and financial investment is crucial to reducing long-term costs and minimizing the spread of IAS in Mediterranean ecosystems.

4. ECONOMIC SUPPORT AND POLICY IMPLICATIONS FOR IAS MANAGEMENT

Addressing the economic impact of invasive alien species (IAS) requires not only biological control strategies but also financial mechanisms that support affected industries and encourage proactive management. Economic support tools, including subsidies, compensation schemes, and financial incentives, play a crucial role in mitigating IAS-related losses while promoting sustainable

practices. When well-structured, these tools align economic incentives with conservation goals, ensuring that resources are allocated efficiently to reduce long-term costs. However, their effectiveness depends on the existence of clear regulatory frameworks, stable funding sources, and coordinated governance at regional and international levels.

Existing policy frameworks:

IAS management in the Mediterranean is shaped by European Union regulations, United Nations Environment Programme Mediterranean Action Plan (UNEP/MAP) initiatives (that also cover non-EU countries), and national policies under the Barcelona Convention (UNEP-MAP, 2003). The EU Invasive Alien Species Regulation (EU 1143/2014) establishes a structured approach to IAS control by emphasizing prevention, early detection, and rapid eradication of newly detected species (EU, 2008; Katsanevakis et al., 2013). Additionally, the Marine Strategy Framework Directive (MSFD) integrates IAS management into broader marine conservation policies, linking invasive species control to the achievement of Good Environmental Status (GES) in European waters. However, implementation challenges persist, particularly in non-EU Mediterranean countries, where financial and institutional constraints limit policy enforcement (Kourantidou et al., 2022). At the international level, the Convention on Biological Diversity (CBD) highlights IAS prevention and control as a key priority under Article 8(h). The International Maritime Organization's (IMO) Ballast Water Management Convention sets specific obligations for reducing marine invasions via shipping activities (CBD, 2014; IMO, 2008). Despite these frameworks, many policies remain reactive rather than preventive, with financial mechanisms often lacking long-term stability.

Economic support tools:

Several economic tools have been proposed to address the financial burden of IAS while encouraging compliance with biosecurity measures. Among these, taxation and market-based instruments are widely discussed as mechanisms to internalize the environmental costs of biological invasions.

Pigouvian taxes are a way of placing responsibility for damage and the repair of damaged environments on the polluter, so as to encourage high-risk players to internalize the social cost of their activity. In the case of IAS, pigouvian taxes impose financial penalties on high-risk activities such as ballast water discharge, ornamental species trade, and aquaculture imports (Baroni, 2013). This tax also sends a price signal to economic agents and improves the competitiveness of equivalent, less polluting products. However, determining appropriate tax rates remains a significant challenge due to the difficulty of quantifying invasion risks and assessing long-term economic damages (Perrings et al., 2005). Other forms of tax, such as customs duties, have also proved effective in limiting the accidental introduction of IAS. Indeed, a 2004 study shows that the decision to establish customs duties, combined with border inspections, is always useful, and that the optimal amount of these duties is greater the higher the risk of importing IAS (McAusland-Costello, 2004). Countries such as Austria and New Zealand have implemented similar taxation models by imposing inspection fees on imported goods to recover biosecurity costs (Carvalho-Souza et al., 2024).

Tradable permits, another market-based tool, has been proposed to regulate the introduction of potentially invasive species by setting limits on translocation and allowing businesses to trade their rights within a controlled system. Although this approach has proven effective in carbon trading mar-

kets, its application in IAS management remains largely theoretical and requires further development (Carvalho-Souza et al., 2024).

Compensation schemes and p**erformance bonds** are additional financial tools designed to hold industries accountable for IAS introductions while ensuring funds are available for mitigation efforts. Environmental liability insurance, for example, requires industries that engage in activities with a high risk of IAS spread, such as shipping and aquaculture, to obtain financial coverage. In the event of an invasion, these funds contribute to remediation and ecosystem restoration (Baroni, 2013). This mechanism ensures that industries bear the financial responsibility for potential environmental damages rather than relying on public funds. Performance bonds operate under a similar principle, requiring companies engaged in high-risk activities to deposit a refundable sum of money. If they comply with biosecurity measures and no IAS introduction occurs, the deposit is returned. This approach provides a financial safeguard by ensuring that funds are available for response actions if an invasion does occur. Although performance bonds have been successfully applied in land-based environmental protection policies, their use in marine IAS management remains limited due to enforcement challenges, in particular the difficulty of identifying the players responsible, and administrative complexities (Carvalho-Souza et al., 2024).

Direct financial incentives, such as **subsidies** and removal incentives, have been particularly effective in encouraging proactive IAS management. In several Mediterranean countries, governments have introduced financial rewards for fishers who actively participate in invasive species removals. In Turkey and Cyprus, for example, financial incentives have been offered to fishers targeting lionfish (Pterois miles) and pufferfish (Lagocephalus sceleratus), integrating their removal into commercial fishing practices (Kleitou et al., 2019; IPBES, 2023). By creating an economic market for these invasive species, such programs reduce IAS populations while simultaneously providing an alternative income source for local fishers. Similar compensation schemes have been introduced for fisheries affected by ecosystem disruptions caused by IAS. Overgrazing by rabbitfish (Siganus spp.) has significantly reduced native fish stocks, leading to substantial financial losses for local fishers. Compensation mechanisms help offset these disruptions and support economic stability in the fishing industry (IPBES, 2023).

Financial support to research and development has also been directed toward habitat restoration and biosecurity improvements. Several European Union-funded programs promote the adoption of ballast water treatment technologies and the rehabilitation of habitats degraded by IAS. The restoration of seagrass meadows, such as Posidonia oceanica, has been supported through biodiversity funding programs that aim to enhance the resilience of native ecosystems while counteracting the ecological damage caused by biological invasions (Hanley et al., 1997; Katsanevakis et al., 2020). Research and development in IAS detection and control technologies have similarly benefited from financial incentives. Advances in environmental DNA (eDNA) monitoring have significantly improved early detection efforts, allowing for more effective and cost-efficient IAS management (Darling & Mahon, 2011). The expansion of such technologies through research grants and government funding has strengthened marine surveillance and response capabilities across the Mediterranean.

Despite progress in integrating financial tools into IAS management, significant gaps remain. Many existing economic incentives depend on short-term grants rather than stable, long-term funding mechanisms, creating uncertainty about the continuity of control programs. This issue is particularly pronounced in non-EU Mediterranean countries, where financial constraints often hinder effective IAS management (IPBES, 2023). Additionally, many economic models used to inform IAS policies fail to fully incorporate ecological and socioeconomic complexities, limiting their effectiveness in guiding decision-making (Kourantidou et al., 2022). The lack of comprehensive data on IAS economic impacts further complicates cost-benefit assessments and reduces the ability to develop tailored financial strategies (Tsirintanis et al., 2022). Expanding case studies, securing long-term financial commitments, and strengthening regional coordination will be crucial in ensuring that economic support mechanisms contribute effectively to sustainable IAS management in the Mediterranean.

An overview of economic tools for IAS management in the Mediterranean, highlighting their respective advantages and challenges as well as their feasibility, is presented in Table 2.

Economic Tool	Prevention	Adaptation	Policy Alignment	Feasibility (EU)	Feasibility (Non-EU Med)	Advantages	Challenges	Real-world Examples
Pigouvian Taxes	High	Low	CBD, IMO Ballast Convention	Medium	Low	Discourages high-risk activities	Difficult to quantify optimal tax levels	Austria, New Zealand
Tradable Permits	High	Low	Market-based EU policies	Medium	Low	Market-driven compliance	Requires robust monitoring	Theoretical application
Compensation	Low	High	EU Funding Schemes	Medium	Medium			
Liability Insurance	Medium	Medium	CBD, EU Directives	Low	Low	Ensures funding for remediation	Complex liability assessment	Limited cases in IAS management
Performance Bonds	High	Low	Regional conventions	Medium	Low	Incentivizes compliance	High administrative costs	Theoretical application
Subsidies	Medium	High	MSFD, EU IAS Regulation	High	Medium	Supports affected industries	Requires sustainable funding	Turkey (pufferfish removal), Cyprus (lionfish control)

TABLE 2
Overview of economic tools for IAS management in the Mediterranean

Case studies for management of IAS in Mediterranean

A few examples of successful financial incentive policies via subsidies and the creation or promotion of new economic markets for IAS are presented below, highlighting the realism of some of the economic instruments presented above. In addition, the Mediterranean context of the first two and the maritime context of the third support the potential transposability of these solutions to similar contexts facing the same issues.

The Turkish government has implemented a program to reduce the populations of the highly toxic pufferfish (Lagocephalus sceleratus). Fishers are compensated for each pufferfish tail collected, directly linking financial incentives to IAS management. This initiative aims to alleviate ecological pressure from the species and mitigate economic losses in fisheries by protecting native fish stocks and fishing gear (Turan et al., 2020; Ulman et al., 2021; IPBES, 2023).

In Cyprus, government-supported programs incentivize the removal of lionfish (Pterois spp.) populations through coordinated culling and market creation. Financial incentives are provided to stakeholders, including divers and fishermen, encouraging their participation in removal efforts. Public awareness campaigns and community engagement also play a critical role by highlighting the ecological threat posed by lionfish while promoting active involvement in management efforts. Scientific research underpins these initiatives, identifying effective removal methods and assessing ecological outcomes. For example, studies have shown that targeted removals significantly reduce local lionfish densities, enhancing native biodiversity and ecosystem resilience (Kleitou et al., 2019; Poursanidis et al., 2020). This participatory approach serves as a model for broader application across the Mediterranean, demonstrating the effectiveness of combining economic incentives with community-driven conservation strategies.

The invasive blue crab (Callinectes sapidus), native to the western Atlantic Ocean, has significantly disrupted Mediterranean ecosystems and fisheries due to its aggressive predatory behavior and rapid population growth. This species preys on native species, competes with local crabs, and damages fishing gear, causing ecological imbalances and economic challenges for coastal communities (Mancinelli et al., 2017; Katsanevakis et al., 2014). Recognizing the bilateral threat caused by blue crabs, various subsidy programs have been initiated to encourage their harvest and reduce their ecological impact. For example, in the Gulf of Cadiz and parts of the Adriatic Sea, local governments have introduced financial incentives for fishermen to target blue crabs actively. These subsidies often cover operational costs, such as fuel and specialized gear, to facilitate large-scale removals. In addition, market creation initiatives promote the commercial use of blue crabs as a food product, transforming a problem into an economic opportunity (Zenetos et al., 2022; Carvalho-Souza et al., 2024). Blue crab meat is highly valued in global seafood markets, and the increasing demand provides additional income for fishers while reducing the species' population. Moreover, research-backed management strategies include the development of traps and bait designed specifically for blue crab harvesting, supported by government funding and subsidies. Public awareness campaigns further enhance these efforts by educating stakeholders about the ecological impacts of blue crabs and the benefits of controlling their populations (Mancinelli et al., 2017). However, challenges such as overharvesting risks and the need for sustained funding highlight the importance of adaptive and science-driven management frameworks (Carvalho-Souza et al., 2024; IPBES, 2023).



5. CONCLUSION

The The urgent need for effective management of IAS in the Mediterranean is underscored by their escalating ecological and economic consequences. The region's high vulnerability to biological invasions demands a shift from reactive control measures toward integrated, proactive strategies that emphasize prevention, economic support, and multi-stakeholder collaboration. Strengthening early detection systems, enhancing legislative frameworks, and securing long-term financial commitments are fundamental steps in mitigating IAS impacts.

A barrier to the effective use of economic tools in IAS management is the reliance on short-term funding cycles, which create uncertainty and limit the sustainability of interventions. To address this, **long-term and stable financing mechanisms should be established at the Mediterranean level.** Meanwhile, economic tools must be reinforced through strong policy frameworks to ensure their effectiveness and enforceability. Expanding the use of Pigouvian taxes can provide funding for IAS management while discouraging harmful practices. Performance bonds and environmental liability insurance could be introduced for industries with high IAS introduction risks, ensuring that businesses are financially accountable for potential damages. Direct financial incentives can also be enhanced, as well as compensation schemes for industries affected by IAS, particularly small-scale fisheries. The roles of various stakeholders are central to successful IAS management. Governments play a critical role in designing and implementing regulatory frameworks, ensuring consistent funding, and fostering international cooperation. Scientific institutions contribute by advancing monitoring technologies and developing evidence-based management strategies, while NGOs facilitate public engagement and education. Fishers and local communities, often the most

affected by IAS, should be actively involved in decision-making and incentivized to participate in removal efforts through financial support mechanisms. Also, since IAS management requires regional cooperation, economic tools should be designed to function across national boundaries, ensuring effective collaboration between EU and non-EU Mediterranean countries. Strengthening the Barcelona Convention framework by developing a regional action plan for economic instruments under UNEP/MAP would provide clear guidelines for tax policies, incentives, and liability schemes.

Beyond traditional stakeholders, private sector involvement can significantly enhance IAS management through public-private partnerships. Businesses can support control programs by investing in monitoring technologies, funding removal efforts, or integrating IAS into commercial markets. Some invasive species, such as lionfish and blue crabs, already have established markets, demonstrating the potential for transforming biological threats into economic opportunities. Encouraging sustainable harvesting, promoting invasive species as alternative seafood sources, and developing value-added products can create financial incentives that complement ecological objectives. Additionally, insurance mechanisms, environmental impact funds, and corporate sponsorships could provide new funding streams for IAS mitigation.

Public awareness and community engagement remain key to long-term success. Integrating traditional ecological knowledge with modern scientific approaches, fostering cross-border collaboration, and adopting adaptive management strategies can improve the resilience of Mediterranean ecosystems. By aligning conservation priorities with economic incentives and leveraging multi-sector cooperation, the Mediterranean can serve as a model for other regions facing similar challenges. A holistic approach that combines scientific innovation, economic tools, and inclusive governance is essential to achieving sustainable IAS management and ensuring the long-term health of marine ecosystems and coastal economies.

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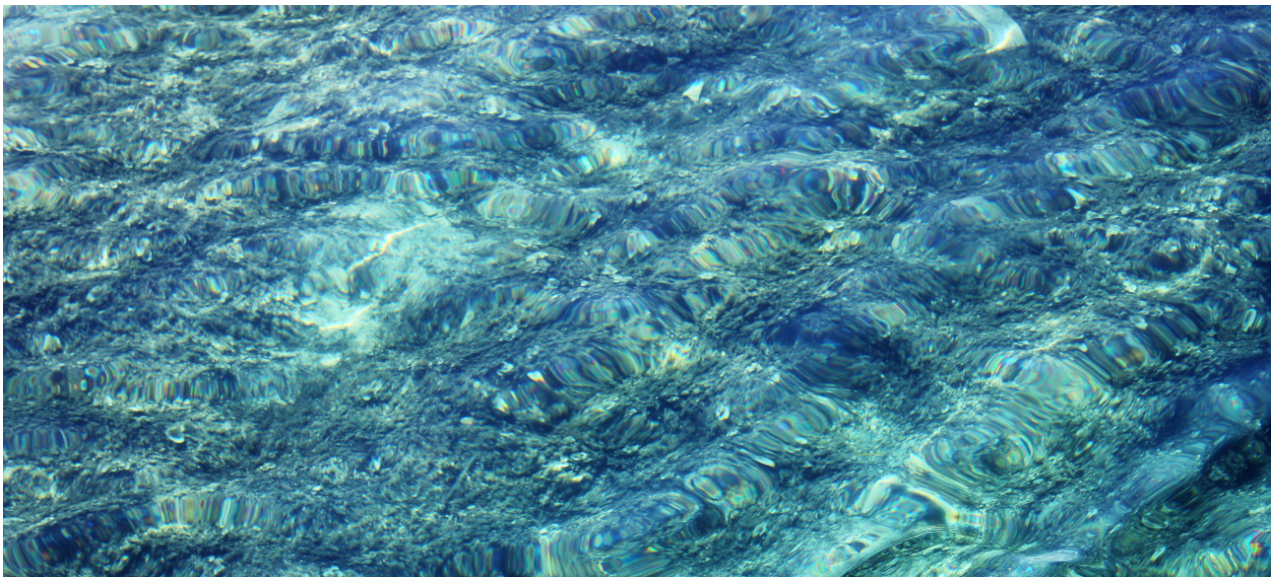
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CHAPTER 6. EU WATER POLICIES AND INNOVATIVE FINANCING MECHANISMS: DEVELOPMENTS AND FUTURE PERSPECTIVES FOR THE MEDITERRANEAN COUNTRIES

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Abstract

Sustainable use and protection of water resources require forward-looking policies and novel financing mechanisms which can support water-related innovations and their market deployment. Europe is a front runner in integrated water management. This chapter collects key EU policies and strategies of relevance to sustainable water management (e.g. Water Framework Directive, Green Deal, and Biodiversity Strategy for 2030) and explores their broader implications for Mediterranean countries. Beyond policies, meeting sustainable water management requires adequate funding of innovation that can support sustainable use and protection of water. Utilizing SWOT analysis, the study assesses modern financing alternatives of relevance to the Mediterranean, to explore the strengths, weaknesses, opportunities, and challenges inherent in deploying modern financial approaches to sustainable water management. The discussion is complemented with case study analysis, drawing from the experience of Zoomaal, a crowdfunding platform in Lebanon. Zoomaal is examined to better understand the conditions that relate to the deployment of novel financing approaches that can support innovation, including those related to water. The case of Zoomaal illustrates the importance of ICT penetration, regulatory, political and the wider socio-economic conditions for the uptake and sustainability of novel financial instruments. Additionally, alternative financing case studies for water innovation are discussed to provide diverse examples. The chapter concludes with considerations for policy making and provides a ranking of the financial instruments based on their effectiveness, in supporting stakeholders targeting sustainable water management and supportive financial innovation in the Mediterranean region. These insights try to guide decision making to more effective water financing solutions.

Résumé

L'utilisation durable et la protection des ressources en eau nécessitent des politiques prospectives et de nouveaux mécanismes de financement pouvant soutenir les innovations liées à l'eau et leur déploiement sur le marché. L'Europe est un leader en gestion intégrée de l'eau. Ce chapitre recueille les principales politiques et stratégies de l'UE pertinentes pour la gestion durable de l'eau (par exemple, la directive-cadre sur l'eau, le Green Deal et la stratégie biodiversité pour 2030) et explore leurs implications plus larges pour les pays méditerranéens. Au-delà des politiques, la gestion durable de l'eau nécessite un financement adéquat pour soutenir l'innovation, qui peut favoriser l'utilisation durable et la protection de l'eau. En utilisant l'analyse SWOT, l'étude évalue les alternatives de financement modernes pertinentes pour la région Méditerranéenne, afin d'explorer les forces, les faiblesses, les opportunités et les défis inhérents au déploiement de nouvelles approches financières pour la gestion durable de l'eau. La discussion est complétée par l'analyse de cas, en s'inspirant de l'expérience de Zoomaal, une plateforme de financement participatif au Liban. Zoomaal est étudiée pour mieux comprendre les conditions liées au déploiement de mécanismes de financement innovants pouvant soutenir l'innovation, y compris dans le domaine de l'eau. Le cas de Zoomaal illustre l'importance de la pénétration des TIC, des conditions réglementaires, politiques et socio-économiques plus larges pour l'adoption et la durabilité de nouveaux instruments financiers. En outre, des études de cas de financements alternatifs pour l'innovation dans l'eau sont discutées pour fournir des exemples diversifiés. Le chapitre se conclut par des considérations pour l'élaboration des politiques et fournit un classement des instruments financiers en fonction de leur efficacité à soutenir les parties prenantes visant une gestion durable de l'eau et l'innovation financière en Méditerranée. Ces perspectives visent à orienter les décisions vers des solutions de financement de l'eau plus efficaces.

1. INTRODUCTION

The Water resources have been a subject of EU policy making for several decades (e.g., Directive for Integrated Pollution and Prevention Control (1996), Groundwater Directive (2006), Water Framework Directive (2000), EU Biodiversity Strategy for 2030 (2020)). Among the most recent developments, the EU Green Deal materializes the EU's strategy on climate-proofing, sustainable development efforts and its industrial strategy to address the challenges of the green and digital transformation (Tsani and Chitou, 2024). Beyond the EU, water trajectories should align with global commitments and targets as stipulated in the UN 2030 Agenda, where SDG6 directly links to sustainable water management. SDG1, SDG2 and SDG8 aim for sustained per capita economic growth, high levels of economic productivity and global resource efficiency, which indirectly link to pressures on the water bodies and the need for sustainable use and protection of water resources at national and global levels (Tsani et al., 2020).

Meeting sustainable water management goals requires not only robust policy frameworks but also substantial financial support for innovations that can transform these policies into actionable solutions. The Sustainable Finance regulation accompanying the Green Deal includes the EU green taxonomy for the classification of sustainable activities, updated financial standards, benchmarks and reporting requirements, and the mandate to include sustainability in credit ratings and market research. These are complemented by funding mechanisms like the Cohesion Fund, European Social Fund, European Regional Development Fund, Common Agricultural Policy, Horizon Europe, LIFE Programme, Connecting Europe Facility, from the auction of allowances under the Emission Trading Scheme, from the dedicated scheme for private investments (InvestEU) and from the European Investment Bank (EIB) dedicated loan scheme for public investments. Beyond EU-wide initiatives and funding available for water-related innovations, investment capi-

tal can be raised through bank lending, private equity, and crowdfunding.

While EU water policies and financing mechanisms have been extensively studied within the context of Member States (e.g., Ludwig et al., 2011; Voulvoulis et al., 2017; European Commission, 2017; Tsani et al., 2020), their implications for the Mediterranean region remain underexplored. No critical assessment can be traced in the literature to date that systematically identifies the links between EU policies to sustainable water management and financing in the Mediterranean countries. While financing alternatives focusing on water sustainability are available, little systematic information on them can be identified with Mediterranean region-specific insights. Extension of the discussion with emphasis on the Mediterranean has significant implications for the countries in the region which face financing and technological constraints related to water and remain a core partner of the EU, so, EU-level developments impact directly on its neighboring countries.

This chapter aims to address these gaps and advance scientific knowledge on sustainable water management and financing tools with focus on the Mediterranean region. Specifically, the chapter:

- identifies and critically discusses the EU policies of relevance to water management in the Mediterranean and the financial alternatives in support of sustainable water management.
- collects and evaluates in a systematic manner the available financing tools in the Mediterranean which can accelerate the meeting of sustainable water management targets as formulated in modern policy frameworks.

- through SWOT (Strengths, Weaknesses, Opportunities, Challenges) analysis it summarizes and critically assesses the core advantages, disadvantages, opportunities and challenges related to alternative financial instruments for sustainable water management in the Mediterranean region.

Furthermore, the chapter advances the discussion on novel instruments to finance water innovation in the Mediterranean countries by identifying and presenting alternative cases to derive practical recommendations. Indicative cases include the public-private partnership in Egypt or crowdfunding platforms in France, Spain and Italy (e.g. Ulule, Goteo, Crowdfundme), with a reference to Zoomaal in Lebanon. The study highlights country-specific factors like capital availability, ICT penetration, political stability and regulatory environment that influence the adoption of these financing mechanisms. Finally, it includes a ranking of financial instruments based on their effectiveness in addressing water sustainability challenges and supporting stakeholders engaged in sustainable water management and financial innovation in the Mediterranean. The chapter contributes by: i) examining the implications of EU policies for sustainable water management, ii) highlighting untapped opportunities for water innovation financing, iii) providing available financing alternatives, and iv) emphasizing the role of technology, socio-economic and regulatory aspects in deploying innovative financial tools.

The conclusions offer insights for policymakers and stakeholders, highlighting the role of regional policies for water management, context-specific enablers, complementarities with the EU water and neighbor policies, and coordinated action to support novel financial tools for sustainable water management.
The remainder of the chapter develops as follows: Section 2 summarizes the EU wa-

ter policies with wider implications for the Mediterranean region and discusses how they can serve sustainable water management in the region. Section 3 discusses the financing alternatives in support of water related innovation, it attempts a systematic assessment of them through SWOT analysis and it sheds more light on applicability through case study analysis. The last section concludes with some considerations for policy making and related stakeholders.

2. WATER POLICIES IN EUROPE OF RELEVANCE TO THE MEDITERRANEAN REGION

2.1 Listing the Relevant EU Policies, Frameworks and Tools

Europe's comprehensive water policies provide valuable frameworks and tools for addressing the Mediterranean region's pressing challenges of water scarcity, environmental degradation, and climate resilience.

Water resources have been the subject of **various EU directives and legislative actions** since the 1980s, initially addressing specific pressures on water bodies independently (e.g., Drinking Water Directive (80/68/EEC), Nitrates Directive (91/676/EEC), Urban Waste-water Treatment Directive (91/271/EEC), and others). These have been followed by the Water Framework Directive (WFD) in 2000 (Directive 2000/60/EC). The EU WFD introduces for the first time an integrated approach to water management that directly acknowledges the human-driven pressures on water bodies and the necessity of recovering the full costs of water use, whether financial, resource, or environmental. The EWFD marks the first recognition of the role of socio-economic assessments and tools in achieving good environmental and chemical status in water bodies. Recent directives following EU WFD include the Groundwater Directive (2006/118/EC), the Bathing Water Directive (2006/7/EC), the EU Floods Directive (2007/60/EC), the Marine Strategy Framework Directive (2008/56/EC), the EU Water Reuse Regulation (EU 2020/741), and the 2024 revision for the Urban Wastewater Treatment Directive[229].

The **EU Green Deal**[230], approved in 2020, entails sustainable water management through efficient use of water, ecosystem conservation, and pollution reduction. In local, regional and transboundary contexts, sustainable water management is essential for the sustainability transition in different economic sectors and activities. Water resources are important for renewable energy production (e.g. hydropower) as energy carriers (e.g. green hydrogen), sustainable agriculture, and ecosystem restoration (Tsani, 2024). By investing in sustainable water projects, countries can transition to greener economies while collaborating on shared water and environmental goals. Funding draws from existing programs within the long-term EU budget (e.g., Cohesion Fund, European Regional Development Fund, Common Agricultural Policy, and LIFE Programme) from InvestEU and from the European Investment Bank (EIB) dedicated loan scheme for public investments. Implementation of the Green Deal necessitates a strong decarbonisation of the EU. The Just Transition Mechanism of the EU supports the decarbonisation efforts while ensuring cohesive and just transformation. The Just Transition Fund, equipped with €40 billion for the period 2021-2024, supports, among other, research and innovation, environmental rehabilitation, and clean energy. While the Just Transition Fund provides funding primarily in the form of grants, InvestEU leverages public and private investment by backing investment projects of financial partners such as the EIB.

The **EU Biodiversity Strategy for 2030**[231], adopted in May 2020, aims for the restoration, protection and the resilience of all European biodiversity and ecosystems by 2050. One objective of the Biodiversity Strategy is to restore freshwater ecosystems and the natural functions of rivers. Member States should examine water abstraction and impoundment permits to implement ecological flows to achieve good qua-

229 https://www.consilium.europa.eu/en/press/press-releases/2024/01/29/urban-wastewater-council-and-parliament-reach-a-deal-on-new-rules-for-more-efficient-treatment-and-monitoring/
230 https://commission.europa.eu/strategy-and-policy/priorities-2019-2024/european-green-deal_en
231 https://environment.ec.europa.eu/strategy/biodiversity-strategy-2030_en

lity or potential of all surface waters and good status of all groundwater by 2027 at the latest. The Nature Restoration Law is the first continent-wide law of its kind and a key component of the EU Biodiversity Strategy. It entered into force on August 18, 2024. This regulation sets a broad restoration goal for the long-term recovery of nature in EU land and sea areas, coupled with restoration targets for specific habitats and species. These measures are intended to cover at least 20% of the EU's land and sea areas by 2030 and ultimately to restore all ecosystems in need by 2050. EU countries are expected to submit National Restoration Plans to the European Commission within two years of the regulation coming into force (by mid-2026), detailing how they will meet these targets.

The **EU Hydrogen Strategy**[232], adopted in July 2020, focuses on fostering the development and use of hydrogen, particularly green hydrogen (produced using renewable energy). Favorable investment opportunities for the EU green hydrogen market in North Africa are assured. This has been substantiated by significant EU policy initiatives, including the Africa-EU Energy Partnership and the Commission's New Agenda for the Mediterranean. Numerous initiatives and projects have been launched by the EU and North Africa to advance hydrogen; within this landscape, Algeria, Morocco, Egypt and Tunisia emerge as key players. The EU has expressed interest in collaborating with Algeria, from which the SoutH2 Corridor project will commence, linking the country to Europe via a new hydrogen backbone. This corridor facilitates connections between North Africa, Italy, Austria and Germany, thereby enabling the provision of low-cost renewable hydrogen produced in the South to critical European demand clusters. Furthermore, the collaborative engagement between the EU and Egypt in hydrogen production is underscored by several initiatives. Worth mentioning, the first integrated green hydrogen facility in the country is being developed with the support of the European Bank for Reconstruction and Development.
In January 2021, the revised **Drinking Water Directive**[233], Directive (EU) 2020/2184, came into effect, setting basic quality standards for water intended for human consumption. The Directive aims to improve access to safe drinking water in line with the latest World Health Organization recommendations, enhance consumer transparency, and reduce reliance on plastic bottles for water. Regarding water reuse, the regulation(EU) 2020/741 of the European Parliament and Council establishes minimum water quality standards for the safe reuse of treated water in agricultural irrigation. The main objectives are to ensure that reclaimed water is safe for irrigation, providing strong environmental protection, safeguarding human and animal health, and supporting the circular economy. Another goal is to encourage the use of treated wastewater to reduce dependence on surface and groundwater extraction.

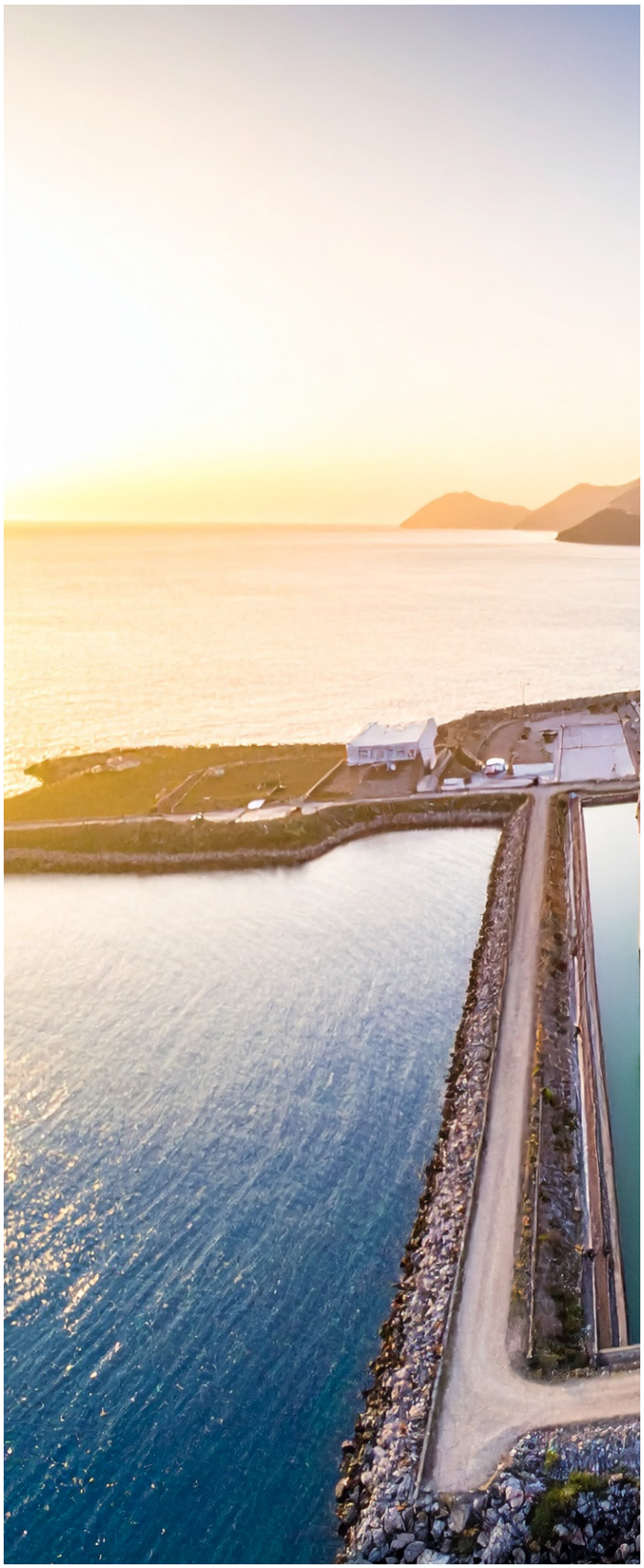
The EU is also promoting **desalination**. EU directives, such as the Water Framework Directive and the Drinking Water Directive, play a crucial role in supporting desalination projects while imposing strict environmental and safety standards. This creates both opportunities and challenges for implementing autonomous desalination units powered by renewables in the Mediterranean. Although these are suitable for remote or arid regions, complex regulations hinder widespread adoption (Gibbons et al, 2008). Recent initiatives underscore the importance of integrating desalination technologies with renewable energy sources and circular approaches. For instance, the SEArcularMINE project illustrates how desalination plants can be effectively combined with saltworks to enhance resource efficiency (Campione et al, 2024). However, expansion should be managed with sustainability. Cyprus's reliance on desalination has led to the reduction of Posidonia oceanica seagrass meadows, with a measurable carbon footprint contributing 2% to the country's emissions (Xevgenos et al., 2021). Developments should focus on energy efficiency and sustainable designs that assess site-specific marine impacts before deployment.

The need to strengthen Europe's water security was highlighted in the political guidelines for

232 https://eur-lex.europa.eu/legal-content/EN/TXT/?uri=CELEX:52020DC0301
233 https://eur-lex.europa.eu/eli/dir/2020/2184/oj/eng

the next European Commission 2024-2029, presented to the European Parliament on 18 July 2024 by the President of the European Commission, Ursula von der Leyen. A new **European Water Resilience Strategy** should «ensure that sources are properly managed, and water scarcity is addressed». The EU should also «enhance the competitive, innovative edge of its water industry and take a circular economy approach»[234]. EU cohesion policy is a core investment policy available to the member states to improve water services, quality and availability in all the EU regions[235]. For the programming period 2021-2027, EUR 16.9 billion have been allocated in priority investment areas related to water, including: Investment in drinking water supply following the water hierarchy, water reuse, investment in waste-water collection and treatment in urban areas, and other measures to improve water networks, among others. Investment allocation by intervention fields varies between member states, reflecting the differences in priorities and water challenges they face.

With the **European Neighborhood Policy (ENP)**, the EU is seeking to reinforce relations with neighboring countries to promote prosperity, stability, and security. ENP regional and multilateral cooperation initiatives include the Union for the Mediterranean, with focus in southern region. In the 2021-2027 period, assistance to the partner countries will be financed through Neighborhood, Development, and International Cooperation Instrument (NDICI). In total, the EU's neighborhood area will be granted at least EUR 19 billion for the period 2021-2027, part of which may support water-related projects and initiatives, though the instrument itself is more general and not water-specific. Several Mediterranean countries are included in ENP, namely: Algeria, Egypt, Israel, Jordan, Lebanon, Libya, Morocco, the occupied Palestinian territory, Syria and Tunisia. The new instrument is based on a "policy first" principle. It streamlines EU external action while preserving the key features of the European Neighborhood Instrument (ENI) in relation to enhanced political cooperation with the ENP partner countries.



234 https://www.europarl.europa.eu/legislative-train/theme-a-european-green-deal/file-water-resilience
235 https://cohesiondata.ec.europa.eu/stories/s/21-27-Sustainable-water-management/ehce-gj6d#investment-priorities

2.2 Leveraging EU Water Policies for Sustainable Water Management in the Mediterranean

The The collection of policies, directives and initiatives above is indicative of the rich policy framework that directly and indirectly links to sustainable water management and financing in the EU. While these water policies are applicable to EU Member States, they have broader implications for the Mediterranean neighbour countries, in terms of water management, environmental protection, and regional cooperation as well as financial support to implement projects that can improve water sustainability. The Mediterranean region faces acute water scarcity, environmental degradation, and challenges related to climate change, all of which are central to Europe's water-related policies. Mediterranean countries can benefit from or be influenced by these policies in several ways. They can draw from the EU integrated water management across sectors such as agriculture, industry, and urban areas, to reduce waste, improve water efficiency, and promote conservation. Mediterranean countries facing water scarcity issues can draw from the EU's experience in developing policies that manage water holistically, balancing environmental, social, and economic factors.

Importantly, any such inspiration must account for the specificities of Mediterranean countries, ensuring that approaches are tailored to regional contexts and not simply transposed of the EU model. The EU WFD can serve as a blueprint for the non-EU Mediterranean countries to adopt more comprehensive water management strategies that account for all sectors, including agriculture, industry, and urban needs. Additionally, the EU WFD encourages collaborative approaches to shared water resources. Mediterranean countries share transboundary water resources (e.g., Nile, Tigris, Euphrates). The EU's experience in transboundary water cooperation, such as the management of the Danube River Basin (see the International Commission for the Protection of the Danube River-ICPDR[236]) or Rhine (see the International Commission for the Protection of the Rhine- ICPR[237]), offers valuable lessons for the Mediterranean countries facing similar challenges. Promoting joint agreements, transparent data sharing, and coordinated management could help resolve long-standing water disputes in the Mediterranean region and foster more sustainable and equitable water governance

Additionally, Mediterranean countries could benefit from the EU's focus on water reuse. As agriculture is one of the largest water consuming sectors, adopting similar water reuse standards would be crucial. Mediterranean countries can learn from the EU Water Reuse Regulation (EU 2020/741), particularly in agriculture, to control reuse of treated water. The regulation promotes the circular economy by enabling safe irrigation of reclaimed water and decreases pressure on freshwater resources. Agriculture-related water scarcity in the Mediterranean could be addressed through similar policies with the ability to stretch limited freshwater and increase efficiency. Countries like Jordan, Israel, and Egypt, which have pioneered wastewater treatment for agricultural use, could scale up these practices by aligning with EU standards for safe water reuse.

The EU Biodiversity Strategy for 2030 and the Nature Restoration Law focus on restoring and protecting aquatic ecosystems, setting ambitious goals for ecological flows and the recovery of freshwater ecosystems. This approach could influence Mediterranean countries to adopt similar initiatives in order to protect their threatened freshwater ecosystems. The region's rivers, lakes, and wetlands are under extreme threat due to over-extraction, pollution, and climate change. Mediterranean countries could protect biodiversity, water quality, and quantity for future generations with ecosystem-based approaches. The EU's focus on protecting water ecosystems can serve as a model for the region, helping to establish policies that balance human and environmental needs. By implementing ecological flow measures for rivers and addressing water

236 https://www.icpdr.org/
237 https://www.iksr.org/en/

abstraction, they could help restore the natural balance of water bodies, ensuring their sustainability for future generations. Yet, it is essential to underline Mediterranean ecosystems and socio-economical specificities to ensure that such initiatives suit local realities.

The EU Green Deal and EU Water Resilience Strategy focus on enhancing water systems' resilience in the face of climate change, with priorities on water efficiency, pollution reduction, and sustainable management. For Mediterranean countries, many of which are highly climate change vulnerable (e.g., higher temperatures, droughts, and desertification), the EU policies are an inspiration for strengthening water system resilience. Mediterranean countries can be more effectively positioned to the increased pressures posed by climate change and deliver long-term water security if they adopt measures to minimize water waste and ensure the water resources.

Overall, it can be argued that EU's policies on integrated water management, reuse, environmental protection, and climate resilience offer useful examples and potential models that Mediterranean countries can study to address their own water challenges (Figure 1). By learning from the EU's experiences and adopting tailored strategies, Mediterranean countries can improve water efficiency, enhance regional cooperation, protect ecosystems, and increase resilience to climate change ensuring water security for their populations. While this can be a clear recommendation for the Mediterranean countries, it should be accompanied by the urge to look for the fallacies or the shortcomings of the EU water-related policies as well as for the local conditions that can ultimately shape the success of the adopted policies. Several shortcomings can be identified in the EU water policies, associated mainly with poor implementation coordination across countries, slow development of the appropriate market and non-market mechanisms to support sustainable water management, etc. (Tsani, 2024). These need to be acknowledged and addressed in a complementary manner by the EU and its Mediterranean neighbors.

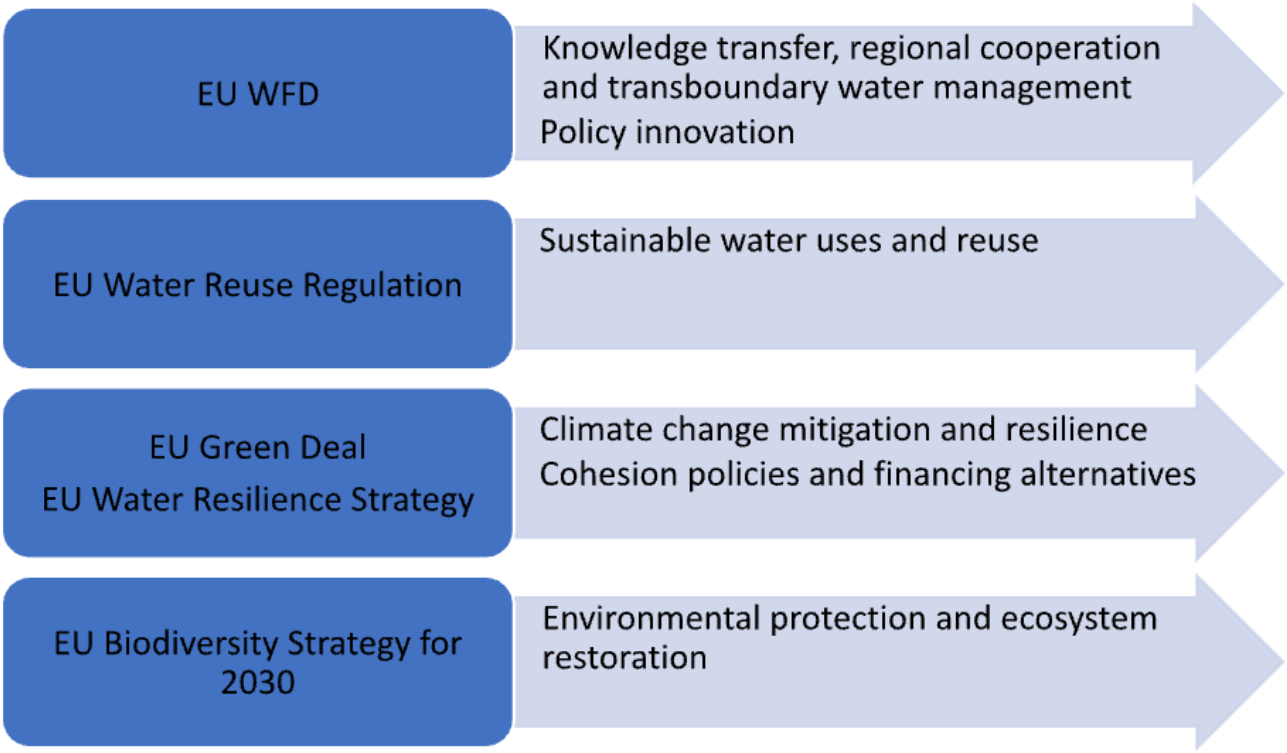


FIGURE.1 *Indicative EU policies as blueprints for water management in the Mediterranean*

An additional impediment to the implementation of EU water policies is related to the low capital allocation to related projects. This has to do with the nature of water (public versus private good, the limited information on the returns to water investments etc.). The EU allocates significant funds for water management through its cohesion policy, grants, and investment programs which support water infrastructure, wastewater treatment, and water reuse projects. However, these funds often prioritize large-scale infrastructure projects, leaving less room for fostering innovation or supporting smaller-scale, experimental technologies that could revolutionize water management. Overall, this is not enough to address the needs to deploy innovation in the water sector or to support novel ideas that are not yet in the market uptake stage. Several novel approaches can be identified and used to support water innovation in Europe and the Mediterranean. Mediterranean countries could benefit from funding mechanisms through international partnerships with the EU or through development assistance. Beyond this, Mediterranean countries can draw inspiration from financial innovations and examine their potential to support the market deployment of technologies that can support sustainable water use and protection. The next section discusses these alternatives and attempts a first systematic assessment of them.

Existing water management frameworks in non-EU Mediterranean countries

Several non-EU Mediterranean countries have developed frameworks for water management, however, many are still underdeveloped or face challenges. In 2020, Morocco launched 2020-2050 National Water Plan (PNE)[238], a long-term strategy that addresses water conservation, increase the use of alternative sources such as desalination, improving water distribution and productivity. Similarly, in December 2017, Egypt introduced the National Water Resources Management Plan 2037 (NWRP 2037), in which outlines key measures to increase annual freshwater, improve water use efficiency in all water sectors, improve the quality of drainage and wastewater effluent, and reduce net outflow into the Mediterranean. Tunisia has also a regulatory framework for water management. The country implemented in 1975 the Water Code[239], which was later supplemented by a water law approved in 2019 to address the current water challenges of the country. In Lebanon, the National Water Sector Strategy (2020-2035)[240] was developed to ensure equitable access to water and sanitation services for all. Meanwhile, Jordan, adopted the National Water Strategy 2023-2040 to address water scarcity challenges. Despite these efforts, challenges such as financial constraints, infrastructure, and water stress continue to affect the implementation of water management strategies in these areas.

3. FINANCIAL INSTRUMENTS FOR WATER INNOVATION IN THE MEDITERRANEAN: OPPORTUNITIES AND CHALLENGES

Water policies are the first step for sustainable water use and protection. Relevant projects need to be identified and implemented to meet sustainability transition. This comes often against significant financial challenges that hinder the efforts to achieve long-term sustainability. These challenges arise from the high costs of infrastructure development, competing demands for limited financial resources, difficulties in aligning funding with long-term goals, or limited private investors' interest in water related investments (Tsani, 2024). Funding challenges often deprive technological innovation targeting sustainable water use and protection from much needed funding. Thus, it remains important to identify and assess all the financing alternatives that relate to sustainable water management. Beyond EU-wide initiatives and funding available for water-related innovations, investment capital can be raised through alternative channels such as grants, private equity, green bonds, and crowdfunding. Drawing from the work of Ja-

238 https://thedocs.worldbank.org/en/doc/073ccc31324add86357b143f4cf64a8e-0280012023/original/BN-Water-Scarcity-and-Droughts-apr23-FINAL.pdf
239 https://water.fanack.com/tunisia/water-management-tunisia/
240 https://www.cdr.gov.lb/getmedia/6a801a3c-5f04-4d51-b75a-f06e9079971a/Short-Summary-Updated-NWSS-MoEW-2020 En.pdf.aspx#:~:text=The%20Updated%20National%20Water%20Sector%20Strategy%20%28NWSS%29-Ministry%20of,is%20comprised%20of%20six%20volumes%2C%20as%20detailed%20below.

niak et al. (2021), the alternative financing tools and their main characteristics are summarized next. Based on the unique characteristics of these alternatives this section proceeds with the identification and discussion of the strengths, weaknesses, opportunities and threats related to each alternative paying attention to the assessment of relevance to the Mediterranean region. Case study analysis complements the discussion to better understand the applicability of novel financial instruments to support sustainable water management in the Mediterranean countries focusing on country-specific contexts.

3.1 Collection of alternative financial instruments

Alternative financial instruments to support water innovation include both traditional mechanisms, such as grants and bank lending, and newer approaches like innovation competitions, public-private partnerships, green bonds, blended finance, private equity, and crowdfunding. Each of these tools offers unique opportunities and challenges, with relevance to both the European and Mediterranean contexts.

Grants consist of financial assistance by governments and organizations awarded competitive submissions as response to project calls. They can fund projects in different stages from research to concept development, testing and demonstration, large-scale validation, and market entry. EU granting schemes of relevance to the Mediterranean countries include Horizon Europe, EIC Accelerator, EIC Transition, EIC Pathfinder, Innovative Europe the Eureka Network, PRIMA Foundation and LIFE+ program. Prima calls are of relevance to the Mediterranean countries, and they have supported several projects of relevance in the past (See for instance the PRIMA NEXUS projects [241]).

Bank lending comes in different forms and products. The core lender for water-related projects in Europe of relevance to the Mediterranean countries is the European Investment Bank's Natural Capital Financing Facility. Bank lending can be more attractive and easier to reach for larger water projects. Indicative projects in the Mediterranean countries financed by EIB include wastewater management in Cyprus and North Macedonia (EIB, 2024).

Innovation competitions are events that invite individuals, teams, or organizations to develop creative solutions to specific challenges. These competitions, such as the Mediterranean Youth Water Hackathon organized by the Union for the Mediterranean (UfM), invite young innovators aged 18 to 35 to develop game-changing solutions to pressing water challenges. The top solutions receive technical and financial support[242].

Public-private partnerships (PPPs) are a type of collaboration between the public and private sectors for the development and management of water projects. Such partnerships may leverage private sector efficiency, technical expertise, and financial resources to build, and operate projects. However, PPPs face several challenges, including regulatory barriers[243], financial risks, political and public skepticism about privatization especially in sectors like water that are seen as essential services, and the need for technical and management expertise (Shambaugh and Joshi, 2021). Additionally, balancing environmental and social concerns with profitability can be difficult. An example from the Mediterranean area is the As-Samra Wastewater Treatment Plant in Jordan, which enhances water quality, minimizes pollution, and allows for safe water use in irrigation[244].

Green Bonds seek to fund projects that have net environmental benefits. These financial products are comparable to conventional bonds, however, they aim at funding sustainability initiatives like renewable energy, energy efficiency, sustainable agriculture, biodiversity conservation, and water resource management. Blue Bonds are relatively new, and lack commonly agreed frameworks or standards, making them less

241 https://app.powerbi.com/view?r=eyJrIjoiNzcxZWU1ZGMtMzVkNS00YmQ2LWI3ODctYmFmMDE1NTYwNmU0IiwidCI6IjdhNzM2ZDlk-LWQ3NDMtNDVlMC1iMTk3LTRjYWM5NTNkMTI3YiIsImMiOjl9&pageName=ReportSection03410af6161bdaf2c810
242 https://ufmsecretariat.org/mediterranean-youth-water-hackathon/
243 https://smartwatermagazine.com/news/almar-water-solutions/regulatory-barriers-ppps-and-perspective-private-sector-companies
244 https://ppp.worldbank.org/public-private-partnership/sites/ppp.worldbank.org/files/2022-06/P3Briefs_JordanAsSamraWastewater-PlantExpansion.pdf

attractive to investors compared to established instruments. Sustainability-related bonds are often seen as risky bonds due to the uncertainties about environmental benefits or the long-term viability of projects. Egypt became the first Middle East and North Africa country to launch a green bond in September 2020 (World Bank, 2022). The proceeds from this bond are earmarked for financing various environmentally sustainable projects, including clean transportation, renewable energy, pollution prevention and control, sustainable water and wastewater management, energy efficiency, and climate change adaptation.

Blended finance combines alternative capital sources (e.g., private, public, philanthropic) with the aim of lowering risk and improving investment assessment in areas that are socially beneficial but often underfunded. While blended finance raises capital bringing together different funding sources, it can also be subject to non-bridging differences between the investor categories (consider for instance philanthropic versus private funds).

Private equity consists of taking minority or majority stakes into private companies (which are not listed on Stock Exchanges) and can be in the form of Venture Capital or Growth Capital. Venture Capital is mainly directed at spinoffs and start-ups seeking financing, primarily for new, innovative and disruptive technologies and services. Venture Capital can take several forms, e.g. from seed funding to scale from a prototype to a product or service, to early-stage funding to help entrepreneurs grow a company and expand working capital, to late stage to contribute to market expansion. Growth Capital is used to consolidate companies' financial structure for the next stage of growth, including acquisitions, internationalization or the development of new product ranges, for example.

Crowdfunding raises funds for innovative solutions through participatory platforms, building on collective intelligence to support economic missions and projects for which traditional methodologies of economic financing actions are failing, especially those driven by a growth mission approach with a public scope, including water protection. Crowdfunding is described by flexibility in funding systems that can be applied in various projects and at different stages of project development. As a financing system, crowdfunding can be featured as: i) Loan instrument (peer to peer lending system), ii) Venture capital (equity crowdfunding), iii) Profit sharing in return for funding, iv) Debt security (bonds emission) and v) Hybrid participation (donation and rewards-based funding). This richness in alternatives makes crowdfunding an easy-to-use fundraising tool from different entities (individual companies, start-ups, scale ups, SMEs and different investor categories which include Angel investors, Investment bankers, Peer to peer lenders and Venture capitalists). Several crowdfunding platforms currently operate in the Mediterranean region and are worth examining to illustrate how they function and the opportunities they offer. These examples are provided for informational purposes and should not be viewed as endorsements or advertisements for any specific platform. They are :

- **Fundahope, Lebanon:** Fundahope, while it is heavily utilized for initiatives in Lebanon, it supports campaigns and donors globally. The platform operates to support causes across medical, educational, environmental, and other critical sectors. Fundahope offers a straightforward process for launching campaigns. Users create an account, submit required documentation to verify identity, and outline their campaign's purpose, goal, and details. Once approved, the campaign goes live, and people can share its unique link or QR code on social media to attract donations. The campaign organizers can monitor their funds through the platform and withdraw them at any time, even if the target is not fully achieved, subject to a small fee.

- **Madad, Egypt :** Madad is an Egyptian social business and crowdfunding platform that operates towards supporting sustainable development in various areas such as poverty, education, health, environment, and

women's empowerment. Madad connects donors to Egyptian NGOs' sustainable development projects suggested to them. The platform allows NGOs to showcase their initiatives via detailed descriptions, visual materials, and transparent progress tracking mechanisms. Donors can choose projects that align with their preferences, contribute financially, and monitor the use of funds and project progress through updates provided on the platform. The goal is to enhance financial inclusion and support long-term development in Egypt.

- **Yomken, Egypt :** Yomken is a crowdsourcing and innovation platform based in Egypt, designed to connect innovators, entrepreneurs, and product designers with organizations seeking solutions to industrial, environmental, and societal challenges. Through its "CrowdSolving" model, Yomken allows these organizations to post challenges on the platform. Innovators can then propose solutions, which may receive financial or non-financial rewards. The platform fosters collaboration and knowledge-sharing, allowing individuals and teams to come together to address local and regional issues, promoting innovation across the MENA region.
- **OurCrowd, Israel :** OurCrowd is an equity crowdfunding platform that has been built exclusively for accredited investors to provide venture capital funding for Israeli and global venture capital start-ups. However technically an outsider on this European list, OurCrowd fuel the startup culture in Israel, within the Mediterranean area, through global investors, including Europe. OurCrowd offers its members the services and management of a Venture capital organization together with the flexibility and choice of angel investing. Together with its partners, they invest in early-stage companies from sustainable energy to healthcare, software, and advanced manufacturing sectors embracing all the economic missions of the European Growth strategy, based on the Green New Deal.
- **Ulule, France :** Since its launch in October 2010, Ulule has helped finance more than 4900 creative, innovative, or community-minded projects with a 67% crowdfunding success rate in 2014. Ulule is B Corp certified. This mark is awarded by an independent international body to companies that, after meeting strict criteria, have had a positive impact on society and the environment. Ulule is the first platform to offer two fundraising types: the project manager can set a budget target, or a few objects / items to pre-sell.
- KissKissBankBank, France : KissKissBankBank, one of the world's leading crowdfunding platforms, supports projects that go beyond mainstream trends. The rewards-based platform has a mentor club of organizations, institutions, media, and brands who submit projects from their own communities and also support projects by providing funds or visibility to a project.
- **Goteo, Spain :** Goteo is a social network for crowdfunding and distributed collaboration (services, infrastructures, microtasks and other resources) for projects that contribute to the common good, free knowledge, and open code. Therefore, Goteo invites both financiers and collaborators to work on getting good social projects off the ground through rewards-based arrangements.
- **Crowdfundme, Italy :** Crowdfundme, founded in 2017, is an investing platform with a wide sectorial portfolio, open to any level of investment and with a major scope to support and facilitate the development of high-tech recognized global solutions.
- **Beehive, Dubai :** Beehive is the first peer to peer (P2P) lending platform in the MENA region. Beehive connects enterprises seeking funding with investors through its digital marketplace. Businesses apply for financing, and upon approval, their requests are listed on the platform for investors to fund. Investors can choose to fund these businesses based on their preferences, earning monthly returns on their investments. This model eliminates traditional banking intermediaries, offering faster, cost-effective loans while giving investors returns.
- **GlobalGiving, United States :** GlobalGiving operates as an online crowdfunding platform that connects donors, corporations, and foundations with nonprofit organizations working on critical issues worldwide. The platform allows individuals and organizations to fund projects in various sectors, including health, education, and the environment, by providing a secure and transparent way to donate. Donors can browse different categories, including water-related projects, and choose to contribute to causes they believe in.

3.2 SWOT Analysis of Novel Financial Instruments

The previous section summarized the main financing alternatives available for water-related innovation, indicating the plethora of options that interested stakeholders have at reach. Nevertheless, these come with different features attached that make them more/less attractive and applicable depending on the end recipients' needs. In this section we summarize the results of SWOT (Strengths-Weaknesses-Opportunities-Threats) analysis employed with the aim of obtaining a systematic assessment of alternative financing approaches.

Initially developed in the early 1970s as a strategic planning and management tool for both public and private sectors, SWOT analysis has since been widely utilized for planning and evaluation purposes. The method is widely used in fields of economics and environmental management and more recent in literature that assess sustainability transition in both developed and developing nations (e.g., Humphrey, 1974; Kurttila et al., 2000; Terrados et al., 2007; Görener et al., 2012; Igliński et al., 2015; Uhunamure et al., 2021; Puyt et al., 2023). SWOT analysis is employed with focus on the links between the alternative tools, water policies and related water innovation financing. To facilitate the reader and make the discussion more focused the SWOT results are provided in tables per financing alternative and per SWOT component (S=Strengths, W=Weaknesses, O=Opportunities, T=Threats). This is followed by a summary discussion and preliminary assessment of the alternatives.

The SWOT analysis of financial instruments for water innovation in the Mediterranean reveals their strengths, weaknesses, opportunities, and threats.

Grants

S	• Grants, especially from programs like Horizon Europe, encourage water technologies that might not receive bank loans due to high risk. • Grants align closely with global environmental goals, fostering water innovation that contributes to sustainability and climate adaptation. • Grants often come with technical assistance, training, and networks, helping projects to succeed. • Grants can be more focused on the targets and projects sought for making the application process more precise. Successful applicants have more specific targets to meet which can align very closely to innovation needs for water. • Grants allow to focus on localized water management issues, such as Mediterranean-specific challenges, fostering tailored innovations that may not attract global private investment.
W	• The application process often involves extensive documentation, requiring significant time and resources. • The funding is often limited and competitive; not all projects can receive support. • Funding coming from EU grants is frequently linked to EU priorities, which may not completely align with localized water challenges in various Mediterranean countries leading to potential gaps or misaligned priorities.
O	• Grants can drive technological innovations in water management, treatment, and reuse, addressing water issues in the Mediterranean. • Successful projects can lead to job creation in the region and have effects beyond the project lifetime. • Regional initiatives such as PRIMA foster partnerships across Mediterranean countries, enhancing shared learning and knowledge transfer.
T	• The availability of grants is related to budgets and political priorities, which may shift over time. In politically unstable Mediterranean countries, shifts in leadership or policies may lead to grant reallocation, affecting the continuity and focus of water innovation projects. • Reliance on grant funding can lead to financial gaps once project funding ends, threatening the continuity of innovations. • Evaluation and approval processes for grants can delay project implementation, for time sensitive water challenges.

Bank Lending

S	• Bank lending can support projects of various sizes, from small community water systems to large-scale facilities, facilitating private sector involvement in infrastructure projects. • Financial institutions offer a defined amount of funding with clear terms, resulting in financial predictability. • Collaboration with entities such as the World Bank, EIB and UNEP can effectively reduce the risk of investments.
W	• Water innovation projects frequently incorporate new technologies, which do not necessarily ensure prompt returns. Banks maintain stringent criteria for loans, which can prove to be challenging for new innovators to meet. • Borrowers are required to pay interest on loans, which can significantly increase the total costs of the project.
O	• Collaboration with entities such as the World Bank, EIB and UNEP can effectively reduce the risk of investments. • Financial institutions can leverage the expanding worldwide movement towards sustainability-linked loans, which are specifically aimed at fostering innovation. • Digital banking solutions can significantly streamline the application and monitoring processes. This, in turn, may make the entire process more efficient.
T	• Political and economic volatility in some Mediterranean countries can affect the ability to repay loans. Additionally, fluctuations in currency exchange rates can exacerbate repayment burdens for cross-border or international water innovation projects, increasing financial uncertainty. • Water innovation projects frequently incorporate new technologies, which do not necessarily ensure prompt returns. Banks maintain stringent criteria for loans, which can prove to be challenging for new innovators to meet. • Borrowers are required to pay interest on loans, which can significantly increase the total costs of the project. • The rise of green bonds, blended finance, and other innovative instruments may reduce demand for traditional bank loans. • High interest rates increase the cost of borrowing, making it more difficult for water projects to secure financing. • Banks may see water innovations as high-risk due to their uncertain environment.

Innovation Competitions

S	• Innovation competitions promote creativity and thinking out of the box solutions to water issues, while also raising public awareness of water challenges, encouraging broader engagement from society. • Winners obtain not just visibility, but also credibility and access to investors and industry leaders. • Prizes awarded in innovation competitions do not require repayment. • Usually, they are accessible to startups, researchers, students, and early-stage innovators, promoting widespread opportunities and participation.
W	• While prize provides immediate support, it is often insufficient to fully develop water innovations projects. • Preparing for competitions can be time-consuming, as it needs effort in areas such as proposal development, pitching, and presentation, with no guarantee of success. • The success of the competition depends on the quality and readiness. • However, they face challenges including securing sustainable funding, ensuring widespread participation, and integrating innovative solutions into existing systems of participants.
O	• Focused themes in competitions can lead to innovative solutions that possess transformative potential. • Engaging communities in competitions has the potential to effectively raise awareness, it can also create new ideas, and collaborations on water innovation. • Virtual competitions can reduce costs and attract a global pool of participants.
T	• Funding is typically one payment, leaving ideas to seek additional resources to grow their projects. • Access to competitions may be better for innovators from wealthier parts of the Mediterranean, excluding marginalized communities with relevant ideas. • Award winning ideas may fail to gain traction due to regulatory, cultural, and infrastructure barriers in the region.

Public-Private Partnerships

S	• Public-private partnerships can mobilize financial resources through public and private funds. This could lead to larger water innovation projects. • Public-private partnerships facilitate the sharing of risks between public and private partners. This reduces the exposure on any entity, increasing project viability. • Public-private partnerships frequently include extended contracts that ensure long-term sustainability of water innovations. • The nature of public-private partnerships ensures that responsibilities are clearly defined, leading to improved accountability and performance. • Moreover, public-private partnerships bring together expertise from both the public and private sectors, enhancing the technical and managerial capabilities of water innovation projects. By using diverse skills and knowledge, these collaborations can lead to more effective solutions.
W	• Establishing public private partnerships can include complex agreements that delay the project. • There is a risk that the private sector may prioritize profit above public interest and lead to inequitable outcomes. • Political shifts in government priorities in countries can break public private partnership. This creates uncertainty mainly for long-term projects.
O	• The risk-sharing framework can reduce the financial risks that are linked to water innovation projects. • The multi-stakeholder nature of public-private partnerships promotes inclusivity, bringing together various parts like governments, private companies and NGOs to address water challenges. • The collaboration between public and private sectors has the potential to enhance the skills and capabilities through knowledge sharing.
T	• Weak institutional frameworks coupled with corruption in certain Mediterranean countries diminish the efficiency and transparency of public-private partnerships. • The private sector's focus on profit may lead to prioritizing cost-effective solutions over long-term sustainability or equity in water distribution. • Climate change issues to the Mediterranean can increase operational risks for these projects, making them less attractive to private investors. • Shifting responsibilities in public-private partnerships can create accountability gaps, increase risks, and reduce project success.

Green Bonds

S	• Green bonds are specifically designed to fund projects that are environmentally beneficial. They align with initiatives focused on water innovation. • The instrument exhibits a degree of flexibility, as evidenced by the various types of issuances. Green bonds may be categorized broadly according to the assets to which they are linked. • Green bonds typically require that issuers provide comprehensive information regarding the use of proceeds, project selection and environmental impact. This increases transparency and builds trust among stakeholders.
W	• Investors who are still unfamiliar with green bonds face limitations regarding their adoption in certain regions. This lack of awareness can hinder potential growth. • The green bond market remains small when compared with traditional bonds and this disparity can restrict liquidity. • The issuance of green bonds involves additional costs compared with traditional bonds.
O	• The European Green Deal along with various sustainability initiatives and COP summits provide crucial momentum for the adoption of green finance. • The rising global interest in Environmental, Social and Governance (ESG) investments creates opportunities for green bonds. • Green bonds can enable investment in initiatives that promote water desalination and wastewater treatment which address the urgent water issues facing the Mediterranean. • Investments by green bonds can promote local economies; this occurs by funding water innovation and creating employment in sectors like infrastructure and technology. However, this depends on different regions. • As the green bond market expands, there are opportunities for water innovation projects to tap into a growing pool of socially responsible investors.
T	• The potential for greenwashing poses a significant threat to investors, particularly when green bonds fail to contribute to sustainability. • Investors remain unfamiliar with green bonds as a financial instrument and this limited understanding can reduce both the adoption and expansion of water-related projects. • Green bonds, although focused on sustainability, remain exposed to the market risks. Potential investors should consider the risks involved. • In the Mediterranean region, different regulations and policies between countries may create significant challenges for green bonds. • Water innovation frequently necessitates an initial investment and technical expertise; this means that innovators can't depend exclusively on green bonds.

Blended Finance

S	• Mobilizes funding from different sectors, creating larger financial opportunities to address water challenges in a region characterized by different needs. • Public and philanthropic funding in blended finance significantly reduces risks for private investors, making water innovation projects more attractive. Blended finance combines concessional funding with private sector investment. Concessional funding is often used to absorb some of the risks that private investors might face. By doing so, blended finance lowers the overall risk profile of water innovation projects, which encourages private sector participation. • This approach creates a balance between the goals of the private sector with the mission of public and philanthropic sectors. By doing this, it delivers not only economic returns but also social outcomes.
W	• Collaboration among stakeholders is often necessary, which can lead to delays. • Availability of public and philanthropic funds depends on economic conditions. • Balancing the interests of public and private sector actors • Blended finance has the potential to create market distortions if public resources are not used effectively, however, it can also lead to challenges when private sector actors take advantage of concessional financing.
O	• Low risk in blended finance can attract funds and institutional investors to water innovation. • Regional initiatives like the Union for the Mediterranean can use blended finance to support water projects. • Blended finance can integrate resources from EU programs to support water innovation in the Mediterranean. • Blended finance can prioritize projects that address climate adaptation and resilience, critical in these regions. • Multilateral development banks and development finance institutions could play an important role in blended finance as the need for sustainable development grows. • Integrating ESG criteria into blended finance initiatives will become important as investors demand accountability and transparency.
T	• Disagreements between public, private, and philanthropic stakeholders could delay projects. • Private investors may prioritize returns, leading to underinvestment. • Political and economic instability in the Mediterranean region could affect private investment.

Growth Capital

S	• Companies with cash flow, ensuring that funds are invested in relatively stable businesses. • Growth capital investors often provide not just funding but expertise, operational support, and access to strategic partnerships and new markets. • The focus on revenue generating companies makes growth capital attractive for the private sector.
W	• Only companies with a proven cash flow can access these funds, excluding smaller or emerging players. • Investors expect a return, which can put pressure on companies to prioritize short-term gains over sustainability. • Many companies in the Mediterranean are situated in areas characterized by either political or economic instability, deterring growth in capital investments.
O	• Funds can help companies with the expansion into new markets, increasing their influence. • The growing emphasis on sustainable investments aligns growth capital with not only profitable but also environmentally beneficial water innovation projects.
T	• Emerging financial instruments may attract investors away from growth capital. • Economic downturns can affect the availability of growth capital. • Growth capital funds will only invest in companies with a recurring cash flow. The main advantage of these options is that they can meet specific innovator and business needs at different stages of development. On the downside, both alternatives come with high competition faced by the applicants

Venture Capital

S	• Venture capital can take high risks for high returns, which can support startups in innovative water technologies. • Investors often provide mentorship and access to partnerships that are crucial for the early stage.
W	• Many early-stage companies fail to achieve high returns, making investments risky and leading to pressures. • The goal of a venture capitalist does not always align with those of the company. While companies might focus on innovation and long-term sustainability goals, investors prioritize short-term economic gains.
O	• The Mediterranean's need for innovative water solutions creates ground for venture capital investments in technologies. • EU initiatives like Horizon Europe can co-finance venture capital innovations, reducing risk. • Global focus on sustainability aligns well with water innovations, attracting socially and environmentally responsible investors.
T	• The time required for water innovation to achieve profitability may discourage venture capitals seeking quicker returns. • Political and economic instability in countries of the Mediterranean may discourage venture capital investment.

Crowdfunding

S	• Increased internet and social media usage facilitate community support for crowdfunding. • Crowdfunding platforms provide global reach, this allows innovators to access a diverse audience of potential funders. • These platforms have relatively low entry barriers, making them accessible to a variety of projects. • Fundraising can be quicker compared to traditional funding methods.
W	• Success depends on the platform's ability to attract several backers, there is no guarantee that projects will achieve their funding objectives. • Relying only on crowdfunding may not yield a sustainable and long-term funding solution. • Low trust in financial systems and civil society organizations can limit participation in crowdfunding.
O	• Employed to support experimental or innovative water solutions that may not qualify for traditional funding. • The rise of fintech can enhance access to financial services and crowdfunding platforms. • Increased visibility of successful campaigns can inspire more social entrepreneurship and community engagement. • Projects that align with sustainability goals can be promoted as green, attracting environmentally conscious funders.
T	• Regional economic challenges in MENA countries may impact funding availability and donor confidence. • Evolving laws and regulations could further complicate the crowdfunding environment. • Crowdfunding can have difficulties in areas where awareness of water issues is low or where online engagement is limited. • No quantitative limit to participation is set, therefore the crowdfunding financial tool contributes to the generation of a more collective economic effort and facilitates the multistakeholder approach. However, for larger water innovation projects, crowdfunding may not provide sufficient capital or may struggle to attract the necessary number of investors to meet financial goals.

- Traditional mechanisms, e.g. bank lending and grants, are reliable and widely used but face challenges including strict eligibility criteria and limited availability.
- Emerging financial instruments, like crowdfunding and green bonds, have strong potential for sustainability-related projects, but need more support from regulations.
- There are possibilities in leveraging public-private partnerships and blended finance to raise a broad spectrum of funds for large, transformational water initiatives.
- The analysis also highlights the necessity for a framework, which monitors these tools and links them to the goals of sustainability.

The **EU Taxonomy** offers a robust solution to these challenges by establishing a clear classification system that guarantees transparency, consistency, and alignment with environmental goals. It sets clear criteria for determining whether economic activity is environmentally sustainable, focusing on six objectives: climate change mitigation, climate change adaptation, sustainable use and protection of water and marine resources, transition to a circular economy, pollution prevention and control, and biodiversity protection and restoration. Taxonomy facilitates the alignment of financial flows with sustainability priorities that ensure not only transparency but also mitigates the risk of greenwashing.

By linking financial instruments aimed at water innovation to EU Taxonomy, policy-makers can ensure that investments in water innovation contribute to environmental targets while meeting compliance criteria. This alignment not only enhances the credibility and attractiveness of these instruments to ESG focused investors but also fosters an approach to addressing regional water challenges in the Mediterranean, essential for the broader goals of EU policies. Each financial instrument can align with the EU Taxonomy by supporting activities that meet its criteria for sustainable water use and resource protection. For instance, green bonds can be utilized to fund projects like wastewater treatment plants or irrigation systems, contributing to pollution control and water conservation. Bank lending can provide loans at reduced interest rates for companies that invest in water-conserving technology, ensuring that they follow the «Do No Significant Harm» principle to prevent any damage to the ecosystem. Grants and crowdfunding can effectively target innovative solutions, such as IoT-based water monitoring systems or research in water innovation, including measurable sustainability goals and impact reporting. Similarly, venture capital and growth capital can provide essential funding for startups that have developing water technologies, with blended equity models. Blended finance and public-private partnerships are critical for large-scale infrastructure projects and should include sustainability criteria into agreements. Furthermore, innovation competitions can focus on new solutions, setting eligibility criteria related to EU taxonomy objectives.

3.3 Case Study Analysis: The Experience of Zoomaal and Lebanon

To dig deeper into the applicability of alternative financial tools for water sustainable management in the Mediterranean, the discussion is complemented with case study analysis drawing from the example of Zoomaal, a crowdfunding platform in Lebanon. The case of Zoomaal was selected as a case study because it provides valuable insights into the conditions necessary for the successful adoption of alternative financing mechanisms in the region. These include capital availability, ICT penetration, regulatory conditions, political, economic and financial aspects. Additionally, Zoomaal's experience illustrates both the potential and the challenges of crowdfunding in a region where financial alternatives remain underdeveloped. For a detailed discussion, readers may refer to the work of Qawariq and Andrade (2018).

Although Zoomaal was not exclusively focused on water-related projects, it served as a funding source for various sustainability-driven initiatives. Crowdfunding platforms, including Zoomaal, have been instrumental in supporting environmental and infrastructure projects. By allowing innovators and organizations to secure funding directly from the public, Zoomaal demonstrated the potential of crowdfunding to complement traditional financing methods in the water sector.

As a reward-based crowdfunding platform, Zoomaal played a significant role in Lebanon's alternative finance landscape. When first launched in Lebanon, in 2012, awareness was low, requiring the platform's team to actively recruit projects and educate potential fundraisers. Gradually, the acceptance and awareness of the platform has changed significantly and Zoomaal became a leading crowdfunding platform. Zoomaal faced significant challenges in the inception stage as it could not receive approval to collect credit card payments, so it had to use payment service provided in the USA (Stripe). This was challenging in terms of administration as well as due to upper limits in the transaction amounts and total value of payments. This first obstacle indicates the role of regulations in the uptake of novel financial tools.

An additional issue for Zoomaal was related to low credit card and mobile payments penetration in the region. In the period 2012-2018, Arab entrepreneurs and activists collected USD 1.7 million for 140 projects. Each project received, on average, USD 12,000 in support[245]. Lebanese initiatives accounted for one-third of all projects and received more than half of the total funds raised. Each Lebanese project received, on average, nearly USD 20,000, with several projects receiving up to USD 100,000. The projects regarded mainly areas in which there was low activity from the government of Lebanon. Despite Zoomaal being open and accessible in all regions in Lebanon, most of the projects came mainly from the capital, Beirut, suggesting that the socio-economic and ecosystem conditions play a part in innovation spur and interest in novel financial alternatives.

Other relevant factors include ICT penetration in Lebanon, access to networks, and social apprehension and acceptance of different financial mechanisms, especially in lower income and education segments of the society. Zoomaal experience provides further information on gender implications of crowdfunding. Lebanese women were very active on Zoomaal, starting more projects or NGOs than men (Qawariq and Andrade, 2018). Nevertheless, projects initiated by women have been funded with significantly lower, less than half, capital as compared to those raised by men. This can be indicative of gender disparities to access financial networks or to social trust to and acceptance of female entrepreneurship and management.

The experience with Zoomaal in Lebanon indicates the flexibility of novel financial alternatives that can reach to end-interested practices, without prior regulatory settings being in place. Nevertheless, the legal and regulatory vacuum that exists in many South Mediterranean countries may create obstacles at a later stage, when capital transfers and fund-raising increase in value. ICT penetration and IT literacy are important factors that determine the popularity of novel financing alternatives, thus if Mediterranean countries want to reap in full the benefits of new available instruments, they need to support IT literacy, network expansion and security. Capital availability seems not to be a manageable issue in the case where mechanisms such as crowdfunding are in place, as bringing together many small lenders to support a greater idea which they collectively believe in, may yield results in terms of raising the necessary investment capital. In this case the weight is on the applicant site which must make a very good and convincing presentation of his/her project case. Overall, the case of Zoomaal in Lebanon shows that the uptake and utilization of financial innovations is related to several factors such as ICT penetration, regulatory conditions, economic, financial and technological.

While crowdfunding may not be the primary tool for financing large scale water infrastructure, it has significant possibilities for smaller scale water projects, particularly in decentralized and community-based settings. Crowdfunding can finance pilot projects, awareness campaigns, research initiatives, and local water solutions that might not otherwise attract investment from traditional sources. Crowdfunding also serves as a testing ground for innovation, where projects can gain visibility and credibility, which can later attract institutional funding.

245 https://giswatch.org/en/country-report/economic-social-and-cultural-rights-escrs/lebanon

3.4 Alternative Financing Case Studies for Water Innovation

To address increasing water demand and environmental concerns, Egypt employed a public private partnership model to build the New Cairo Wastewater Treatment Plant[246], the first of its kind in the country. The plant was financed through a 20-year-build operate transfer (BOT) agreement, where the private partner would finance, construct, and operate the plant. This has reduced the financial burden on the government while ensuring efficient service delivery. Wastewater treatment capacity has also significantly increased. As this is Egypt's first public private partnership project, initially the project faced significant governance issues, since there was no legal or regulatory structure to handle public private partnerships.

Green bonds are gaining traction in the investment world as a valid source of funding for projects that are environmentally friendly. Conservation of water is one sector in which green bonds have been successfully used. In 2017, the Mexico City Water Fund raised 9.5 million USD through the issuance of green bonds to maintain the city's water supply[247]. The funds raised were used to finance conservation activities such as reforestation and soil conservation in the city's watersheds. As a result, the project improved the water quality, increased water availability, and provided numerous benefits to local communities.

Chennai Metro Water Supply and Sewerage Board (CMWSSB) in India issued a 100 million USD green bond in 2019 to finance water supply and sewerage projects. The funds were invested in upgrading water supply infrastructure, reducing water losses, and enhancing the water supply system efficiency. The project provided clean drinking water for over one million people and improved the sanitation facilities within the city. The success of these projects is a result of the synergy between the public and private sectors, where resources and expertise are combined.

Bank lending is one of the most important financing mechanism for large scale water infrastructure developments. Financial institutions provide loans to governments, municipalities, and private entities to fund water facilities. In August 2024, the European Investment Bank (EIB) made its largest water financing in Jordan by approving a €400 million, 30-year loan to enhance the availability, security, and sustainability of water across the country. The financing will increase access to water supply, sanitation, and reduce water losses and thereby address Jordan's major water management concerns. In Lebanon, the central bank, Banque du Liban, established the Lebanese Environmental Action mechanism, enabling commercial banks to offer loans with very low interest rates for projects related to water efficiency. Eligible initiatives include wastewater treatment, rainwater harvesting, and the implementation of sustainable water fixtures.

Innovation competitions are also employed to finance innovative water management solutions. In 2021, the European Institute of Innovation and Technology selected 20 innovative companies that would combat water scarcity in Southern Europe, such as Greece, Spain, and Italy[248]. Competitors were eligible for prizes of up to €30,000 and the possibility of testing their solutions on end-user facilities. This initiative promoted viable, scalable innovations to address the water issues at the regional level. The #EYESONBLUE competition targeted[249] blue entrepreneurs in eight Southern Mediterranean countries: Algeria, Egypt, Jordan, Lebanon, Libya, Morocco, Palestine, and Tunisia. The competition aimed to identify and support the best projects targeting the water or the blue economy, providing recognition and resources.

3.5 Ranking of Financial Instruments

To further improve the evaluation of financing alternatives, a ranking of financial instruments has been created in addressing water sustainability issues and supporting different stakeholders in the Mediterranean. The ranking follows the key elements identified in the SWOT analysis as well as the existing literature in the topic. It includes different criteria, like ease of access, regulatory support, scalability, environmental impact, and investor appeal. The full ranking is presented in Table A1 in the appendix. The analysis presents

246 https://www.worldbank.org/en/programs/wicer/case-studies
247 https://fastercapital.com/topics/case-studies-of-successful-green-bond-projects.html

that public-private partnerships and blended finance score high in various dimensions, particularly in scalability, environmental impact, and investor appeal, making them effective tools for large-scale water innovation projects. Grants are also well-ranked due to high regulatory support and environmental impact, but with lower scalability. Crowdfunding and innovation competitions have high accessibility but low scalability and regulatory alignment. Meanwhile, green bonds and private equity are noted by high scalability but moderate to high investor participation and regulatory support.

4. CONCLUDING REMARKS AND RECOMMENDATIONS

This chapter aims at identifying the EU water policies of relevance to the Mediterranean and at discussing how they can serve sustainable water management in the region. Moreover, it identifies the novel financial instruments that can direct capital to much needed water innovations, discussing their advantages, shortcomings, challenges, and obstacles. The analysis shows that public-private partnerships, blended finance, and grants are promising for large-scale and long-term water management projects, due to their regulatory support, scalability, and environmental impact. Other instruments, such as crowdfunding and innovation competitions, offer opportunities for promoting small-scale innovations. Effectiveness depends mainly on country specific factors, including ICT penetration, regulatory support, and capital availability.

Based on the analysis, the following recommendations highlight some points of consideration for policy makers and different stakeholders in the Mediterranean region:

- Mediterranean countries should fund collaborative models of water management learning from the EU policies and directives. Multi-stakeholder platforms need to be established to exchange knowledge, enhance capacity, and act collectively. National or regional water innovation hubs can be designed to bring together government, private sector, researchers, and local communities to develop innovative water solutions. Public private partnerships can be used to drive co-investment in water projects, with the private sector providing technical expertise and finance and the public institutions giving regulatory support.
- Policies should leverage alternative financial mechanisms to support water innovation for sustainable water management and use. In this direction appropriate regulatory, legal, financial, social and technological frameworks need to be put in place. The creation of government-backed crowdfunding platforms for water infrastructure and innovation will ensure credibility and regulatory oversight. Identify water projects to be green bond-issuance eligible (e.g., modeled Egypt's sovereign green bond, which included water projects). In order to encourage water infrastructure and climate resilience sustainable investment, the countries of the Mediterranean should have a regional Green Bond Framework which will align with the EU Green Bond Standard. The EU Green Bond Standard is a framework introduced by the European Commission to set criteria for green bond issuance. It ensures that green bond proceeds are invested in EU Taxonomy compliant projects. Although some Mediterranean countries (like, Egypt and Morocco) have successfully issued green bonds, a regional framework would standardize practices, increase investor trust, and facilitate cross-border green investment in the Mediterranean. Regional institutions and governments need to collaborate to develop a Mediterranean Green Bond Framework that draws from EU Green Bond Standard principles.
- Additional supportive frameworks should be established to facilitate the financial instrument evaluation and alignment with sustainability goals. Into this direction the EU Taxonomy can provide valuable guidance in developing a clear classification system that ensures alignment with environmental goals.

248 https://www.eitfood.eu/news/the-european-institute-of-innovation-selects-20-innovative-companies-to-find-solutions-for-water-scarcity
249 https://switchmed.eu/news/eyesonblue-competition-2022

Mediterranean countries can harmonize their policies with the EU's criteria to encourage investment, requiring companies and financial institutions in the Mediterranean to disclose their water-related investments in alignment with the EU Taxonomy framework. Also, collaboration with the EU and other bodies to develop capacity building programs for policymakers and private sector actors to ensure effective implementation.

Sustainable water management in the Mediterranean calls for policy alignment and innovative financing instruments. Using a combination of traditional and innovative finance instruments and the adaptation of their application to suit local conditions, policymakers can enhance the resilience of water infrastructure, enhance innovation, and facilitate long-term environmental sustainability. The current work contributes a framework for future policymaking and research by emphasizing the need for integrated financial and policy strategies for sustainable water management.



Appendix

Financial Instrument	Ease of w Access	Regulatory Support	Scalability	Environmental Impact	Investor Appeal	Justification (based on SWOT analysis)
Grants	Moderate	High	Low	High	Low	The competitive and multi-step application process offers moderate levels of accessibility. Grants enable specific water innovation financing, specifically for sustainability initiatives. They are strongly aligned to regulation as well as environmental objectives but lack scalability as they are time and budget-dependent. Investor appeal is low because grants do not provide direct returns.
Bank Lending	Moderate	High	Moderate	Moderate	High	Bank lending provides structured financing with clear terms, making it predictable for borrowers. Regulatory support is strong, especially with institutions like the World Bank and EIB. Loan terms and interest rates restrict access, particularly to new water technology with longer repayment periods. Sustainability loans can enhance the environmental impact, but they are still a low percentage of overall bank lending.
Innovation Competitions	High	Moderate	Low	High	Moderate	Competitions promote creativity for water innovation, offering non-repayable funding to winners. However, funding is usually one time, making scalability low unless winners secure additional financing. Regulatory support is moderate as competition is normally arranged by NGOs, universities, or corporate sponsors. Environmental impact is high and investor appeal is moderate, with ideas usually needing additional validation before attracting private investors' attention.
Public-Private Partnerships	Moderate	High	High	High	High	Public-private partnerships involve both public and private finances, thus facilitating large-scale water projects. They are highly scalable and have strong regulatory frameworks. While environmental impact is high, there is a risk of private sector profit seeking over long-term sustainability. Investor attractiveness is high since in this case we have financial returns and risk sharing contracts.
Green Bonds	Low	Moderate	High	High	Moderate	Green bonds offer sustainable financing for water projects, attracting investors and ESG funds. They are very scalable but need robust regulatory framework and transparency to prevent greenwashing. High cost of issuance and low liquidity in certain mediterranean nations restrict ease of access. Global trends in ESG enhance investor appeal.
Blended Finance	Moderate	High	High	High	High	Blended finance uses funds from different sources and reduces risk for private investors. Blended finance can be maximized, but there should be coordination between stakeholders. There is high regulatory support since governments and international institutions favor blended finance. There is high investor appeal since it mitigates risk with public money and mobilizes institutional capital.
Private Equity	Low	Moderate	High	Moderate	High	Private equity funds water businesses and startups, making it highly scalable but difficult to access for early-stage innovators. Regulatory support is moderate, as investment is mainly profit driven. While investor appeal is high, Mediterranean political and economic instability can change investment.
Crowdfunding	High	Low	Low	Moderate	Low	Crowdfunding offers accessibility and global reach, making it an effective tool for small-scale water projects. Poor investor confidence, lack of regulatory support, and inapplicability to large infrastructure projects are drawbacks. The environmental impact is moderate as campaigns can support green projects, but inconsistent success rates. There are no guaranteed returns that attract investors.

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CHAPTER 7. GREEN BONDS AS A FINANCIAL INSTRUMENT FOR THE ENERGY TRANSITION: A FSAM APPROACH

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Abstract

Across the Mediterranean, countries are seeking ways to align financial systems with the urgent demands of the energy transition. This chapter explores how green bonds can serve as a lever for that shift, focusing on Türkiye as a case study with broader regional relevance. Using a Financially Social Accounting Matrix (FSAM), the analysis captures how green bond issuance affects sectoral linkages and the real economy. Findings show that green bonds contribute modestly to strengthening renewable sectors—such as wind energy—as their systemic impact is limited by regulatory gaps, fragmented financial markets, and low investor awareness. These constraints are shared across much of the Mediterranean, where green finance remains underdeveloped despite growing climate commitments. Strengthening regulatory clarity, investing in grid and renewable infrastructure, and building investor capacity could unlock greater impact—not just nationally, but regionally.

Résumé

Dans l'ensemble du pourtour méditerranéen, les pays cherchent à aligner leurs systèmes financiers sur les exigences urgentes de la transition énergétique. Ce chapitre examine comment les obligations vertes peuvent constituer un levier en ce sens, en prenant la Turquie comme étude de cas à portée régionale. En s'appuyant sur une matrice élargie de comptabilité sociale et financière (FSAM), l'analyse met en lumière les effets de l'émission d'obligations vertes sur les liens sectoriels et l'économie réelle. Les résultats montrent que ces instruments contribuent modestement au renforcement des secteurs des énergies renouvelables — notamment l'éolien — en raison de limites systémiques liées à des lacunes réglementaires, à la fragmentation des marchés financiers et à une faible sensibilisation des investisseurs. Ces contraintes sont partagées par de nombreux pays méditerranéens, où la finance verte reste encore peu développée malgré des engagements climatiques croissants. Un renforcement de la clarté réglementaire, des investissements accrus dans les infrastructures énergétiques – en particulier les réseaux et les capacités renouvelables – ainsi qu'un effort soutenu de montée en compétence des acteurs financiers pourraient considérablement accroître l'impact de ces instruments, tant au niveau national que régional.

1. INTRODUCTION

The evolution of green bonds over the last 15 years reflects a significant advancement in climate finance, marked by notable milestones and global growth. Initially introduced in 2007, green bonds have gained traction as an effective financial instrument to fund sustainable projects (Weber and Saravade 2019). By offering these bonds, issuers can attract investors focused on environmental sustainability, helping to mitigate climate change while ensuring financial returns. Key milestones include the establishment of green bond principles in 2014, which provided a framework for transparency and credibility in the market (Jaycocks 2019). In recent years, countries such as France and Germany have embraced green bonds to finance renewable energy projects, demonstrating the viability of this instrument as a tool for sustainable development (Bhutta et al. 2022). Additionally, the growth of green bonds has been particularly remarkable in emerging economies (E7), where opportunities and challenges for sustainable growth (Khan, Arora and Meena, 2025) are being navigated. Successful case studies include the pioneering issuance of sovereign green bonds in 2016, which attracted significant international interest (Rossitto 2021). In addition, corporate issuances from leading multinational companies have demonstrated growing participation and commitment to sustainability (Lebelle, Lajili Jarjir, and Sassi 2020). The ongoing financing of green bonds promises to further strengthen the transition to clean energy, positioning them as essential for promoting inclusive green growth (KNUTH 2018; FAY 2012).

Meanwhile, the emergence of green bonds in Türkiye marks a significant step toward sustainable financing, enabling the implementation of numerous environmental projects. Ay, Söylemez, and Güneş Ay (2023) highlight their importance in fostering a sustainable environment, while Güzhan and Ergun (2024) emphasize their role in advancing sustainable development goals. The literature further underscores that these instruments unlock essential funding for green initiatives, as demonstrated by Bhutta et al. (2022) and corroborated by Weber and Saravade (2019). In addition, əliyeva (2024) explores their integration within financial markets, correlating with the results of Nurgaliyeva et al. (2022) on their use in developing nations. Ultimately, research by Ning et al. (2023) reiterates that green bonds are essential for promoting energy efficiency and economic growth, highlighting their impact on Türkiye's environmental objectives.

2. GREEN BONDS AS A FINANCIAL INSTRUMENT OF TÜRKIYE'S ENERGY TRANSITION: OPPORTUNITIES AND CHALLENGES

Türkiye is an ideal case study for analyzing the economic impact of green bonds due to its ambitious sustainability goals and emerging role in green finance. The country has committed to significant progress in renewable energy, energy efficiency, and sustainable infrastructure as part of its alignment with global climate targets, such as the Paris Agreement. Green bonds have emerged as a key financial instrument in Türkiye's efforts to mobilize private capital for public sustainability objectives, funding projects like renewable energy, green buildings, and pollution prevention. As an emerging market economy, Türkiye faces unique challenges in balancing economic growth with environmental sustainability, making green bonds a critical tool for achieving its sustainable development goals (SDGs), particularly SDG 7 (Affordable and Clean Energy) and SDG 11 (Sustainable Cities and Communities).

Türkiye's energy transition is characterized by ambitious goals to increase the share of renewable energies in its energy mix, as is articulated in its national energy and mining policy frameworks. The Turkish government has set a target to reach 30% of its electricity production from renewable sources by 2030, supported by various strategic plans, including the 2010 Renewable Energy Law, which provides incentives to developers of renewable projects (Ministry of Energy and Natural Resources, 2021). This determination to shift towards sustainable energy production, results from several factors, particularly the need to diversify energy sources, reduce greenhouse gas emissions, and improve energy security amid fluctuating global fossil fuel prices. In this regard, financial instruments such as green bonds emerge as vital mechanisms to mobilize the capital necessary to implement these renewable energy projects effectively.

Green bonds emerged as a fundamental financial instrument in the mobilization of capital for renewable energy projects in Türkiye, showing increasing alignment with the country's energy transition goals. The emission of green bonds has increased significantly, driven by national and international investors who seek environmentally sustainable investment opportunities. This financial tool offers an innovative mechanism for funding renewable energy projects, thus playing a crucial role in Türkiye's ambition to diversify its energy portfolio and reduce fossil fuel dependence.

The importance of green bonds in Türkiye's financial landscape is underlined by their potential to attract a wider range of investors focused on environmentally friendly investment strategies. While the Turkish market is starting to align with global trends prioritizing sustainable finance, green bonds offer an important means of improving access to capital for renewable energy initiatives which could otherwise fight to achieve financing by traditional financing routes (ASLAN et al., 2021). Indeed, we can already see that the positive results of green bonds financing are aligned with national objectives to increase the participation of renewable energy in the power mix to 30% by 2030 (LIZA et al., 2024). In addition, the issue of green bonds can contribute to the development of a more robust green financing ecosystem within Türkiye, providing a platform to integrate environmental, social and governance (ESG) criteria in the process of investment decision-making.
As also discussed in other chapters of this report, research indicates that green bonds have been effective in plumbing back to various renewable energy initiatives, including solar, wind and biomass projects (LIZA et al., 2024). For example, the Turkish government and the private sector successfully used green bonds to finance the construction of large -scale solar farms, which contributed significantly to the country's renewable energy capacity. Between 2016 and 2023, Türkiye issued green bonds valued at approximately US $ 1.5 billion, with revenues for renewable energy projects and green infrastructure developments (TIWARI et al., 2024). This financial influx has made not only the execution of the project, but also technological advances in energy production methodologies, thus increasing the general standards of energy efficiency.

Despite their potential, the effective deployment of green bonds in Türkiye's energy transition faces a range of challenges. The absence of a robust regulatory structure makes it difficult to develop a cohesive market for green bonds in Türkiye. The efforts to establish clearer guidelines and incentives for the issuance of green bonds are essential for improving market attractiveness and accessibility (LIZA et al., 2024).

Another major challenge is the limited awareness and understanding of green financial instruments between broadcasters and potential investors. There is a persistent need for training initiatives aimed at educating stakeholders about the benefits and processes associated with the issuance of green bonds (TIWARI et al., 2024). The educational difference concerning the distinct characteristics of green bonds, associated with a limited marketing of issuers, indeed represents an obstacle to investment. Consequently, this can lead to a vicious circle where insufficient demand limits the issue of new green bonds, further stifling market growth.

In addition, maintaining investor confidence is a key challenge in attracting foreign investors in particular. Volatility in exchange rates and macroeconomic instability can pose risks for foreign investment in Türkiye's green bond market, further complicating the effectiveness of green securities as a financing mechanism. In addition, the lack of standard definitions and structures for what qualifies a project such as 'green' creates ambiguity, potentially leading to greenwashing and dilution of investors' confidence.

Addressing these challenges presents an opportunity for stakeholders, including the government, financial institutions and project developers, to collaborate in the promotion of an environment empowering green investment.

The intersection of green bonds and the energy transition of Türkiye highlights a critical link of opportunities and challenges in the rapid landscape of sustainable finance. As Türkiye seeks to meet renewable energy targets, the role of green bonds stands out as a significant contributor to the financial architecture supporting this transition, carrying implications not only for the domestic renewable sector but also for Türkiye's commitment to broad global climate goals (Wei et al., 2024).

The opportunities presented by green bonds in the Turkish financial scenario are promising.

As the global demand for sustainable investment continues to gain impetus, Türkiye has the potential to position itself as a regional center of green finance, attracting investments abroad. With institutional investors increasingly seeking to balance their portfolios with sustainable assets, the Turkish green bond market could serve as an attractive avenue to capitalize on this demand, supporting the country's renewable energy initiatives. Nevertheless, Türkiye will need to make efforts to harmonize regulations and standards with international green finance initiatives in order to unlock substantial investment potential from global institutional investors.

In addition, recent developments in Turkish policies have created a favorable environment for the issue of green bonds, with the introduction of a framework aimed at standardizing green financial products (Jiu et al., 2024). Especially, the development of a robust secondary market for green bonds also offers the opportunity to increase liquidity and attract a wider range of investors. The Turkish Capital Markets Board has made great strides to improve the regulatory framework that governs the issue and trading of green bonds, thus promoting an environment that could facilitate greater participation in renewable energy investments. As the liquidity improves, the perceived risk associated with green bonds can decrease, potentially bringing to lower loan costs for project developers. These strategic partnerships between the government,

financial institutions and private sector participants can improve market structure, leading to improved emission practices and expanding the range of available financial instruments (TIWARI et al., 2024). These various initiatives are essential to promote the trust of investors and potentially increase the volume of capital aimed at renewable energy projects.

Finally, a remarkable opportunity lies in the possible diversification of offers of green bonds. The unique geographical and climatic conditions of Türkiye have significant potential for various sources of renewable energy including solar energy, wind and hydroelectric. The issuance of green bonds specifically tailor -made for renewable energy projects can attract investments that turn to these different modalities of energy generation (Meo & Stankerski, 2024).

These different opportunities, aligned with the Turkish government's commitment to achieve net-zero emissions by 2053, therefore underline the strong potential of green bonds to catalyze Turkey's transition to a renewable energy panorama.

In our chapter, we also reviewed reports from banks, companies, and municipalities, primarily consisting of second-party opinions and issuer documentation related to sustainable finance frameworks for green and social bonds and loans. These reports evaluate alignment with established standards such as the Green Bond Principles (GBP), Social Bond Principles (SBP), Sustainability Bond Guidelines (SBG), Green Loan Principles (GLP), and Social Loan Principles (SLP). The entities assessed include companies like YEO Teknoloji, Limak Renewable Energy, Aydem Renewables, and Arçelik A.Ş.; banks such as Yapı Kredi, İşbank, and QNB; and municipalities like the Istanbul Metropolitan Municipality. The evaluations focus on the intended use of proceeds, project selection processes, management of funds, and reporting practices, as outlined in reports by the International Capital Market Association.

In summary, it appears that the Turkish green bond market, while developing, could considerably benefit from the lessons learned from the established G20 markets. The implementation of best practices in regulatory transparency, investor engagement and strategic integration into national policies will be crucial to overcome existing challenges and capitalize on the opportunities inherent in the financial landscape of renewable energy projects . The critical analysis of the role of green bonds in the energy transition of Türkiye underlines their double nature as facilitators of loans and renewable energy tools subject to regulatory, market and information challenges. As documented in various studies, green bonds have emerged as a significant financial mechanism aimed at mobilizing investments for eco-compatible projects, thus aligning the financial markets with the objectives of environmental sustainability (Akkemik et al., 2024; Sarabdeen et al., 2024). However, existing literature reveals that **the effectiveness of green bonds in Türkiye is not uniform and is influenced by a series of factors.** These challenges include a lack of standardization in the certification of green bonds, a limited awareness of the market between investors and the overall size and maturity of the financial market, which can hinder the wider adoption of green financing mechanisms (Yılmaz et al., 2023).



3. METHODOLOGY

To analyze the systemic role of green bonds in Türkiye's economy, we employ a **Financially Extended Social Accounting Matrix (FSAM)**. This methodology builds upon a core principle in economics: that all economic transactions are interconnected, and in a closed system, total incomes must equal total expenditures.

At its foundation, a Social Accounting Matrix (SAM) is a comprehensive, economy-wide framework that captures the flow of all economic transactions within a given year. It is organized in a square matrix format, where rows represent revenues and columns represent expenditures for each account. For instance, goods and services produced by firms (activities) are purchased by households (expenditures), while households provide labor to these firms (income). Each account's total income (row) should equal its total expenditure (column), reflecting the basic equilibrium condition of an economy (Piskin and Hannum, 2017).

The SAM framework includes various accounts: production activities, commodities, factors of production (e.g., labor and capital), institutional agents (households, firms, government), and capital accounts. This enables a detailed representation of real economic transactions and interdependencies.

The value added of using FSAM lies in its extension of the traditional SAM by integrating financial transactions and institutions, thereby capturing the interactions between the real economy and the financial sector. In our case, this allows for the explicit modeling of how green bonds operate as financial instruments within the economy—tracking the issuance, allocation, and investment of green bond proceeds, and analyzing their ripple effects across sectors.

The FSAM used in our analysis serves as the sole data source for modeling and evaluation. Its construction involved several key steps designed to ensure accuracy, sectoral relevance, and alignment with the real economic structure of Türkiye.

- We began by constructing a **SAM** based on Türkiye's 2012 input-output table, which is the most recent comprehensive table available. The original dataset includes 64 economic sectors; however, for the purposes of this study, we aggregated some sectors and disaggregated others to better reflect the role of energy in the economy. In particular, we disaggregated the electricity sector by energy source to isolate renewable energy dynamics. As a result, our SAM focuses on **17 key sectors**, including: agriculture, mining, manufacturing (with sub-sectors such as refined petroleum, chemicals, metallic/non-metallic products, and equipment manufacturing), various electricity sub-sectors (coal, gas, wind/renewables, and others), natural water and sewerage services, construction, trade, transportation, and services. Notably, wind energy was used as a proxy for renewables due to the lack of available solar data in the GTAP database.
- To reflect recent economic developments, the SAM was calibrated to reflect the structure of the Turkish economy in 2022. This update drew on the most recent institutional accounts and macroeconomic aggregates published by the Turkish Statistical Institute (TÜİK), complemented by sectoral shares and adjustments based on data from the Global Trade Analysis Project (GTAP). The calibration process involved aligning key economic flows—such as private and government consumption, gross fixed capital formation, and trade with the rest of the world—with 2022 benchmarks. This ensured that the updated SAM not only captured the relative sectoral composition but also accurately reflected the scale and structure of the contemporary Turkish economy.
- Following this, we incorporated financial accounts using 2022 data on financial assets and liabilities, obtained from the official website of the Central Bank of Türkiye. This step allowed us to extend the SAM into a FSAM by linking the real economy with financial flows, setting the stage for analyzing the transmission channels of green finance.
- Finally, we integrated green bond issuance data into the FSAM. The data were sourced from the official website of the Turkish Ministry of Climate Change and Environment, covering issuances from the first green bond in 2016 to October 2022. For the purposes of this analysis, we included the two most recent green bond issuances from 2022, enabling us to evaluate their systemic impact within a fully articulated FSAM framework.

Issue date	Amount (million)	Currency	Maturity	Type	Issuer
07.12.2016	288	EURO	20 years	Green Bond	Rönesans Sağlık Yatırım
17.08.2017	400	TL	4 years 3 months	Green Bond	YDA İnşaat
05.05.2020	50	TL	1 year	Sustainable Lease Certificate	Zorlu Enerji
17.08.2020	100.5	TL	2 years	Green Bond	Vestel
10.05.2021	350	EURO	5 years	Green Bond	Arçelik
27.08.2021	750	USD	5.5 years	Green Bond	Aydem Yenilebilir Enerji
15.11.2021	250	TL	2 years	"Transition to low-carbon economy" themed	Palen Enerji
17.12.2021	133.5	TL	1 year	Sustainable Lease Certificate	YEDAŞ
21.01.2022	500	USD	7 years	Sustainability-Index Bond	Coca Cola
21.10.2022	1500	TL	728 days	Green Bond	Enerjisa

TABLE 1
Corporate Bond Issuance

We can see below the summary of our FSAM after including all the data and balancing the expenditures and incomes for each account:

	Activities	Commodities	Labor	Capital	HH	Gov	ROW	Capital accumulation	Financial accounts	Total
Activities		32 023 115 715								32 023 115 715
Commo-dities	18 404 606 558				8 603 034 452	1 749 354 204	5 792 173 995	4 970 927 663		39 520 096 870
Labor	3 540 154 218									3 540 154 218
Capital	9 993 655 772									9 993 655 772
HH			3 540 154 218	9 993 655 772		440 617 624,9				13 974 427 614
Gov	84 699 167,59	1 104 077 119			1 001 195 542					2 189 971 829
ROW		6 392 904 037						6 011 786 902	5 068 378 581	1 747 306 9520
Capital accumu-lation					4 370 197 620		600 730 042,2		55 752 024 170	60 722 951 833
Financial accounts							11 080 165 483	49 740 237 268		60 820 402 751
Total	32 023 115 715	39 520 096 870	3 540 154 218	9 993 655 772	13 974 427 614	2 189 971 829	1 747 306 9520	60 722 951 833	60 820 402 751	

TABLE 2

Financially extended social accounting matrix of Türkiye 2022

The study employs a multi-layered analytical approach to evaluate Türkiye's energy transition dynamics and the systemic role of green bonds. Below is a breakdown of the core components:

3.1 Backward and Forward Linkage Analysis: Mapping Economic Interdependence

Our first step is to understand how sectors are interconnected within the economy. To do this, we rely on what is known as linkage analysis, which measures how much a given sector depends on other sectors (its suppliers) and how much other sectors depend on it (its role as a supplier).

Sectors with strong **backward linkages (BL**) are those that require a large amount of inputs from other industries in order to function—such as manufacturing, which depends on raw materials, energy, and logistics. A high BL (greater than 1) means the sector is highly dependent on a broad supply network—this reflects a **demand-pull effect.** In contrast, sectors with strong **forward linkages (FL)** provide key inputs to many other industries, making them vital to the downstream production of goods and services—such as the electricity sector, which powers virtually all economic activity. A high FL (greater than 1) highlights a **supply-push effect,** showing systemic importance for downstream production.

This analysis helps us classify sectors into three strategic categories. Some sectors show both strong backward and forward linkages (identified when **BL + FL > 3**), meaning they are critical both in terms of their demand for inputs and their supply to other sectors. These are labeled as "key sectors" because of their central position in the economy. Others may have strong backward linkages but weak forward ones, indicating that they are more reliant on others than others are on them—these we term "demand-driven". Conversely, some sectors may have strong forward linkages but weak backward ones—"bottleneck sectors"—meaning they play a crucial role in enabling the rest of the economy to function, even though they rely on few inputs themselves. This classification is particularly helpful for understanding which parts of the economy are most sensitive to changes in policy or investment, especially in relation to energy and green finance.

3.2 Social Accounting Matrix (SAM) vs. Financially Extended SAM (FSAM)

To systematically capture these relationships across the economy, we use a SAM, which as explained above is a detailed, square matrix that records all the transactions in an economy over a given year. It includes households, firms, government, and foreign trade, showing who produces what, who consumes what, and how income flows among different actors.

However, a standard SAM only includes real economic flows—it tells us what is produced and consumed, but not how these activities are financed. To address this limitation, we construct the FSAM, which goes a step further by incorporating financial flows such as credit, savings, and bond issuance. This allows us to analyze not only the structure of the real economy but also how access to finance—or the lack thereof—affects the ability of sectors to grow and respond to investment.

The **comparison between the SAM and FSAM is revealing.** While the SAM shows the theoretical potential of the economy if financing were unconstrained, the FSAM reflects a more realistic picture by intro-

ducing liquidity constraints, funding bottlenecks, and the actual structure of financial intermediation. This is especially important in the case of renewable energy, which often requires significant upfront investment and may suffer from limited access to capital markets. In many cases, we observe that multipliers—indicators of how much an economic shock or investment in one sector stimulates the rest of the economy—are significantly lower in the FSAM than in the SAM. This means that financial frictions are holding back sectoral performance, especially in capital-intensive or emerging industries like green energy.

3.3 Hypothetical Extraction Method (HEM): Measuring the Cost of Sectoral Absence

To further understand the importance of each sector, we apply the Hypothetical Extraction Method (HEM). This technique asks a simple but powerful question: what would happen to the economy if a particular sector were removed? By simulating the complete removal of a sector and calculating the resulting change in total output, we can assess how critical that sector is to overall economic functioning. If removing a sector leads to a substantial decline in total economic activity, it is clearly a cornerstone of the economy. Conversely, if its removal actually improves efficiency or increases output, it may be playing a negative or extractive role.

This method provides a unique ranking of sectors based not just on their size or output, but on their structural contribution to the economy. In the context of the energy transition, HEM helps us identify which sectors should be prioritized for investment and protection, and which may need to be restructured or phased out as part of a just and sustainable transition.

3.4 Green Bond Integration in FSAM

To The final step of our analysis is to simulate the role of **green bonds** within the FSAM. Green bonds are a type of financial instrument specifically designed to raise capital for environmentally beneficial projects, such as renewable energy infrastructure. But their effectiveness depends on how they are integrated into the broader economy. We construct two scenarios. In the first, green bonds are **endogenously distributed**—that is, they are treated as part of the internal financial system and channeled toward specific renewable energy sectors. This allows us to trace how the proceeds of green bonds circulate through the economy, affecting output, employment, and inter-sectoral dynamics. In the second scenario, green bonds are treated as exogenous injections, meaning they exist outside the core financial system. This isolates their impact and allows us to understand their stand-alone value.

By comparing these two scenarios, we can test how effective green bonds are in overcoming financial bottlenecks and promoting renewable energy integration. The results also show whether green bonds serve as a meaningful tool for policy action, or if they remain largely symbolic without deeper financial sector reforms.

This integrated approach brings together economic theory, structural analysis, and financial modeling in a way that provides actionable insights. Linkage analysis helps identify where interventions would be most effective. The comparison between SAM and FSAM highlights the real-world limitations imposed by financial markets. HEM provides a ranking of sectoral importance that goes beyond simple economic output. And the green bond simulations offer a forward-looking test of how sustainable finance instruments can support national energy and development goals. Altogether,

this framework offers a powerful toolkit for understanding Türkiye's energy transition, revealing both the economic interdependencies and the financial pathways that must be navigated to make the green shift successful.

3.5 Understanding the Limitations of the Analytical Framework: Prerequisite for Results Interpretation

Before delving into the results of FSAM, it is important to openly acknowledge its limitations. This transparency helps ensure the robustness of any conclusions drawn, while recognizing that FSAM remains a valuable analytical tool when used appropriately.

Firstly, FSAM is based on an accounting equilibrium (incomes = expenses), which assumes a closed, stable economy. It therefore does not consider cyclical imbalances, financial shocks or dynamic phenomena such as crises, speculative bubbles and so on.

It should also be borne in mind that FSAM describes a static snapshot of the economy in a given year. This limitation can lead to an overestimation of immediate effects and may overlook the structural inertia, especially in green investments. Furthermore, the 2022 data are derived by updating 2012 figures using TÜİK and GTAP data, which might not fully represent the actual economic conditions in Turkey in 2022. As a result, this perspective may miss some industrial transformations that Turkey has undergone, and therefore may not accurately reflect the independence of certain sectors.

Moreover, multiplier analyses, such as the Hypothetical Extraction Method, assume that the marginal effect of an investment is constant, which leads to linearity of effects and may exaggerate or underestimate the real impact if thresholds or diminishing returns exist.

It should also be noted that FSAM does not infer causal relationships per se. It is not an econometric or dynamic model: it is an accounting tool. The effects observed are potential, structural, but not necessarily effective. For example, if a multiplier is high in a sector, this does not systematically mean that green investments in this sector will generate this effect in reality, especially in the presence of frictions or rigidities.

As regards the definition of the various sectors, a number of points need to be borne in mind. Firstly, the aggregation of certain sectors that has been decided upon could in some cases mask the heterogeneity of the sectors. Also, the lack of data on solar energy, which led to the use of the wind energy sector alone as a proxy for all renewable energies, may bias the conclusions, especially in a country like Türkiye where solar energy is a fast-growing sector.

Finally, the behavior of financial agents is complex and subject to numerous influences that cannot be taken into account by an FSAM, unlike a Computable General Equilibrium, for example. Analyses of the precise transmission mechanisms of green finance, including the impact of Green Bonds, may therefore be limited in detail. Furthermore, FSAM does not directly capture positive or negative environmental externalities, potentially biasing conclusions on the social effects of integrating green bonds into the matrix.

Even so, FSAM is an excellent structural modeling tool, but its results should be interpreted as indicative orders of magnitude rather than firm predictions. They are sensitive to assumptions, matrix construction choices, data quality and the absence of temporal dynamics. It is a tool for systemic understanding, but caution should be exercised when using it to make predictions or identify causality. The conclusions drawn from the FSAM model must therefore be interpreted in the light of the elements highlighted in the literature review.



4. FINDINGS

4.1 Backward and Forward Linkages: Strategic Sector Identification

Electricity Gas: The Economic Linchpin

The **electricity gas** sector stands out due to its significant role in both backward and forward linkages. With a **BL of 1.653** and a **FL of 1.420**, it has a combined BL+FL of **3.073**, which places it in the «Key Sector» category.

- **Backward Linkages (Demand-pull):** Electricity gas has a high demand for inputs, particularly from industries like natural gas infrastructure and manufacturing. Around 23% of its inputs come from the manufacturing sector, showing its reliance on upstream industries.
- **Forward Linkages (Supply-push):** This sector also plays a crucial role in supplying energy to downstream industries.

It provides about 42% of the inputs required by the construction sector. This reflects its central role in driving urbanization, industrial growth, and infrastructure development, making it vital to the broader economy.

Given that electricity gas contributes to **35% of Türkiye's electricity generation**, its dual role as both a major consumer of inputs and a major supplier makes it an economic linchpin. Any disruption or shift in this sector could have widespread effects across many industries.

Electricity Wind: Potential vs. Realized Impact

The **electricity wind** sector presents an interesting case. It has a **high BL of 1.503**, indicating that it depends significantly on foreign inputs like turbines and maintenance services. This shows Türkiye's reliance on imported technology and expertise for its wind energy sector.

However, its **FL of 0.340** is relatively low, meaning that despite its importance in energy generation, it has limited integration with downstream industries. It doesn't have the same systemic impact as sectors like electricity gas, even though policy has prioritized wind energy as a part of Türkiye's renewable energy strategy. This sector's limited integration into the economy results in a lower economic multiplier, meaning the overall economic impact of wind energy investment is more contained compared to other sectors.

Services: A Bottleneck Sector

The services sector plays a critical role in the economy, with a **FL of 3.652**, which signifies that many sectors depend heavily on services like trade, transportation, and logistics. However, it has a relatively low **BL of 1.185**, meaning that while it is crucial for downstream economic activity, it doesn't rely as much on upstream industries. This makes it a **bottleneck sector.**

This sector's role as a bottleneck means it is essential for enabling economic activity in other sectors, but it suffers from underinvestment in areas that could drive renewable energy growth, such as smart grids, clean technology services, and renewable energy infrastructure. Without addressing these gaps, the services sector could limit the overall success of Türkiye's transition to a more sustainable energy system.

In a nutshell, one could say that to support Türkiye's energy transition, it is crucial to prioritize the modernization of the energy grid to enhance the integration of wind energy, increasing its economic impact. At the same time, maintaining the existing gas infrastructure might be necessary to ensure a stable energy supply during the transition period.

Sector	BL	Economic implication
Electricity gas	1.653	Drives metallic manufacturing (+24% demand)
Electricity coal	0.695	Limited supply chain integration
Equipment manufacturing	0.752	Subordinate to energy sector needs

TABLE 3
Key BL patterns

Sector	FL	Economic implication
Electricity gas	1.42	42% of construction sector inputs
Electricity wind	0.34	Limited integration beyond direct power supply

TABLE 4
Notable FL relationships

4.2 Financial Constraints: SAM vs. FSAM Multiplier Analysis

The analysis of output multipliers reveals the economic ripple effects generated by demand increases in various sectors. These multipliers capture both direct and indirect effects, with higher values indicating sectors that are more integrated into the broader economy and capable of driving greater economic activity. In the SAM, which assumes no financial constraints, the following sectors stand out:

- **Electricity Gas (5.87)**: This sector has the highest multiplier, reflecting its pivotal role both as a major consumer of inputs (demand-pull) and as a key supplier to the construction sector (supply-push). Its dominance in Türkiye's energy mix (35% of electricity generation) reinforces its economic importance.
- **Electricity Wind (5.70):** Despite being a renewable energy source, wind energy shows a surprisingly high multiplier, driven by strong backward linkages (such as imported turbines and maintenance services). However, its weak forward linkages (FL=0.340) limit its broader economic impact.
- **Services (4.96):** Services depend heavily on trade and transportation but lack sufficient renewable-linked services, such as smart grids, to capitalize on future growth.

- **Agriculture (4.45):** Agriculture shows solid integration with the rural economy, though it remains constrained by low-value-added activities.

When considering the **FSAM,** which accounts for capital market imperfections, the multipliers decrease by about 25-30% on average. This reduction reflects the constraints imposed by financial frictions, limiting the ability of sectors like wind energy to fully capitalize on their potential.

Sector	SAM	FSAM	Decline	Economic implication
Electricity gas	5.87	4.87	-17%	Reduced fuel supply chain integration
Electricity wind	5.7	4.44	-22.1%	Financing hurdles for renewables
Agriculture	4.45	3.12	-29.8%	Credit constraints in rural economy
Manufacturing	4.56	3.41	-25.2%	Capital-intensive production limits
Services	4.96	3.49	-29.6%	Liquidity constraints in service chains

TABLE 5
SAM vs FSAM Comparison

The FSAM analysis reveals several critical insights regarding Türkiye's energy transition. Financial frictions in the capital markets hinder growth potential in sectors such as wind energy. In this context, wind energy's FSAM multiplier (4.44) is lower than that of coal (4.87), highlighting the difficulty wind energy faces in competing despite being more environmentally friendly. This gap can be attributed to the limited financial integration of the sector.

Türkiye's renewable energy target of 30% is at risk due to weak financial integration, particularly in the wind energy sector. The low forward linkage (FL=0.340) of wind energy in the FSAM indicates that it struggles to connect with downstream industries, which impedes its ability to drive broader economic growth. This structural weakness may reflect not only a possible policy-implementation gap, one that could delay the achievement of Türkiye's renewable energy objectives, but also the intrinsic intermittency of wind power, which limits its reliability as a consistent energy input for other sectors.

Additionally, the services sector shows a significant decline in its multiplier (-29.6%), reflecting its vulnerability to financial constraints. This decline is primarily due to the sector's reliance on capital markets that are not fluid enough to support growth.

From a strategic perspective, it is crucial to maintain focus on electricity gas infrastructure during the transition, as it remains a cornerstone of Türkiye's economic stability.

However, modernization efforts are necessary to reduce dependence on imports. To support the growth of wind energy, addressing the financial barriers, such as introducing green bonds, would be beneficial in improving its forward linkages and economic multiplier. Moreover, the phase-out of coal should be managed in a way that redirects savings toward renewable energy projects and grid modernization, ensuring a smoother transition.

The contrast between SAM and FSAM highlights the urgent need to align Türkiye's financial systems with its energy transition objectives, thereby enabling the full potential of renewable energy to be realized.

4.3 Hypothetical Extraction Method (HEM)

The Hypothetical Extraction Method (HEM) helps assess the systemic importance of different sectors by simulating their removal and quantifying the economic impact. The analysis uses an impact score formula to rank energy sectors based on their importance in Türkiye's economy. The impact score is calculated by comparing the difference between the original FSAM multiplier and the FSAM multiplier after removing a sector, then expressing it as a percentage of the original FSAM multiplier.

$$Impact\ score = \left(\frac{Original\ FSAM\ multiplier - Post\ HEM\ FSAM\ multiplier}{Original\ FSAM\ multiplier}\right)*100$$

A positive Impact score (IS) means that the withdrawal of a sector has a negative impact on overall economic activity, the higher the IS, the greater the impact. Conversely, a negative IS means that the withdrawal of the sector has a positive impact on overall economic activity.

Rank	Sector	Impact score	Systemic role
1	Electricity gas	+18.7%	Core energy hub with dual linkages
2	Electricity other	+17.1%	Renewable backbone for services
3	Electricity wind	+0.8%	Policy-prioritized but low linkage
4	Electricity coal	-28.7%	Inefficient sector with net drag

TABLE 6
Sector ranking by importance

The results highlight significant variations in the energy sectors' economic importance:

Electricity Gas: The Economic Linchpin

The removal of Electricity Gas results in an 18.7% output loss, underlining its central role in the economy. With a backward linkage (BL) of 1.653, the sector drives demand for upstream industries, particularly manufacturing, where it supplies 23% of energy inputs for machinery and chemical production. Additionally, its forward linkage (FL) of 1.420 positions it as a key supplier to downstream sectors like construction, which depends on gas for 42% of its energy needs. This dual function creates a multiplier effect: gas infrastructure investments stimulate metallurgical and pipeline manufacturing (BL), while its energy output drives urbanization and industrial growth (FL). This strategic importance is closely linked to Türkiye's reliance on gas for 35% of electricity generation. However, this entrenched reliance on gas poses challenges for transitioning to renewable energy sources, as it risks carbon lock-in. Policymakers must carefully balance the short-term economic necessity of gas with the long-term goal of decarbonization.

Electricity Other (Hydro/Geothermal): The Silent Enabler

Electricity Other (hydropower and geothermal) reveals a 17.1% output loss when hypothetically removed, highlighting its often overlooked importance. With a FL of 1.491, this sector is vital for trade and services, supplying 15% of transportation energy and 12% of commercial sector inputs. Its BL of 1.545 reflects its dependence on equipment manufacturing for turbines and grid components, which supports regional employment. Despite not being as politically visible as gas or wind, its stability—particularly geothermal's 90% capacity factor—ensures grid reliability and mitigates the intermittency of renewable energy. However, the decline in its FSAM multiplier signals underinvestment in modernization. To better support Türkiye's 30% renewable target, strategic upgrades could enhance its FL, particularly by connecting geothermal plants to district heating networks.

Electricity Wind: High Potential, Low Integration

The marginal 0.8% output loss from removing wind energy points to structural bottlenecks that limit its impact. Although it has a strong BL of 1.503, largely due to imports of turbines and maintenance services, its FL is much weaker at 0.340, reflecting limited downstream integration. This is partly due to grid limitations: 38% of wind farms in Türkiye face curtailment during peak production because of transmission bottlenecks. While the SAM multiplier suggests wind's theoretical importance, financial constraints reduce its FSAM multiplier to 4.44, which is lower than coal's (4.87). To meet national renewable energy targets, Türkiye needs to address three key barriers: modernizing the grid to connect Aegean wind clusters to industrial zones (and more generally promote the integration of wind farms into the national power grid), incentivizing domestic turbine production to reduce import reliance, and deploying storage systems such as batteries, mechanical storage or hydrogen storage to stabilize supply.

Electricity Coal: The Inefficiency Drag

The removal of coal results in a significant 28.7% output gain, demonstrating its inefficiency. With a BL of 0.695 and FL of 0.757, coal has limited integration into supply chains, contributing only 12% of mining sector outputs to coal plants, compared to 23%

for gas. Its low productivity (45% average capacity factor vs. 85% for gas) and high emissions intensity (950 gCO2/kWh vs. 450 for gas) make it an economic liability. Phasing out coal could free up $750 million per year in subsidies that could be redirected to renewable energy projects. The negative HEM score supports Türkiye's plan to phase out 5 GW of coal capacity by 2030.

Policy Insights

Based on the analysis, several key policy actions can be taken:

- **Gas:** It remains a crucial transition fuel, but carbon pricing could be implemented to incentivize greater efficiency and accelerate the move towards cleaner energy.
- **Wind:** Focus on grid modernization and local content rules to boost wind energy's FL from 0.34 to over 1.0, ensuring better integration into the economy.
- **Coal:** Savings from the coal phase-out should be directed towards worker retraining programs and establishing renewable energy industrial zones to ensure a just transition.
- **Hydro/Geothermal:** Expanding capacity in Eastern Anatolia can help balance regional disparities and ensure that geothermal and hydropower contribute more to the renewable energy mix.

These steps would align the findings from the HEM analysis with Türkiye's 2053 net-zero roadmap, shifting the energy sector from a fossil-fuel-based system to one driven by renewable energy.

4.4 Green Bond Integration: Limited Efficacy and Structural Barriers

The integration of green bonds into the FSAM highlights the potential of green bonds to support renewable energy projects, but the results also reveal significant limitations. While green bonds are designed to fund renewable energy initiatives and strengthen sectoral linkages, the analysis shows that their impact on Türkiye's energy sectors is relatively small due to underlying structural barriers and inefficiencies.

Forward Linkage (FL) Improvements

For wind energy, the forward linkage (FL) increased slightly from 0.340 to 0.342 after the introduction of green bonds. While this change represents a modest improvement in wind energy's integration into downstream sectors, it is still far lower than the FL for gas (1.420). This indicates that wind energy remains limited in its ability to serve as a critical input for industries like manufacturing or services. The small increase in FL suggests that green bonds alone cannot overcome structural challenges, such as grid bottlenecks and inadequate storage solutions for intermittent renewable energy. Unless these barriers are addressed, wind energy will continue to face difficulties in contributing meaningfully to downstream sectors.

Backward Linkage (BL) Adjustments

In equipment manufacturing, the backward linkage (BL) improved marginally by 0.001, reflecting a slight increase in demand for upstream inputs like turbines and renewable energy components. However, this minimal change indicates that green bonds have a limited effect on stimulating local supply chains for renewable energy technologies. Türkiye's dependence on imported components for wind and solar projects restricts the ability of green bonds to significantly boost domestic economic activity in these sectors.

Sectoral Multiplier Effects

The introduction of green bonds had minimal effects on the FSAM multipliers across sectors:

- **Electricity Gas:** The multiplier increased from 4.868 to 4.869.
- **Electricity Wind:** The multiplier rose from 4.440 to 4.441.

These negligible changes highlight the challenges in translating green bond financing into substantial economic impacts. While green bonds provide targeted funding for renewable energy projects, their effectiveness is hindered by broader financial market inefficiencies and regulatory gaps, limiting their ability to generate meaningful economic growth.

Coal Sector Unchanged

The multipliers for coal remained unchanged at 2.046, consistent with its negative hypothetical extraction score, which showed a 28.7% output gain from phasing out coal. This reflects coal's inefficiency and reinforces the rationale for its phase-out. The lack of impact on coal further emphasizes the disconnect between green bond allocations and efforts to reduce fossil fuel dependency. Redirecting green bond proceeds toward renewable infrastructure could not only accelerate the phase-out of coal but also strengthen the linkages within the renewable energy sector, driving more sustainable economic growth.

Sector	FSAM multiplier	FSAM/Bonds multiplier	Absolute change	% change	Policy priority
Electricity gas	4.868	4.869	+0.001	+0.02%	Medium
Electricity wind	4.44	4.441	+0.001	+0.02%	High
Electricity coal	2.046	2.046	0.000	0%	Phase-out
Electricity other	4.548	4.549	+0.001	+0.02%	Medium-high

TABLE 7
Green bonds sectoral impact comparison

5. CONCLUSION

The The analysis of Türkiye's energy sectors using the FSAM and the HEM provides critical insights into the systemic importance of energy sectors, the impact of green bonds, and the challenges in implementing sustainable finance mechanisms.

Electricity Gas emerges as the most strategic sector with the highest backward and forward linkage. Its removal results in an estimated 18.7% output loss, confirming its critical role in driving demand for upstream industries (e.g., metallic manufacturing) and supplying inputs to downstream sectors like construction. However, Electricity Wind, despite its high backward linkage, has a weak forward linkage, limiting its systemic importance. The findings align with Türkiye's energy transition goals as articulated in the National Energy Plan 2023, which prio-

ritizes renewable energy development but highlights structural challenges in integrating wind energy into broader economic linkages.

The FSAM results reveal that financial constraints significantly reduce output multipliers across all sectors, with an average decline of 25-30%. For example :

- Electricity Gas multiplier drops from 5.87 (SAM) to 4.87 (FSAM), reflecting reduced financial system integration.
- Electricity Wind experiences a steeper decline, from 5.70 to 4.44 (-22%), highlighting financing hurdles for renewables.

This pattern underscores capital market imperfections, consistent with findings from Demir et al. (2022), which identified liquidity constraints as a major barrier to sustainable financing in emerging economies.

Meanwhile, the HEM results rank energy sectors based on their systemic importance:

- Electricity Gas: Most critical (+18.7% output loss upon extraction).
- Electricity Other: Second (+17.1%), driven by strong FL supporting services and trade.
- Electricity Wind: Minimal impact (+0.8%), reflecting weak downstream integration despite policy prioritization.
- Electricity Coal: Negative impact (-28.7% output gain), confirming its inefficiency and alignment with phase-out commitments.

These rankings highlight the need to balance economic realities with policy objectives, particularly in transitioning away from coal while strengthening renewable energy integration.

Finally, green bonds show marginal improvements across sectors, with multiplier increases of +0.001 for Electricity Gas, Wind, and Other under FSAM/Bonds scenarios:

- Forward Linkage for wind increases slightly from 0.340 to 0.342, but remains insufficient to drive systemic change.
- Coal multipliers remain unchanged, aligning with phase-out commitments.

The limited impact of green bonds reflects challenges in their implementation, including regulatory fragmentation and the lack of standardized criteria for green project qualification, as discussed by Weber & Saravade (2019).

6. CHALLENGES AND POLICY RECOMMENDATIONS

Despite growing interest in green bonds as a tool to finance sustainable development, their effective deployment remains constrained by several obstacles. Understanding the challenges faced is key to aligning them with national and regional climate goals.

Challenges in Implementing Green Bonds

Despite Several key challenges may hinder the effective implementation of green bonds. The first of these is regulatory barriers. The lack of standardized definitions for green projects creates significant uncertainty, which discourages investor confidence and raises the risk of greenwashing. Without clear criteria, projects may be falsely marketed as environmentally sustainable, undermining the credibility of green bonds and hampering market growth (Demir et al., 2022).

Another challenge is market fragmentation. Türkiye's green bond market has relatively limited liquidity, which restricts the participa-

tion of a broad range of investors. This lack of liquidity also prevents the development of a secondary market, stifling the growth of green bond issuance. As a result, green bonds are unable to attract the broad investor base needed to scale up investments in renewable energy (Liza et al., 2024).

Last but not least, low awareness among local investors also poses a significant hurdle. Many investors lack understanding of the benefits that green bonds offer, limiting demand and stifling the potential for growth in the market. Without increased investor education, green bonds will continue to struggle in gaining traction (Rehman et al., 2024).

Role of the National Energy Plan 2023

The National Energy Plan 2023 of Türkiye can provide a structured approach to addressing these challenges. It outlines strategies to facilitate the integration of green bonds into the country's energy transition. One of the Plan's key focuses is grid modernization, which is essential to better accommodate renewable energy. Improving the forward linkage of sectors like wind energy is a priority, as these sectors currently face challenges connecting to downstream industries.

Another critical aspect of the National Energy Plan is the development of a Green Taxonomy. This initiative aims to establish clearer guidelines for green bond issuance, providing a standardized framework for classifying green projects. By enhancing transparency and building investor trust, this framework would facilitate the growth of green finance in Türkiye (Ministry of Treasury, 2024).

Additionally, the Plan acknowledges the savings from phasing out coal, which can be redirected toward funding renewable energy integration projects. This strategy is part of a broader effort to accelerate the transition from fossil fuels to clean energy, aligning with Türkiye's decarbonization goals.

Final Insights

The Mediterranean region stands at a pivotal point in advancing its energy transition and sustainable finance agenda. Countries like Türkiye, which have set ambitious goals—such as reaching 30% renewable electricity by 2030 and net-zero emissions by 2053—can offer useful insights for peers facing comparable challenges.
Green bonds represent a promising financing mechanism for clean energy and nature-based solutions, yet their deployment across the region remains constrained by regulatory uncertainties and underdeveloped market structures. Strengthening legal frameworks, establishing clear definitions for green investments, and enhancing transparency could collectively improve investor confidence and reduce the risk of greenwashing.

Targeted investments in grid modernization and renewable energy integration—especially for solar and wind—are equally important. These efforts, supported by greater investor awareness, could help build the foundations of a more robust green finance market across the Mediterranean. As national strategies evolve, individual progress—if supported by sound governance and implementation—can contribute meaningfully to shared regional objectives.

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TABLE 8
Output multipliers

		No HE hypothetical extraction			HE coal		HE gas		HE wind		HE other	
		SAM	FSAM	FSAM / bonds	FSAM	FSAM / bonds	FSAM	FSAM / bonds	FSAM	FSAM / bonds	FSAM	FSAM / bonds
output multipliers	Agriculture	4,4458355	3,12232904	3,12248012	3,16824125	3,1683975	3,06452797	3,06467739	3,11916391	3,11931483	3,0664165	3,06656469
	Mining	1,08458835	0,77380378	0,77383926	0,78937761	0,7894146	0,75308909	0,75312426	0,77266646	0,77270189	0,7537342	0,75376893
	Manufacturing	4,56128394	3,40890797	3,40903951	3,46482727	3,46496418	3,34224017	3,34237052	3,40525252	3,40538392	3,34467043	3,34479928
	Refined petro-lium	1,05730752	0,8647978	0,86481978	0,873288	0,87331084	0,85354559	0,85356735	0,86418025	0,8642022	0,85389447	0,85391599
	Chemicals	2,13505738	1,63158619	1,63164366	1,65965441	1,65971443	1,59325516	1,59331203	1,62947727	1,62953467	1,59442264	1,59447869
	Metallic & non-metallic manufcturing	2,89864185	2,21635783	2,21643571	2,26668233	2,26676435	2,1460625	2,14613966	2,21250146	2,21257922	2,148128	2,14820365
	Equipment ma-nufacturing	2,48180668	1,88734286	1,88741071	1,91625057	1,9163212	1,85003656	1,85010373	1,88529527	1,88536304	1,85124579	1,85131215
	Gas	5,6292987	4,54870188	4,54882523	5,35965811	5,3598185	3,91936043	3,91948783	4,52055003	4,52067265	3,95996798	3,96007366
	Electricity Other	**5,7299487**	**4,48967301**	**4,48981459**	**5,27680422**	**5,27698523**	**3,8482564**	**3,84840635**	**4,46081848**	**4,46095953**	**3,88688875**	**3,88701767**
	Electricity Coal	**2,54711502**	**2,04674797**	**2,04680509**	**2,18106143**	**2,18112653**	**1,78247123**	**1,78252598**	**2,03292369**	**2,03298043**	**1,78694322**	**1,78699283**
	Electricity Gas	**5,87174652**	**4,8685923**	**4,8687068**	**6,26433406**	**6,26450447**	**3,96003183**	**3,96015054**	**4,83367117**	**4,83378447**	**4,03294028**	**4,03302045**
	Electricity Wind	**5,69614459**	**4,43970147**	**4,43984489**	**5,21671921**	**5,21690224**	**3,78790115**	**3,78805333**	**4,41038186**	**4,41052478**	**3,82480876**	**3,82494006**
	Natural water & sewerage services	2,83342003	2,04036873	2,04045926	2,09221697	2,09231208	1,9748241	1,97491413	2,03678636	2,03687678	1,97703612	1,97712471
	Construction	4,61395296	3,45204335	3,45217598	3,49926856	3,4994061	3,39110956	3,39124076	3,44870518	3,44883766	3,39305886	3,39318876
	Trade	5,04891912	3,5798465	3,58001419	3,64118952	3,6413636	3,50411413	3,50428026	3,57569722	3,57586473	3,50670774	3,50687222
	Transportation	4,39946722	3,1833368	3,18347561	3,22501349	3,22515702	3,13101714	3,13115442	3,18047291	3,18061158	3,13273799	3,13287416
	Services	4,95528642	3,48962274	3,48979004	3,55007506	3,5502487	3,41476894	3,41493468	3,48552009	3,48568722	3,41732078	3,41748489

			Agriculture	Mining	Manufacturing	Refined petrolium	Chemicals	Metallic & non-metallic manufcturing	Equipment manufacturing	Gas
No HE hypothetical extraction	FSAM	BL	1,06066358	0,26286323	1,15801521	0,29377414	0,55425422	0,75290272	0,64113545	1,54520627
		FL	1,04220508	0,33645682	1,54220563	0,33044037	0,51314651	0,6372117	0,58700018	0,35941856
	FSAM / bonds	BL	1,06067632	0,26286572	1,15801777	0,29377092	0,55425358	0,75290179	0,64113518	1,54519197
		FL	1,04219923	0,3364509	1,5421982	0,33043537	0,51314214	0,63723131	0,5870279	0,35940633
HE coal	FSAM	BL	0,98926321	0,24647815	1,08187031	0,27267863	0,51821655	0,70775716	0,59833707	1,67351921
		FL	1,01873497	0,24809525	1,53216786	0,32238758	0,49418535	0,61410801	0,57930021	0,33265041
	FSAM / bonds	BL	0,98927476	0,24648042	1,08187234	0,2726755	0,51821578	0,70775613	0,5983366	1,6735063
		FL	1,01872992	0,24809178	1,53216092	0,32238276	0,49418156	0,61412885	0,57932881	0,33263877
HE gas	FSAM	BL	1,12480109	0,27641302	1,22673228	0,31328447	0,58478668	0,7876885	0,67903545	1,43855788
		FL	1,14525375	0,35477012	1,70021589	0,35094839	0,56244375	0,69729634	0,6439782	0,38876251
	FSAM / bonds	BL	1,12481146	0,276415	1,22673162	0,31328007	0,58478443	0,78768567	0,67903326	1,43854777
		FL	1,14524431	0,3547629	1,70020312	0,35094225	0,56243751	0,6973164	0,64400725	0,38874808
HE wind	FSAM	BL	1,06319361	0,26336995	1,16070936	0,29456321	0,55542122	0,75414999	0,64261897	1,54086802
		FL	1,04506644	0,33853296	1,54612259	0,33181	0,51476853	0,63917467	0,58849505	0,36061426
	FSAM / bonds	BL	1,06320635	0,26337244	1,16071189	0,29455997	0,55542057	0,75414904	0,64261868	1,54085373
		FL	1,04506051	0,33852697	1,54611507	0,33180496	0,51476412	0,63919427	0,58852279	0,36060197
HE other	FSAM	BL	1,12031049	0,27537561	1,22197013	0,31196901	0,58251982	0,78481522	0,67634976	1,44676813
		FL	1,09746869	0,39023473	1,61253066	0,3624962	0,54542886	0,67655129	0,6147549	0,38579002
	FSAM / bonds	BL	1,12032345	0,27537818	1,22197229	0,31196541	0,58251889	0,78481401	0,67634915	1,44675356
		FL	1,0974614	0,39022693	1,6125215	0,36249015	0,54542359	0,67657057	0,61478278	0,3857767

			Electricity Other	Electricity Coal	Electricity Gas	Electricity Wind	Natural water & sewerage services	Construction	Trade	Transporta-tion	Services
No HE hypothetical extraction	FSAM	BL	**1,525154**	**0,69528579**	**1,6538739**	**1,50817854**	0,69311875	1,17266841	1,21608349	1,08138808	1,18543423
		FL	**1,4911701**	**0,75710362**	**1,42008062**	**0,40106268**	0,32274968	0,93027188	1,48056542	1,19719327	3,65171787
	FSAM / bonds	BL	**1,52514662**	**0,69527991**	**1,65385265**	**1,5081724**	0,69312429	1,17267082	1,21609622	1,0813959	1,18544795
		FL	**1,49112542**	**0,75708021**	**1,42003795**	**0,4010486**	0,32274385	0,93038484	1,48057614	1,19718808	3,65172352
HE coal	FSAM	BL	**1,64764861**	**0,68102258**	**1,95599853**	**1,62888745**	0,65328146	1,09262439	1,1369383	1,00698998	1,10848839
		FL	**1,85243295**	**0,23826118**	**1,75848191**	**0,39438575**	0,30427931	0,9143517	1,47239034	1,17563563	3,74815159
	FSAM / bonds	BL	**1,64764311**	**0,68101727**	**1,95597811**	**1,62888328**	0,65328657	1,0926262	1,13694986	1,00699689	1,10850088
		FL	**1,85237581**	**0,23825221**	**1,75842754**	**0,39437157**	0,30427401	0,91446752	1,47240178	1,17563119	3,74815502
HE gas	FSAM	BL	**1,41245994**	**0,65423635**	**1,45348587**	**1,39030721**	0,72483734	1,24466925	1,28614632	1,1492052	1,25335316
		FL	**1,32363338**	**0,69368052**	**0,36367025**	**0,41800747**	0,35221683	1,02073662	1,62940063	1,31537167	4,03961369
	FSAM / bonds	BL	**1,41245913**	**0,65423057**	**1,45347198**	**1,3903081**	0,72484172	1,24466819	1,28615645	1,14921015	1,25336444
		FL	**1,32358761**	**0,69365593**	**0,36365587**	**0,41799129**	0,35220957	1,0208591	1,62940814	1,31536247	4,03960822
HE wind	FSAM	BL	**1,52050801**	**0,69293937**	**1,64759803**	**1,50331626**	0,694256	1,17552057	1,21880688	1,08409131	1,18806924
		FL	**1,50097297**	**0,76172584**	**1,42937966**	**0,34067346**	0,32386326	0,93271509	1,48431685	1,20043069	3,66133768
	FSAM / bonds	BL	**1,52050074**	**0,69293349**	**1,64757668**	**1,50331025**	0,69426155	1,17552293	1,21881962	1,08409911	1,18808296
		FL	**1,50092785**	**0,76170223**	**1,42933657**	**0,34066106**	0,3238574	0,93282819	1,48432751	1,20042542	3,66134312
HE other	FSAM	BL	**1,42006875**	**0,65285692**	**1,47342844**	**1,39738792**	0,72230707	1,23964877	1,28117021	1,14454094	1,24851282
		FL	**0,36508593**	**0,90377819**	**1,7214181**	**0,44229951**	0,34618539	0,97681261	1,54918845	1,26064551	3,74933096
	FSAM / bonds	BL	**1,42006365**	**0,65285105**	**1,47340358**	**1,39738453**	0,72231288	1,23965066	1,28118321	1,14454862	1,24852689
		FL	**0,36507251**	**0,9037489**	**1,72136338**	**0,44228374**	0,34617883	0,97692775	1,54919788	1,26063864	3,74933475

TABLE 9

Forward and backward linkages

CHAPTER 8. CLEARING THE AIR: EVALUATING THE EFFECTIVENESS OF GREEN BONDS IN REDUCING AIR POLLUTION IN THE MEDITERRANEAN REGION

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Abstract

This chapter examines the effectiveness of green bonds in reducing air pollution across 21 Mediterranean countries from 2012 to 2022. Using panel regression analyses, the research shows that green bond issuance significantly lowers air pollution levels in issuing countries compared to non-issuing ones. Key results reveal that while the total volume of green bonds does not substantially reduce pollution, bonds with moderate maturities (5–10 years) and higher issuance frequency are most effective. The chapter also identifies reductions in key pollutants—carbon dioxide (CO_2), methane (CH_2), and nitrous oxide (N_2O)—and highlights stronger impacts in high-pollution sectors. The findings support targeted green bond policies, regional coordination, and standardized frameworks to enhance environmental outcomes in the Mediterranean region.

Résumé

Ce chapitre analyse l'efficacité des obligations vertes à réduire la pollution atmosphérique dans 21 pays méditerranéens entre 2012 et 2022. À l'aide d'analyses de régression panel, les résultats montrent que l'émission d'obligations vertes réduit significativement les niveaux de pollution dans les pays émetteurs par rapport aux non-émetteurs. Les obligations avec des maturités modérées (5–10 ans) et une fréquence d'émission élevée s'avèrent les plus efficaces. Des réductions sont observées pour des polluants spécifiques—le dioxyde de carbone (CO_2), le méthane (CH_2) et le protoxyde d'azote (N_2O)—avec des effets plus marqués dans les secteurs très polluants. Le chapitre préconise des politiques ciblées, une coordination régionale et des cadres standardisés afin d'amplifier les bénéfices environnementaux en Méditerranée.

1. INTRODUCTION

The aim of this chapter is to determine whether the issuance of green bonds leads to a significant difference in air pollution levels between issuing and non-issuing countries of the Mediterranean region.

Green bonds are emerging as a strategic financial instrument for mobilizing capital towards concrete solutions to this problem. Green bonds specifically finance projects with proven environmental benefits, particularly in key sectors responsible for polluting emissions. Their mechanism can be explained in three ways. First, green bonds make it possible to reduce dependence on fossil fuels, the main source of harmful atmospheric emissions, by supporting the development of renewable energies. Second, they allow the modernization of polluting infrastructures by facilitating the adoption of clean technologies in industry and transport. Third, given the strict regulatory frameworks and transparency requirements, these financial instruments ensure that the funds invested generate measurable improvements in air quality.

Previous studies have investigated the impact of green bonds on various environmental and financial outcomes such as financial performance (Tang and Zhang, 2020), corporate environmental performance (Flammer, 2021) and carbon emissions (Maltais and Nykvist, 2020). However, these studies present limitations. First, they only identify environmental impacts through land and water pollutants, water abstraction, waste generation and natural resource use and greenhouse gases, whereas air pollution is an important component of environmental dimensions (Bargaoui, Khanchel and Lassoued, 2024). Indeed, air pollution is often attributed solely to greenhouse gases, although other pollutants play an equally important role. Unlike greenhouse gases, which interact with the climate, air pollution has direct and, above all, chronic effects on human health. Second, many of these studies (Lassoued, Khanchel and Khiari, 2024) are only conducted in the United States, European and Chinese contexts. This limited focus makes the external validity of these studies uncertain in other contexts, especially the Mediterranean context. In the Mediterranean region, this issue is of particular importance because of the high levels of air pollution and the potential for green bond financing to address this environmental challenge.

These shortcomings have arguably compromised the full understanding of the effects of green bonds on environmental performance justifying further scrutiny. Specifically, this research offers multiple valuable added values.

First, despite having to rely on the same data due to lack of availability and homogeneity across the different countries in the region, it attempts to broaden the analysis of green bond impacts beyond the commonly studied outcomes of financial performance and greenhouse gas emissions, by focusing on the issue of air pollution. This is an important environmental dimension that has received less attention, despite the significant public health consequences of air pollution in the Mediterranean region.

Second, the chapter provides much-needed evidence on the environmental impacts of green bonds in a non-Western, developing context - the Mediterranean region - which has distinct economic, political, and environmental characteristics compared to the US, European, and Chinese settings of prior research. This enhances the external validity and generalizability of the findings.

Third, the chapter's focus on air pollution aligns with growing policy priorities to address this pressing environmental and public health challenge in the Mediterranean region, particularly in light of the region's vulnerability to climate change impacts. The results can thus inform the design of more effective green bond policies and programs to support sustainable development and climate adaptation efforts in the region.

Fourth, by examining the differential impacts of green bond issuance on air pollution levels between issuing and non-issuing countries, the study offers insights into the mechanisms through which green bonds may (or may not) contribute to environmental improvements.

Finally, this research contributes to the limited empirical evidence on the environmental impacts of green bonds in developing and emerging market contexts, providing policymakers and investors with crucial data to evaluate the effectiveness of green bond programs in achieving tangible environmental outcomes

Therefore, our study focuses on a sample of 21 Mediterranean countries during the period 2012-2022, using panel regression analyses.

The results of this chapter are as follows: First, there appears to be a significant reduction in air pollution levels in countries that issued green bonds. Second, while the overall volume of green bonds issued does not result in a substantial decrease in air pollution, increases in both the maturity of the green bonds and the number of bonds issued lead to lower levels of atmospheric pollutants. Third, focusing on the effects of green bonds on various pollutants, the results demonstrate a reduction in three out of four key atmospheric contaminants: carbon dioxide, methane, and nitrous oxide. Fourth, by examining the data across polluting and less-polluting sectors, we find that green bond issuance reduces air pollution in both categories, with a more considerable impact observed in sectors characterized by higher pollution levels. Finally, the findings suggest that green bonds with moderate maturities—ranging from 5 to 10 years—are the most effective mechanism for mitigating air pollution compared to short-maturity bonds (under 5 years) or long-maturity bonds (over 10 years).

This chapter also has important regional policy implications. The Mediterranean region has increasingly adopted green bond policies and incentives to mobilize financing for sustainability initiatives (OECD, 2020; Climate Bonds Initiative, 2022). However, the environmental effectiveness of these policies remains uncertain. This study can inform policymakers in the region on the environmental impacts and cost-effectiveness of green bond programs. For instance, the results could guide the design of green bond taxonomies, eligibility criteria, and monitoring frameworks to ensure green bonds effectively address air quality issues (Ehlers and Packer, 2017; Migliorelli and Dessertine, 2019). Furthermore, the findings may urge regional coordination on harmonizing green bond standards and disclosures, which is crucial for expanding sustainable finance in the Mediterranean (EC, 2021; OECD, 2016). Finally, this research can support Mediterranean countries in using green bonds as an effective tool for environmental and public health protection.

The remainder of this paper is structured as follows. Section 2 presents the institutional background. Section 3 outlines the literature review and develops the hypotheses. Section 4 presents the empirical analysis. Section 5 reports and discusses the empirical findings, and Section 6 concludes the paper.

2. INSTITUTIONAL BACKGROUND

The Mediterranean region is one of the world's most polluted areas, with several countries exceeding WHO air quality guidelines. For example, in 2020, average annual PM2.5 levels in cities like Cairo, Algiers, and Beirut were more than double the WHO recommended limit (WHO, 2021). Also, air pollution is a major public health concern in Mediterranean cities, with high levels of particulate matter, nitrogen oxides, and ozone contributing to increased mortality and morbidity (EEA, 2020). This poses significant public health risks, leading to increased respiratory illnesses, cardiovascular disease, and premature mortality (Lelieveld et al., 2015). Furthermore, the Mediterranean region is highly vulnerable to the impacts of climate change, including increased frequency and intensity of heatwaves, droughts, and wildfires (IPCC, 2021).

The intersection of air pollution and climate change vulnerabilities in the Mediterranean highlights the urgent need for innovative financing mechanisms to address these challenges. Green bonds represent a potential solution, providing a systematic way to direct investments into initiatives that manage these difficulties. By financing renewable energy, clean transportation, and industrial decarbonization, green bonds can simultaneously reduce emissions and alleviate public health risks. This dual potential positions green bonds as an important instrument for achieving the region's sustainability goals.

Green Bond trends

Green bond issuance has been growing rapidly in the Mediterranean region, with significant growth observed in countries like Spain, Italy, and France (Climate Bonds Initiative, 2022). Green bond financing could play a key role in supporting climate adaptation and mitigation efforts in the region. Specifically, Among the 21 Mediterranean countries considered in this study, 10 have issued green bonds: Cyprus, Egypt, France, Greece, Israel, Italy, Morocco, Slovenia, Spain and Turkey. The following graphic shows that green bond issuance has risen overall from $0.609 billion in 2012 to a peak of $108.239 billion in 2021, before falling back to $60.425 billion in 2022. This trend underlines the growing adoption of green bonds in these countries, although annual fluctuations.

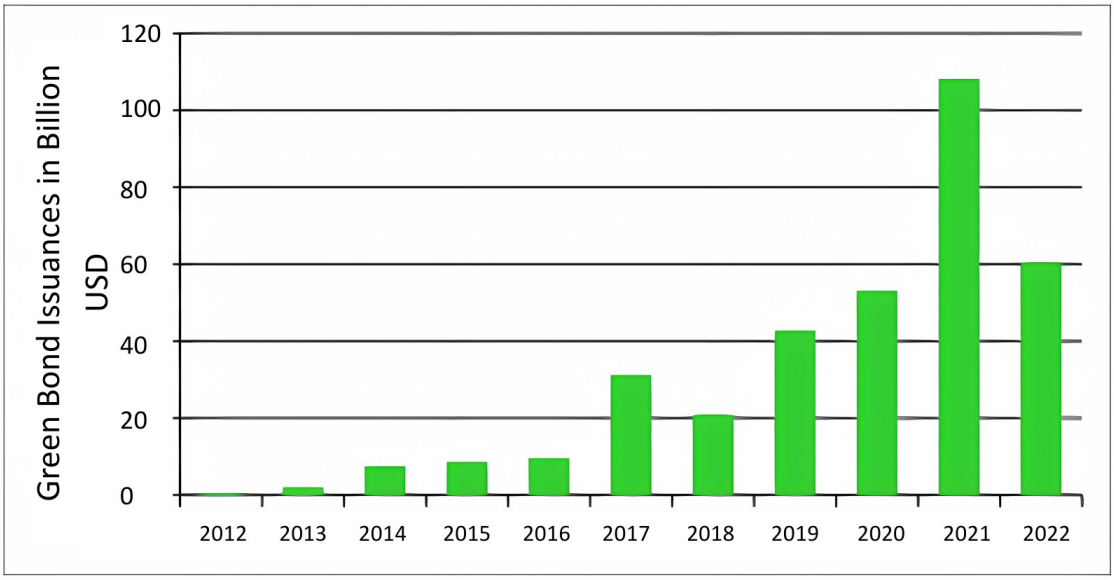


FIGURE.1 *Green Bond Issuances in the Mediterranean region*
Source: International Monetary Fund. (2022)

The increasing air pollution and public health risks in the Mediterranean region—where PM2.5 levels in Cairo (42.4 μg/m³) and Tunis (31.6 μg/m³) exceed WHO limits by 2-3×, contributing to over 40,000 premature deaths annually (WHO, 2021)—combined with the potential of green bond financing to support climate adaptation and mitigation efforts (e.g., Egypt's 2020 sovereign green bond reduced Cairo's traffic-related PM2.5 by 18% through Metro Line 3 (Green Financing Working Group, 2021), highlight the urgent need for a cohesive and strategic approach to environmental sustainability. With pediatric asthma rates surpassing 15% in industrial coastal zones (European Environment Agency, 2020) and maritime transport generating 30% of regional NO_2 emissions (Plan Bleu, 2019), green bonds have confirmed their viability for health-environment solutions, as seen in Italy's 2021 port electrification project that cut NO_x emissions by 25% (European Commission, 2022).

The need for a Med Green Taxonomy

Currently, the absence of a unified Green Taxonomy across the Mediterranean region limits the standardization and effectiveness of sustainable financial investments. While EU countries such as Spain, France, and Greece adhere to the EU Green Taxonomy, others like Egypt, Morocco, and Türkiye are developing national frameworks influenced by international standards (Climate Bonds Initiative, 2022; Ehlers & Packer, 2017). This fragmentation creates barriers to impactful implementation, as identical projects may qualify as «green» in one market but not another, despite similar air pollution impacts.

A Mediterranean-specific taxonomy must address shared challenges such as water scarcity, high solar energy potential, and coastal ecosystem preservation, offering tailored criteria for sectors like agriculture, tourism, and maritime transportation. Standardized thresholds for pollution-intensive sectors (e.g., maritime transport) and uniform reporting for key pollutants (e.g., PM2.5, SO_2) would enable meaningful cross-border comparisons (OECD, 2020). Regional initiatives, including discussions by Plan Bleu and UNEP/MAP, highlight the growing momentum toward harmonized green finance standards. However, measurable air quality improvements will require binding mechanisms, such as unified third-party verification and financial incentives (e.g., preferential lending rates for taxonomy-aligned bonds), to ensure consistent adoption across jurisdictions.

3. LITERATURE REVIEW AND HYPOTHESES DEVELOPMENT

Currently, The emergence of green bonds represents a critical intersection between financial innovation and environmental sustainability. Prior research has highlighted the potential of these financial instruments to address environmental challenges, showing a complex landscape of opportunities and limitations that extends beyond traditional financial mechanisms. This study specifically examines how green bond issuance affects air pollution levels in the Mediterranean context.

The existing literature has highlighted the potential for green bonds to contribute to environmental performance improvements. Several studies have found that the issuance of green bonds can lead to reductions in greenhouse gas emissions, both in the short and long term (Flammer, 2021; Khanchel, Lassoued and Khiari, 2024). Green bonds have also been shown to facilitate a shift away from fossil fuel-based energy sources towards renewable alternatives, thereby mitigating global CO2 emissions (Glomsrød and Wei, 2018). Researchers have further suggested that the implementation of green finance policies, including the use of green

bonds, can enhance environmental performance (Khanchel, Lassoued and Bargaoui, 2024). Recent studies have also indicated the effectiveness of green energy bonds in reducing the use of toxic materials (Lassoued and Khanchel, 2023).

While green bonds show promise for environmental finance, significant implementation challenges threaten their effectiveness in the Mediterranean context. First, definitional ambiguities in project eligibility have allowed controversial inclusions, such as fossil fuel-related projects branded as «transitional» investments (Climate Bonds Initiative, 2022), creating potential misalignment with the Paris Agreement's climate targets. Second, inconsistent monitoring and verification protocols, particularly in developing Mediterranean economies (Green, 2023), enable «impact washing» where reported environmental benefits may exceed actual outcomes. Third, the region's regulatory fragmentation - with EU members following stringent taxonomy standards while neighboring states develop weaker national frameworks - risks creating a two-tier market where bond quality varies significantly by jurisdiction (Ehlers & Packer, 2017). These structural challenges are compounded by behavioral factors, as empirical evidence suggests some issuers prioritize reputational gains over substantive environmental action (Flammer, 2021), particularly when short-term bond maturities incentivize superficial compliance rather than long-term transformation (Khanchel et al., 2024).

While prior research has examined the environmental impacts of green bonds more broadly, this study specifically focuses on the potential for green bond issuance to influence air pollution levels in the Mediterranean region. Numerous arguments highlight the value of green bonds in reducing air pollution.

- *First,* green bond financing in the Mediterranean could serve as an important resource for countries and firms seeking to address the pressing issue of air pollution. The ability of green bonds to facilitate investment in pollution control technologies, renewable energy, and other sustainability initiatives makes them a potentially valuable tool for mitigating air quality challenges in the region.
- *Second,* the impact of air pollution on public health and the environment is a major reputational concern for governments and businesses in the Mediterranean. Green bond issuance could, therefore, be used as a means to enhance these entities' environmental credentials, align with stakeholder expectations, and ultimately contribute to reducing air pollutant emissions and improving overall environmental performance.
- *Third,* the use of green bonds by Mediterranean countries and firms may be part of a broader set of mechanisms employed to minimize air pollution and other environmental impacts. The integration of green bond financing with other pollution control measures could help to mitigate environmental uncertainties and answer synergies in addressing the region's air quality challenges.

Therefore, building on the previous arguments and the distinctive characteristics of Mediterranean region, we present our hypothesis as follows:

H1: The issuance of green bonds leads to a significant reduction in air pollution levels in issuing countries compared to non-issuing countries in the Mediterranean region.



4. METHODOLOGY

4.1 Sample

The sample for this study comprises 21 Mediterranean countries: Albania, Algeria, Bosnia and Herzegovina, Cyprus, Croatia, Egypt, Spain, State of Palestine, France, Greece, Italy, Lebanon, Libya, Malta, Morocco, Monaco, Montenegro, Slovenia, Syria, Tunisia and Türkiye. Of these 21 countries, 10 issued green bonds during the study period: This selection enables an in-depth comparative analysis between green bond issuing and non-issuing countries in the Mediterranean context.

The study period is 2012-2022. We choose this period because 2012 marks the beginning of the significant emergence of the green bond market on an international scale. This decade offers sufficient time to observe medium-term trends and encompasses the market's rapid growth phase, including peak issuance in 2021 and decline in 2022. It also matches with major developments in climate policy, notably the Paris Agreement in 2015. In addition, it ensures the availability of complete and consistent data from the IMF's Climate Change Indicators Dashboard for all countries in the study.

4.2 Data source

The data used for this study comes from several sources. The data on air pollution comes from the EDGAR database (Emission Database for Global Atmospheric Research). Macroeconomic indicators were extracted from World Bank databases and information on green bonds was taken from Refinitiv.

4.3 Econometrical Specification

The objective is to determine whether the issuance of green bonds leads to a significant difference in air pollution levels between issuing and non-issuing countries.

$$AIR_POL_{it} = \alpha_0 + \alpha_1 GB_{it} + country\ control\ variables + Year_{fixed} + Country_{fixed} + \varepsilon_{it}$$

With :

AIR_POL_{it} represents the level of air pollution in country i during year t. It is measured as greenhouse gas emissions per capita. There are several reasons for our use of per capita greenhouse gas emissions as the main indicator of air pollution. First, this measure captures the main anthropogenic sources of pollution (energy, transport, industry) which are also targeted by the projects financed by green bonds. Second, unlike more spe-

cific indicators such as PM2.5, greenhouse gas emissions data provides comprehensive and standardized coverage for all 21 Mediterranean countries in our study, which is essential for rigorous cross-national comparisons.Moreover, greenhouse gas emissions are the main target of green financial regulations (EU Taxonomy, ICMA principles), aligning our metric with existing assessment frameworks.

GB_{it} is a dummy variable that takes the value of 1 if the country issues green bonds and 0 otherwise. Green bond issuance is expected to reduce air pollution because it directs financing toward high-emission sectors for instance, by financing renewable projects (solar, wind) that displace fossil fuel power plants, cutting CO_2 and particulate emissions. Also, green bond funds can support electric vehicles and public transit, reducing NOx and PM2.5 from road traffic.

In addition, Green bonds may finance upgrades in manufacturing (e.g., cement, steel) to lower energy use and associated pollutants.

We introduce several control variables to isolate the specific effect of green bond issuance on air pollution by accounting for other influential factors:

- Energy intensity (ENER_INT) proxied by the ratio of energy supply to gross domestic product (GDP), measured at purchasing power parity. It reflects a country's energy efficiency, where higher values typically indicate greater reliance on fossil fuels and consequently higher pollution levels, suggesting a positive relationship with air pollution. Note that this control variable includes all energies combined, including renewable energies, for the sake of data comparability between the countries studied. Nevertheless, as the energy mix of the countries in the region remains largely dominated by fossil fuels, the results of the models do not appear to be biased. This assumption is confirmed by the robustness tests carried out, which validate the relevance of this control variable despite the inclusion of renewables in its measurement.
- Climate vulnerability (CLIM_VUL), measured by the ND-GAIN (Notre Dame Global Adaptation Initiative) index. It captures both exposure to climate risks and adaptive capacity, as countries facing greater environmental threats may implement more stringent pollution controls, potentially leading to a negative association with air pollution.
- Economic openness (ECO_OPN), which is measured by the proportion of international trade (exports and imports) relative to the size of a country's economy, represented by its GDP. This variable presents a dual dynamic: while increased trade can lead to pollution haven effects through industrial relocation to less regulated areas, it may also facilitate cleaner technology transfers, with the net effect depending on institutional context and development level.
- Governance quality (GOV_IND) measured by the Kaufmann Governance IndexIndex. (World Bank), .captures six institutional dimensions critical for air pollution control: (1) political stability ensures continuity in environmental policies; (2) government effectiveness determines implementation capacity for green bond-funded projects; (3) regulatory quality affects emissions standard enforcement; (4) rule of law enables contract enforcement for renewable energy investments; (5) control of corruption prevents misallocation of green financing; and (6) political accountability influences

environmental policy priorities. Stronger governance reduces air pollution through three mechanisms: effective regulation (higher-quality environmental standards and stricter enforcement, particularly in industrial sectors), efficient resource allocation (preventing corruption in green investments and ensuring pollution control funds reach intended projects), and policy stability (maintaining long-term emission reduction strategies despite political changes).

- Unemployment rate (UNEMP_RT) (World Bank) controls for economic downturns that reduce industrial activity and energy demand, reducing emissions from polluting sectors. However, governments may reduce environmental regulations to stimulate job growth, offsetting these reductions. The variable captures the net tension between decreased production (reducing pollution) and weaker enforcement (increasing pollution) during high-unemployment periods.
- Economic growth (GDP_GTH) (World Bank) captures expansion in economic activity that increases energy use and industrial output, raising emissions from fossil fuel combustion and manufacturing sectors. However, beyond a certain income threshold, the environmental Kuznets curve suggests growth may enable cleaner technologies and stricter regulations, reducing pollution intensity.

We also include country-year fixed effects in our analysis. This means we account for factors specific to each country that do not change over time, such as geography, long-standing infrastructure, or cultural characteristics, as well as year-specific factors like global economic conditions or international climate agreements. By doing this, we ensure that our results focus on the actual relationship between green bond issuance and air pollution, without being influenced by these unchanging or shared external factors.

5. MAIN FINDINGS

5.1 Descriptive Statistics

Panel A of **Table 1 provides a snapshot of the key data used in this study. The average level of air pollution (measured as greenhouse gas emissions per person) is 37.5. This shows a considerable variation in pollution levels across the 21 countries studied.**

The green bond variable has an average value of 0.21, meaning that, on average, green bonds were issued in 21% of the country-year observations during the study period.

A breakdown of other key data points shows :

- Energy Intensity (ENER_INT): On average, energy use in these countries is relatively high compared to their economic output, with an average value of 3.01.
- Climate Vulnerability (CLIM_VUL): The average value of 0.418 indicates that these countries face moderate challenges in adapting to climate change, considering both their exposure to risks and their ability to respond to them.
- Economic Openness (ECO_OPN): With an average of 54.5, this shows that international trade (exports and imports) makes up a large part of the economies in these countries.
- Governance Quality (GOV_IND): With a mean of 0.1, this suggests a wide range of governance quality, from strong to weak institutions.
- Unemployment Rate (UNEMP_RT): The average unemployment rate is 10.55%, reflecting the economic challenges some of these countries face.
- Economic Growth (GDP_GTH): The average GDP growth rate is 3.13%, but this varies greatly across countries, from periods of strong growth to times of economic recession.

In Panel B of Table B, we report that the distribution of green bond issuance across countries and years reveals a growing trend over time, with notable disparities among countries. France and Italy are the most active issuers, each with 11 issuances over the years, followed by Spain (9) and Türkiye and Greece (4 each). Cyprus, Israel, Morocco, and Slovenia have only issued green bonds once a year, indicating limited participation, while Egypt has had two issuances. From a temporal perspective, green bond issuance started slowly, with only one occurrence in 2012 and 2015, but gained momentum from 2016 onwards. The highest activity was recorded in 2020 and 2021, with seven countries as issuers each year, suggesting a peak in adoption, possibly driven by increased global attention to sustainable finance and regulatory incentives.

Panel A : Descriptive statistics

	Mean	SD	Min	Max
AIR_POL	37.50	14.64	5.77	71.36
GB	0.21	0.419	0	1
ENER_INT	3.01	1.07	1.18	8.01
CLIM_VUL	0.418	0.039	0.348	0.546
ECO_OPN	54.5	35.2	19.84	120
GOV_IND	0.10	1.87	-4.72	2.67
UNEMP_RT	10.55	5.05	2.93	27.70
GDP_GTH	3.13	10.32	-58.32	153.49

Panel B : Distribution of green bonds by country and by year

By country*		By year	
Cyprus	1	2012	1
Egypt	2	2013	3
France	11	2014	3
Greece	4	2015	1
Israel	1	2016	3
Italy	11	2017	5
Morocco	1	2018	5
Slovenia	1	2019	5
Spain	9	2020	7
Türkiye	4	2021	7
		2022	5

TABLE 1

Summary statistics

** we display only issuer countries*

5.2 Main findings: The effect of Green Bonds Emissions on Air Pollution

Table 2 presents the key results of our analysis, showing that the issuance of green bonds is linked to a reduction in air pollution. Specifically:

- In the first model (Specification 1), green bond issuance is associated with a reduction of 0.43 units in air pollution, which is a statistically significant result (meaning the finding is unlikely to be due to chance).
- When we add control variables in the second model (Specification 2), the reduction is even larger, at 0.63 units. This suggests that green bonds have an even stronger effect on pollution when we account for other factors like energy use and economic openness.

These results suggest that green bonds can be a powerful tool in reducing air pollution.

Specifically, the issuers cover a diverse economic spectrum, from advanced economies like France, Italy, and Spain, with their developed financial markets and stringent environmental regulations, to emerging economies such as Egypt, Morocco, and Türkiye, which use green bonds to drive sustainable development. The effectiveness of green bonds in reducing air pollution can be attributed to both direct and indirect mechanisms. **Direct effects** emerge via specific projects funded by green bond proceeds, including renewable energy installations, energy efficiency improvements, and clean transportation infrastructure. **Indirect effects** manifest through broader market signals, raising environmental awareness and creating pressure for comprehensive ecological improvements.

The varying impact of green bonds across these countries reflects their distinct economic and institutional characteristics. Economically **advanced economies**, particularly EU members like France, Italy, Spain, Greece, and Cyprus, benefit from established regulatory frameworks and the European Green Deal, enhancing their capacity to implement environmental projects effectively. Conversely, **non-EU members** use green bonds as instruments to align with international climate commitments and attract environmental investments. The geographic distribution of these countries also plays a crucial role, as pollution reduction effects are influenced by factors such as industrial concentration, and population density.

The temporal dimension introduces additional complexity, as countries initiated their green bond programs at different times, suggesting varying levels of market maturity and implementation experience. Larger economies like France, Italy, and Spain exert more significant influence on regional air quality, while smaller economies' impacts may be more localized. Furthermore, spillover effects create regional benefits through technology transfer and knowledge sharing, benefiting non-issuing neighboring countries. This positive environmental impact extends beyond national borders, encouraging regional cooperation and environmental improvement initiatives throughout the Mediterranean basin.

The effectiveness of green bonds in reducing air pollution also depends on **implementation capacity**, which benefits advanced economies with better infrastructure and institutional frameworks. However, emerging economies, despite facing greater implementation challenges, show commitment to environmental improvement through their green bond initiatives. This dynamic landscape of green bond issuance among Mediterranean countries illustrates the potential of financial instruments to drive environmental improvements, while highlighting the importance of considering country-specific characteristics in assessing their impact on air pollution reduction.

VARIABLES	(1) AIR_POL	(2) AIR_POL
GB	-0.430*** (0.069)	-0.628*** (0.079)
ENER_INT		0.262*** (0.067)
CLIM_VUL		0.0180 (0.0124)
ECO_OPN		0.0670*** (0.0217)
GOV_IND		-0.738*** (0.140)
UNEMP_RT		0.905*** (0.0525)
GDP_GTH		0.244*** (0.0215)
CountryxYear effect	Fixed Included	Included
Observations	219	219
R-squared	0.147	0.476

*The values in parentheses are robust standard errors, and * indicates statistical significance at the 10% level, ** at the 5% level, and *** at the 1% level.*

TABLE 2

The impact of green bonds emissions on air pollution

5.3 Further Evidence

5.3.1 Robustness Checks

An endogeneity problem may arise when studying the relationship between the issuance of green bonds by countries and air pollution, as unobserved factors may affect both the decision to issue these bonds and pollution levels. For example, issuing countries may already have stricter environmental policies or specific characteristics that influence both green bond issuance and pollution. To address this issue, a difference-in-differences (DiD) approach can be employed to control for these unobserved factors and isolate the causal effect of green bonds on air pollution. As shown in Table 3, the results confirm the robustness of the main findings: green bond issuance has a causal negative impact on air pollution. Indeed, the DiD coefficient (GB_issuer × Post = -0.402) is negative and highly significant ($p < 0.01$), confirming that countries issuing green bonds experienced a greater reduction in air pollution compared to non-issuers.

Furthermore, the impact of being a green bond issuer is negative and significant (-0.215, $p < 1\%$), suggesting that even before issuance, these countries had lower pollution levels compared to non-issuers. However, this effect is smaller than the post-issuance effect, reinforcing the role of green bond policies.

Finally, the Post coefficient is positive and significant, indicating that air pollution slightly increased over time for all countries. This strengthens the argument that the reduction observed in green bond issuers is policy-driven rather than part of a broader trend.

VARIABLES	(1) AIR_POL
GB_issuer × Post	-0.402*** (0.095)
GB_issuer	-0.215** (0.088)
Post	0.147** (0.102)
ENER_INT	0.262*** (0.067)
CLIM_VUL	0.0180 (0.0124)
ECO_OPN	0.0670*** (0.0217)
GOV_IND	-0.738*** (0.140)
UNEMP_RT	0.905*** (0.0525)
GDP_GTH	0.244*** (0.0215)
Observations	219

*The values in parentheses are robust standard errors, and * indicates statistical significance at the 10% level, ** at the 5% level, and *** at the 1% level.*

TABLE 3
Robustness check: DID approach

5.3.2 Analysis of the Impact of Green Bonds Characteristics

The dummy variable approach for green bond issuance (GB) provides a useful binary classification but has important limitations. First, it fails to capture variations in issuance scale, treating a an issuar of $50 million green bond the same as an issuer's $5 billion program. Second, it overlooks qualitative differences between bond types, such as sovereign versus corporate issuances or sector-specific allocations (e.g., renewables vs. transport). Third, the binary coding cannot detect potential learning effects or the accumulation of impact over multiple issuance years. To address these limitations, we incorporate green bond characteristics such as maturity and issuance frequency.

Specifically, we estimate the following equation:

$$AIR_POL_{it} = \alpha_0 + \alpha_1 CHARACT_{it} + country\ control\ variables + Year_{fixed} + Country_{fixed} + \varepsilon_{it}$$

The CHARACT variable includes three characteristics of green bonds:

- AMOUNT: the total green bonds issued, serving as an indicator of financial commitment to environmental projects. Larger amounts may signal higher investment in reducing air pollution and promoting sustainability.
- MATURITY: the average maturity of green bonds, reflecting the commitment duration for funded projects. Longer maturities may correlate with more sustained environmental benefits.
- FREQ_INS: the frequency of green bond issuances, capturing the regularity of initiatives aimed at air pollution reduction. More frequent issuances may indicate a proactive approach to addressing environmental issues.

Impact of green bond amounts on Air Pollution: Strategic deployment more important than volume

GAs indicated in Column 1 of Table 4, the amount of green bonds (AMOUNT) shows a negative coefficient of -0.221, but this result is not statistically significant. This suggests that the total amount of green bonds issued does not necessarily have a measurable effect on pollution reduction, i.e., reductions in air pollution do not appear to be proportional to the amounts invested in green bonds, as further discussed below. In advanced EU economies such as France, Italy, and Spain, large issuance amounts support comprehensive environmental projects; however, the impact on air quality does not appear to be proportionately reflected. Although substantial green bond amounts fund various environmental initiatives, the direct link to pollution reduction remains statistically insignificant. For smaller economies like Cyprus and Greece, this finding is particularly relevant, as it suggests that their more modest issuance amounts may still be effective when appropriately targeted. In emerging markets such as Egypt, Morocco, and Türkiye—where varying green bond amounts support different scales of environmental projects—the size of the issuance alone does not guarantee stronger improvements in air quality. **Our results lead us to conclude that the strategic deployment of funds, rather than just volume, may be more critical for achieving environmental impact. It is therefore legitimate to assume that combining the efforts of the region's partners to spread the adoption of green bonds across as many countries as possible, especially those that have not yet managed to issue them, is a more beneficial strategy for air quality than increasing the amount of green bond issuance in countries that have already made use of this financial instrument. Consequently, while green bond amounts may**

contribute to pollution reduction, other factors—such as project selection, implementation efficiency, and strategic allocation of funds across the region—are likely to play more decisive roles in enhancing air quality across the Mediterranean region.

Longer-maturity green bonds more effective in reducing air pollution

The average maturity of green bonds (MATURITY) displays a larger negative coefficient of -0.885, which is statistically significant at the 10% level. **This finding indicates that longer-maturity green bonds tend to be more effective in reducing air pollution**. This relationship may be explained by the fact that long-term environmental projects potentially have a more lasting and important impact on air quality. The effectiveness of these longer-term instruments in reducing air pollution is evident across both advanced and emerging economies, suggesting that extended bond durations provide the necessary timeframe for implementing substantial emission reduction projects throughout the Mediterranean basin. Specifically, advanced EU economies like France, Italy, and Spain influence their well-developed financial markets to issue medium to long-term green bonds specifically targeting air quality improvement through major infrastructure projects such as clean energy installations and low-emission transportation systems. Their ability to place longer-dated bonds enables sustained investment in pollution reduction technologies across industrial sectors. The pattern extends to smaller EU members like Greece and Cyprus, who use longer-term green bonds to finance renewable energy projects that directly reduce air pollution from conventional power generation. Especially notable are the emerging Mediterranean economies such as Egypt, Morocco, and Türkiye, where longer maturities enable projects targeting industrial emissions and urban air quality. These countries use long-term green bonds to finance the transition from polluting industrial processes to cleaner technologies, and to develop renewable energy infrastructure that reduces reliance on high-emission power generation.

Potentially most effective approach: increasing the issuance frequency of green bonds

The emission frequency (FREQ_INS) shows a significant effect with a coefficient of -0.3671, statistically significant at the 1% level. **This result suggests that, despite a lower coefficient than that associated with maturity, which reflects a more limited effect on air pollution, increasing the issuance frequency of green bonds is the most statistically robust, and therefore the most reliable, method of reducing air pollution.** This effectiveness can be attributed to the diversification of environmental projects and a more regular and sustained implementation of green initiatives. In France, for instance, frequent issuance supports an ongoing sequence of urban air quality projects, from electrifying public transportation to implementing industrial emission control systems. Similarly, Italy's regular issuance pattern facilitates the gradual transformation of industrial zones through sequential funding of cleaner production technologies and air monitoring systems. The effectiveness of frequent issuance is particularly evident in the emerging economies of the region, where Morocco and Egypt show how frequent issuance can support progressive yet reliable progress in air quality management. Rather than relying on single, large issuances, these countries use frequent bonds to fund phased implementation of pollution reduction initiatives, from installing air quality monitoring networks to upgrading industrial filtration systems. Frequent green bond

issuance in Türkiye enables the systematic modernization of industrial facilities and power generation units, and thus contribute to consistent improvements in urban air quality. Also, similarly, smaller EU members like Greece and Cyprus have found that regular issuance patterns, even at modest scales, enable them to address air pollution through a series of interconnected projects.

Sovereign vs. non-sovereign Green Bonds

At this stage, we examine whether sovereign status modifies the impact of green bonds on air pollution (AIR_POL). The GB×SOV interaction allows us to isolate the specific effect of sovereign issuance. As shown in Table 4 (column (4)), sovereign green bonds have a significantly greater impact than private issues, with a coefficient of -0.350 for the GB×SOV interaction. This difference can be explained by the ability of governments to mobilize larger-scale projects, benefit from increased political visibility, and have easier access to institutional investors. These results suggest that policymakers should prioritize sovereign issuance to maximize climate impact while strengthening regulatory frameworks for private issuers to ensure the environmental effectiveness of the green bond market as a whole. Additionally, the longer maturity of sovereign bonds seems to provide an advantage for financing the energy transition over the long term.



VARIABLES	(1) AIR_POL	(2) AIR_POL	(3) AIR_POL	(4) AIR_POL
AMOUNT	-0.221 (0.187)			
MATURITY		-0.885* (0.518)		
FREQ_INS			-0.3671*** (0.0125)	
GB×SOV				-0.350*** (0.120)**
ENER_INT		0.269** (0.139)	0.299** (0.094)	0.262*** (0.067)
CLIM_VUL		0.812** (0.448)	0.682*** (0.148)	0.0180 (0.0124)
ECO_OPN		0.396*** (0.00208)	0.397*** (0.00195)	0.0670*** (0.0217)
GOV_IND		-0.0525* (0.0307)	-0.0519* (0.0307)	-0.738*** (0.142)
UNEMP_RT		0.435 (0. 385)	0.465 (0.585)	0.905*** (0.0525)
GDP_GTH		-0.360*** (0. 133)	-0. 334** (0. 134)	-0.244*** (0.0215)
CountryxYear fixed effect	Included	Included	Included	Included
Observations	219	219	219	219
R-squared	0.352	0.466	0.498	0.502

*The values in parentheses are robust standard errors, and * indicates statistical significance at the 10% level, ** at the 5% level, and *** at the 1% level.*

TABLE 4
The Impact of Green Bond Characteristics on Air Pollution

5.3.3 Analysis of the Impact of Green Bonds Emissions on Different Components of Air Pollution Components

In our analysis, we have focused on the relationship between green bond characteristics and air pollution levels as a whole. However, air pollution is a complex issue, with different components (e.g., particulate matter, nitrogen oxides, sulfur dioxide) contributing to the overall air quality in distinct ways. In this section, we shift our focus to examining the specific impact of green bond emissions on these individual components of air pollution.

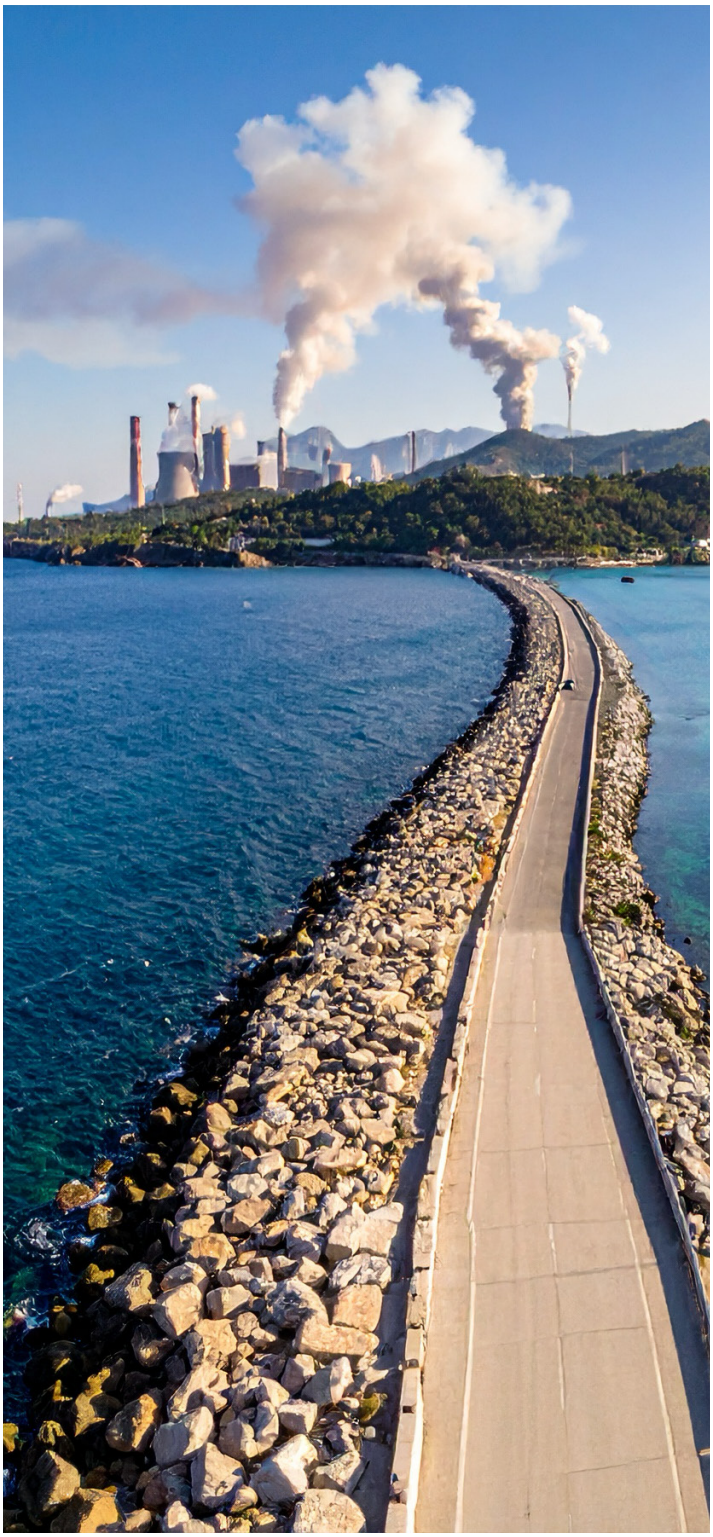
This deeper dive aims to determine whether green bonds can effectively reduce specific forms of air pollution. We test several indicators: carbon dioxide (CO_2), methane (CH_4), nitrous oxide (N_2O), and fluorinated gases (F-gases).

As shown in Table 5, green bonds exhibit significant negative effects on three of the four atmospheric pollutants studied. Specifically:

- **They clearly reduce carbon dioxide** with a coefficient of -0.601, significant at the 1% threshold, showing their strong effectiveness in mitigating this major greenhouse gas. The significant relationship between green bonds and CO_2 reduction in the Mediterranean region is strongly rooted in multilayered regulatory and voluntary frameworks. Mediterranean EU members (France, Spain, Italy, Greece, Cyprus) structure their green bonds primarily according to the EU Taxonomy for Sustainable Activities, which sets specific technical screening criteria for climate change mitigation. This taxonomy provides detailed CO_2 emission thresholds across energy, manufacturing, and transport sectors. These efforts are further reinforced by Paris Agreement commitments, where each country's Nationally Determined Contributions (NDCs) guide their green bond project selection and implementation. The framework is enriched by international standards such as the International Capital Market Association (ICMA) Green Bond Principles and Climate Bonds Initiative (CBI) Standards, which provide specific metrics and certification requirements for CO_2 reduction projects. These standards require quantifiable impact measurements and regular reporting, ensuring that green bond-funded projects maintain consistent focus on emissions reduction. Non-EU Mediterranean issuers like Egypt, Morocco, and Türkiye have effectively integrated these international standards while aligning with regional frameworks such as the Mediterranean Strategy for Sustainable Development (MSSD) and the Union for the Mediterranean's climate action plans. This adherence to multiple frameworks creates a structured approach to CO_2 reduction, where green bonds serve as financial instruments directly supporting specific, measurable climate targets. The alignment of green bond projects with these various protocols ensures that funded initiatives target CO_2 emissions, particularly in key sectors like renewable energy development, industrial process improvement, and sustainable transportation infrastructure, thereby contributing to the CO_2 reduction across the Mediterranean countries.
- **For methane, the impact is also negative, with a coefficient of -0.502, significant at the 5% threshold, indicating a noteworthy reduction in emissions of this pollutant.** This result reflects the effectiveness of targeted green bond projects in agriculture and waste management sectors. These initiatives align with the EU Methane Strategy and international methane reduction pledges, particularly evident in countries like France, Italy, and Egypt where green bonds fund

advanced waste treatment facilities and sustainable agricultural practices. Mediterranean issuers often integrate methane reduction targets into their green bond frameworks, following specific ICMA and CBI guidelines for waste management and agricultural projects.

- **The most substantial effect is observed for nitrous oxide, with a coefficient of -0.817, significant at the 5% threshold, suggesting a strong capacity of green bonds to reduce this type of emission.** This substantial impact aligns with the EU Industrial Emissions Directive and agricultural sustainability frameworks across the Mediterranean region. Countries like Spain, Türkiye, and Morocco particularly focus on modernizing industrial processes and implementing precision agriculture techniques through green bond funding, directly targeting N_2O emissions from these sectors.
- **Conversely, with regard to fluorinated gases (F-gases), although the coefficient is positive (0.294), the lack of statistical significance does not allow us to conclude that green bonds have a meaningful effect on these gases.**This result reflects the limited focus of current Mediterranean green bond frameworks on F-gas reduction initiatives. Despite the EU F-gas Regulation and international phase-down agreements under the Kigali Amendment to the Montreal Protocol, green bond projects across both EU (France, Italy) and non-EU Mediterranean issuers (Egypt, Morocco) have not significantly targeted sectors producing these gases, such as refrigeration and specialized industrial processes. This gap suggests potential opportunities for expanding green bond initiatives to better address F-gas emissions through targeted industrial modernization projects.



VARIABLES		(1) Carbon dioxide	(2) Methane	(3) Nitrous oxide	(4) F- gases
GB		-0.601***	-0.502**	-0.817**	0.294
		(0.126)	(0.244)	(0.411)	(0.504)
ENER_INT		0.652***	0.132**	0.10	0.813***
		(0.143)	(0.071)	(0.131)	(0.184)
CLIM_VUL		0.00376	0.0650	0.0614	0.0355
		(0.0894)	(0.246)	(0.321)	(0.115)
ECO_OPN		0.0395	0.612***	0.726***	0.679***
		(0.156)	(0.130)	(0.161)	(0.201)
GOV_IND		-0.615***	-0.604	-0.321***	0.532
		(0.181)	(0.673)	(0.093)	(0.099)
UNEMP_RT		0.032	0.439	0.703	0.670
		(0.377)	(0.403)	(0.735)	(0.685)
GDP_GTH		0.306*	0.297***	0.200**	0.542***
		(0.154)	(0.105)	(0.101)	(0.199)
CountryxYear fixed effect	Fixed	Included	Included	Included	Included
Observations		219	219	219	219
R-squared		0.399	0.991	0.882	0.979

*The values in parentheses are robust standard errors, and * indicates statistical significance at the 10% level, ** at the 5% level, and *** at the 1% level.*

TABLE 5
The Impact of Green Bond Emissions on Air Pollution Components

5.3.4 Sensitivity Analyses by Sectors: Polluting Sectors versus Less-Polluting Sectors

This section aims to examine how green bond investments affect pollution mitigation across different sectors, focusing on the distinction between polluting sectors and less-polluting sectors. By conducting separate analyses for each, we can assess whether green bonds are more effective in reducing emissions in high-pollution sectors compared to sectors with a lesser environmental footprint.

It is worth mentioning that the Mediterranean countries issuing green bonds represent a diverse economic environment with complex sectoral approaches to air pollution reduction. These nations employ varied strategies for using green financial instruments across both polluting and less-polluting sectors. Developed economies like France and Italy use advanced green bond mechanisms to modernize industrial infrastructure, specifically targeting high-emission manufacturing and energy sectors through precision-engineered technological interventions. Emerging economies such as Türkiye, Egypt, and Mo-

rocco use these financial tools to accelerate sustainable industrial transitions, addressing significant pollution challenges associated with rapid industrialization. Smaller economies like Cyprus position themselves in green financial markets by focusing on targeted sector modernization and innovative emissions reduction strategies.

This analysis aims to investigate whether green bond investments lead to the most significant pollution mitigation in sectors with substantial carbon footprints—primarily manufacturing, energy production, and heavy industry—by facilitating technological upgrades, enhancing efficiency, and promoting cleaner production methodologies. Specifically, conducting separate analyses by economic sectors allows us to identify the specific contributions of green bond issuance to air pollution within each sector.
To classify the sectors, we referred to the methodology developed by the Central Pollution Control Board (CPCB) (2023), which classifies industrial sectors and other polluting activities. This classification was designed to provide a uniform and objective approach to pollution management, facilitating the application of environmental regulation mechanisms. Sectors are classified into four categories: Red, Orange, Green, and White.
We have applied these criteria to distinguish the most polluting sectors from those with a lesser environmental impact. Sectors are classified according to several factors, such as pollution intensity, scale of operations, and the use of cleaner technologies or fuels. High-emission sectors, such as manufacturing, energy production, and heavy industry, are classified as Red or Orange, while those with a smaller environmental footprint, such as agriculture or services, are classified as Green or White. This approach allows for more targeted actions to reduce pollution and encourages the transition to less polluting technologies, thereby helping to improve the environmental performance of industrial sectors.

The results presented in Table 6 show that the effect of green bond issuance contributes to reducing air pollution in both subsamples, with a more pronounced effect in the polluting sectors. Specifically, polluting sectors, characterized by high carbon emissions such as manufacturing, energy production, and heavy industry, show a more substantial pollution mitigation response compared to less-polluting sectors like agriculture, construction, and services. This differentiated impact arises from the targeted nature of green bond investments, which channel financial resources into emission-intensive industrial processes. By focusing on technological enhancements, efficiency improvements, and cleaner production methodologies within these polluting sectors, green bonds create a direct mechanism for environmental transformation. In this line, when green bonds are deployed in sectors with significant pollution footprints, they can lead to important changes in industrial practices, driving down air pollution more effectively than interventions in less polluting economic domains.

VARIABLES	(1) Less-polluting sectors	(2) Polluting sectors
GB	-0.482*** (0.160)	-1.853*** (0.279)
ENER_INT	0.387*** (0.108)	0.669*** (0.204)
CLIM_VUL	0.209*** (0.0683)	0.0532 (0.0782)
ECO_OPN	0.0556 (0.0446)	0.0681*** (0.0217)
GOV_IND	-0.131** (0.063)	-0.776*** (0.140)
UNEMP_RT	0.353* (0.187)	0.909*** (0.0525)
GDP_GTH_GTH	0.0419 (0.0688)	0.245*** (0.0215)
CountryxYear effect	Fixed Included	Included
Observations	96	113
R-squared	0.581	0.576

*The values in parentheses are robust standard errors, and * indicates statistical significance at the 10% level, ** at the 5% level, and *** at the 1% level.*

TABLE 6

The impact of green bonds emissions on air pollution: polluting sectors versus less-polluting sectors

5.3.5 The Role of Maturity Length

Lastly, this section is designed to explore how the duration of green bonds influences their effectiveness in reducing air pollution. The underlying idea is to assess whether the impact of green bonds on environmental outcomes, specifically air pollution, varies based on the length of time until maturity. We thus re-estimate the effect of green bonds on air pollution by dividing our sample according to maturity: short maturity (under 5 years), moderate maturity (between 5 and 10 years), and long maturity (over 10 years).

The results, reported in Table 7, indicate that green bonds have a significant negative effect on air pollution regardless of their maturity, but with varying intensities. Moderate-maturity green bonds appear to be the most effective, with a coefficient of -0.820 significant at the 1% threshold. The impact is less pronounced, yet still significant, for long-maturity bonds, which have a coefficient of -0.414, and for short-maturity bonds, with a coefficient of -0.389, significant at the 5% threshold.

These results suggest that moderate-maturity green bonds are the most effective instrument for reducing air pollution, being approximately twice as effective as either short- or long-maturity bonds. The strong impact of moderate-maturity bonds (5-10 years) on pollution reduction indicates an optimal timeframe for environmental projects within the Mediterranean context. This effectiveness can be attributed to their alignment with typical renewable energy project implementation cycles, industrial modernization timeframes, and a balance between project flexibility and accountability. This timeline is particularly suitable for both advanced economies like France, Italy, and Spain, as well as emerging markets such as Egypt, Morocco, and Türkiye, allowing sufficient time for meaningful implementation while maintaining project momentum.

Long-maturity bonds (over 10 years) are suitable for major infrastructure projects and fundamental transitions, especially in emerging Mediterranean economies. These bonds align with longer-term climate goals and national environmental strategies, although their extended duration may present challenges in maintaining project efficiency. Conversely, short-maturity bonds (under 5 years) are particularly valuable for quick-implementation projects and immediate environmental impact initiatives. This shorter timeframe is well-suited for smaller issuers like Cyprus and Greece, enabling focused environmental projects. The lower impact of short-maturity green bonds can also possibly be explained by the relatively smaller scale of the projects financed. A more in-depth analysis could study the impact of green bonds on air pollution by maturity, relating them to the amount invested in order to obtain the effectiveness of a bond euro on pollution according to the type of bond maturity in which this euro is contained. In any case, the results should not lead us to underestimate the importance of short-maturity bonds, which are suited to specific projects, as mentioned above, even among larger issuers.

The higher performance of moderate-maturity bonds indicates that the 5-10 year timeframe represents an optimal balance among project implementation requirements, investment return horizons, environmental impact measurement, and risk management considerations across varying levels of economic development in the Mediterranean region.



VARIABLES	(1) Short maturity	(2) Moderated maturity	(3) Long maturity
GB	-0.389** (0.0192)	-0.820*** (0.186)	-0.414*** (0.118)
ENER_INT	0.194*** (0.0285)	-0.108*** (0.016)	0.170*** (0.051)
CLIM_VUL	-0.00518 (0.0342)	0.675* (0.391)	-0.524 (0.933)
ECO_OPN	0.397*** (0.0134)	0.395*** (0.0733)	0.392*** (0.0877)
GOV_IND	-0.0666** (0.0319)	0.172*** (0.035)	-0.536*** (0.261)
UNEMP_RT	0.0153 (0.0188)	-0.0152* (0.00776)	0.0295 (0.135)
GDP_GTH	0.354** (0.0138)	0.204** (0.0937)	0.506*** (0.089)
CountryxYear fixed effect	Included	Included	Included
R-squared	0.498	0.327	0.488

*The values in parentheses are robust standard errors, and * indicates statistical significance at the 10% level, ** at the 5% level, and *** at the 1% level.*

TABLE 7
The impact of green bonds emissions on air pollution by maturity

6. CONCLUSION AND RECOMMENDATIONS

This chapter examines the impact of green bond issuance on air pollution across a sample of 21 Mediterranean countries (Albania, Algeria, Bosnia and Herzegovina, Cyprus, Croatia, Egypt, Spain, State of Palestine, France, Greece, Italy, Lebanon, Libya, Malta, Morocco, Monaco, Montenegro, Slovenia, Syria, Tunisia and Türkiye observed from 2012 to 2022. The results indicate that green bond issuance leads to a reduction in air pollution. Furthermore, additional evidence is provided by considering three characteristics of green bonds : their amount, maturity and frequency of issue. The findings show that while the total amount of green bonds issued does not significantly reduce air pollution, increases in the maturity of green bonds and the frequency of green bonds issued correlate with decreased air pollution levels. By analyzing the effects of green bond issuance on each form of air pollution, the results show a reduction in three of the four atmospheric pollutants: carbon dioxide, methane, and nitrous oxide. When the sample is divided into polluting sectors and less-polluting sectors, the results show that green bond issuance decreases air pollution in both categories, with a more pronounced effect in the polluting sectors. Finally, the findings indicate that green bonds with moderate maturity (between 5 and 10 years) are the most effective instrument for reducing air pollution

when compared to short-maturity bonds (under 5 years) or long-maturity bonds (over 10 years).

The findings from this research provide valuable insights that can inform policy recommendations to use green bonds as an effective tool for addressing air pollution in the Mediterranean region. Specifically:

- **Our results support the sustained promotion and expansion of green bond programs across the Mediterranean.** Policymakers could incorporate these results when developing their national green bond strategies to set realistic and relevant targets in alignment with the learnings from this chapter in order to maximize air pollution mitigation.
- Similarly, the negative relationship between the number of green bonds issued and air pollution levels can guide governments in **setting mandatory green bond issuance quotas for key industries and state-owned enterprises as part of their air quality management strategies.**
- Policymakers could also explore mechanisms to provide financial incentives, such as **tax credits or preferential lending rates, to increase the flow of green bond financing** towards sectors and activities that have the greatest potential to reduce air pollutant emissions, such as energy-intensive industries.
- The differential impacts across polluting sectors and less-polluting sectors could inform regional coordination efforts, through Plan Bleu - UNEP/MAP notably, to drive regional green bond implementation by **establishing a Mediterranean Green Bond Observatory**. Such a regional coordination and collaboration initiative would be aligned with the MSSD objective related to developing a regional Framework for Green and Sustainable Investments, and would help build a Mediterranean knowledge community. In practical terms, this Mediterranean green bond observatory would make it possible to track and analyze regional trends, developing standardized methodological guidelines for green bond issuance, creating capacity-building programs for policymakers and professionals from the financial sector, facilitating knowledge exchange and technical assistance across Mediterranean countries and producing annual reports on green bond impact and environmental outcomes. This would help ensure green bonds are deployed holistically, consistently and effectively across the diverse Mediterranean economies to address their unique air pollution challenges.
- In this line, Mediterranean countries facing significant environmental challenges, could develop national green bond strategies targeting high-carbon-intensity sectors. For instance, countries hosting the most dynamic industrial ports and which may suffer from air pollution largely caused by this activity, could, on the basis of these results, implement a green bond issuance strategy to facilitate the sustainable transition of players in the sector. Meanwhile, in countries more heavily dependent on oil and gas industries, green bonds could finance energy transition projects. The maritime transportation sector, crucial in the Mediterranean, could also benefit from green bonds funding low-emission shipping technologies and port infrastructure upgrades.

Overall, the empirical evidence generated by this chapter can give policymakers the necessary insights to design and implement comprehensive green bond policy packages that facilitate sustainable investments and carry tangible improvements in air qua-

lity throughout the Mediterranean region. A key prerequisite for success is coordination, which should be encouraged in order to make the most of the environmental benefits associated with green bonds. To this end, the development of a green taxonomy for sustainable activities on a Mediterranean scale seems essential in order to standardize such interventions and put in place optimal conditions for such instruments to flourish.

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CHAPTER 9. TOWARDS MEDITERRANEAN GREEN BOND GUIDELINES

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Abstract

The objective of this chapter is to show that there are currently no specific legal guidelines in the Mediterranean region to support the development and use of green bonds by economic actors. While international and European frameworks define what green bonds are and aim to harmonize practices, they offer little practical guidance tailored to the Mediterranean context. Yet, this financial tool could play a significant role in addressing regional environmental challenges, particularly pollution. The chapter argues for the creation of Mediterranean Guidelines on green bonds—soft law instruments that would clarify possible applications and encourage their use in line with existing legislation. These guidelines could help promote environmentally friendly investments while fostering cooperation among Mediterranean countries.

Résumé

L'objectif de ce chapitre est de montrer qu'il n'existe actuellement aucune orientation juridique spécifique en Méditerranée pour soutenir le développement et l'utilisation des obligations vertes par les acteurs économiques. Si les cadres international et européen définissent ce que sont les obligations vertes et visent à harmoniser les pratiques, ils offrent peu de recommandations concrètes adaptées au contexte méditerranéen. Pourtant, cet outil financier pourrait jouer un rôle important face aux défis environnementaux de la région, notamment la pollution. Le chapitre plaide donc pour l'élaboration de lignes directrices méditerranéennes sur les obligations vertes – des instruments de "soft law" qui clarifieraient les usages possibles et encourageraient leur déploiement dans le respect des législations existantes. Ces lignes directrices contribueraient à promouvoir les investissements respectueux de l'environnement tout en renforçant la coopération entre les pays méditerranéens.

1. INTRODUCTION

Green bonds, debt securities issued by a private company or a public entity to finance activities or projects with an environmental benefit, are experiencing explosive success worldwide today: the International Capital Market Association (ICMA) counts green issues worldwide at 481.6 billion in 2024[250]. Green bonds represent a means of financing the actions put in place by each country signatory to the Paris Agreement at the 21st Conference of the Parties to reduce emissions, combat global warming, protect biodiversity and adapt to a changing climate, i.e. Nationally Determined Contributions (NDC)[251],[252].

These bonds are now one of the main instruments for financing investments related to green technologies, energy efficiency, efficient use of resources, as well as sustainable transport and research infrastructure. For example, in Japan, " Green Bonds are becoming one of the effective tools to drive private funds for Green Projects, including ones that contribute to the reduction of GHG emissions and the prevention of natural capital deterioration"[253].

This funding tool for the ecological transition is all the more necessary as we are no longer in a simple environmental crisis. A crisis by definition is temporary, it has a beginning and an end. However, environmental issues require us to permanently transform the way we interact with the world around us. Some contemporary challenges, such as the preservation of biodiversity and the fight against climate change, are colossal. They are reshaping the world and suggesting a genuine reorientation of our relationship to the production and consumption of goods and services.

The current regulatory context, especially in the Mediterranean[254], must address these challenges. As part of the broader push for societal and economic transformation, the law is increasingly integrating green and sustainable finance. Green bonds, in particular, offer a structured and long-term tool to tackle environmental issues by promoting more sustainable business practices.

As part of the development of the green bond market, French players have been particularly present compared to other countries[255]. In 2007, the European Investment Bank (EIB) issued the very first green bond in the world to finance the regional bloc's climate change strategy[256]. This five-year bond, called a " Climate Awareness Bond " (CAB), raised 600 million euros[257]. France, through the Agence France Trésor, was the first State in the world to issue a green OAT (Obligation Assimilable du Trésor, i.e. Assimilable Treasury Bond) for a substantial amount of 7 billion euros in January 2017[258]. Five years earlier, in 2012, the Ile-de-France Region issued the first local public issue for an amount of 350 million euros, renewed in 2014 with an issue of 600 million euros. Other examples reflect the enthusiasm and importance of funding, such as the 1.4 billion euro issue by EDF, the 2.5 billion euro issue by ENGIE and the 1 billion euro issue by the Agence Française de Développement (AFD).

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250 https://www.icmagroup.org/sustainable-finance/sustainable-bonds-database/
251 CDKN, Rapport Planifier la mise en œuvre de la CDN.
252 Goldman Sachs, Guide du marché des obligations vertes, Financer la transition climatique, 2024, p. 2.
253 Ministry of the Environment, Japan, Green Bond and Sustainability Linked Bond Guidelines, 2017, revised in 2024, p. 16.
254 Convention sur la protection du milieu marin et du littoral de la Méditerranée et ses protocoles, 1976, amendée en 1995
255 Voy. Paris EUROPPLACE, 2015.
256 « Climate awareness bond ».
257 European Investment Bank, Climate Awareness Bonds and Sustainability Awareness Bonds in the context of evolving EU legislation on sustainable finance, 2024, p. 5.
258 https://www.aft.gouv.fr/fr/oat-verte. Several green issues have complemented the French market: a 2nd green OAT in March 2021, a 3rd inflation-indexed green bond in 2022, and a 4th in 2024.

Since 2016, 19 middle-income countries, from Chile to Uzbekistan, have in turn issued green bonds to finance the climate transition, encourage a just transition away from fossil fuels and achieve their Sustainable Development Goals (SDG)[259]. In early 2023, for example, India, a country still on a clear development trajectory, issued its first green bond to raise around two billion dollars to finance projects contributing to climate change mitigation, adaptation, environmental protection, resource and biodiversity conservation, as well as achieving carbon neutrality[260]. Higher-income countries have also turned to this tool. On July 18, 2024, it was the turn of Abu Dhabi Future Energy Company PJSC – Masdar, the United Arab Emirates (UAE) clean energy leader, to raise USD 1 billion with its second green bond issue. A final example illustrates the full diversity of green bonds: Adif Alta Velocidad, a public utility company within the Spanish Ministry of Transport, Mobility and Urban Agenda, issued its first green bond in 2017, becoming the first Spanish public entity to access this market. Since then, the company has regularly tapped the market to finance its main activity, namely building and managing the country's high-speed rail network. In April 2024, Adif AV issued a 600 million euro green bond that was 5.5 times oversubscribed, the second most oversubscribed issue in the company's history[261].

As for the Mediterranean, there are some notable green bond initiatives. For example, in 2020, Egypt issued its first sovereign green bond worth $750 million[262]. In April 2018, the leaders of the Fransabank group issued $60 million in green bonds, a first in Lebanon[263].

The practical success of green bonds led to the publication of the Green Bond Principles (GBP) by the ICMA. Four international banks[264] initiated the drafting of these international recommendations. These principles constitute a proposed, non-mandatory framework aimed at combating greenwashing. Since green bonds finance projects aimed at, among other things, energy efficiency, pollution prevention, sustainable agriculture and fishing, the protection of terrestrial and marine ecosystems, clean transport, and sustainable water management, it is important to ensure the sincerity of the commitments made and the results obtained. A sustained effort of transparency - at the pre-contractual stage as well as throughout the execution of the project - is thus required of green bond issuers in order to preserve the integrity of the market[265]. Alongside the ICMA, other bodies have established recommendations such as the Climate Bonds Standard issued by the Climate Bond Initiative[266], the ASEAN Green Bond Standards[267], and the Japanese Green Bond Guidelines[268]. European green bonds, called EUGBS, are different. They stem from a European regulation that came into force at the end of 2023 with a one-year implementation period[269] and, in this respect, constitute a much stricter framework[270]. Finally, ISO standard 14030 Environmental performance evaluation of the International Organization for Standardization also deals with green bonds[271].

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259 World Bank Group, « From India to Indonesia, Green Bonds Help Countries Move Toward Sustainability », April 10, 2023, available online www.banquemondiale.org
260 Ibid.
261 « Green Financing Framework », Adif AV. Août 2022.
262 https://sites.tufts.edu/farescenter/egypt-leads-the-way-for-sovereign-green-bonds-in-the-mena-region/
263 www.lorientlejour.com/
264 Bank of America, Merrill Lynch, Citigroup, JP Morgan Chase et Crédit Agricole CIB.
265 ICMA, The green bonds principles, 2021, p. 1. Paris EuroPlace, Initiative verte et durable de la Place de Paris, p. 26.
266 www.climatebonds.net
267 https://www.theacmf.org/sustainable-finance/publications/asean-green-bond-standards.
268 https://greenfinanceportal.env.go.jp/en/bond/guideline/guideline.html
269 PE et Cons. UE, règl. (UE) 2023/2631, 22 nov.2023
270 Voy. égal. V. Delaittre et B. de Moras, « Green bonds : d'une pratique de marché établie à l'élaboration d'un standard européen », RLDA, mai 2021, no 7210, p. 37.
271 ISO 14030, Environmental performance evaluation : Green debt instruments, 2021.

Green bonds are covered by various texts, but none provide recommendations tailored to the Mediterranean context. Surveys show that existing standards, such as recent EU guidelines, are not fully aligned with regional needs—for instance, over 30% of respondents in a Maltese study found them unsuitable[272].

This chapter thus aims to develop specific recommendations for Mediterranean economic actors. Given the diversity of current issuers—including supranational bodies like the World Bank, banks like Caisse des Dépôts and Crédit Agricole, and companies like EDF and Engie—the potential is broad.

Mediterranean guidelines could have the core aim of promoting green bonds as a legal tool to help develop and expand the green bond market in the region. By way of illustration, in Japan, three years after the publication of its 'Green Bond Guidelines' in 2017, the total amount of issues on the Japanese green bond market increased considerably, reaching around 820 billion yen in 2019[273] : « the purpose of the Guidelines is to expand the Green Bond market and the Sustainability-Linked Bond market in Japan »[274]. Beyond promoting green bonds, it is essential to assess the relevance of regional guidelines given the Mediterranean's specific context. Green bond use varies greatly across Mediterranean countries, largely due to a lack of information, guidance, and a tailored framework[275]. Dedicated guidelines would help unify and steer economic actors toward shared objectives, especially as the region is among the most vulnerable to climate change. Tools must be adapted to local needs to support the transition to a green and blue economy. Establishing Mediterranean guidelines would also help attract investors to region-specific projects, addressing a current regulatory gap. To build trust among public and private stakeholders, these guidelines should be based on key principles such as transparency, legal certainty, and alignment with regional priorities. These principles will inform the recommendations for designing the legal structure, drafting prospectuses, adopting best practices, and implementing controls.

2. GUIDELINES FOR GREEN BONDS IN THE MEDITERRANEAN: THE ISSUES AT STAKE

2.1 A Transition To Be Made

2.1.1 Environmental Challenges to Address

To Sustainable development is a crucial issue for the Mediterranean because the living conditions of certain populations are closely linked to the preservation of their environment[276]. The Mediterranean is a closed sea, which, in this respect, is particularly exposed to pollution[277] : it is one of the most polluted large bodies of water in the world[278]. According to the IPCC, Mediterranean ecosystems are among the most impacted by climate change globally[279].

Therefore, there are primarily environmental challenges to address. However, they differ from one country to another depending on the regulations in force and the economic development of each country[280]. According to the OECD, « developing countries

272 Central bank of Malta, Green finance in the local capital market, p. 17, www.centralbankmalta.org/site/Reports-Articles/2022/Green-finance-local-capital-markets.pdf?revcount=9728.
273 Ministry of the Environment, Japan, Green Bond and Sustainability Linked Bond Guidelines, 2017, revised in 2024, p. 194.
274 Ministry of the Environment, Japan, Green Bond and Sustainability Linked Bond Guidelines, 2017, revised in 2024, p.17.
275 IENE, The Role of Green Bonds in Enhancing Energy Transition in SE Europe, 2024, p. 22.
276 R. Degron, « L'environnement de la Méditerranée En Péril ? Un Diagnostic Géographique Au Prisme Historique des Cinq Temps de la Biosphère », Les Analyses de Population & Avenir, 53, spéc. p. 4.
277 UNEP MAP, Mediterranean Strategy for Sustainable Development (MSSD), 2016-2025, p. 7.
278 Plan Bleu (2025). MED 2050, The Mediterranean by 2050, A foresight by Plan Bleu, p. 43.
279 UNEP MAP, Mediterranean Strategy for Sustainable Development (MSSD), 2016-2025, p. 7.
280 R. Degron, « La taxonomie verte, un outil financier au service de la transition écologique et adaptative », Revue française de finances publiques, n°167, p. 3.

will also need to find new ways of accessing the significant global pool of private capital to bridge the gap »[281]. For example, in Tunisia, the context is particularly favorable to the development of the green bond market. The country has committed to reducing the carbon intensity of its economy by 45% by 2030. This commitment requires a funding volume of USD 19.4 billion over the period 2021-2030[282]. Additionally, climate change has a negative impact on country ratings, according to the OECD[283]. This therefore corroborates the central role that green bonds can play in this context of significant funding needs to address climate change.

This therefore confirms the central role that green bonds can play in this context of significant funding needs to address issues such as climate change or the massive exploitation of fishery resources[285]. Green bonds governed by a unified and coherent regional framework would allow for the necessary coordination of common challenges while attracting global capital flows to achieve a sustainable transition.

2.1.2 Increasing Legal Obligations to Respect

The ecological transition is reflected in law through various obligations. Green bonds help economic actors meet expectations set by frameworks like the UN SDGs, the EU due diligence duty, and the Paris Agreement—whose Article 2 calls for aligning financial flows with climate-resilient development. By way of illustration, in this context, in 2023 the Board of Governors of Arab Central Banks and Monetary Authorities considered celebrating the «Arab Day for Financial Inclusion» under the theme: «Strengthening Financial Inclusion to Support Efforts to Combat the Repercussions of Climate Change» in 2023[286].

These legal rules reflect a growing awareness of the duty to act environmentally responsibly, with green bonds directly linked to these requirements[287]. The generalization of the issuance of green bonds in the region would for example be a tool to progressively move away from any new fossil energy project or even to reduce oil and gas production[288]. To help actors in the banking sector and institutional investors to see more clearly in this emerging legal environment, the United Nations Environment Programme has established an unparalleled partnership between the global financial sector and the United Nations: the UNEP Finance Initiative. Thus, a realignment of financial mechanisms with a sustainable development model, favored by this type of institution, promotes a redirection of capital towards sustainable projects, including in the Mediterranean.

2.2 Encouraging Green Business Practices in the Mediterranean

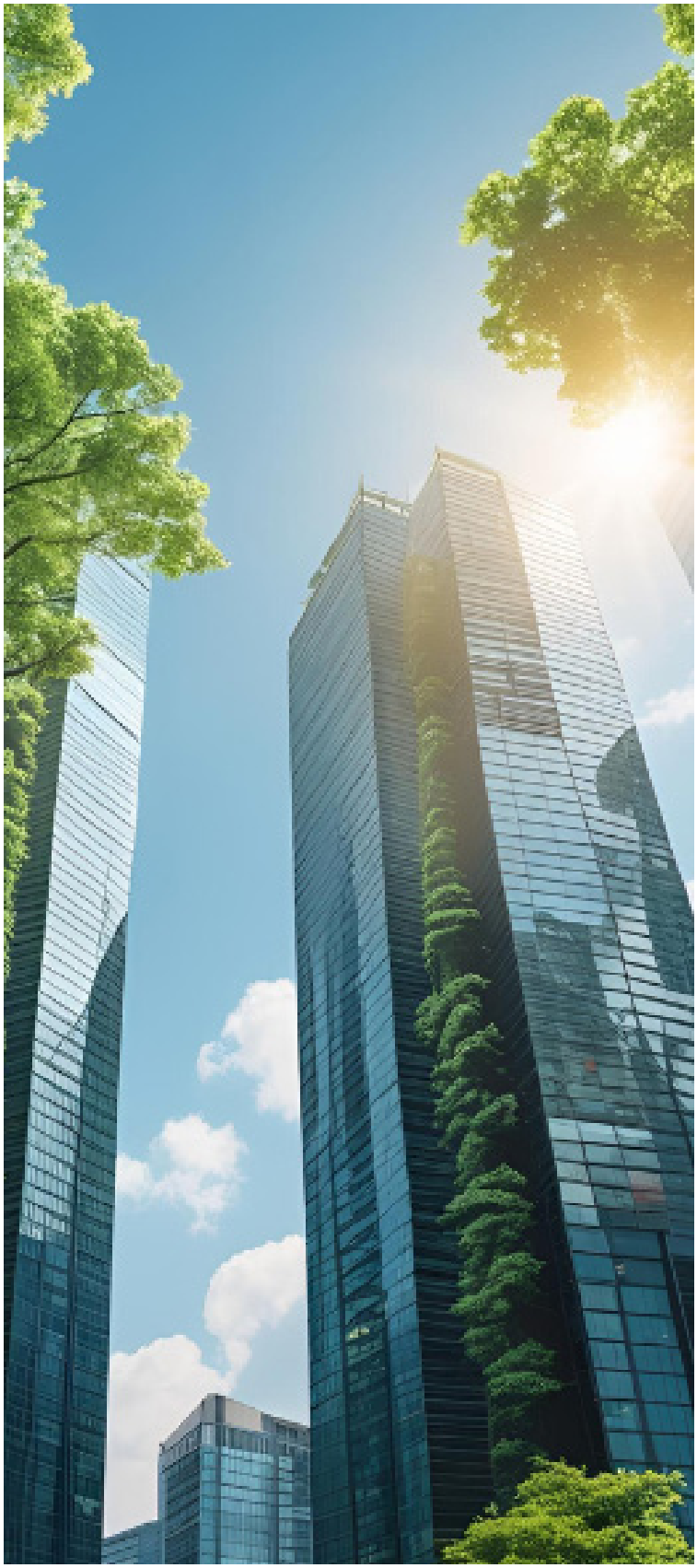
Today, we are witnessing a surge in new expectations from investors, who are increasingly sensitive to non-financial aspects. Expectations are high, and the role of green bond guidelines is to encourage such investments and reassure investors by communicating about these products. This is the case in Japan: « Cases where a borrower finds the necessity to assist in the understanding of the Green Loans among selected overseas lenders expected to be unfamiliar with Green Projects and related information in Japan »[289]. Similarly, these guidelines emphasize the benefits of a green bond for the issuer, such as improving the company's sustainability and reputation, the opportunity for states to meet their international commitments, etc.
The objective of these guidelines would the-

281 OECD, Scaling up green, social, sustainability and sustainability-linked bond issuances in developing countries, 2021, p. 18.
282 République Tunisienne, Contribution Déterminée au niveau National (CDN) actualisée, Tunisie, 2021, p. 8-9
283 OECD, Scaling up green, social, sustainability and sustainability-linked bond issuances in developing countries, 2021, p. 19.
284 UNEP MAP, Mediterranean Strategy for Sustainable Development (MSSD), 2016-2025, p. 7.
285 Th. Lavoux et G. Leone, « Allocution d'ouverture. Le Plan Bleu a quarante ans », Pour Mémoire, HS, n° 20, 2020, p. 8, spéc. p. 12.
286 https://www.bdl.gov.lb/pressrelease1.php?pressid=7273
287 OECD, Scaling up green, social, sustainability and sustainability-linked bond issuances in developing countries, 2021, p. 19.
288 Dan Welsby, James Price, Steve Pye & Paul Ekins, Unextractable fossil fuels in a 1.5 °C world, Nature, janvier 2022.
289 Ministry of the Environment, Japan, Green Bond and Sustainability Linked Bond Guidelines, 2017, revised in 2024, p. 112.

refore be to build a virtuous circle. By communicating in a targeted manner about the projects or activities that companies wish to finance in the Mediterranean, according to the needs of this territory, the attractiveness of this financial tool will be favored. This will allow communication about projects financed by green bonds in the Mediterranean region. The general trend is also towards transparency. The AMF, for example, recommends that an entity issuing green bonds should provide information on how the funds will be used[290].

2.3 Highlighting Mediterranean Diversity

Guidelines for green bonds for regional actors could aim to strengthen the sense of belonging to the Mediterranean community. This would further emphasize the realization of necessary projects in the Mediterranean. Despite its diversity, the Mediterranean faces common challenges. Therefore, the guidelines should be based on a number of documents, such as the ecosystem approach roadmap and the Protocol on Integrated Coastal Zone Management in the Mediterranean, to guide economic actors and propose projects adapted to the needs of Mediterranean countries. The obligation for issuers and investors to take these various texts specific to the Mediterranean into account would allow for the issuance of green bonds adapted to Mediterranean specificities. At the same time, increased collaboration between the southern, northern, and eastern shores of the Mediterranean could be fostered by this financial instrument, aligning with the SDGs' respect for diverse development priorities[291]. For example, France, Italy, and the EU jointly finance the Lyon-Turin railway via green bonds to support decarbonized transport[292].



290 AMF, Position Paper on Green / Social / Sustainable Bonds, 14 mars 2019.
291 R. Degron, « Les Objectifs de développement durable 2015-2030 : Un cadre international d'actions sous forte contrainte financière », GFP N° 3-2020 / Mai-Juin 2020
292 Agence Française du Trésor, OAT vertes. Rapport d'allocation et de performance, 2023, p. 31

BOX 1

Shortcomings of the current Mediterranean green bond market

Current texts focus on harmonizing green bond practices but overlook Mediterranean specificities. While European and international laws define green bonds and their features, there is no practical guidance or dedicated framework for the Mediterranean. Establishing such guidance would expand investment opportunities and help prevent greenwashing by clearly identifying sustainable projects.

The Network for Greening the Financial System (NGFS), bringing together nearly 140 central banks and supervisory authorities representing the five continents, has also highlighted the lack of stringency in international labels[293], particularly regarding the activities that can be included[294]. Self-labeling is also a danger of non-compliance, as this same working group notes: « Global share of self-labelled green bonds not compliant with ICMA guidelines »[295]. To address these issues, we suggest the creation of a unique label: the MedGreenBonds.

Finally, it is regrettable that the green bond market is predominantly dominated by large issuers (Public Investment Banks, large companies, local authorities), mainly due to high transaction costs. It would therefore be wise to explore solutions to reduce these costs for smaller issuers to encourage them to issue green bonds.

3. ROLE THAT THE MEDITERRANEAN GREEN BOND GUIDELINES COULD PLAY

To The guidelines suggested in this chapter are based on major environmental texts and align with international frameworks relating to green bonds. For example, the Caisse des Dépôts published a framework document on February 16, 2023, aligned with the United Nations Sustainable Development Goals[296].

These guidelines would also serve to ensure the integrity of the market[297]. To avoid the pitfall of greenwashing[298], it will be necessary to organize the ex post control of these environmental projects financed by green bonds. Control may be more or less stringent, from the simple obligation to communicate on a dedicated portal to verification by an independent third party. Green bonds are indeed often subject to certification and verification processes by third parties to guarantee their compliance with environmental criteria and their credibility in the financial market.

Transparency is a key principle of these guidelines, required at every stage from bond issuance to project completion. This includes clear project eligibility criteria based on uniform standards—such as ESG fac-

293 NGFS (Network for Greening the Financial System), Synthesis report on the greening of the financial system Insights for financial actors in advanced and emerging economies, November 2024, P. 20.
294 NGFS (Network for Greening the Financial System), Synthesis report on the greening of the financial system Insights for financial actors in advanced and emerging economies, November 2024, p. 24.
295 NGFS (Network for Greening the Financial System), Synthesis report on the greening of the financial system Insights for financial actors in advanced and emerging economies, November 2024, p. 23.
296 CDC, Document cadre, Obligations vertes, sociales et durables, 2023, p. 27 et s.
297 Institut de la finance durable p. 20.
298 NGFS (Network for Greening the Financial System), Synthesis report on the greening of the financial system Insights for financial actors in advanced and emerging economies, November 2024, p. 23.

tors, reporting requirements, and eligibility conditions. Defining a common sustainable activity standard is essential, drawing on the European taxonomy, which classifies environmentally beneficial economic activities. Similarly, the EU Green Bond label mandates that at least 85% of bond proceeds fund activities aligned with this taxonomy.

Nevertheless, the Mediterranean guidelines should be based on a taxonomy specific to the region[299]. According to the ICMA, it is indeed necessary to open up to other taxonomies, without restricting oneself to the European one, which does not fully reflect the green bond market[300]. In this regard, many countries and regions in the world have adopted or are in the process of developing their own taxonomy[301].

These guidelines can also serve an educational purpose, addressing the urgent funding needs of the Mediterranean's ecological crisis. Green bonds are a suitable legal tool but remain poorly known and require reassurance for economic actors[302]. Clear, region-specific guidelines can build public and private confidence by providing legal certainty and predictability. This framework will boost investor appeal, as green bonds combine positive environmental impact with attractive financial returns. According to Lupin Rahman, Global Head of Sovereign Markets at Pacific Investment Management Company (PIMCO), "Green bonds in emerging markets are an increasingly attractive option for fixed-income investors, as issuers stand out for their sustainability credentials, they have enhanced targets and clear frameworks to tackle the energy transition and climate risks, as well as broader sustainability objectives"[303].

4. RECOMMENDATIONS FOR ESTABLISHING A REFERENCE FRAMEWORK FOR MEDITERRANEAN GREEN BONDS

4.1 The Content of the Green Bond Guidelines

In a Mediterranean Green Bond Guidelines document, we recommend defining what can be qualified as "sustainable activities", then detailing possible Mediterranean projects to be financed. In the Japanese guidelines dedicated to green bonds, for example, environmental objectives and typical projects to be financed are listed[304]. It is also necessary to specify the specific and general exclusions, i.e., the projects that absolutely should not be financed by this type of financial instrument. Transparency must be organized at the pre-contractual stage as well as throughout the life of the project. It is first necessary to develop a standard form containing detailed information on the project that the issuer intends to finance with the proceeds of the issuance.

4.1.1 Description of the Sustainable Project

The aim here will be to be transparent and precise. For example, the ICMA guide entitled Green Enabling Projects Guidance provides guidance for these green projects[305]. In this way, these green bonds will be attractive to investors from Mediterranean countries. The objective of these Guidelines is thus to build a virtuous circle: by communicating in a targeted manner about the projects or ac-

299 R. Degron, « La taxonomie verte, un outil financier au service de la transition écologique et adaptative, Le cas du Bassin méditerranéen », RFFP, p. 145.
300 ICMA, A time for change in the sustainable fund market. Reflections and recommendations in a new regulatory environment, March 202, p. 21.
301 Brazilian Finance Minister, « Taxonomia Sustentável Brasileira Consulta pública do Plano de Ação », september 2023 ; Singapour, « MAS Launches World's First Multi-Sector Transition Taxonomy », communiqué de presse du MAS, december 2023 ; ASEAN, « SEAN Taxonomy for Sustainable Finance Version 3 », ASEAN Financial Markets Forum, april 2024 ; Australia, « Consultation process for Australian taxonomy commences », press release from the Australian Sustainable Finance Institute, may 2024 ; Hong Kong, « Hong Kong Taxonomy for Sustainable Finance », press release from the Hong Kong Monetary Authority, may 2024
302 Institut de la finance durable p. 20.
303 WWF, Les obligations vertes doivent tenir leurs promesses, p. 10, 2016.
304 Ministry of the Environment, Japan, Green Bond and Sustainability Linked Bond Guidelines, 2017, revised in 2024, p. 145 et s.
305 ICMA, Green Enabling Projects Guidance document, 2024, p. 2.

tivities that companies wish to finance in the Mediterranean according to the needs of this territory, the attractiveness of this financial tool will be favored.

The idea is to propose a text where companies in each Mediterranean country would systematically link the sustainable activity financed by the green bond to the benefit for the Mediterranean. For example, green bonds allocated to water management in the Mediterranean will be welcome, as it is estimated that by 2050, at least 290 million people will be in a situation of significant water stress[306]. In the Cypriot guidelines, for example, the replacement of obsolete water supply system infrastructure is one of the projects eligible for green financing[307]. It is therefore necessary to require companies that wish to issue green bonds to emphasize, by providing details, the link between the planned investments and the categories of projects authorized in the guidelines.

4.1.2 Standardization of the Qualification of Sustainable Activity

It will also be necessary to define the type of activities that can be qualified as sustainable. To do this, it is interesting to take a look at the definition of «sustainable activities» stated in the various texts in force. There are indeed different definitions, for example, recital no. 12 of the European regulation emphasizes the need to define at the European level what a sustainable activity is in order to harmonize practices[308]. The regulation thus determines whether an economic activity is sustainable in consideration of six environmental objectives: climate change mitigation; climate change adaptation; sustainable use and protection of aquatic resources; transition to a circular economy; pollution prevention and control; protection and restoration of biodiversity and ecosystems.

In the same spirit, the qualification of sustainable activity must be based on the UN Sustainable Development Goals for the period 2015-2030, such as climate change mitigation SDG no. 13; climate change adaptation SDG no. 13; water resource management SDGs no. 6; pollution reduction SDGs no. 3, 6, 11 and 12; sustainable production and consumption SDG no. 12 or the preservation of biodiversity and marine and terrestrial ecosystems SDGs no. 14 and 15. For example, in Spain, "Among the projects eligible for green bond financing, one of the largest investments concerns the high-speed line linking Madrid to the Galicia region in northwestern Spain". Funds have also been allocated to the development of reversible substations that recover the energy generated by train braking and return it to the grid. According to the company, its green bonds contribute to the UN SDGs: SDG 11 (sustainable cities and communities) as well as SDG 13 (measures to combat climate change)[309]. A final example from France this time: Caisse des Dépôts has been a recurring issuer on the green, social and sustainable debt market since 2017. In particular, it financed the Croix de Mérotte wind farm project and contributes to Sustainable Development Goals 7 (clean and affordable energy), 11 (sustainable cities and communities) and 13 (measures to combat climate change).[310]

Also, an economic activity should only be considered environmentally sustainable when it is carried out within the framework of the OECD Guidelines for Multinational Enterprises and the United Nations Guiding Principles on Business and Human Rights, including the International Labor Organi-

306 Plan Bleu (2025). MED 2050, The Mediterranean by 2050, A foresight by Plan Bleu, p. 45.
307 Republic of Cyprus, Sustainable Finance Framework, 2023, p. 19.
308 REGULATION (EU) 2020/852 OF THE EUROPEAN PARLIAMENT AND OF THE COUNCIL of 18 June 2020 on the establishment of a framework to promote sustainable investments and amending Regulation (EU) 2019/2088.
309 « Fixed Income Investor Presentation », site Internet d'Adif AV. Avril 2023
310 CDC, Obligations durables, Rapport annuel 2023, p. 39.

zation (ILO) Declaration on Fundamental Principles and Rights at Work, the eight fundamental ILO conventions, and the International Bill of Human Rights.

It might also be interesting to define priority sectors in the guidelines[311], as is done in the Bosnia and Herzegovina guidelines, for example regarding the water sector: « It is also necessary to improve further the public sector of water supply and sanitation. Only 58% of the population in Bosnia and Herzegovina is connected to the public water supply network, and only 31% to the public sewer network. Only 15% of the wastewater produced in the country is treated before it reaches the country's rivers»[312]. Or in Cyprus where adaptation to climate change is highlighted: « Example projects: Construction of coastal defence structures using naturally occurring stone and designed to battle erosion of the Cypriot coastline; climate risk prevention and precaution investments in forest fire resiliency infrastructure, including monitoring stations, truck and plane fleet buildout to reduce reaction time and mitigate forest loss due to fire »[313].

The definition of the project's sustainability must also take into account the level of sustainability expected, notably via quantitative criteria. For example, the Asian Development Bank has defined it more or less strictly. « Under the ASEAN Green Bond Standard, all renewable energy is eligible; while under the Climate Bonds Standard, there are substantial requirements for hydropower assets. Furthermore, under the Climate Bonds Standard, any hydropower asset must meet a threshold based on its greenhouse gas emissions footprint as well as undergo a site-specific assessment using the Environmental, Social, and Governance Gap Analysis Tool »[314].

It would also be appropriate to provide specific exclusions, such as driftnet fishing when the latter exceeds certain dimensions, or to provide more general exclusions related to certain international conventions, such as the production or trade of any product deemed illegal under international agreements such as certain pharmaceuticals, pesticides, polychlorinated biphenyls, etc.

4.2 Creation of a Mediterranean Dynamic Dedicated to Green Bonds

The creation of Mediterranean guidelines on green bonds would present many advantages, such as popularizing them among investors, residents of the region, and political institutions, making them more attractive, or supporting the realization of funded projects. This project would thus include a practical component (the prospectus, the recommendations dedicated to green bonds), but also a more dynamic, collaborative component.

We thus recommend the creation of a charter on green bonds, containing the main principles of green bonds as well as a collection of good Mediterranean practices in this area. And this in such a way that this legal vehicle specific to the Mediterranean is a real force causing a common regional dynamic articulated around this tool: the Green Bonds Med Union. In the same spirit, the City of London launched, in January 2016, its Green Finance Initiative, an approach developed with strong support from the UNEP Inquiry, the Mayor of London, the Treasury, and leaders of the British financial sector, in order to emphasize the development of green bonds for sustainable infrastructure projects[315]. China has also made green growth the priority of its G20 Presidency and has also positioned itself for

311 Financing Framework for the Sustainable, Development Goals in Bosnia and Herzegovina, 2023, p. 10.
312 Financing Framework for the Sustainable, Development Goals in Bosnia and Herzegovina, 2023, p. 12.
313 Republic of Cyprus, Sustainable Finance Framework, 2023, p. 20.
314 ADB, Detailed guidance for using green bonds in developing countries, déc. 2021, p. 17.
315 Paris EuroPlace, Initiative verte et durable de la Place de Paris, p. 21.

the development of green finance, with the establishment of a dedicated Green Finance Task Force supported by the UNEP Inquiry [316].

An annual summit could take place in different Mediterranean cities, in turn, in order to share good business practices, to evolve the Mediterranean Green Bond Charter or to improve, if necessary, the Med Green Bonds label and the requirements in this area. In doing so, this annual meeting articulated around green bonds would be an opportunity to strengthen ties between Mediterranean countries, which, united around a common fate, will address the challenges to come with a common instrument.

Meanwhile, capacity building and technical assistance must be prioritized. Many potential issuers, including local governments, SMEs, and emerging market players in the region, may lack the technical expertise or institutional readiness to develop and manage green bond issuances according to the stringent sustainability criteria. Establishing dedicated training programs, workshops, and advisory services will help these actors understand the requirements for green bond issuance, including project eligibility, documentation standards, and impact reporting. Capacity building should also extend to investors and financial intermediaries to raise awareness of the benefits and risks associated with green bonds and to promote informed investment decisions. Technical assistance can be provided through regional cooperation mechanisms or partnerships with international organizations, helping to bridge knowledge gaps and foster market development. This will enhance market depth and liquidity, contributing to a sustainable green finance ecosystem across the Mediterranean.

4.3 Creation of a Dedicated Portal

A global platform for Mediterranean green bonds would highlight the region's specificities to promote sustainable investments there. Like the Luxembourg Green Exchange (LGX), the world's leading platform for green finance instruments[317], such a platform would make it easy to guide people wishing to invest in the green and blue transition and people sensitive to Mediterranean issues.

Declaring in public is to expose oneself, to reveal oneself, and, in fine, to act. The ICMA, for example, recommends that issuers of green bonds communicate on the use of the funds raised[318]. Article 11 of the European EuGB regulation requires issuers of European green bonds to produce public reports, at least once a year, until the funds have been fully allocated, so that investors and anyone else concerned about the state of the environment in the region can follow the progress of current projects.

Similarly, issuers of Mediterranean green bonds will be required to provide full transparency on the use of funds raised, as well as on the environmental impact of funded projects. The Mediterranean green bond framework should mandate the adoption of standardized impact assessment methodologies to quantify benefits such as carbon emissions avoided, water saved, or ecosystem restored. Issuers should commit to publishing detailed, periodic reports—ideally annual—through the dedicated Mediterranean green bond portal, including verified data and narratives on project progress and challenges. These reports should be structured to facilitate comparability and aggregation across projects and countries, thereby enabling regional impact analysis. Furthermore, independent third-party impact verification or assurance can enhance report credibility. This transparent repor-

316 Ibid, p. 11.
317 Ibid.
318 ICMA, The green bonds principles, 2021, p. 1.

ting loop will create accountability and enable investors, civil society, and regulators to track whether projects deliver on their promised environmental and social benefits.

Moreover, in the event that the issuer of a green bond does not respect its obligations, it would be conceivable to mention it on this site. In this way, investor confidence would be strengthened and the fight against greenwashing supported by such a sanction. The latter would have a certain deterrent effect because the image a company has with its customers represents a very important economic value. It would be interesting to draw inspiration from a recent report published at the end of 2024[319] that proposes adding such a reputational sanction. It would be added to other more classic penalties such as the fine provided for as an illustration by the Green Bond Principles: « Where a person breaches or fails to comply with a code, directive, guideline or circular issued by the Commission, the Commission may : (b) impose an administrative penalty of not less »[320].

4.4 Creation of a MedGreenBonds Label

The To strengthen the legitimacy, reliability, and recognition of green bonds issued in the region, the creation of a MedGreenBonds label could be a guarantee of quality for issuers of Mediterranean green bonds, as it is today to be, for example, aligned with the ICMA principles[321]. In Cyprus, for example, the first green bond dedicated to solar energy was certified by the ICMA: « First Green Solar Bond to be issued in Cyprus has met the rigorous criteria for Certification by the Climate Bonds Standard Board. (...) A verification report was prepared by the Institute of Energy for SE Europe (IENE), an Approved Verifier, confirming that the bond meets the organisation's exacting standards »[322]. The need for legitimacy is indeed filled by such certifications or labels. In the same spirit as these international labels, it would be interesting to create a label specific to green bonds, the MedGreenbonds label. Certifiers will thus have to analyze the project, the way it is implemented over the long term, but also the current behavior of the project leader.

The label committee could be composed, for example, of representatives from different countries, ambassadors of professional or non-professional investors and portfolio management companies, representatives of civil society, as well as qualified individuals in the field of financial asset management or certification. Such a composition will ensure the transparency and reliability of this label.

Furthermore, the credibility and integrity of Mediterranean green bonds hinge on rigorous third-party verification and certification processes. While the proposed MedGreenBonds label will provide regional legitimacy, it must be underpinned by clear, transparent rules for independent verification. These rules should specify the qualifications and responsibilities of verifiers, the scope and frequency of assessments, and the methodological standards to be applied. Independent audits must confirm that the use of proceeds aligns strictly with the defined sustainable activities and that issuers comply with reporting obligations throughout the bond's lifecycle. Such third-party validation would protect investors from greenwashing

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319 Assemblée nationale, Rapport fait au nom de la commission du développement durable et de l'aménagement du territoire sur le projet de loi, après engagement de la procédure accélérée, portant diverses dispositions d'adaptation au droit de l'Union européenne en matière économique, financière, environnementale, énergétique, de transport, de santé et de circulation des personnes (n° 529), 27 nov. 2024.
320 GREEN BOND GUIDELINES 2024 SEC/GUI/003/03/2024, p. 7.
321 BpiFrance, Ethifinance, Second Party opinion, mars 2025, p. 3
322 https://www.iene.eu/first-green-bond-issued-in-cyprus-achieves-certification-for-best-practice-standards-iene-acted-as-verifier-p7155.html

risks and reinforce confidence in the Mediterranean green bond market. The label committee could oversee the accreditation of verifiers to maintain high standards and consistency across issuances, creating a robust assurance framework comparable to international best practices.

Appendix

Real estate projects' impact indicators (1)

Issuance concerned		Average energy consumption per m² (kWhPE/m²/year)	Avoided CO2 emissions relative to RT2012 (tCO_2eq/year)	Energy savings relative to RT2012 (kWhPE/year)	Jobs directly and indirectly sustained during construction and renovation works (FTE/year)	Area (m^2)
2017 Green bond	New constructions	37	275	2,738,339	788	89,189
	Renovation	49	227	1,438,980	205	21,717
	Total	**40**	**502**	**4,177,319**	**993**	**110,906**

FIGURE.1 *Real estate projects impact indicators*
Source: Caisse des dépôts, Green and sustainability bonds, Annual Report 2021, p. 38

List of green energy production infrastructure projects

2017 Green bond

Type	Internet link	Operation [1]	Progress as of 2021/12/31
Wind (power generation)		**Ostwind wind farms** (France) 5 wind projects in partnership with wind power developer OSTWIND International	In operation
		Aalto Power wind farms (France) Development of 9 wind projects	Sold
		Sainte-Rose Wind farm – Guadeloupe (97) Development and construction of a wind farm made up of 8 wind turbines, the largest renewable energy project in Guadeloupe	In operation
		Tramuntana (France) Investment in 5 wind farms developed by La Compagnie du Vent	In operation
Solar thermal power (electricity production)		**eLLO thermodynamic solar power plant** – Llo (66) Development and construction of an electricity production plant using solar thermal power located in Llo, Pyrénées-Orientales	In operation
Photovoltaic solar power (electricity production)		**Saint-Jean-de-Côle** photovoltaic power plant (24) Joint venture with JPEE for the development of a ready-to-build photovoltaic power plant	In operation
		Garein solar power plant (40) Horizon Energies Operation of a ground-based solar power plant on trackers in Garein in the Landes department	Sold
		Fonroche – Photovoltaic Greenhouses (FICE) – Roquefort (47) 8 agricultural solar greenhouse assets, Gironde	http://www.parc-ec
		Fonroche Investments AO (FIAO) – Roquefort (47) 6 agricultural solar greenhouse assets, Gironde	Sold
Biomass (heat production)		**Biomass cogeneration plant** - Novillars (25) Development, construction, financing and operation of a biomass cogeneration plant located on the industrial site of the GemDoubs cardboard factory	Sold
Biomass (electricity production)		**Sylviana biomass power plant** – Brignoles (83) Inova Var Biomasse Investment in the construction of a biomass power plant in Brignoles, Var	Sold
Biomass (heat and electricity production)		**Biomass Energy biomass cogeneration plant VSG solutions** – Vielle-Saint-Girons (40) 100% replacement of a natural gas boiler with a biomass-wood cogeneration plant and condensing turbine in Vielle-Saint-Girons, Landes	In operation
		Estrées-Mons Biomass Cogeneration Plant (80) 100% replacement of a natural gas boiler installed on the industrial site of the Conserverie Bonduelle in Estrées-Mons (Somme) with a wood biomass installation	Sold
Geothermal energy (heat generation)		**EGOGI geothermal power plant** – Beinheim (67) Exploitation of deep geothermal energy for industry (Roquette Frères in Beinheim, Bas-Rhin)	In operation

FIGURE.2 *List of green energy production infrastructure projects*
Source: Caisse des dépôts, Green and sustainability bonds, Annual Report 2021, p. 35

Sectors	Sub-sectors	Examples of eligibility criteria	Environmental and climate goals	Social goals	SDGs
Assets eligible for a green bond or sustainability bond					
Infrastructure for production and storage of green energy and heat	Renewable electricity generation (wind, solar, biomass, geothermal, etc.)	Specific sustainability criteria for solidwood-based biomass	Limit GHG emissions	Support green employment	
	Efficient heat production (heating or cooling networks, biomass cogeneration, etc.)	- Écoréseau de chaleur: eco-accreditation for heating - User tariffs in the bottom third of French tariffs	- Use of waste heat recovered from a production site - Limit GHG emissions	Support green employment	
	Renewable energy storage	Projects considered as eligible by the EETC ('Energy andecological transition for the climate') label nomenclature (1)	Facilitate use of renewable energy by mitigating their intermittency	Support green employment	
Green real estate	New construction and renovation (tertiary, residential, etc.)	Recognised environmental accreditation such as BBC Effinergie+, E+C–, HQE Excellent.	- Limit GHG emissions - Limit energy consumption	- Fight against fuel poverty - Support green employment	
Soil decontami-nationand site remediation	Making all types of sites suitable for new industrial, commercial, or residential use	Significantly polluted sites with high potential for redevelopment	- Avoid artificial use of land and GHG emissions - Reduce exposure to polluting substances	- Improve the living environment - Support green employment	
Infrastructure and services for sustainable mobility	Transport by rail, river, fleets of clean rolling stock and associated supply chains	Electric and hydrogen technologies	- Limit GHG emissions - Reduce local atmospheric pollutants	- Improve security - Support fragile populations and create green jobs	
Digital infrastructure	Eco-efficient datacenters	- Power Usage Effectiveness (PUE) below 1.3 - Carbon Usage Effectiveness (CUE) below 80 g/kWh	Curtail the digital carbon footprint	Support employment	

FIGURE.3 *Assets eligible for a green bond or sustainability bond*
Source: Caisse des dépôts, Green and sustainability bonds, Annual Report 2021, p. 26

CHAPTER 10. DOES ENERGY TAXATION MATTER FOR ENERGY EFFICIENT INNOVATIONS? EVIDENCE FROM FIRMS IN THE SOUTHERN MEDITERRANEAN COUNTRIES

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Abstract

The main objective of this chapter is to examine the association between green public finance tools (i.e. energy taxation) and energy-efficient innovations. We focus on 6,952 privately-owned firms operating in the manufacturing and non-manufacturing (retail and service) sectors in seven Southern Mediterranean Countries. The main findings show that energy taxation is positively and significantly associated with energy-efficient innovation for all industries in the private sector, and most importantly for the retail and service sectors. In addition, the analysis shows that the external pressure of customers requiring environmental certification exerts a significant impact on energy-efficient innovation. Also, enhancing firms' green capabilities in terms of high-quality energy management positively adds to business potential for innovation in sustainable energy solutions. Sub-sample regression results show that energy taxation triggers innovation only within firms with environmental self-ruling practices, and within firms operating in energy-intensive industries. Finally, energy taxation significantly influences firms' tendency to introduce energy-efficient innovation in all manufacturing and non-manufacturing sectors only if the firms recognize the impact of innovation on its environmental footprint. These findings show that governments in SMCs need to implement a comprehensive regulatory framework that emphasizes the implementation of green public finance tools to incentivize innovation in energy efficiency, and most importantly to target these regulations to energy-intensive firms. Moreover, governments need to increase firms' environmental awareness among different customers and stakeholders, encouraging them to undertake proactive energy management practices. Also, the implementation of green public finance tools must be coupled with other measures that improve energy efficiency such as the provision of fiscal incentives, the gradual removal or reform of energy subsidies, enhancing firm's technological capabilities, and improving their access to finance. Finally, firms must be provided with technical guidelines for the implementation of proper energy efficiency measures throughout their whole production processes and projects.

Résumé

L'objectif principal de ce chapitre est d'examiner l'association entre les outils de finances publiques vertes (tels que la taxation énergétique) et les innovations en matière d'efficacité énergétique. Nous nous concentrons sur 6 952 entreprises privées opérant dans les secteurs manufacturiers et non manufacturiers (commerce de détail et services) dans sept pays du Sud de la Méditerranée. Les principales conclusions montrent que la taxation énergétique est positivement et significativement associée à l'innovation en matière d'efficacité énergétique pour toutes les industries du secteur privé, et plus particulièrement pour les secteurs du commerce de détail et des services. En outre, l'analyse révèle que la pression externe exercée par les clients exigeant une certification environnementale a un impact significatif sur l'innovation en matière d'efficacité énergétique. De plus, le renforcement des capacités écologiques des entreprises, notamment en matière de gestion énergétique de haute qualité, contribue positivement au potentiel d'innovation dans les solutions énergétiques durables. Les résultats des régressions sur des sous-échantillons montrent que la taxation énergétique stimule l'innovation uniquement dans les entreprises dotées de pratiques autonomes en matière environnementale et celles opérant dans des industries énergivores. Enfin, la taxation énergétique influence significativement la tendance des entreprises à introduire des innovations en matière d'efficacité énergétique dans tous les secteurs manufacturiers et non manufacturiers, à condition que les entreprises reconnaissent l'impact de ces innovations sur leur empreinte environnementale. Ces résultats démontrent que les gouvernements des pays du Sud de la Méditerranée doivent mettre en place un cadre réglementaire complet qui met l'accent sur l'utilisation des outils de finances publiques vertes pour inciter à l'innovation en matière d'efficacité énergétique, en ciblant en priorité les entreprises énergivores. Par ailleurs, les gouvernements doivent renforcer la sensibilisation environnementale des entreprises auprès de différents clients et parties prenantes, en les encourageant à adopter des pratiques proactives de gestion énergétique. De plus, la mise en œuvre des outils de finances publiques vertes doit être complétée par d'autres types de politiques favorisant l'efficacité énergétique, telles que la suppression progressive des subventions à l'énergie, le renforcement des capacités technologiques des entreprises et l'amélioration de leur accès au financement. Enfin, le cadre réglementaire doit fournir des lignes directrices techniques détaillées pour aider les entreprises à mieux comprendre l'empreinte environnementale de leurs innovations en matière d'efficacité énergétique.

1. INTRODUCTION

Climate change is a global phenomenon that poses serious threats and risks to millions of lives. The urgency to undertake radical actions and to actively seek solutions makes almost every country in the world involved in the global fight against climate change. The European Union is a leading global key player in emboldening global climate action plans and environmental conduct guidelines. In 2019 and 2020, the EU launched and adopted the European Green Deal (EGD) [323]. In addition, the European Commission (EC) proposed the 2018 Action Plan on Sustainable Finance[324] that aims at directing investments toward sustainable projects and activities, then the EU Taxonomy entered into force in 2020. The EU taxonomy is designed to support the implementation of the EGD policy packages as it represents a classification tool that provides firms, capital markets, and policy makers with a clearer vision of identifying economic activities as sustainable, and channelling resources into those activities[325] (Niewold, 2024).

323 The EGD consists of a set of policy packages that help the EU reduces its emissions by 55% by 2030 and achieves its ultimate goal of climate neutrality (zero net emissions) by 2050, and to set the EU on the path of a green transition (European Parliament, 2023; European Council & Council of the European Union, 2024)

324 Sustainable finance refers to "the process of taking environmental, social and governance (ESG) considerations into account when making investment decisions in the financial sector, leading to more long-term investments in sustainable economic activities and projects" (European Commission, 2024).

325 According to the EU taxonomy, sustainable projects and economic activities must achieve the following objectives: (1) climate change mitigation, (2) climate change adaptation, (3) sustainable use and protection of water and marine resources, (4) transition to a circular economy, (5) pollution prevention and control, and (6) protection and restoration of biodiversity and ecosystems (Doyle, 2021).

Governments play a crucial role in developing the appropriate sustainable finance framework required to finance economic activities that account for environmental considerations (European Commission, 2021; Almeida et al., 2023). Thereby, developing green public tools that integrate environmental considerations in the public financial management and the economic decision-making is highly prioritized in the policy agenda. Among different types of green public finance tools, environmental taxation emerges as a powerful instrument to mitigate negative externalities that are generated by economic activities while also incentivizing environmentally-friendly activities at both, firm and individual level (Ben Youssef et al., 2023). In particular, energy taxation is an important tool that governments can use not only to raise revenues but also to achieve different climate goals, among which enhancing energy efficiency (European Court of Auditors, 2022). Energy efficiency refers to "using less energy for the same output or producing more with the same energy input, and minimizing energy waste" (European Environment Agency, 2024). Given the fact that the energy supply sector is a major contributor to GHG emissions, energy efficiency is set as a key priority for a clean energy transition in the EGD[326] (European Economic and Social Committee, 2023). It is usually the case that when governments, firms, and households reduce their energy consumption and minimize their emissions of harmful wastes, the overall demand for energy decreases, which prevents and reduces the release of GHG emissions in the atmosphere. Hence, enhancing energy efficiency plays a central role in achieving climate change mitigation objectives[327]. Energy taxation could motivate firms to engage in climate abatement activities through the development of low-carbon and energy-efficient technologies that help reduce energy/material use (Tchorzewska et al., 2022; Clementi & Garofalo, 2023).

Thereupon, the main objective of this chapter is to examine the association between energy taxation and energy-efficient innovations. We focus on 6,952 privately-owned firms operating in the manufacturing, retail and service sectors in seven Southern Mediterranean Countries (SMCs), namely Egypt, Jordan, Lebanon, Morocco, Tunisia, Türkiye, and West Bank and Gaza[328]. The importance of the study stems from the following: (1) the Mediterranean region is particularly vulnerable to climate change problems with global warming 20% faster than the global average (UNEP, 2024). This urges the necessity to accelerate climate mitigation efforts and the implementation of green public tools for a sustainable financing of green transitory efforts. Despite recorded progress, SMCs are still lagging in the mainstreaming of green and sustainable development principles into their economies (European Institute of the Mediterranean, 2021). (2) With the recent wave of rising prices of energy inputs and growing concerns about the climate crisis, researchers and policymakers stress on the urge to shift away from the massive use of fossil fuels and transit towards more sustainable and efficient energy systems (Capozza et al., 2021). (3) Focusing on SMCs is crucial because they currently account for 40% of the Mediterranean region's energy demand, which is projected to expand to 61% by 2050 with their energy consumption in industry set to increase by 53% during the same period. (4) From 1970 to 2018, CO2 emissions from fuel combustion more than doubled in the Mediterranean region, and the SMCs

327 Enhancing energy efficiency represents more than 40% of the emissions abatement needed by 2040 (International Energy Agency, 2021).
328 We follow the EU classification to identify the Mediterranean countries (European Environment Agency, 2015). For the country of Palestine, we use the terminology that refers to the geographical region of West Bank and Gaza as obtained from the EBRD-EIB-WB enterprise surveys 2018-2020. It refers to the districts of West Bank (including East Jerusalem and Gaza Strip).

are projected to expand their share of the region's CO2 emissions to 67% by 2050[329]. Thus, these projections and assumptions show that SMCs must prioritize their energy efficiency transition for their economies to embark upon the path of carbon neutrality.

The chapter is divided as follows. Section two presents the literature review and the knowledge gap we aim to address. Section three discusses the data and the stylized facts of the seven SMC countries' context regarding energy taxation and innovation. Section four is dedicated for explaining the adopted methodology. Section five analyses the main empirical findings. Section six presents the policy implications. Section seven concludes.

2. LITERATURE REVIEW AND THE KNOWLEDGE GAP

In the process of examining the impact of environmental regulations on firms' performance, researchers provide evidence that a stringent and well-designed MBI regulation incentivizes firms to introduce and adopt environmental innovations that improve productivity gains, partially/fully offset compliance cost, and even enhance the competitiveness of firms (Porter & Van der Linde, 1995). Environmental innovation is defined as "a new or significantly improved product (good or service), process, organizational method or marketing method that creates environmental benefits compared to alternatives." (European Commission, 2008). It facilitates decreasing environmental damage and pollution associated with resources use (e.g. intensive energy inputs) (Clementi & Garofalo, 2023). More specifically, energy innovations are classified as a sub-category of environmental process innovation[330], which aims at reducing energy and/or material use (Clementi & Garofalo, 2023). Two main types of energy-related innovation are identified: energy efficient innovation in technologies that reduce total energy consumption (upgrading machinery, improving lighting systems, etc.) and renewable energy innovation that replace fossil fuel-based technologies with renewable energy sources (solar, wind, geothermal, etc.) (Capozzo et al., 2021; Wu, 2023).

A wide strand of literature focuses on identifying main determinants of businesses' environmental innovations. Firm decision to environmentally innovate is affected by set of its internal factors (financial resources, technological capabilities, organizational innovation, and green knowledge) and external stakeholder pressure (regulation, demand-pull effect, sectoral environmental practices and agreements) (Krammer, 2009; Song & Oh, 2015; Šūmakaris et al., 2021). In the same sense, a subfield of environmental innovation literature studies key drivers of innovation in specific fields of renewable and efficient energy resources. In general, energy innovation is triggered by structural characteristics, intensive energy use, internationalization, innovative and technological capacities, green awareness and management; environmental market demand, regulatory pressure (Costa- Campi et al., 2015; Song & Oh, 2015; Garrone et al., 2014; Clementi & Garofalo, 2023). When

329 The Observatoire Méditerranéen de l'Energie (2021) projections are based on the following assumptions: (a) SMCs receive no international financing or other aids; (b) increased demand for electricity continues to be met with the traditional primary energy sources and others available in the future; (c) SMCs neither implement strong energy efficiency programs and nor diversification in their energy mix based on their submitted NDCs of each country; and (d) SMCs do not develop new clean fuels and renewable energy technologies substituting to oil and coal input in electricity generation capacity to curb carbon dioxide (CO2) emissions.
330 Environmental process innovations are divided into two main types. First, end-of-pipe (EP) technologies that curb emissions by implementing add-on measures or devices (e.g. pollution abatement filters). Second, clean production (CP) technologies that are integrated into the production process to reduce resource use and pollution at the source by using cleaner products and production methods (e.g. switching to renewable energies from fossil sources, recycling of materials and waste, etc.) (Frondel et al., 2004). Existing empirical evidence supports that CP technologies are superior from an environmental and economic point of view because they lead to reductions in both pollution levels and energy and resource inputs use (Clementi & Garofalo, 2023).

it comes to specific analysis of regulatory drivers, some studies examine the green innovation effect of different environmental regulations, while differentiating between the command-and-control (CAC) regulations and (technology and performance standards) and market-based instruments (MBIs) (environmental taxes, environmental subsidies, tradable emission permits) (Williams, 2012; Ren et al., 2021; Stucki et al., 2018). Existent evidence suggests that MBIs are more advantageous in generating cost-effective allocation and motivating the introduction of CP technologies across pollution-heavy firms (Stavins, 2001; Rozendaal & Vollebergh, 2021). This effect is valid as long as its implementation is not lax (Garcia-Quevedo et al., 2022). With recent surge in policy-driven environmental interventions to ration firms' fuel-based energy consumption, evaluation of environmental policy effect extends to eco innovation in energy context. Some scholars dedicate their analysis to uncovering the firm level environmental regulation-energy innovation nexus, yet existing evidence is quite scant and with contrasting results. On one hand, policy incentives like technology standards, tax measures, voluntary agreements, and public subsidies are significantly effective in fostering innovation in energy-efficient and renewable energy technologies (Neesta et al., 2014; Woerter et al., 2017; Hille et al., 2020; Du et al., 2022). Besides, firms increase their investment in resource efficiency technologies in anticipation of future changes in the CAC legislation (Moreno-Mondéjar & Cuerva, 2020). On the other hand, some arguments provide no support for the effective impact of regulations and environmental taxation in triggering innovative energy-efficiency investments (Garrone et al., 2014; Capozza et al., 2021). Further evidence stresses on the complementary role of investment subsidies and tax credits (Garcia-Quevedo et al., 2022), market-pull factors, internal technological capabilities (R&D), and internal environmental awareness (Segarra-Blasco & Jove-Llopis, 2019) to enhance energy innovation.

Upon this review, the contribution of this chapter is threefold: (1) Unlike previous work that tackles policy instruments-energy innovation nexus (Capozza et al., 2021; Hille et al., 2020; García-Quevedo & Jové-Llopis, 2021), **it adds to the limited examination of energy innovation specificity, particularly in relation to energy taxation that aim to reduce the impact of energy consumption in production. (2) We undertake a new empirical investigation** that uncovers to what extent imposing energy taxes can drive firm-level innovation in technologies and processes that require less energy. Thereupon, in comparison to existing analyses that focus on energy innovations in general (Woerter et al., 2017; Segarra-Blasco & Jove-Llopis, 2019), we narrow our analysis to process innovation in clean production techniques that lead to energy efficiency improvements. (3) We conduct a **cross-country analysis for firms in seven SMCs** (Egypt, Jordan, Lebanon, Morocco, Tunisia, Türkiye, and West Bank and Gaza), which is novel in the literature that is mostly based on single-country analysis (García-Quevedo & Jové-Llopis (2021) in Spain, Clementi & Garofalo (2023) in Italy, and Deng et al. (2023) and Cao et al., (2024) in China). Besides, cross-country examinations of firm-level engagement in specific environmental upgrades is still not well developed (Segarra-Blasco & Jove-Llopis, 2019; Hill et al., 2020; Capozza et al., 2021). To our knowledge, no previous evidence of innovative ramifications of energy taxation has been provided in Mediterranean or North African countries, prior conclusions are for European countries (Capozza et al., 2021).

3. DATA AND STYLIZED FACTS

3.1 Data Description

The main research question we want to address is "to what extent imposing energy taxes can drive firm-level innovation in technologies and processes that require less energy?". For this purpose, we conduct ***a cross-country analysis*** for firms in Egypt, Jordan, Lebanon, Morocco, Tunisia, Türkiye, and West Bank and Gaza using firm-level data from the EBRD-EIB-WB enterprise surveys for the latest years 2018, 2019, and 2020[331]. We focus on 6,952 firms operating in the manufacturing, retail and service sector. The sample includes 3,052 Egyptian, 1,610 Turkish, 530 Lebanese, 904 Moroccan, 602 Tunisian, 598 Jordanian, 360 West Bank and Gaza firms. In terms of industry of operation, 2,445 firms are retail, 2,445 are manufacturing and 4,447 are functioning in the service sector. Notably, we limit the analysis to privately owned firms, either foreign or domestic, and exclude government owned ones since they represent only 3% of the sample and are not consistently representative.

3.2 Stylized Facts and Overview of the Selected SMCs

Countries in the Southern Mediterranean region are strongly engaged in addressing energy-efficiency issues and developing their renewable energy strategies. Moreover, the geopolitical tensions amid the Russia-Ukraine war have sparked concerns about the global energy crisis, placing energy transition at the Center of Euro-Mediterranean relations (European Economic and Social Committee, 2023). Table (1) presents some energy indicators in six SMCs[332] with reference to Europe. Regarding energy-related CO2 emission[333], Egypt and Türkiye are top emitters, whereas the rest of SMCs emit lower CO2 levels compared to European countries[334]. Different types of factors would explain the latter findings.

First, Egypt and Türkiye together represent more than 60% of electricity consumption in the South Mediterranean (Observatoire Méditerranéen de l'Energie, 2021). Also, electricity and heat production, transport and industry account altogether for 50 % of these emissions in both countries, since they rely on the extensive burning of fossil fuels (e.g. coal, oil and natural gas) for power generation or fuelling vehicles and machines (International Energy Agency, 2024a).

Second, the share of fossil fuel subsidies in GDP is higher in Egypt and Türkiye compared other SMCs[335], which explains the overuse and consumption of polluting fossil fuels in both countries.

Third, more specifically for Egypt, the country was the third-largest emitter of CO2 emissions in the MENA region, following Iran and Saudi Arabia (World Bank, 2022). The country is among the most diversified economies in the MENA region across farming, industry, tourism and service sectors. The economy has grown to be the sixth-largest in the MENA while highly relying on nurturing manufacturing industries that account for more than 40% of its GDP. Yet, the expansion of manufacturing sectors has been tightly tied to unlimited growing energy demand of fossil fuels. Egypt is Africa' biggest natural gas and oil user, it represents more than 20% of overall oil demand and more than 40% of natural gas consumption (Raihan et al., 2023). A

332 Data of West Bank and Gaza are missing.
333 Data of energy-related CO2 emissions per capita is not available.
334 The top three emitters European countries such as Germany (612 Mt CO2), Italy (310. 29 Mt CO2), and United Kingdom (309.42 Mt CO2).
335 As of 2025, the shares of fossil fuel subsidies are 30.2% in Egypt, 15.05% in Türkiye, 9.07% in Tunisia, 8.81% in West Bank and Gaza, 7.25% in Lebanon, 6.29% in Morocco, and 4.87% in Jordan (World Bank, 2025).

wide array of Egyptian industries qualifies as environmentally-degrading such as electricity, gas and water non-metallic mineral products, basic metals, rubber and plastic products, cement, chemical products, paper products, food, transportation and storage, and textiles (Al-Ayouty, 2025). For instance, in 2022, coal combustion in cement production caused around 9 million metric tons of CO_2 emissions (Sayad et al., 2023).

Fourth, Türkiye accounts for two-third of coal use in the region (Observatoire Méditerranéen de l'Energie, 2021). In addition, while rapid increases in its energy-related CO2 emissions are mainly linked to the intensive use of oil and coal in power generation, and industry and transport, population growth, urbanization and industrialization have also intensified demand for the increasing use of natural gas for energy supply (OECD, 2021). For energy intensity and energy supply[336], we find that, compared to Europe, SMCs are greatly relying on energy to generate one unit per output, and these countries rely on natural gas for energy generation (Egypt and Tunisia), oil (Jordan, Lebanon and Morocco), or on multiple sources such as coal, natural gas, and oil (Türkiye) for energy supply (Energy International Agency, 2024a)[337]. Nonetheless, there is evidence that some SMCs (Türkiye and Jordan) rely also on renewable energy sources.

Finally, the most contributing sectors to energy consumption in SMCs and in Europe are transport, residential and industries, accounting altogether for more than 60%.



336 Energy intensity is the ratio between energy supply and gross domestic product measured at purchasing power parity. Lower ratio indicates that less energy is used to produce one unit per output. It is used to track progress on global energy intensity (International Energy Agency, 2024b).
337 For Europe, the data shows that there is still great reliance on polluting energy sources mainly oil and natural gas. Yet, Europe is on its way to using more clean energy sources such as nuclear power and biofuels and waste, followed by renewable energies.

		Egypt	Jordan	Lebanon	Morocco	Tunisia	Türkiye	Europe
Energy-related CO2 emissions (Mt CO2)		217.81	21.35	9.43	67.17	26.38	389.98	1 092.34
Total energy supply per unit of GDP (PPP) (MJ/ thousand 2015 USD)		2763.29	3558.78	2386.48	3056.36	3809.99	2 260.872	1 585.55
Total energy supply by source (%)	Coal	1.79	2.66	2.95	31.74	0.00	26.11	13.55
	Natural gas	51.70	41.36	0.00	0.86	48.93	26.25	24.66
	Nuclear	0.00	0.00	0.00	0.00	0.00	0.00	10.77
	Hydro	1.24	0.02	1.68	0.13	0.01	3.48	2.62
	Wind, solar, etc.	0.91	7.68	4.91	3.62	1.07	11.62	5.42
	Biofuels and waste	3.27	1.16	4.22	5.64	9.82	3.38	10.66
	Oil	41.10	47.11	86.24	58.01	40.17	29.17	32.32
Total final energy consumption by sector (%)	Industry	25.59	16.25	8.85	18.51	24.39	29.59	23.50
	Transport	30.61	41.55	70.52	35.07	31.93	26.73	28.46
	Residential	20.22	26.12	14.34	27.47	27.02	22.15	24.63
	Commercial and public services	6.11	8.17	2.49	8.57	8.55	12.69	12.04
	Agriculture / forestry	2.64	3.68	0.00	7.71	6.14	4.35	2.77
	Fishing	0.00	0.00	0.00	0.00	0.00	0.12	0.18
	Non-specified	0.15	3.62	3.18	0.00	0.00	0.00	1.06
	Non-energy use	14.69	0.61	0.63	2.68	1.96	4.38	7.36

TABLE 1

Energy indicators of the SMCs and Europe, 2022

Source : Authors'own elaboration using data from International Energy Agency (2024a).

Table (2) draws on data from the WBES and presents the status of energy taxation, energy innovation and adoption of energy efficiency measures by firms from the SMCs and the EU. The data shows that the share of firms that are levied an energy taxation is very low in the EU and SMCs, with the exception of Tunisia, Jordan, and Türkiye. Also, while the evidence shows that few firms undertake energy efficiency measures, more than 50% of firms in Jordan, Lebanon, Tunisia and West Bank and Gaza argue that they undertake energy-efficient innovations, which is relatively high compared to the EU firms. Finally, our data reveals that firms that have internal energy management measures constitute 41% of the sample and only 8% of sampled businesses have consumers with environmental requirements.

	Egypt	Jordan	Lebanon	Morocco	Tunisia	Türkiye	West Bank and Gaza	Europe
Energy efficiency measures (%)	8.97	18.58	16.13	20.16	12.87	35.52	11.39	27.38
Energy innovation (%)	43.82	66.36	57.48	45.38	62.64	48.08	62.28	56.45
Energy tax (%)	19.26	29.27	7.78	12.86	40.5	26.17	4.58	7.3

TABLE 2

Energy taxation, energy innovation, and efficiency measures in firms from SMCs and the EU

Source : Authors'own elaboration using data from WBES. Notes: Weights are used.

Ambitious action plans but slow energy transition in the SMCs

The Mediterranean region as a whole is engaged in the decarbonization of its economies and the SMCs are engaged in a long process for enhancing their energy efficiency and have put in place national energy strategies, national energy efficiency action plans (NEEAPs) and renewable energy action plans, in addition to allocating investment funds to promote sustainable energy practices. They have also set some ambitious targets for energy efficiency levels, with some examples including Egypt and Jordan, which aim to reduce energy consumption by 18% by 2030; Türkiye, targeting a 16% reduction by 2030; and Tunisia, aiming for a 30% reduction by 2030 (meetMed, 2019; Ministry of Energy and Natural Resources, 2024). By contrast, targets for other countries such as Morocco and West Bank and Gaza included reductions of 20% by 2030 and 5% by 2020, respectively. For Lebanon, its national energy efficiency action plan aimed at a level of 5% savings in the total electric power demand in 2020. The NEEAPs also specify the energy reduction targets across different economic sectors such as construction, transport, industry, commercial and public services, agriculture and forestry (meetMed, 2019).

Nonetheless, the efforts are not equal in the Northern and in the Southern regions for three reasons. (1) The outcomes of decarbonization in SMCs are uncertain given the political, economic, and social turmoil that constrain the developments of their energy systems. (2) SMCs are still highly dependent on carbon-intensive industries and continue to rely on fossil fuels to meet their energy needs (European Institute of the Mediterranean, 2024). Also, while the Northern and Southern regions were using the same amounts of hydrocarbons in 2018, the North's share in total Mediterranean hydrocarbons is expected to decline from 51% in 2018 to less than 20% in 2050, whereas the South's share is expected to increase with Türkiye and Egypt being the largest producers and users of fossil fuels. (3) The SMCs are witnessing rapid electricity demand growth in the industrial, residential and transport sectors with Türkiye and Egypt representing more than 60% of the total electricity consumption in the South region and are expected to witness an average annual growth rate of 2.7% in electricity demand between 2018 and 2050 (Observatoire Méditerranéen de l'Energie, 2021).

Challenges and obstacles to energy efficiency

SMCs have laid foundations of supporting schemes and measures for their energy efficiency efforts. Egypt, Jordan, Lebanon, Morocco, Tunisia, and West Bank and Gaza have established energy efficiency funds that provide firms and businesses with loans, grants and subsidies to invest in energy efficiency projects, which promote energy savings, renewable energy technologies, awareness raising campaigns and market competitiveness (meetMed, 2019). Türkiye has developed a commercializing Sustainable Energy Finance program in cooperation between the International Finance Corporation and Turkish Financial Institutions (United Nations, 2024). Also, Egypt, Jordan, Morocco, Tunisia, and Türkiye have implemented a scheme for the provision of fiscal incentives (e.g. tax credits, tax reductions and tax exemptions) that reduce the overall costs of the energy efficiency investments.

Yet, these countries face many challenges that slow the implementation of their energy efficiency action plans. The meetMed (2019) categorize these challenges into three groups, (1) Information barriers that are mainly related to the lack of energy data, low dissemination of energy efficiency benefits, and low awareness among different entities of the importance of enhancing energy efficiency, (2) Technical barriers due to lack of capacity of the private sector to develop energy efficiency products and services, lack of accredited equipment testing laboratories, and lack of monitory and evaluation for previous projects, (3) Governmental barriers due to the shortage of financing solutions, coordination problems among governmental agencies and ministries that hinder the decision-making process, the weak enforcement of the regulatory framework, and the existence of energy subsidies that reduce energy prices for consumers, inhibiting business energy efficiency initiatives across different sectors.

4. METHODOLOGY

To empirically examine the impact of energy tax on energy innovation, we construct the following multiple regression model:
where:

$$EnergyInnovation_{isct}=\beta 0 + \beta 1\ EnergyTax_{isct}+ \varphi X_{isct}+\gamma_s+ \alpha_c +\Theta_t+\varepsilon_{isct}$$

and year, respectively,

- γ_s and α_c (industry and country fixed effects): these account for differences in technology progress, industrial policies, market mechanisms, and institutional characteristics across industries and countries. This ensures the analysis is not skewed by these variations,
- Θ_t (time fixed effects): these capture broader time-specific factors, such as global economic trends or major policy changes, that could influence innovation,
- ε_{sct} is the error term, representing random variations not captured by the model.

We have two main variables of interest: energy innovation and energy taxation. Energy innovation is a dummy variable that equals 1 if a firm undertakes at least one energy innovation practice in its production process and 0 otherwise. Five innovation activities in energy efficiency are defined: heating and cooling improvements, lighting system improvements, machinery and equipment upgrades, vehicle upgrades, and climate-friendly energy generation on site. We follow Moreno-Mondéjar & Cuerva (2020) and Wu (2023)'s identification of energy tax as one dimension of external management enforced by an external stakeholder that is the government. The main independent variable of energy tax is proxied by a dummy that takes the value of 1 if the firm is subjected to an energy tax and 0 otherwise.

Vector X of control variables is identified based on findings of recent studies on firm-level environmental innovation determinants, in general (Inoue et al., 2013; Capozza et al., 2021; Šūmakaris et al., 2021; Rhaiem and Doloreux, 2022), and energy efficiency upgrades in particular (Song & Oh, 2015; Garrone et al., 2018; Chao & Hong, 2019; Chappin et al., 2020; Zhang et al., 2020; Li et al., 2021; Ren et al., 2021; Xue & Wang, 2021; García-Quevedo et al., 2022; Du et al., 2022; Zhou et al., 2022; Clementi & Garofalo, 2023; Wu, 2023). Given the data at our disposal, we specify as many environmental innovation factors as possible to reduce the possible effect of omission bias in our empirical analysis. Thus, we include the following control variables:

- (1) Firms' internal environmental management is referred to as internal organizational non-productive measures. It is added as a dichotomous variable that takes value of 1 if a firm embraces any of energy-related management measures of setting energy target, monitoring its energy consumption, enhancing its energy efficient measures over the last three years and appointing an environmental manager.
- (2) Firms' technological and innovation capacities are proxied by whether the firm has spent on R&D activities in the last three years.
- (3) Energy intensity is calculated as the share of energy costs (coal, electricity, fuel) in total sales, showing how dependent the firm is on energy.
- (4) Encountering competition from informal firms may pressure formal firms to innovate in energy saving to maintain its market share. Informal competition is accounted for by a binary variable that takes value of 1 if practice from informal competitor poses severe or major obstacle to firms.
- (5) As one of the main structural characteristics, firm size is included as dummy variables for different sizes depending on the number of full-time employees[338].
- (6) Firm's age is defined by the number of years since its establishment. It is calculated as the natural logarithmic of the subtracted value of the firm's establishment from the survey year.
- (7) Constrained financial capacity is a relevant obstacle to firms' environmental innovation. Access to finance is measured by whether the establishment have a line of credit or a loan from a financial institution.
- (8) Access to worldwide technology enhances productivity and innovative capacities, which is related to how close firms are to the foreign markets (De Loecker, 2013).

338 For Europe, the data shows that there is still great reliance on polluting energy sources mainly oil and natural gas. Yet, Europe is on its way to using more clean energy sources such as nuclear power and biofuels and waste, followed by renewable energies.

- (9) Firms' internationalization is proxied by share of exports of total annual sales for the firm's internationalization.

The baseline model is extended in two ways to consider the complementary role of other driving forces for eco-innovations and define mediator factors for the relationship.

First, we allow for the influence of external pressure related to demand-pull effects[339]. With rising awareness of climate change and environmental protection rationales, energy innovation is likely to be triggered by increasing demand for less energy consuming technologies by both firms and consumers (Russo & Perrini, 2010; Chao & Hong, 2019; Capozza et al., 2021). Upon this, we believe that the variable of whether a firm's customers require environmental certifications or adherence to certain environmental standards matters to eco-friendly energy advancements (Wu, 2023).

Second, we estimate subsample regression to draw inferences on the underlying heterogenous and moderator factors like firm-level voluntarily energy stewardship and industry-level intensive energy consumption[340]. Further analysis is conducted to uncover the implications of encouraged corporate energy friendly innovation on its environmental footprint. Innovation in energy efficiency is one form of firm-level source control measures to reduce its pollution emissions by reallocating the structure of production inputs and improving production process (Du et al., 2022). Given data limitations[341], we replace the main dependent variable of energy efficient innovation with another dummy capturing the undertaken energy innovation actions that are internally believed to minimize firms' environmental impact. To construct a measure for perceived environmental gains from energy innovation, we follow the league of Paschoaleto and Martínez-Zarzoso (2024) by relying on firms' response to survey question of Which of environmental measures contributed the most to reduce the company's negative environmental impact? Hence, main dependent variable takes 1 not only if firm adopts any of the beforementioned innovation practices but also if it identifies it as instrumental in reducing its adverse environmental footprint. It is worth mentioning that baseline and sub sampling regression are estimated for sampled firms across all sectors and for each of manufacturing and non-manufacturing businesses to reach sectoral-specific empirical findings. Moreover, independent probit regressions are conducted to specifically identify the effect of energy tax imposition on the probability of innovating each energy efficient innovation measure.

Therefore, the empirical analysis aims to test three main hypotheses: H1: Energy taxation is positively associated with firm-level energy-efficient innovation. H2: Pressure from external stakeholders (customers) favourably drives firm-level energy-efficient innovation. H3: energy tax effect on energy efficient innovation is more evident among firms with voluntary environmental management.

Given the dichotomous nature of the dependent variable (i.e., it takes only two possible values: 1 if the firm adopts energy-efficient innovation and 0 otherwise), the most appropriate empirical technique is the probit regression (method used to model binary outcome variables). We believe that pooled cross-sectional analysis is the best fit, since the survey comprises independently sampled observations in each time-period[342]. An essential empirical remark worth mentioning is that we pool data for different countries and years, and so country-sector fixed effects are added to control for unobservable factors at the country-sector levels. This is mainly attributed to sectoral different characteristics in

339 Assessing the effect of external demand pressure to adhere to environmental standards and certifications could be better accounted for by using a continuous variable for the intensity of market demand pressure. But due to data limitation, a binary proxy is used for whether the firm faces this external pressure from its customers or not.
340 We follow the work of Akbostanci et al. (2007) and Du et al. (2022) to identify firms that operate in energy intensive industries based on the median value of sub-sector energy intensity. Around 66% of firms belong to sub-sectors with intensive energy expenditure metrics exceeding median value. Also, firms that function in sectors that are subjected to EU-ETS are considered as operating in energy intensive industries like paper production-based sectors (Borghesi et al., 2015).
341 We lack quantified data on co2 emissions to conduct typical median effect analysis with co2 emission intensity measure as proxy for firm-level environmental performance
342 We employ cross-sectional analysis because we use pooled data of individual firms that are independently surveyed across three years 2018, 2019, and 2020. Since the survey lacks data of same firms repeatedly tracked over time, we are unable to employ panel data approach that allows for dynamic causal analysis and simultaneously account for the complexities of individual firms' characteristics and time. Panel data is particularly favorable when it comes to tackling unobserved cross section heterogeneity, yet we make sure to control for it via instrumental variable approach at a later stage in robustness checks.

each country, including energy taxation imposition. However, baseline results might be subjected to endogeneity bias (a situation where independent variables are correlated with the error term, potentially leading to biased results) due to omission bias and reverse causality[343] (Nesta et al., 2014; Hille et al., 2020; Du et al., 2022). To control for potential endogeneity, we opt for an instrumental variable approach[344] (identifying variables that influence the independent variable but are not directly related to the dependent variable) where energy taxation is instrumented by a shift share variable of energy taxation aggregated by country-year-sector minus the firm's own status on subjection to energy taxation. Energy taxation that is corrected from individual firm characteristics and aspects is expected to affect levying energy tax on firms without having a direct impact on energy innovation[345]. Finally, we check for robustness of baseline estimates by using different sensitivity analyses: (1) Alternative variables for few independent variables are considered like size, financial accessibility, and firm's internationalization. (2) we add more controls to the baseline and re-estimate the baseline equation such as the role of governmental integration as an investor in the markets and human capital as captured by the total number of highly educated permanent workers.

5. EMPIRICAL RESULTS

In Table 3 presents the empirical outcome of estimating baseline model to uncover the effect of imposing energy tax on the probability of firms' pursuit of innovation in their energy efficiency. Column 1 shows the positive significant effect of levying energy tax on firms' energy efficiency innovation in SMCs. The marginal effect of changing the subjection to energy tax from 0 to 1 on SMC firms' energy efficient innovation increases by 22 percentage points. We extend the model in column 4 to allow for the influence of demand-pull effects, as one dimension of stakeholder pressure on adopting eco-friendly energy advancements. Energy tax retains its significant effect on energy efficiency innovation. Customers' environmental requirements appear to have considerable impact on energy efficient innovation by around 30 percentage points. However, the magnitude of the energy tax effect substantially declined amid adding the demand-pull factor. This reduction demonstrates that the relation under study is partially mediated and influenced by the customers' environmental requirement, reflecting the importance of market-related factors in clarifying the underlying analysis.

Regarding other control variables' effect, green capabilities in terms of introducing energy management within the firm positively add to business potential for innovation in sustainable energy solutions (Costa-Campi et al., 2015; Šūmakaris et al., 2021). Higher technological and innovative capacity (R&D) significantly implies greater probability of energy efficient innovation (Borghesi et al., 2015; Costa-Campi et al., 2015; Šūmakaris et al., 2021). Seamless access to finance stimulates development of resource efficient innovation (Šūmakaris et al., 2021; Du et al., 2022). Competition from unregistered entities significantly induce firms to reduce their energy intensity by adopting resource efficient innovation (Zhao et al., 2022; Herdia et al., 2024). Larger and younger firms are significantly more up to innovating in reducing their energy intensity (Capozza et al., 2021; Du et al., 2022). The limited impact of a company's energy intensity on the incentive to innovate may be explained by the fact that it may be less costly in the short term to purchase more energy than to bear the often high initial costs associated with technological or organizational innovation aimed at reducing energy intensity. Surprisingly, direct exports and foreign ownership exhibit no significant impact, which could perhaps be explained by the fact that these factors do not always necessarily guarantee the transfer of technologies or innovative practices related to energy efficiency. It is essential to pinpoint that the positive effect of energy tax on energy-saving innovation is specifically evident for innovation measures of lightening and heating improvement systems,

343 According to the mutual reinforcement effect (Downing & White, 1986) innovative firms in clean energy historically gain more lobbying powers towards policy makers which induce reverse causality bias.
344 Notably, we use extended probit regression since the endogenous is bivariate and does not fit the typical IV regressions. Still all used instruments have been checked against endogeneity, and overidentification to abide by the exclusivity criteria.
345 We use firm-level lobbying behavior as another instrument for robustness. The instrument is dummy that takes 1 for lobbying effort by firms belonging to organized sectors (business associations or trade unions) to influence state decision making process, including its subjection to energy tax, and 0 otherwise (Anger et al., 2015; Aboushady & Zaki, 2024).

and vehicle updates (See Table 9 in Appendix). Before delving into further empirical examination, we make sure that the baseline energy tax estimates are not contaminated by reverse causality or omission bias. The extended probit estimates of instrumenting the potential endogenous energy tax variable with two distinct instruments, separately, reveal robust positive effect on energy efficiency innovation (See Table 7 in Appendix). Moreover, energy tax maintains its significance when different proxies are used for main key variables and more controls are added to equation (1) (See Table 8 in Appendix). The baseline empirical results validate the study's main hypothesis that energy tax can incentivize firms' inclination to innovate in reducing



Variable	(1) All sectors	(2) Manufactu-ring sector	(3) Non-manufacturing sector	(4) All sectors	(5) Manufacturing sector	(6) 0.607*
Energy tax	0.638***	0.291	0.856**	0.437**	0.168	(0.323)
	(0.230)	(0.207)	(0.346)	(0.211)	(0.209)	0.939
Energy intensity	0.817	-0.644	1.473*	0.375	-0.728	(1.030)
	(0.634)	(0.759)	(0.887)	(0.762)	(0.731)	0.160
Internal energy management	0.303**	0.521***	0.155	0.267**	0.436**	(0.172)
	(0.128)	(0.183)	(0.179)	(0.127)	(0.182)	1.042***
Market Demand				0.905***	0.643***	(0.214)
				(0.178)	(0.220)	1.628***
R&D	1.512***	1.461***	1.582***	1.529***	1.392***	(0.301)
	(0.179)	(0.181)	(0.298)	(0.184)	(0.183)	0.260
Financial access	0.329**	0.355**	0.272	0.306**	0.338**	(0.171)
	(0.131)	(0.161)	(0.177)	(0.128)	(0.168)	0.243
Informal competition	0.171	0.116	0.175	0.233**	0.162	(0.164)
	(0.120)	(0.142)	(0.171)	(0.117)	(0.140)	-0.0105***
Direct exports	-0.00295	-0.00295	-0.00616*	-0.00501**	-0.00339	(0.00333)
	(0.00209)	(0.00254)	(0.00338)	(0.00219)	(0.00255)	-0.00208
Foreign ownership	-0.000760	0.000395	-0.00185	-0.000545	0.00134	(0.00580)
	(0.00408)	(0.00273)	(0.00548)	(0.00418)	(0.00280)	1.046***
Large firm	0.411**	-0.149	1.018***	0.440***	-0.151	(0.257)
	(0.172)	(0.173)	(0.263)	(0.162)	(0.165)	0.123
Small firm	-0.0497	-0.192	0.0822	-0.0230	-0.172	(0.189)
	(0.156)	(0.159)	(0.215)	(0.138)	(0.155)	-0.00739
age	-0.00749**	-0.00656*	-0.00905	-0.00595*	-0.00560	(0.00567)
	(0.00353)	(0.00363)	(0.00574)	(0.00343)	(0.00341)	-0.977***
Constant	-0.484*	-0.220	-0.884**	-0.576**	-0.319	(0.361)
	(0.266)	(0.341)	(0.362)	(0.247)	(0.311)	Yes
Country-sector fixed effect	Yes	Yes	Yes	Yes	Yes	Yes
Time fixed effect	Yes	Yes	Yes	Yes	Yes	2,197
Observations	5,750	3,543	2,207	5,727	3,530	

*Robust and clustered standard errors in parentheses *** is for p-value <0.01, ** p-value <0.05, *p-value <0.1*

TABLE 3

Probit baseline and demand-pull extension results for energy-efficient innovation

their energy intensive consumption. To assess whether this effect holds when considering enterprises' heterogeneity, a subsample regression method is employed where the main sample is divided into environmental self-regulated versus non-self-regulated firms and firms operating in the energy intensive sector versus firms belonging to less energy intensive industries. The first subsample regression in Table 4 focuses on energy tax-induced innovation across different firm-level self-rule energy management practices. In view of the natural-resource-based view (Hart, 1995), firms with proactive strategic environmental management draw a systematic pattern with their voluntary actions to limit their environmental impact (Nguyen, 2024). Adopting organizational measures are decisive factors in installing green cost-saving processes (Costa-Campi et al., 2015; Bitat, 2018; Šūmakaris et al., 2021). As expected, the subsample results show that energy taxation significantly prompts innovative behaviour in energy efficiency only among SMC firms with voluntary energy management measures. As an external factor to firm-level innovation decision, the second subsample regression examines whether propensity of energy efficiency innovation is related to sectoral energy intensity. The results show that energy tax triggers innovation in energy efficiency in firms operating in higher energy intensive industries like metal, machinery and equipment manufacturing. The higher the firms' energy expenditure per unit output, the higher the tax-induced energy cost burden and so, the higher the incentive to innovate in energy cost-saving methods (Horbach et al. 2012; Borghesi et al., 2015). On the other side, energy regulation does not exhibit any significant effect on energy efficient innovation in less energy intensive sectors. One possible explanation can be that pollution costs constitute higher shares from the total cost of energy intensive firms than their less intensive counterparts (Du et al., 2022). This is tightly linked to the nature of production in energy intensive sectors where production lines are heavenly dependent on highly energy-demanding machinery and equipment (Macharia et al., 2022). From a firm-level environmental performance perspective, Table 5 presents probit estimates while providing more granularity in identifying energy efficient innovative efforts to mitigate firm-level environmental footprint. Coefficients on perceived environmental impact reduction from energy innovation suggest that energy tax significantly influences firms' tendency to innovate in their energy efficiency only if they recognize it as impactful for reducing their environmental footprint. In other words, energy tax can help improve firm-level environmental performance through energy-specific eco-innovation conditional on a firm's environmental awareness-driven behaviour (Doran & Ryan, 2012; Bitat, 2018).

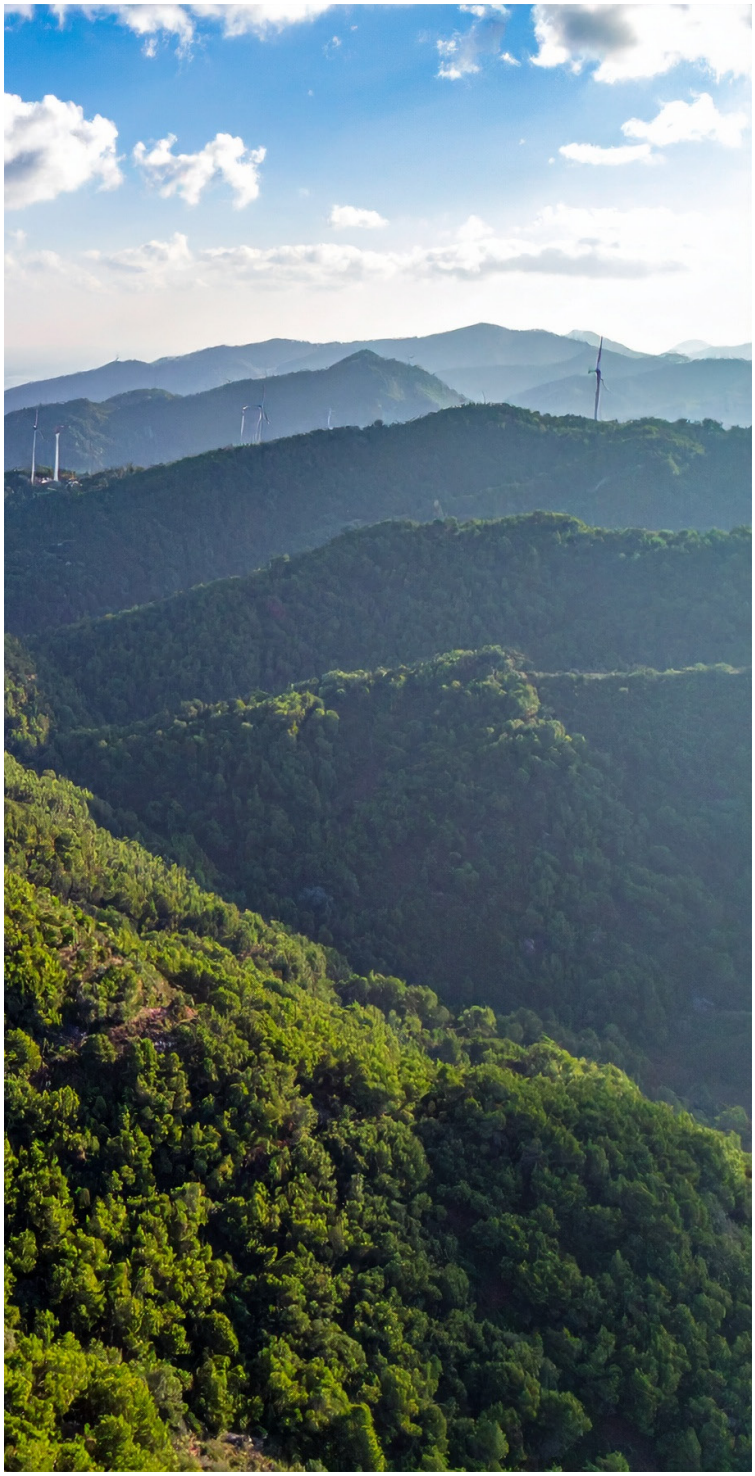
Variable	(1) Environmental self-ruling	(2) Environmental non- self- ruling	(3) Energy Intensive sector	(4) Energy efficient sector
Energy tax	0.719***	-0.120	0.373*	0.509
	(0.278)	(0.133)	(0.224)	(0.351)
Energy intensity	1.596	0.200	0.468	0.290
	(1.146)	(0.888)	(0.711)	(1.159)
Internal energy management			0.271*	0.266
			(0.164)	(0.185)
Market Demand			0.564***	1.145***
			(0.191)	(0.229)
R&D	0.898***	0.713	1.528***	1.586***
	(0.139)	(0.454)	(0.190)	(0.299)
Financial access	1.444***	1.508***	0.221*	0.334*
	(0.251)	(0.322)	(0.129)	(0.200)
Informal competition	0.325	0.303**	0.248*	0.230
	(0.199)	(0.154)	(0.135)	(0.179)
Direct exports	0.339**	0.107	-0.00160	-0.00807**
	(0.172)	(0.169)	(0.00250)	(0.00359)
Foreign ownership	0.000798	-0.00698**	-0.00484	0.00206
	(0.00376)	(0.00278)	(0.00393)	(0.00548)
Large firm	-0.00253	0.00144	0.0244	0.943***
	(0.00379)	(0.00437)	(0.165)	(0.255)
Small firm	0.384*	0.546***	-0.132	0.0809
	(0.222)	(0.201)	(0.139)	(0.205)
age	-0.0458	-0.00765	-0.00297	-0.00873
	(0.188)	(0.152)	(0.00312)	(0.00606)
Constant	-0.00286	-0.00858**	-0.490*	-0.567
	(0.00530)	(0.00360)	(0.251)	(0.374)
Country-sector fixed effect	-0.339	-0.591**	Yes	Yes
Time fixed effect	(0.384)	(0.274)	Yes	Yes
Observations	Yes	Yes	3,913	1,814

*Robust and clustered standard errors in parentheses *** is for p -value <0.01, ** p-value <0.05, * p-value <0.1*

TABLE 4

Probit heterogenous results for energy-efficient innovation

Lastly, heterogenous results across manufacturing and non-manufacturing firms demonstrate that energy taxation's significant effect on energy efficient innovation is obvious among non-manufacturing firms, that is service and retail businesses. Tax-driven innovation in energy efficiency is relevant for the case of manufacturing firms only when innovating entities view their efforts as supportive of ameliorating their ecological footprint. This differential impact can be attributed to structural and operational disparities between both types of firms. Manufacturing firms are more of capital-intensive and continuous production processes, where adapting to regulatory pressures entail disruption and costs that go beyond their resource constraints (Horbach et al., 2012; Ambec et al., 2013). In contrast, service and retail enterprises exhibit more flexible production processes allowing them to develop innovative practices with minimal operational disruptions and opportunity costs (Rennings & Rammer, 2011).



Overall, the results confirm the hypotheses and highlight several implications for policymakers. First, energy taxation serves as an effective tool to accelerate national energy transition strategies in SMCs by encouraging clean energy innovation at the firm level. Second, this market-based instrument (MBI) is particularly effective in promoting energy-efficient production processes within energy-intensive sectors, which are key barriers to the region's decarbonization efforts. Third, the positive impact of energy taxation on eco-innovation is more pronounced in firms that voluntarily manage their energy consumption and are committed to offsetting their negative externalities. Fourth, fostering clean energy innovation at the firm level supports SMCs' commitment to carbon neutrality as part of their pollution control measures. Fifth, unlike non-manufacturing businesses, manufacturing firms are more likely to view energy taxes as a compliance requirement rather than a driver for innovation, unless they consider innovation as a means to reduce their environmental impact.

Variable	(1) Environmental Impact Perceived Innovation	(2) Environmental Impact Perceived Innovation- Manufacturing sector	(3) Environmental Impact Perceived Innovation- Non-Manufacturing sector
Energy tax	0.756***	0.492**	0.964***
	(0.198)	(0.208)	(0.289)
Energy intensity	-0.264	-0.337	0.0861
	(0.840)	(0.882)	(1.229)
Internal energy management	0.393***	0.287**	0.402***
	(0.113)	(0.137)	(0.151)
Market Demand	0.523***	0.677***	0.545***
	(0.119)	(0.189)	(0.164)
R&D	0.325	-0.240	1.162***
	(0.268)	(0.347)	(0.333)
Financial access	0.225**	0.187	0.159
	(0.110)	(0.192)	(0.148)
Informal competition	0.0373	0.175	-0.169
	(0.180)	(0.141)	(0.268)
Direct exports	0.000918	0.00345	-0.00409
	(0.00296)	(0.00294)	(0.00670)
Foreign ownership	-0.00295	-0.00241	-0.00546
	(0.00369)	(0.00246)	(0.00535)
Large firm	0.0321	0.259	-0.394
	(0.259)	(0.290)	(0.608)
Small firm	0.0765	0.00165	0.0565
	(0.179)	(0.230)	(0.201)
age	-0.00514	-0.00568	-0.00728
	(0.00468)	(0.00566)	(0.00685)
Constant	-1.547***	-1.430***	-1.633***
	(0.325)	(0.422)	(0.393)
Country-sector fixed effect	Yes	Yes	Yes
Time fixed effect	Yes	Yes	Yes
Observations	5,698	3,527	2,171

*Robust and clustered standard errors in parentheses *** is for p -value <0.01, ** p-value <0.05, * p-value <0.1*

TABLE 5

Environmental footprint Mechanism results for EEI

6. DISCUSSION AND POLICY IMPLICATION

Our findings show that energy taxation is positively and significantly associated with energy-efficient innovation for all industries in the private sector, and most importantly for the retail and service sectors. The extended analysis precludes that environmental demand factor is of substantial influence on energy innovation. Sub-sample regression results show that, on one hand, firms with proactive environmental self-ruling measures draw a systematic pattern with their voluntary actions to limit their environmental impact. On the other hand, energy tax triggers innovation in energy efficiency in firms operating in high energy-intensive industries like metal, chemicals machinery and equipment manufacturing. Finally, for the manufacturing sector, while baseline regressions show no significant effect of energy taxation, the environmental footprint analysis shows that energy taxation can induce its energy-specific innovation conditional on a firm's environmental awareness. This is because manufacturing firms may perceive tax-induced innovation as disruptive for the production processes unless they recognize their positive effects on their environmental footprint.

In general, our results reflect on SMC countries' readiness to impose and implement energy-efficient measures for different economic sectors. For example, in the construction sector, one of the largest energy consumers in SMCs, energy building codes[346] are better to be implemented at earlier stages of project operation during the design, construction and renovation of residential and commercial buildings while establishing the baseline for the envelope of the buildings, systems and equipment. By contrast, other measures related to energy consumption levels of machinery and appliances could be addressed at a later stage (meetMed, 2019). Except for Lebanon and West Bank and Gaza, the implementation of these codes is mandatory at early stages to optimize the energy load for space heating and cooling in the rest of SMCs (meetMed, 2019). In the industrial sector, some SMCs implement energy-efficiency measures. For instance, Egypt, Jordan, Morocco, and Tunisia have in place mandatory energy audits for relatively high energy-intensive manufacturing industries. The appointment of energy managers is legislated in high energy-consuming facilities in Egypt and Tunisia to optimize power usage efficiency and secure annual energy registries[347]. For the agricultural and forestry sector, it is reported that Moroccan agricultural firms are provided with tailored public programs for optimizing their energy performance and reducing their energy bills through installing energy management systems and adopting cleaner energy sources. Also, Egypt, Jordan, Lebanon, Morocco, Palestine and have established energy efficiency funds to provide firms and businesses with loans, grants and subsidies targeted mainly for investing in energy efficiency projects, deploying renewable energy technologies, raising awareness campaigns and encouraging market competitiveness (meetMed, 2019). Besides, fiscal incentives are available in most SMCs. For instance, while Egypt and West Bank and Gaza provide custom duties exemption, Jordan and Tunisia provide both sales tax and custom duties exemption for the energy efficient equipment. Also, Egypt has recently ratified a legislation that provides tax and non-tax incentives for firms to invest in green hydrogen. These incentives include VAT exemption on equipment, tools, machines, raw materials, supplies, and transportation means needed for initiating the project, a cash investment incentive equivalent to 33% up to 55% of the tax paid on income generated from initiating activities in the project or its expansions and facilitating business licensing and permits (Kamal & Ramzy, 2024). In addition, Morocco suppresses VAT on solar pumping and gives 10% reduction of tax duties on SWH, whereas Lebanon legislated tax exemptions and reductions for electric and hybrid vehicles (meetMed, 2019).

Regarding policy implications that could be derived from our findings, we argue that governments in the Southern Mediterranean countries need to establish a comprehensive regulatory framework for the implementation of different energy efficiency measures that is also coupled

346 Energy building codes consist of minimum standards related to the energy load for space heating and cooling.

with beyond taxation measures and cross-cutting policies. This is mostly preeminent for the case of SMCs which report poor enforcement of regulations and lack of financing solutions as concrete constraints to advancing their energy efficiency (meetMed, 2019). SMCs can enhance the adoption of energy-efficient technologies and accelerate the process of green energy transition through the following improvement areas at the national level.

First, the regulatory framework must encompass well designed incentive-based environmental regulations, namely market-based instruments that would encourage firms to enhance the energy efficiency of their production processes and reduce their carbon footprint. Environmental taxation, that is energy taxation in our case, proves to be an environmentally-friendly public finance tool that encourages firms to adopt energy-efficient innovation. When compared to the CAC approach, MBIs provide firms with static and dynamic efficient advantages. Static efficiency is achieved as firms tend to flexibly choose the appropriate method of enhancing their energy efficiency to minimize their externalities up to the point where marginal cost of green investment is equal to the tax. Dynamic efficiency arises when a taxation instrument propels firms to provide continuous innovation in new technologies for the sake of reducing energy costs over time and fostering long-term enhanced productivity and environmental performance (Fabrizi et al., 2024). Energy taxation implies higher pollution control and energy input costs, inducing profit-maximizing firms to optimize their production processes and alter their energy use structure. Businesses are incentivized to improve their energy efficiency, since it improves their environmental performance, decreases their environmental externalities and results in lower costs in terms of saved taxes. Hence, firms prioritize to carry out energy source control through innovation in low-cost energy-saving technologies and investment in cleaner energy sources such as solar and wind technologies. Process innovation in reducing energy consumption can be in form of measures to isolate the building or parts of the production process, change the steam boiler, improve cooling and lightening systems within the production area, monitor the production process through frequency converters, and increase storage temperature (less needed cooling and so less energy) (Woerter et al., 2017; Du et al., 2022). In addition, based on our empirical findings, we suggest targeting green public finance tools and more specifically energy tax to energy-intensive industries, where higher energy expenditure per unit output incentivizes firms to enhance energy efficiency of its production machinery and equipment to mitigate the higher tax-induced energy cost burden[348]. Notably, the implementation of energy taxation must be coupled with the phasing-out of energy subsidies, which remain relatively high in some SMCs, especially Egypt and Türkiye[349]. Energy subsidies keep energy prices too low, restraining energy efficiency measures. By contrast, when energy subsidies are gradually removed[350], local energy prices become higher, and the value of energy savings increases, making it easier to finance energy efficient investments due to shorter payback periods with high energy prices (meetMed, 2019). Finally, while imposing and enforcing energy taxation is the first policy implication, it is important also to emphasize the importance of setting an appropriate energy tax rate. This is because while energy taxation coupled with other cross-cutting policies may improve the efficiency of the energy system, energy service costs may fall, encouraging firms to overconsume energy, and so a rebound effect prevails. Hence, to offset the latter, an appropriate energy tax rate should be identified and imposed by governments (Benjamin & Alejandra, 2019).

Second, the regulatory framework must be coupled with beyond taxation measures. Despite the implementation of different energy efficiency measures in different economic sectors in the SMCs, they are not mandatory in every country and not very well enforced (meetMed, 2019). Hence, it is important that the regulatory framework includes all detailed technical gui-

348 These results contrast those of Sarker et al. (2020) according to which governments may resort to tax exemptions for high energy-intensive industries to ensure fairness, equity and to safeguard their competitiveness from the negative effects of environmental taxation.
349 As of 2025, the share of fossil fuel subsidies in GDP amounts to 30.2% and 15.05% in Egypt and Türkiye respectively (World Bank, 2025). In fact, Türkiye has announced its plans in early 2025 to phase out its state subsidies for high annual electricity consumption over 5,000 kWh plans, encouraging large energy consumers, specifically industrial firms to adopt energy-efficient practices to cushion increased energy costs
350 While the removal of energy subsidies is politically challenging, governments in the SMCs can simultaneously implement different social welfare programs to protect the most vulnerable and to enhance public trust and adaptation towards such reforms (Plan Bleu & UNEP/MAP, 2024).

delines specific for the implementation of proper energy efficiency measures across different sectors of the economy and for phasing out inefficient systems and products like incandescent bulbs. Also, it is more evident that most SMCs firms operating in the industrial sector do not highly prioritize improving its energy efficiency as they strive to expand investment in its productive capacity (meetMed, 2019). Hence, SMC governments need to ensure the implementation of mandatory energy management norms (ISO 50001 or equivalent) and promote highly efficient industrial equipment and systems such as the cogeneration and trigeneration technologies. They can further encourage the installment of labelling systems for industrial equipment to optimize the use of energy contained in a fuel source. In the agriculture sector, more detailed guidelines for technical issues can include solar pumping projects to reduce energy consumption from diesel generators need to be adopted in most SMCs countries. Furthermore, it is important that the government and business support sectors cooperate to help firms identify energy saving opportunities and periodically monitor their energy management progress. Finally, it is crucial to generalize the adoption of minimum energy performance standards across different sectors of the economy as one of the energy efficiency policy innovations that incentivize firms to innovate in reducing their energy consumption by specifying set of energy consumption requirements for production. Yet, the design of such a policy requires balancing the trade-off between minimizing financial cost of compliance with minimum benchmarks and maximizing energy consumption reductions (Sonnenschein et al., 2019; McAllister & Nase, 2023). Furthermore, most SMCs do not have enough energy service providers with essential competencies to support businesses in identifying potential energy saving opportunities. To that end, governments must emphasize the role of competent energy efficiency service providers and to legalize their embeddedness within firms' operating system and structure. Energy service providers can help firms identify energy-saving investment opportunities and provide them with technical guidelines for installing energy management systems to streamline measuring, reporting, and verification (MRV) their energy consumption.

Third, the regulatory framework should reinforce its beyond taxation incentives with cross-cutting policies to stimulate firm-level energy intensity reduction, while jointly bridging the gap between optimal energy efficiency outcomes and what is actually achieved. Factors like lack of incentives, high cost of energy efficient technologies and equipment, insufficient available financial resources are commonly cited as the most impudent challenges to firm-level adoption of optimizing energy resources and implementing energy efficiency measures. Under such conditions, governments need to develop a comprehensive supporting scheme to enhance firms' technological capabilities and R&D investments in green energy areas. Public supportive scheme should be solidified by a set of public policy interventions, specifically fiscal incentives, like sustainable financial instruments, green subsidies, and tax credit incentives to encourage firms undertake R&D investments in energy related fields. It is imperative to sustain cooperation between governmental entities and business support sector to fill in the financial resource gaps and facilitate firms' access to a wide array of green financing opportunities, such as concessional loans targeted to energy-efficiency investments. One potential approach can be public-private sustainable financing mechanisms that is co-financed by international developmental banks, like EBRD, to provide firms with low-interest green loans, subsidies and VAT and custom duty reduction on energy saving material and equipment. To further cushion financing pressure and catalyse enterprise clean energy investment and innovation, governments can provide firms with better tax schemes (i.e. tax reductions or exemption). An additional proposition is to match reduced fossil-fuel energy subsidies with R&D subsidies. Prior evidence identifies the effective impact of R&D subsidies on firm-level green innovation from a different perspective: First, R&D subsidies compensate for firms' financial shortages and high costs of R&D investment in specific green production process areas that can eventually contribute to reducing its energy consumption per output unit. Green energy related R&D areas are related to automation and smart manufacturing techniques, lean manufacturing process (e.g: optimizing waste heat recovery, process redesign, and energy-efficient

material employment), adoption of lightweight and composite materials in manufacturing (e.g: usage of aluminium alloys in automobile manufacturing and construction), and smart energy management systems (Li et al., 2018; Bai et al., 2019). Second, R&D subsidies can guide the directions of green R&D and reduce the risk of green innovation, specifically in cases of tight compliance with strict environmental regulations. Third, the government R&D subsidies distributed to energy-intensive firms result in differential innovation, marketing positioning, and cost-effective production. Such competitive forces can spur business green energy innovation and adoption of eco-friendly materials and technologies. In this sense, R&D subsidies encourage firms, particularly energy-intensive ones, to practice green energy innovation, introduce advanced clean energy technologies and equipment, and efficiently exploit return on green innovative investment.

While some SMCs already provide fiscal incentives and have in place energy efficiency funds, the effect of these financial support mechanisms is quite limited due to the lack of information about these mechanisms, the limited awareness about the importance of improving energy efficiency, and the insufficient coordination among different governmental entities (meetMed, 2019). Here comes again the importance of resorting to the energy efficiency service providers that could match firms with different types of green financing and improve their awareness of existing financial schemes. Also, governments must cooperate with the business support sector to raise campaign awareness about energy efficiency practices. Finally, it is important to ensure institutional coordination between different governmental entities and to assign them with clear responsibilities to facilitate efficient decision-making.

Fourth and finally, based on our findings, demand-pull market factors and firms' voluntary actions for energy management play a complementary role to energy taxation in enhancing energy-efficient innovation. As such, our conclusions pose two important policy facts.

- Governments can rely on voluntary agreements, as well as energy taxation. These voluntary agreements are "agreements between government and industry to facilitate voluntary actions with desirable social outcome" (Sarker et al., 2020). It aims at reducing the potential negative effect of taxation on firms' competitiveness. Besides, it allows firms to flexibly choose their environmental adaptation process and avoid the high adoption costs of eco-friendly investment. In this case, governments propose a voluntary agreement, and volunteering firms agree upon specific energy consumption levels and may receive a special tax reduction if the target is reached. To this end, governments may also provide some assistance to firms in order to enhance their energy management practices, i.e. the capacity to monitor, report, and verify (MRV) energy consumption levels.
- Furthermore, governments need to recognize the importance of focusing on the demand side for green practices. It is imperative to couple the implementation of energy taxation with campaign awareness about environmentally friendly practices and to encourage the introduction of energy labelling and sustainability certification of final products. These measures would enhance demand for green products and practices, which in turn increase the diffusion of energy-efficient technologies.

At the regional level, SMCs have made some progress since most of their governments already developed their national strategies and priorities for green growth stimulation. SMC economies are signatories of the Paris Agreement, they have updated their nationally determined contributions (NDCs) and adopted their national renewable energy plans for different time horizons. However, there is a strong need for regional cooperation and coordinated actions among SMCs to enhance the effectiveness of their policies and initiatives, which could be achieved through the following steps. ***First,*** SMCs governments need to start harmonizing their environmental regulations to avoid firms relocating their polluting activities from countries with stringent regulations to those with laxer ones. They also need to couple this with the gradual removal or reform of different types of ener-

gy subsidies at the regional level to accelerate their green energy transition. ***Second,*** governments need to accelerate the establishment of a regional voluntary carbon market (VCM) and to secure the use of revenues through the selling of carbon credits for assisting firms in developing clean energy technologies. In response to the implementation of the EU Carbon Border Adjustment Mechanism (CBAM) regulation in October 2023, Egypt has already undertaken a significant step in launching its first VCM dedicated to the registration, issuance, and trading of Certified Emission Reductions (CERs), or carbon credits. Hence, a regional dialogue for the establishment for a regional version of a VCM is highly advised, especially that these countries need to enhance their preparedness to implement more energy-efficient innovation policies, while leveraging on their EU neighbour's initiatives. ***Third,*** one important act of regional cooperation is the creation of networks and platforms for a green dialogue among Mediterranean countries. These regional networks can facilitate countries' communication and knowledge sharing on best practices for energy-efficient technical guidelines, tools and technologies and for the mobilization of resources for climate financing. ***Fourth,*** the development of a regional energy statistics database is highly recommended to provide essential comparable information about implemented environmental taxation rates and energy-efficiency measures to better analyse the countries' action plans and identify the most successful cross-cutting measures for energy efficiency (meetMed, 2019).

7. CONCLUSION

In The main objective of this chapter is to examine the association between energy taxation and energy-efficient innovations. We focus on 6,952 privately-owned firms operating in the manufacturing and non-manufacturing (retail and service) sectors in seven Southern Mediterranean Countries. The main findings show that energy taxation is positively and significantly associated with energy-efficient innovation for all industries in the private sector, and particularly for the retail and service sectors. Our extended empirical analysis shows that market-pull factors (i.e. the external pressure of customers requiring environmental certification) exerts a significant impact on energy-efficient innovation. Also, undertaking efforts to enhance energy management within the firm positively add to business potential for innovation in sustainable energy solutions. Sub-sample regression results show that the positive effect of energy-taxation on firms' energy-efficiency innovation is prevailing only among SMC firms with voluntary energy management measures. Finally, firms that are highly aware of the potential positive effects of energy innovation on their environmental footprints are more likely to exhibit higher tax-induced energy-innovation to accelerate their decarbonization.

These findings suggest that governments in SMCs need to implement a comprehensive regulatory framework that promotes the implementation of incentive-based energy tax to enhance firms' dynamic efficiency and adoption of energy-efficient innovations. Nevertheless, while greenhouse gas emission taxes are more effective when accompanied by strict regulations, certain rules may actually hinder their application, creating contradictions between fiscal and regulatory instruments. They also need to couple the implementation of energy tax with the gradual removal or reform of energy subsidies that remain a real challenge for undertaking energy-efficient measures, whether these subsidies are direct or indirect. Indeed, many energy-intensive sectors benefit from preferential tariffs or tax exemptions, which can sometimes limit the impact of energy taxes and prevent the intended energy innovation incentives from being fully realized. Governments must also focus on the importance of providing firms with capacity building and fiscal incentives to improve their technological capability and overcome their financial constraints, especially for SMEs. In addition, important policy implications could be derived for a better regional cooperation that would help SMCs governments to harmonize their environmental regulations and energy policies on one hand, and to establish a regional network for a green dialogue, facilitating the exchange of green practices and knowledge, on the other hand.

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Appendix

Variable	Obs	Mean	Std. Dev.	Min	Max
energy innovation	7073	.548	.498	0	1
energy tax	7103	.255	.436	0	1
Energy intensity	6268	.057	.087	0	1.25
Internal energy management	7217	.415	.493	0	1
Market demand	7167	.085	.279	0	1
R&D	7242	.096	.295	0	1
Financial access	7408	.205	.404	0	1
Informal competition	7656	.288	.453	0	1
Direct exports	7567	8.809	23.392	0	100
Foreign ownership	7646	3.761	16.451	0	100
Small firm	7579	.502	.5	0	1
Large firm	7579	.191	.393	0	1
Age	7532	21.635	15.707	1	163

TABLE 6
Descriptive Statistics

Variables	(1) IV- Shift share	(2) IV- Lobbying behavior
Energy tax	1.728*** (0.103)	1.787*** (0.127)
Energy intensity	0.220 (0.521)	0.314 (0.617)
Internal energy management	0.213** (0.0933)	0.252** (0.101)
Market Demand	0.617*** (0.125)	0.510*** (0.113)
R&D	0.944*** (0.121)	1.014*** (0.137)
Financial access	0.199** (0.0851)	0.162* (0.0900)
Informal competition	0.153** (0.0767)	0.189** (0.0843)
Direct exports	-0.00433*** (0.00155)	-0.00333** (0.00163)
Foreign ownership	-0.00136 (0.00250)	-0.00176 (0.00304)
Large firm	0.235** (0.109)	0.301** (0.129)
Small firm	0.00937 (0.0950)	0.0213 (0.0947)
age	-0.00469* (0.00240)	-0.00209 (0.00269)
Constant	-0.709*** (0.202)	-0.957*** (0.217)
Country-sector fixed effect	Yes	Yes
Time fixed effect	Yes	Yes
Observations	5,727	4,618

*Robust and clustered standard errors in parentheses *** is for p -value <0.01, ** p-value <0.05, * p-value <0.1*

TABLE 7

Robustness-instrumental variable modelling

Variable	(1) Different internatio-nalisation proxy	(2) Different financial access proxy	(3) Different firm size proxy	(4) Add more controls	(5) Add more controls
Energy tax	0.414*	0.447**	0.441**	0.406*	0.358**
	(0.212)	(0.214)	(0.220)	(0.217)	(0.168)
Energy intensity	0.213	0.463	0.408	0.339	-0.0719
	(0.849)	(0.761)	(0.765)	(0.759)	(0.824)
Internal energy management	0.285**	0.256**	0.250**	0.265**	0.109
	(0.126)	(0.127)	(0.127)	(0.128)	(0.153)
Market demand	0.817***	0.915***	0.897***	0.916***	0.845***
	(0.189)	(0.178)	(0.177)	(0.185)	(0.271)
R&D	1.442***	1.572***	1.467***	1.489***	1.692***
	(0.191)	(0.191)	(0.187)	(0.174)	(0.209)
Financial access	0.303**		0.295**	0.276**	0.203
	(0.126)		(0.124)	(0.127)	(0.148)
Informal competition	0.223*	0.239**	0.237**	0.237**	0.360**
	(0.119)	(0.114)	(0.115)	(0.117)	(0.153)
Direct exports		-0.00506**	-0.00637***	-0.00482**	-0.00222
		(0.00222)	(0.00217)	(0.00221)	(0.00272)
Foreign ownership		-0.000867	-0.000774	-0.000431	0.000479
		(0.00423)	(0.00433)	(0.00419)	(0.00277)
Governmental relation				0.471***	
				(0.181)	
Large firm	0.388**	0.436***		0.423***	0.303
	(0.165)	(0.167)		(0.162)	(0.236)
Small firm	0.00259	-0.0380		-0.00135	-0.142
	(0.138)	(0.143)		(0.137)	(0.157)
age	-0.00657*	-0.00662*	-0.00647*	-0.00576*	6.35e-06
	(0.00354)	(0.00358)	(0.00370)	(0.00347)	(0.00443)
Possession of technological license	0.476***				
	(0.162)				
Applied for a loan		0.221			
		(0.149)			
Human capital					0.00291
					(0.00216)
Log (permanent employees)			0.174***		
			(0.0565)		
Constant	-0.574**	-0.484*	-1.003***	-0.628***	-0.805***
	(0.250)	(0.251)	(0.288)	(0.239)	(0.307)
Observations	5,715	5,720	5,740	5,711	3,206

*Robust and clustered standard errors in parentheses *** is for p -value <0.01, ** p-value <0.05, * p-value <0.1*

TABLE 8

Robustness-alternative model specification and data measures

Variable	(1) Lightening Improving Systems	(2) Heating and Cooling Improvement Systems	(3) Vehicle Updates	(4) Machinery and Equipment Upgrades	(5) Onsite Climate-friendly Energy Savings
Energy tax	0.681***	0.571***	0.482***	-0.108	0.145
	(0.252)	(0.156)	(0.182)	(0.162)	(0.270)
Energy intensity	-0.121	0.386	1.378	0.589	0.841
	(0.894)	(0.810)	(1.014)	(0.565)	(0.842)
Internal energy management	0.363**	0.447***	-0.0955	0.118	0.250
	(0.163)	(0.118)	(0.137)	(0.123)	(0.174)
Market Demand	0.956***	0.527***	0.108	0.597***	-0.0594
	(0.213)	(0.179)	(0.273)	(0.148)	(0.290)
R&D	0.710***	0.489**	0.445*	0.611***	-0.0720
	(0.186)	(0.248)	(0.235)	(0.236)	(0.283)
Financial access	0.374***	0.104	0.758***	0.218	0.471**
	(0.138)	(0.206)	(0.158)	(0.140)	(0.224)
Informal competition	0.236*	0.0765	0.0637	0.00546	-0.311
	(0.130)	(0.131)	(0.125)	(0.128)	(0.191)
Direct exports	-0.00386	-0.000191	-0.00389	-0.000582	0.00516**
	(0.00268)	(0.00340)	(0.00303)	(0.00200)	(0.00221)
Foreign ownership	0.00241	0.000468	-0.000843	-0.00338	-0.000466
	(0.00535)	(0.00299)	(0.00477)	(0.00260)	(0.00263)
Large firm	0.00210	0.00870	0.316	0.463***	0.965***
	(0.180)	(0.224)	(0.225)	(0.176)	(0.228)
Small firm	0.0878	-0.0829	-0.315**	-0.145	0.121
	(0.180)	(0.149)	(0.128)	(0.139)	(0.203)
age	2.59e-05	-0.00865*	-0.00127	-0.00336	0.00711
	(0.00429)	(0.00521)	(0.00336)	(0.00377)	(0.00487)
Constant	-1.728***	-1.368***	-1.235***	-0.719***	-1.944***
	(0.340)	(0.388)	(0.315)	(0.271)	(0.407)
Country-sector fixed effect	Yes	Yes	Yes	Yes	Yes
Time fixed effect	Yes	Yes	Yes	Yes	Yes
Observations	5,614	5,302	5,472	5,561	5,228

*Robust and clustered standard errors in parentheses *** is for p -value <0.01, **

TABLE 9

Independent Probit Regression of Energy Efficient Innovation

Variable	(1) All sectors	(2) Manufacturing sector	(3) Non-manufacturing sector	(4) All sectors	(5) Manufacturing sector	(6) Non-manufacturing sector
Energy tax	0.638***	0.291	0.856**	0.168	0.437**	0.607*
	(0.230)	(0.207)	(0.346)	(0.209)	(0.211)	(0.323)
Energy intensity	0.817	-0.644	1.473*	-0.728	0.375	0.939
	(0.634)	(0.759)	(0.887)	(0.731)	(0.762)	(1.030)
Internal energy management	0.303**	0.521***	0.155	0.436**	0.267**	0.160
	(0.128)	(0.183)	(0.179)	(0.182)	(0.127)	(0.172)
Market Demand				0.643***	0.905***	1.042***
				(0.220)	(0.178)	(0.214)
R&D	1.512***	1.461***	1.582***	1.392***	1.529***	1.628***
	(0.179)	(0.181)	(0.298)	(0.183)	(0.184)	(0.301)
Financial access	0.329**	0.355**	0.272	0.338**	0.306**	0.260
	(0.131)	(0.161)	(0.177)	(0.168)	(0.128)	(0.171)
Informal competition	0.171	0.116	0.175	0.162	0.233**	0.243
	(0.120)	(0.142)	(0.171)	(0.140)	(0.117)	(0.164)
Direct exports	-0.003	-0.003	-0.006*	-0.003	-0.005**	-0.011***
	(0.002)	(0.003)	(0.003)	(0.003)	(0.002)	(0.003)
Foreign ownership	-0.001	0.000	-0.002	0.001	-0.001	-0.002
	(0.004)	(0.003)	(0.005)	(0.003)	(0.004)	(0.006)
Large firm	0.411**	-0.149	1.018***	-0.151	0.440***	1.046***
	(0.172)	(0.173)	(0.263)	(0.165)	(0.162)	(0.257)
Small firm	-0.050	-0.192	0.082	-0.172	-0.023	0.123
	(0.156)	(0.159)	(0.215)	(0.155)	(0.138)	(0.189)
age	-0.007**	-0.007*	-0.009	-0.006	-0.006*	-0.007
	(0.004)	(0.004)	(0.006)	(0.003)	(0.003)	(0.006)
Constant	-0.484*	-0.220	-0.884**	-0.319	-0.576**	-0.977***
	(0.266)	(0.341)	(0.362)	(0.311)	(0.247)	(0.361)
Country-sector fixed effect	Yes	Yes	Yes	Yes	Yes	Yes
Time fixed effect	Yes	Yes	Yes	Yes	Yes	Yes
Observations	5,750	3,543	2,207	3,530	5,727	2,197

*Robust and clustered standard errors in parentheses *** is for p -value <0.01, ** p-value <0.05, * p-value <0.1*

TABLE 10

Average marginal effects of baseline and demand-pull extended regression

Variable	(1) Environmental self-ruling	(2) Environmental non- self- ruling	(3) Energy Intensive sector	(4) Energy efficient sector
Energy tax	0.719***	-0.120	0.373*	0.509
	(0.278)	(0.133)	(0.224)	(0.351)
Energy intensity	1.596	0.200	0.468	0.290
	(1.146)	(0.888)	(0.711)	(1.159)
Internal energy management			0.271*	0.266
			(0.164)	(0.185)
Market Demand	0.898***	0.713	0.564***	1.145***
	(0.139)	(0.454)	(0.191)	(0.229)
R&D	1.444***	1.508***	1.528***	1.586***
	(0.251)	(0.322)	(0.190)	(0.299)
Financial access	0.325	0.303**	0.221*	0.334*
	(0.199)	(0.154)	(0.129)	(0.200)
Informal competition	0.339**	0.107	0.248*	0.230
	(0.172)	(0.169)	(0.135)	(0.179)
Direct exports	0.000798	-0.00698**	-0.00160	-0.00807**
	(0.00376)	(0.00278)	(0.00250)	(0.00359)
Foreign ownership	-0.00253	0.00144	-0.00484	0.00206
	(0.00379)	(0.00437)	(0.00393)	(0.00548)
Large firm	0.384*	0.546***	0.0244	0.943***
	(0.222)	(0.201)	(0.165)	(0.255)
Small firm	-0.0458	-0.00765	-0.132	0.0809
	(0.188)	(0.152)	(0.139)	(0.205)
age	-0.00286	-0.00858**	-0.00297	-0.00873
	(0.00530)	(0.00360)	(0.00312)	(0.00606)
Constant	-0.339	-0.591**	-0.490*	-0.567
	(0.384)	(0.274)	(0.251)	(0.374)
Country-sector fixed effect	Yes	Yes	Yes	Yes
Time fixed effect	Yes	Yes	Yes	Yes
Observations	2,463	3,264	3,913	1,814

*Robust and clustered standard errors in parentheses *** is for p -value <0.01, ** p-value <0.05, * p-value <0.1*

TABLE 11

Average marginal effects for heterogenous analysis

Variables	(1) Environmental self-ruling	(2) Environmental Impact Perceived Innovation- Manufacturing sector	(3) Environmental Impact Perceived Innovation- Non-Manufacturing sector
Energy tax	0.756*** (0.198)	0.492** (0.208)	0.964*** (0.289)
Energy intensity	-0.264 (0.840)	-0.337 (0.882)	0.0861 (1.229)
Internal energy management	0.393*** (0.113)	0.287** (0.137)	0.402*** (0.151)
Market Demand	0.523*** (0.119)	0.677*** (0.189)	0.545*** (0.164)
R&D	0.325 (0.268)	-0.240 (0.347)	1.162*** (0.333)
Financial access	0.225** (0.110)	0.187 (0.192)	0.159 (0.148)
Informal competition	0.0373 (0.180)	0.175 (0.141)	-0.169 (0.268)
Direct exports	0.000918 (0.00296)	0.00345 (0.00294)	-0.00409 (0.00670)
Foreign ownership	-0.00295 (0.00369)	-0.00241 (0.00246)	-0.00546 (0.00535)
Large firm	0.0321 (0.259)	0.259 (0.290)	-0.394 (0.608)
Small firm	0.0765 (0.179)	0.00165 (0.230)	0.0565 (0.201)
age	-0.00514 (0.00468)	-0.00568 (0.00566)	-0.00728 (0.00685)
Constant	-1.547*** (0.325)	-1.430*** (0.422)	-1.633*** (0.393)
Country-sector fixed effect	Yes	Yes	Yes
Time fixed effect	Yes	Yes	Yes
Observations	5,698	3,527	2,171

*Robust and clustered standard errors in parentheses *** is for p -value <0.01, ** p-value <0.05, * p-value <0.*

TABLE 12
Average marginal effects of environmental footprint mechanism

CHAPTER 11. ALIGNING GREEN PUBLIC FINANCE AND LAW: EXPLORING THE POSSIBILITIES FOR A RENEWABLE ENERGY HUB

Author : Merve Ergun



Abstract

Energy security and independence are among the most critical objectives for countries worldwide. While the international trade of fossil fuels is well established, the same cannot yet be said for renewable energy. In our chapter, we argue that fostering cross-border trade in renewable energy, supported by targeted fiscal incentives, could significantly accelerate the energy transition in the Mediterranean region. We propose the creation of a regional energy hub founded on green technologies as a concrete example of international and regional cooperation. Such a hub would enable Mediterranean countries to collaborate more effectively on a fair and rapid shift toward clean energy. We suggest that a regional trade agreement (RTA) among Mediterranean nations could serve as a key instrument in laying the foundations for this energy hub and advancing a more integrated and sustainable regional energy market.

Résumé

La sécurité et l'indépendance énergétiques figurent parmi les objectifs les plus cruciaux pour les pays à travers le monde. Alors que le commerce international des combustibles fossiles est bien établi, il n'en va pas de même pour les énergies renouvelables. Dans notre chapitre, nous soutenons que le développement du commerce transfrontalier d'énergies renouvelables, appuyé par des incitations fiscales ciblées, pourrait fortement accélérer la transition énergétique dans la région méditerranéenne. Nous proposons la création d'un pôle énergétique régional fondé sur des technologies vertes, comme exemple concret de coopération internationale et régionale. Un tel pôle permettrait aux pays méditerranéens de collaborer plus efficacement en faveur d'une transition juste et rapide vers les énergies propres. Nous suggérons qu'un accord commercial régional (ACR) entre les pays méditerranéens pourrait constituer un levier clé pour poser les bases de ce pôle énergétique et favoriser l'émergence d'un marché énergétique régional plus intégré et durable.

1.THE STATEMENT OF RESEARCH

1.1 A Proposed Framework for Regional Cooperation

Addressing the climate crisis requires a rapid and sustained acceleration of the energy transition. In this context, enhanced fiscal cooperation among Mediterranean countries is crucial. This chapter argues that regionally coordinated fiscal instruments, designed with lessons learned from both effective and flawed practices, should be implemented to support decarbonization, facilitate cross-border renewable energy trade, and incentivize green innovation. Depending on the legal frameworks and preferences of the participating countries, this cooperation could be institutionalized through binding or non-binding international legal instruments. The proposed forms of regional cooperation are outlined below.

The most comprehensive form of cooperation would involve the establishment of a **regional trade agreement (RTA)** designed to facilitate the creation of a **Renewable Energy Hub (REH)**. This instrument would combine fiscal obligations with structural commitments to advance renewable energy integration and trade across the region. Under this RTA, countries would agree on a regional minimum carbon price specifically targeting industrial production. In the interests of fairness, this minimum price could be differentiated according to the level of income and fossil fuel dependency of the countries concerned. Additionally, legal guarantees for green bonds and tax credits would be provided to support the renewable energy sector. The RTA would also introduce tailored fiscal instruments designed specifically for the Mediterranean context, offering incentives to renewable energy producers, particularly local energy communities, and stakeholders involved in research and development activities supporting the energy transition. Moreover, the agreement would establish the introduction of effective carbon and energy taxes in countries where such measures are not yet in place. Annual monitoring and reporting obligations would also be included to ensure transparency and accountability in the use of carbon taxation revenues. In terms of energy infrastructure, the RTA would require the development of interconnected super grids or cross-border infrastructures to facilitate the trade of electricity generated from renewable sources. This would also involve the removal of barriers to trade for renewable energy products and services. Lastly, the establishment of new institutions or the accreditation of existing ones to verify that traded electricity originates from certified renewable sources would be required to ensure the integrity of the system.

As this form of comprehensive and global cooperation may meet with some resistance when it comes to implementation, it is also possible to envisage similar cooperation on a smaller scale, which would still involve cooperation between countries. For example, **bilateral trade agreements** could be negotiated between certain neighbouring Mediterranean countries, including those belonging to the European Union. These agreements would focus on the creation of smaller-scale energy hubs or interconnected microgrids, incorporating fiscal obligations similar to those outlined in the RTA. This approach, though smaller in scale, may be more politically feasible in the short term and could serve as a foundation for broader regional cooperation in the future.

Another option involves the creation of a **regional international agreement** that sets a minimum carbon tax across Mediterranean countries. This agreement, perhaps more realistic to achieve in the short term, would focus on establishing standardized annual monitoring and reporting obligations to ensure transparency regarding how the revenues from the carbon tax are collected and used, on a regional scale, for greater international coherence.

Finally, a less formal option would involve the **adoption of non-binding guidelines, or soft law instruments.** These guidelines would be based on comparative research assessing the most effective fiscal tools for facilitating the energy transition. The guidelines would encourage voluntary alignment among Mediterranean countries on fiscal incentive mechanisms, providing recommendations for best practices in supporting the renewable energy transition.

Among these options, the first—combining fiscal obligations with the creation of a Renewable Energy Hub—presents the most robust and transformative path forward. The remainder of this chapter will focus on elaborating the concept of the REH and providing a detailed analysis of the fiscal instruments proposed to facilitate its implementation.

The chapter employs international and comparative legal research, given the availability of international materials and the diversity of national legal frameworks concerning green public finances and financial instruments. A comparative legal analysis is conducted to examine the balance between different financial instruments and assess their legal impacts and designs.

1.2 The Renewable Energy Hub (REH)

The creation of a REH could significantly reduce the Mediterranean region's reliance on fossil fuels while promoting investments in renewable energy and accelerating the region's energy transition. It would also promote regional coordination through an elevated level of energy security. The REH is commonly defined as a collaborative framework that integrates geopolitical, economic, environmental, and financial elements to facilitate and stimulate energy transition investments. There is already a complex relation between fiscal incentives and energy investments. This complexity, together with the procedural difficulties and complicated nature of fiscal incentives, acts as a barrier to the RE investments. Also, the lack of investment, integration and regional capacity planning are among the main problems associated with energy transition[351]. The REH addresses these issues by providing an integrated system and promoting market liquidity, while green financial tools can help channel the necessary investments into renewable energy projects. The idea of global sustainable finance and international cooperation to promote green fiscal tools have been among the hot topics of the recent years[352].

For the REH to function effectively, new institutional structures may be required to manage revenue generation, collection, and monitoring strategies. These institutions must be designed to account for negative externalities, such as environmental harm. Revenue can be generated through environmental taxation, particularly carbon taxes, which would provide the financial support needed for the transition. Simultaneously, positive externalities created by renewable energy investments should be incentivized through green fiscal policies. The allocation of subsidies must align with regional energy transition goals and ensure transparency.

Creating a regional hub based on renewable electricity trade should not be excessively difficult considering the fact that there is already a constant practice for electricity import and export in the OECD Countries. For instance, the European Power Exchange EPEX SPOT, founded in 2008 and based in Paris, works as an electricity exchange market between 13 European Countries[353] and is known as the biggest power exchange between the EU countries[354]. For example, the chart[355] illustrating OECD Europe's electricity imports and exports from 1997 to 2020 shows a consistent flow of electricity across borders. Furthermore, global trends in cross-border electricity trade, based on gross imports, highlight the growing interconnectedness of energy markets. Between 2000 and 2018[356], European countries with strong interconnection capacities, such as France, emerged as major exporters, with nuclear power generation playing a key role. In 2021, the top electricity exporters were Germany, France, Switzerland, Spain, Belgium, and the Czech Republic[357]. Even if this is not an undeniable guarantee of the success of a Mediterranean hub, given the new challenges posed by the integration of non-OECD countries facing particular energy challenges, the maturity of the inter-regional electricity exchange market in European countries can be a strong asset.

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351 Burak Guler, Emre Çelebi, Jatin Nathwani,
'Cost-effective decarbonization through investment in transmission interconnectors as part of regional energy hubs (REH)' The Electricity Journal,Volume 34, Issue 3, 2021,376.
352 Sandra Eckert, 'The European Green Deal and the EU's Regulatory Power in Times of Crisis' (2021) 59 J Common Mkt Stud 81, 84.
353 Europex: <https://www.europex.org/members/epex-spot/> accessed 28 April 2025.
354 EC Europe: <https://ec.europa.eu/commission/presscorner/detail/es/ip_21_1523> accessed 28 April 2025.
355 IEA: the OECD Europe Electricity Imports and Exports <https://www.iea.org/data-and-statistics/charts/oecd-europe-electricity-imports-and-exports-1974-2020p> accessed 2 December 2024.
356 IEA: 2020 Global Overview: Trade < https://www.iea.org/reports/electricity-market-report-december-2020/2020-global-overview-trade> accessed 1 April 2025.
357 WITS: World Bank , Electrical Energy Exports by Country in 2021<https://wits.worldbank.org/trade/comtrade/en/country/ALL/year/2021/tradeflow/Exports/partner/WLD/product/271600#:~:text=In%202021%2C%20Top%20exporters%20of,22%2C330%2C500%20kWh%20(1000%20KW%2FH).> accessed 2 April 2025. ni,

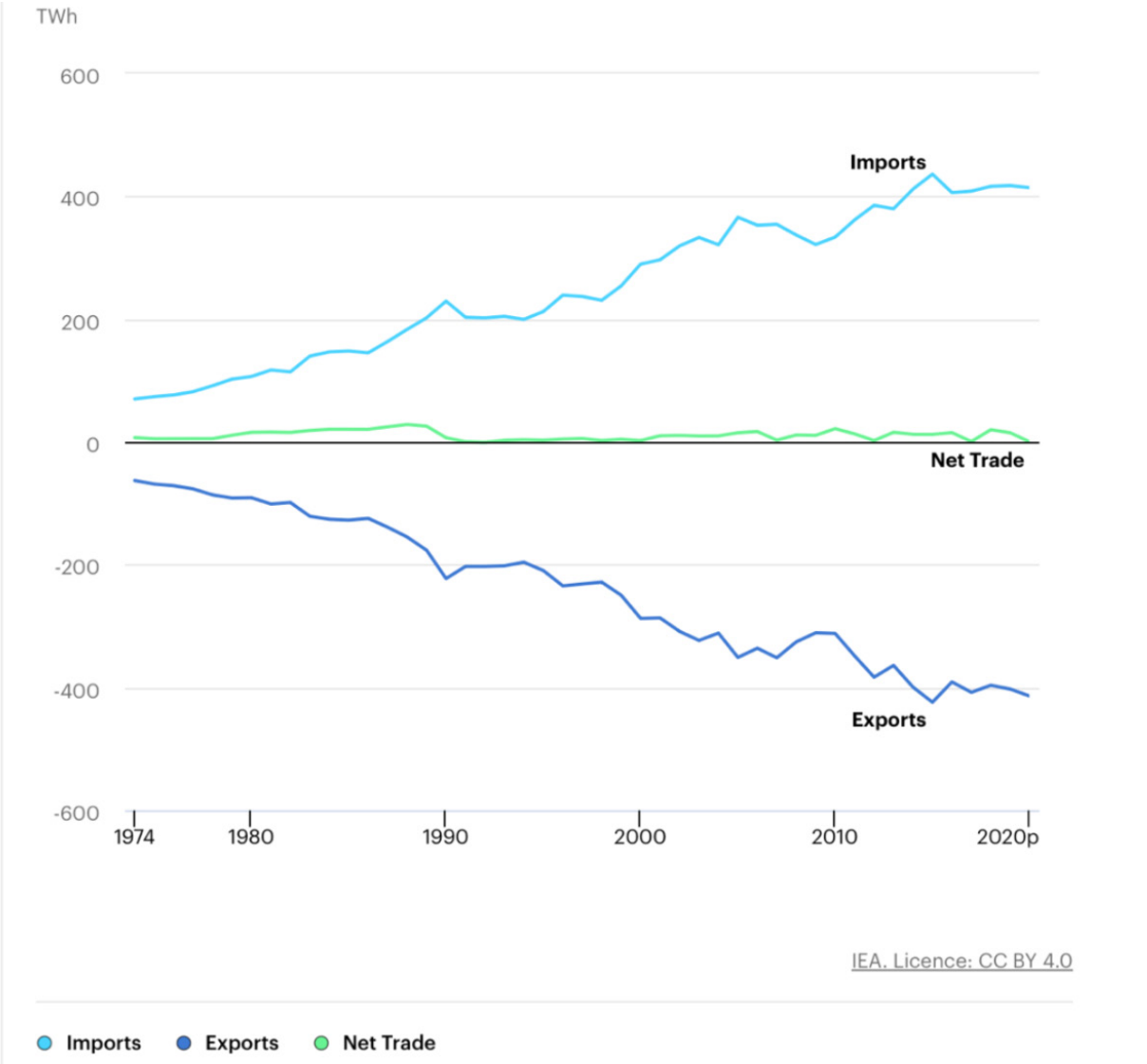


FIGURE.1 *Europe's electricity imports and exports from 1997 to 2020, OECD*

It is nevertheless highlighted that the handicap of REHs may be their lack of financial resource and inability produce such resources. It can be argued that green fiscal tools may enable Mediterranean Countries to deal with this dilemma.

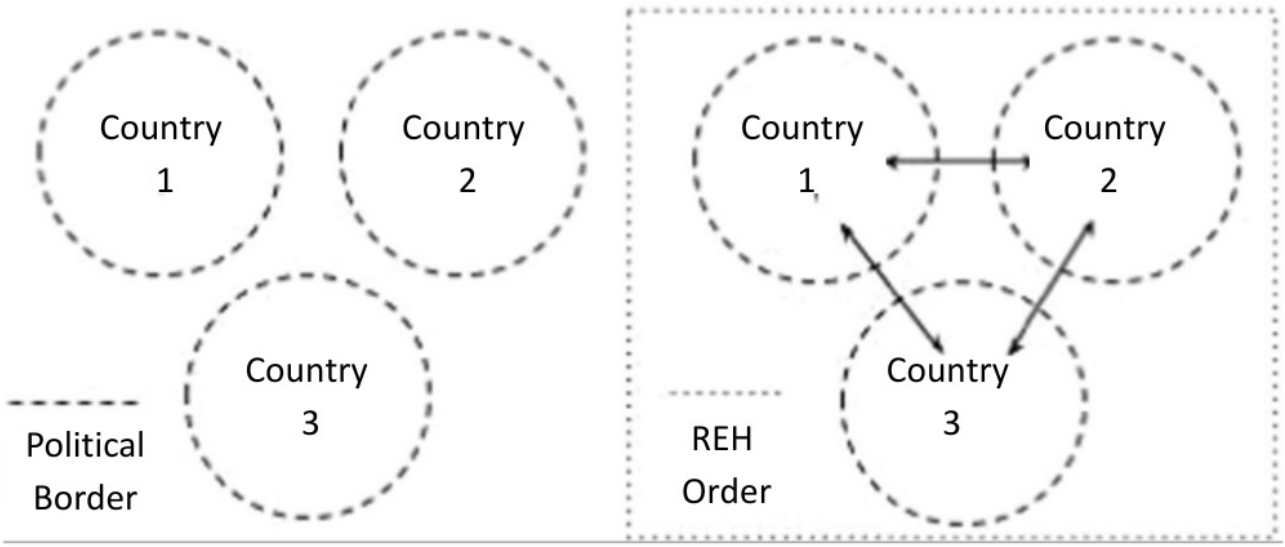
In this sense, an independent monitoring institution should be set up to observe whether contracting parties fulfil their obligations and how the revenues collected are disseminated or used by states.

Ideally, these revenues should be utilised as fiscal incentives or subsidies to be granted for supporting renewable energy industry.

1.2.1 What would the Features of the Regional Hub be?

As indicated by Guler et al (2021), the operation of a REH should not be strictly confined to political borders. Rather, as illustrated below, it should be designed to consider the operational boundaries of the REH, which may extend beyond national borders to better address regional energy needs and opportunities[359].

359 Burak Guler, Emre Çelebi, Jatin Nathwani,
'Cost-effective decarbonization through investment in transmission interconnectors as part of regional energy hubs (REH)' The Electricity Journal,Volume 34, Issue 3, 2021,378.



The feasibility of establishing a REH is evaluated through various parameters, with geography often being considered as the first step. Other important factors include economic, environmental, and financial considerations[360]. A case study involving Romania, Bulgaria, Türkiye, and Greece suggests that a potential regional trade agreement could offer significant benefits[361].

In principle, countries that are geographically closer to one another tend to have greater potential for cooperation, as they may require less investment to establish energy generation facilities and interconnection points. However, larger domestic markets and limited connections with neighboring countries may present challenges to electricity trade, as the focus may remain on domestic energy needs[362].

Even though electricity trade is quite a common practice between states, legal questions associated with the regional energy hub, revenue to be generated and compliance with the EU Law (and broader international and Mediterranean countries' legal frameworks) should be carefully answered.

1.2.2 What Technical Questions Associated with the REHs?

Super grids are defined as large scale electricity transmission points or networks, enabling the trade of high volumes of electricity[363]. From a technical point of view, it is argued by Guler et al (2021) that Super Grids connecting different countries would bring an additional transmission capacity. In other words, transmission lines between the countries will connect them to optimise their fuel mixes used for electricity generation[364]. However, their installation and effective operation require consistent investments and incentives. In this sense, consistent and effective green public finances and financial tools play a crucial role for the system.

360 Burak Guler, Emre Çelebi, Jatin Nathwani,
'Cost-effective decarbonization through investment in transmission interconnectors as part of regional energy hubs (REH)' The Electricity Journal,Volume 34, Issue 3, 2021,379-380.
361 Burak Guler, Emre Çelebi, Jatin Nathwani,
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362 IEA: 2020 Global Overview: Trade < https://www.iea.org/reports/electricity-market-report-december-2020/2020-global-overview-trade> accessed 1 April 2025.
363 Eddie O- Connor, Teruyuki Ono, Michael Hayes, 'Connected Energy: Super grids: making the right connections for a sustainable future' Insight,16

1.2.3 What Legal Questions in Relation to the REH?

WTO rules

Energy trade involves several factors, all of which must comply with WTO rules[365]. This is because energy and its products are subject to international trade rules[366]. The WTO Law does not involve specific provisions regarding electricity. Therefore, whether the WTO rules could be applied for the energy or electricity trade has been among debated topics for decades[367].

From a legal perspective, electricity can be classified either as a good or a service[368], and this classification affects the applicable regulations. Depending on whether electricity is considered a good or a service, different legal frameworks, such as the General Agreement on Tariffs and Trade (GATT), the General Agreement on Trade in Services (GATS), and other international agreements, may apply. However, it is generally accepted in international legal practice that electricity is primarily considered a good[369], while the supply of energy is treated as a service[370].

International electricity trade is referred to under the HS 2716 heading of the International Convention on The Harmonized Commodity Description and Coding System (HS Nomenclature) which regulates the rules governing commodities in global trade[371]. In the HS Nomenclature, electricity is regarded as good;therefore, electrical energy must comply with the GATT 1994[372].

The Energy Charter Treaty (1994) regulating energy trade concepts as a multilateral treaty was finalised outside the GATT/WTO framework[373], and it covers five main areas, such as investment protection, trade, transit environmental protection and dispute settlement[374]. This treaty is combined with an Energy Efficiency Protocol and Trade Amendment. In addition to that, the European Energy Charter (1991) and International Energy Charter (2015) are important legal instruments. While the former is a pre-requisite for accession to the Energy Charter Treaty (1994), the latter refers to a declaration which does not contain any legally binding obligations or commitments[375].

This treaty is exclusively applicable to the economic activities in the energy sector[376]; according to Article 1(5) of the ECT[377] and Annexes, EM para 27.16[378] and NI, both production and sale of electrical energy as energy materials are regarded as 'economic activity in the energy sector'[379].

The ECT has faced criticism for its perceived limitations on governments' ability to regulate fossil fuel use and its provision of investment protection even in cases where environmental protection measures are at stake[380] . While the ECT has facilitated energy trade among its parties, there is a growing call for updates to the treaty to include specific incentives supporting renewable energy

365 Yulia Selivanova, 'The WTO and Energy: WTO Rules and Agreements of Relevance to the Electricty Sector', ICTSD, Isuue Paper No:1, August 2007, 5.
366 Thomas Cottier, Garba Malumfashi, Sofya Matteotii-Berkutova, Olga Nartova, Joele De Sepibus and Sadeq z. Bigdeli, 'Energy in WTO Law and Policy' Working Paper No:2009/25 (May 2009),4.
367 Olawuyi, D. S., & Athwal, E. I. (2023). «26: Energy in WTO law and policy». In The Elgar Companion to the World Trade Organization. Cheltenham, UK: Edward Elgar Publishing. Retrieved Apr 1, 2025, from https://doi.org/10.4337/9781800882867.00034
368 Yulia Selivanova, 'The WTO and Energy: WTO Rules and Agreements of Relevance to the Electricty Sector', ICTSD, Isuue Paper No:1, August 2007,21.
369 Michail Skouzes, 'Energy Transit under GATT Article V and Energy Trade Dispute Resolution in the WTO' WTI working paper no.11/2023, 15.
370 Peter Cameron, Competition in Energy Markets: Law and Regulation in the European Union(Oxford University Press 2002)9.
371 Willie Shumba, 'The International Convention on the Harmonized Commodity Description and Coding System: Legal Pillar Behind the Harmonized System', (2024), 19, Global Trade and Customs Journal, Issue 2, pp. 114-123, https://kluwerlawonline.com/journalarticle/Global+Trade+and+Customs+Journal/19.9/GTCJ2024004#
372 Thomas Cottier, Garba Malumfashi, Sofya Matteotii-Berkutova, Olga Nartova, Joele De Sepibus and Sadeq z. Bigdeli, 'Energy in WTO Law and Policy' Working Paper No:2009/25 (May 2009),5.
373 Vitaliy Pogoretskyy, Energy in International Trade Law: Concepts, Regulation and Changing Markets, Journal of International Economic Law, Volume 25, Issue 4, December 2022, Pages 699–702, https://doi.org/10.1093/jiel/jgac037
374 Rafael Leal-Arcas, Commentary on the Energy Charter Treaty(2nd edn,Edward Elgar Publishing,2023)1.
375 Energy Chater, < https://www.energycharter.org/process/international-energy-charter-2015/overview/> accessed 2 April 2025.
376 Rafael Leal-Arcas, Commentary on the Energy Charter Treaty(2nd edn,Edward Elgar Publishing,2023)34.
377 "Economic Activity in the Energy Sector" means an economic activity concerning the exploration, extraction, refining, production, storage, land transport, transmission, distribution, trade, marketing, or sale of Energy Materials and Products except those included in Annex NI, or concerning the distribution of heat to multiple premises. ECT Article 1(5).
378 Annex EM I: Energy Materials and Products(in accordance with Article 1(4) ECT), pragraph 27.16: Electrical energy
379 Electrabel S.A. v. The Republic of Hungary, ICSID Case No. ARB/07/19, paragraph 5.50. < https://jusmundi.com/en/document/decision/en-electrabel-s-a-v-the-republic-of-hungary-decision-on-jurisdiction-applicable-law-and-liability-friday-30th-november-2012> accessed 2 April 2025.
380 Rafael Leal-Arcas, Commentary on the Energy Charter Treaty(2nd edn,Edward Elgar Publishing,2023)5.

development[381]. Given the ECT's strong protection of fossil fuel investments, several countries have chosen to withdraw, citing concerns over its alignment with the Paris Agreement[382] European Council Decisions were adopted on 30 May 2024 for the withdrawal of the European Union and the Euratom from the ECT[383]. These withdrawals will take effect one year after the notification is received by the depositary.

Energy trade has several dimensions, and this trade must comply with the WTO Rules and the ECT, if applicable. Non-renewable energy sources may be subject to import or export directly; however, renewable energy (natural energy) is not directly traded. Instead, consumer products, such as electricity from renewable energy, can be traded[384]. Trade of electricity energy is primarily associated with the WTO Customs Valuation Agreement (CVA) and the Agreement on Implementation of Article VII of the General Agreement on Tariffs and Trade 1994[385]. The electricity's value chain is composed of four activities: generation, transmission, distribution and supply[386]. While the technical infrastructure is crucial for the REH, legal considerations also play a vital role in its implementation, particularly concerning energy trade and state aid rules.

The European Single Energy Market

The creation of a European Single Energy Market has been among the European Union's plans for a very long time[387]. The integration of provisional REH within the European Single Market, or the interconnection between them, should be clarified. While assessing the issues related with the internal market, the Commission has always considered the trade relations with third countries via bilateral agreements and reciprocity. In the proposals and Commission Communications, main principles highlighted are centred around the following concepts: equivalent quantitative market opening percentages; equivalent qualitative market access (including those related with transmission fees and access to dispute resolution mechanisms); and equivalent environmental standards in electricity generation[388].

Considering the idea of supporting renewables and increasing competition in the market, the new electricity market rules were adopted in the EU on 21 May 2024 as part of the Green Deal Industrial Plan. These new electricity market design rules, particularly the amending Directive EU/2024/1711 and the amending Regulation EU/2024/1747, were adopted on 21 May 2024 and entered into force on 16 July 2024[389].

EU State Aid Control

As of today, there are no direct taxes collected by the EU; taxes are levied by Member States, and the Union does not have a direct revenue coming from taxes collected by the Union institutions[390]. In order to cope with the problems or consequences associated with cross-border taxation situations, the interrelation between tax law provisions and the primacy order must be clarified[391].

That being said, in case of a regional cooperation, the interrelation between the EU State Aid Control Mechanism and EU Countries which would become part of the regional cooperation and hub should be clarified. **In this sense, it is clear that all tax credits or any other form of fiscal incentives to be granted by the European Union Member States must comply with the EU State Aid Rules.**

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381 Rafael Leal-Arcas, Commentary on the Energy Charter Treaty(2nd edn,Edward Elgar Publishing,2023)9.
382 EESC: Decision on the interpretation and application of the Energy Charter Treaty, < https://www.eesc.europa.eu/en/news-media/press-summaries/decision-interpretation-and-application-energy-charter-treaty> accessed 3 April 2025.
383 Council Decision on the withdrawal of the union from the energy charter treaty; and Council Decision on the approval of the withdrawal of the european atomic energy community from the energy charter treaty.
384 SHIH, W.-C. (2009). Energy Security, GATT/WTO, and Regional Agreements. Natural Resources Journal, 49(2), 437.
385 WTO(by Leonardo Maceo): Electricity energy and the wto customs valuation agreement, < https://www.wto.org/english/res_e/publications_e/wtr10_forum_e/wtr10_2july10_e.htm> accessed 1 December 2024.
386 Thomas Cottier, Garba Malumfashi, Sofya Matteotii-Berkutova, Olga Nartova, Joele De Sepibus and Sadeq z. Bigdeli, 'Energy in WTO Law and Policy' Working Paper No:2009/25 (May 2009),4.
387 Burak Guler, Emre Çelebi, Jatin Nathwani,
'Cost-effective decarbonization through investment in transmission interconnectors as part of regional energy hubs (REH)' The Electricity Journal,Volume 34, Issue 3, 2021,378.
388 Peter Cameron, Competition in Energy Markets: Law and Regulation in the European Union(Oxford University Press 2002)280.
389 European Commission: Electricty Market Design < https://energy.ec.europa.eu/topics/markets-and-consumers/electricity-market-design_en> accessed 2 April 2025.

As per Articles 107 and 108 of the TFEU and by virtue of the secondary EU legislation, such as: European Commission's notices and guidelines and jurisprudence from the EU Courts[392], aids granted by Member States or through their sources must comply with the EU State Aid Control Mechanism. There are several derogations from this general prohibition of state aid rules, and energy transition related measures may benefit from these derogations under certain conditions. For instance, the GBER (the General Block Exemption Regulation) or SGEI (Services of General Economic Interest) packages are examples of these. In other words, an aid which fulfils all the criteria stated under Article 107/1 of the TFEU is prohibited unless it is justified under other EU State Aid Rules or Frameworks. In this way, the internal market competition is protected[393].

For the existence of State Aid Criteria, all conditions listed under Article 107(1) of the TFEU[394] must be met; even if one of these is not present in the case in question, then the State Aid Rules are not applied to the aid in question[395]. According to Article 107/1, there must be an aid granted by a Member State or through its sources. This aid, for sure, may be granted in various ways; moreover, the aid in question must be favouring certain undertakings or production of certain goods. Finally, the aid must be selective, providing an advantage to the receiver while simultaneously distorting or threatening to distort competition in the market by affecting trade between Member States.

Considering that fiscal incentives to be designed in the REH should be favouring renewable energy investors thanks to revenues generated for this purpose, they are very likely to comply with the criteria indicated under Article 107/1. However, this does not mean that they are not compatible with the State Aid Rules. Considering existing EU Legislation and fiscal policy, there are many derogations and exemptions which may cover incentives to be proposed/ designed. Further incentives may be directly granted by the EU institutions as EU level funds.

Any international agreement signed between the Mediterranean European Union Member States cannot exclude them from the EU State Aid Control Mechanism. This means that measures to be introduced by the Member States must be within the scope of permitted aids and exemptions under the EU State Aid Mechanism.

Further, even the establishment of autonomous institutions, such as regional institutions monitoring fiscal measures, cannot exempt the Member States from the State Aid Rules. As indicated in the Judgment of the General Court of 12 December 1996, Air France v Commission[396].

'In cases where a public authority grants an advantage to a beneficiary, the measure is by definition imputable to the State, even if the authority in question enjoys legal autonomy from other public authorities. The same applies if a public authority designates a private or public body to administer a measure conferring an advantage. Indeed, Union law cannot permit the rules on State aid to be circumvented through the creation of autonomous institutions charged with allocating aid.'[397] Furthermore, the origin of the funds or resources, including those of intra-State entities, cannot constitute exemption from the state aid rules if those funds, at some stage, come under the public control[398]. Also, there are situations under which measures granted are regarded as state aid despite funds not being under the control of the public authorities. Such cases involve subsidies granted using parafiscal charges or compulsory contributions imposed by the state legislation even though they are managed by institutions which are distinct from the public authorities[399].

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392 Nicola Saccardo, Tsax Implications of Brexit, (Bloomsburry Professional, 1st edn, 2021) 145.
393 Rene Barents, Directory of EC Case Law on State Aids (Kluwer International, Aalpen aan den Rijn, 2008),1.
394 Article 107(1): Save as otherwise provided in the Treaties, any aid granted by a Member State or through State resources in any form whatsoever which distorts or threatens to distort competition by favouring certain undertakings or the production of certain goods shall, in so far as it affects trade between Member States, be incompatible with the internal market.
395 Jonathan Faull and Ali Nikpay, The EC Law of Competition (Oxford University Press, 2nd Edn, 2007)1705.
396 T-358/94, ECLI:EU:T:1996:194, paragraph 62.
397 Commission Notice on the notion of State aid as referred to in Article 107(1) of the Treaty on the Functioning of the European Union,para 39.
398 Commission Notice on the notion of State aid as referred to in Article 107(1) of the Treaty on the Functioning of the European Union,Para 57.
399 Italy v Commission, 173/73, ECLI:EU:C:1974:71, para 16.

EU Competences

Division of the EU Competences is important while considering the involvement of the EU Member States. It is known that trade policy is regarded as an exclusive EU competence[400]. This means that, by virtue of the Article 3 of TFEU[401], only the EU shall act on behalf of national governments in the event of trade outside the union. In other words, when it comes to trade policy (Common Commercial Policy), the EU has the exclusive competence; therefore, unless specific frameworks established by the EU enables Member States to form certain relations, bilateral trade agreements are negotiated and signed at the Union Level.

When it comes to financial obligations, it is seen that the founding treaties of the EU do not cover direct taxes; only exceptions to this generalisation at the EU level could be regarded as Article 293 of the EC Treaty concerning the right of the Member States to conclude tax treaties in order to avoid double taxation.

Even though there is no explicit reference to direct taxes, both the TFEU and TEU cover provisions affecting direct taxes. The EU law prevails over the national legislations, and the primacy of EU law encompasses the EU directives as well[402]. This means that, in the event of a conflict between constitutional provisions of a Member State and the EU Law, the EU law will prevail. As per the primacy and direct application of the EU law provisions, the EU provisions and principles are applied ex officio. According to the EU Mechanism, once a conflict between domestic laws and the EU Law is detected, then Member States must amend or abolish the national law provisions which are not in conformity with the EU legislation. The assimilation (or equivalence) principle requires Member States to implement EU law obligations in the same manner as they do with national laws[403]. Therefore, any Regional Trade Agreements (RTAs) and fiscal or non-fiscal obligations introduced must fully align with EU legislation. For example, if EU law provides more favorable tax treatment for taxpayers paying direct taxes, it takes precedence over national laws. However, this principle includes some exceptions, particularly where tax avoidance is considered to have no detrimental effect on the functioning of the internal market[404].

Considering these, both the provisional Regional Trade Agreement to be signed and the fiscal or non-fiscal obligations associated with such an agreement must fully comply with the EU Legislation. This also means that the fiscal measures should be flexible in a way to be cleared under the existing EU frameworks, or a new EU facility (similar to the Recovery and Resilience Facility or Temporary Frameworks) may be introduced at the EU level for this purpose. Moreover, from the perspective of feasibility, the effectiveness of tax incentives is closely linked to the extent to which they are flexible and adaptable enough to adjust to changing market conditions and ongoing digital transformation[405].

1.3 Green Public Finances & Fiscal Tools in the context of the REH

Division The primary objective of the signatory states to the Paris Climate Change Agreement is to reduce their greenhouse gas (GHG) emissions. Under Article 2(c) of the Agreement, financial flows are expected to align with a trajectory

400 EC: EU Trade Policy < https://www.consilium.europa.eu/en/policies/trade-policy/> accessed 4 December 2024.
401 Article 3
1. The Union shall have exclusive competence in the following areas:
(a) customs union;
(b) the establishing of the competition rules necessary for the functioning of the internal market;
(c) monetary policy for the Member States whose currency is the euro;
(d) the conservation of marine biological resources under the common fisheries policy;
(e) common commercial policy.
2. The Union shall also have exclusive competence for the conclusion of an international agreement when its conclusion is provided for in a legislative act of the Union or is necessary to enable the Union to exercise its internal competence, or in so far as its conclusion may affect common rules or alter their scope.
402 Marjaana Helminen, EU Tax Law: Direct Taxation(2022, Amsterdam,IBFD)7.
403 Marjaana Helminen, EU Tax Law: Direct Taxation(2022, Amsterdam,IBFD)7-8.
404 Marjaana Helminen, EU Tax Law: Direct Taxation(2022, Amsterdam,IBFD)9.
405 Yaya Sonjaya and Muhamad Yamin Noch, ' Analysis of the Effectiveness of Tax incentives on Energy Sector Investments' Advances in TaxationResearch, 2(2)(2024),124.

toward low GHG emissions. As previously outlined, the proposed framework of cooperation includes fiscal obligations. In this context, the introduction of tailored fiscal instruments for the Mediterranean region, as well as for local authorities, could play a crucial role in accelerating and facilitating the energy transition process.

Increasing the local authority engagement in energy transition is important for several reasons; therefore, the EU's Recovery and Resilience Facility has focused on the local authority engagement for implementation of the EU policies at the local level. However, in the EU, the advantages provided from the regional or public bodies or through their sources are regarded as state aid(-Case C-156/98 Germany v. Commission, 2000, ECR I-6857) if they fulfil the conditions indicated under Article 107/1 of the TFEU[406]. It is seen that the local authority engagement has been promoted in the EU Recovery and Resilience Facility which is under the umbrella of the Next Generation EU Fund. Yet, even though the engagement of local authorities during the initial phases of the National Recovery and Resilience Plans was significant, their presence during the implementation process may not be regarded as particularly successful due to some central governments' attitudes or policies[407].

Like states, the regional and local authorities may grant aid under particular circumstances and/or with the approval of the Commission. There are facilitated mechanisms, such as the GBER, which do not require approval of the Commission. Even though there is positive integration policy for the state aid mechanism, still the traditional wait-and-see attitude (a-priori compatibility) is often preferred by the European regional or local authorities when it comes to fiscal incentives (since the famous Altmark Case)[408].

1.3.1 Carbon Pricing

Carbon pricing, which is a financial instrument requiring emitters to pay for the negative externalities they create, comes into prominence in different forms, such as the introduction of the Emissions Trading System (ETS), carbon taxes, internal carbon prices brought by organisations and the results-based climate finance (RBCF)[409].

From a traditional Pigouvian perspective, environmental taxes are considered the optimal solution for addressing market failure, particularly when externalities are present[410]. This approach implies that carbon-intensive industries should bear the financial responsibility for the externalities they generate. However, relying solely on this approach is insufficient to achieve optimal outcomes. Therefore, the Pigouvian model should be complemented with other sustainable financial tools.

There are several such tools, each serving different purposes and applied under varying circumstances, often tailored to the specific beneficiaries or industries involved. These tools, alongside national taxation policies, are integrated into the legal frameworks of countries, with significant variation in their design and implementation. In this context, introducing a regional minimum carbon tax rate for industries engaged in environmentally harmful energy generation could be a crucial step in generating the necessary revenues for supporting the transition.

Alternatively, the development level of the countries may be taken into account while assessing carbon taxation rates to be introduced.

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406 Judgment of the Court of 19 September 2000. Federal Republic of Germany v Commission of the European Communities, Case C-156/98.
407 A.VALENZA, A. IACOB, C. AMICHETTI, P. CELOTTI, S. ZILLMER AND J.KOTRASINSKI, 'Regional and local authorities and the National Recovery and Resilience Plans' European Committee of Regions- Commission for Economic Policy, 2021,p.2.
408 K.H. LAMBERTZ-M. HORNUNG, State Aid Rules on Services of General Economic Interest: For the Committee of the Regions the Glass Is Half-Full' (2012) 11 Eur St Aid LQ, p.329.
409 World Bank Group: what is carbon pricing? <Https://carbonpricingdashboard.worldbank.org/what-carbon-pricing> accessed 21 July 2024.
410 Alberto Majocchi, 'Taxation and the Green Growth Challenge: Foreword' (2023) Critical Issues in Environmental Taxation 2023(25)XIV.

1.3.2 Direct Forms of Incentives

Tax credits, which are totally different from tax deductions and exemptions[411], are often used in renewable energy projects[412]. Depending on the legal framework covering them, their functions, types and purposes differ. Several studies have been conducted to assess the effectiveness of the tax credits on renewable energy deployment. Among them, the USA example is notable due to two main reasons: firstly, there were several studies conducted to observe the effect of tax credits on renewable energy sector and deployment of wind and solar projects; and, secondly, the effects' of the US Energy Policy on these renewable instalments and investor behaviour were visible thanks to the empirical studies[413]. They might be grouped as refundable or non-refundable. For instance, in the USA's energy industry, they are primarily classified as investment and production tax credits (ITC and PTC respectively)[414]. These tax credits are extended under the Inflation Reduction Act (IRA). It is seen that additional requirements are brought for the projects to benefit from the ITC. Meanwhile, the IRA enabled all the projects that are under construction, and whose construction started before the end of 2024, eligible for the PTCs at the full rate[415]. This perspective has adversely affected the investor behaviour. Moreover, tax rates tend to affect investor behaviour directly[416]. As indicated in a De Mooij and Ederveen's study[417] conducted in 2003, tax rates based on laws (such as marginal or average rates) often spark more significant reactions from the investors[418].

Green bonds are among the other financial instruments supporting energy transition. For instance: the EU's Next Generation EU Plan offers a considerable amount of green bonds for sustainable finance purposes. **Green bonds** are often regarded as new funding instrument for sustainable projects and green finance in general[419].

1.3.3 Indirect Forms of Incentives

Even though the main aim of tax incentives is not raising the revenue to finance activities of governments[420], they may easily influence taxpayer behaviours. Besides, they are used to correct market failures[421].

In this sense, countries which are part of the Regional Hub may be required to make sure that they do not incentivise environmentally hazardous energy generation activities more than they do for the renewable energy generation activities.

However, it is clear that in order to financially incentivise renewable energy investments in the region, a significant revenue would be required. This revenue should primarily come from taxation of the main emitters of GhG emissions, with a particular reference to carbon-dioxide taxation. Furthermore, once the priority is given to industry, rather than the households, the energy transition process may show significant rise. Meanwhile, it should not be forgotten that the industry should be supported with the green fiscal incentives simultaneously.

Tax incentives facilitating R&D investments, such as those related with energy storage and carbon capture technologies, are also crucial for energy integration and transition[422].

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411 Foundation: Tax Credit < https://taxfoundation.org/taxedu/glossary/tax-credit/> accessed 20 July 2024.
412 Matthew Edwards, 'Windward Woes: The Misalignment of Economic Incentives and Renewable Energy Development Goals' (2024) 29 Ocean & Coastal LJ 89,96.
413 Yaya Sonjaya and Muhamad Yamin Noch, ' Analysis of the Effectiveness of Tax incentives on Energy Sector Investments' Advances in TaxationResearch, 2(2)(2024),121 and 125
414 Matthew Edwards, 'Windward Woes: The Misalignment of Economic Incentives and Renewable Energy Development Goals' (2024) 29 Ocean & Coastal LJ 89,99.
415 Matthew Edwards, 'Windward Woes: The Misalignment of Economic Incentives and Renewable Energy Development Goals' (2024) 29 Ocean & Coastal LJ 89,102.
416 Yaya Sonjaya and Muhamad Yamin Noch, ' Analysis of the Effectiveness of Tax incentives on Energy Sector Investments' Advances in TaxationResearch, 2(2)(2024),122.
417 Ederveen, Sjef and De Mooij, Ruud A., To Which Tax Rate Does Investment Respond? A Synthesis of Empirical Research on Taxation and Foreign Direct Investment (April 3, 2003). Tax Policy Conference, p. 327, 2003, Available at SSRN: https://ssrn.com/abstract=2073387
418 Ibid, 348.
419 Taghizadeh-Hesary, F.; Yoshino, N.; Phoumin, H. Analyzing the Characteristics of Green Bond Markets to Facilitate Green Finance in the Post-COVID-19 World. Sustainability 2021, 13, 5719. https://doi.org/10.3390/su13105719
420 Avi-Yonah, Reuven S. and Edrey, Yoseph M., «Constitutional Review of Federal Tax Legislation» (2021). Law & Economics Working Papers. 175.
421 FYaya Sonjaya and Muhamad Yamin Noch, ' Analysis of the Effectiveness of Tax incentives on Energy Sector Investments' Advances in TaxationResearch, 2(2)(2024),122.
422 Yaya Sonjaya and Muhamad Yamin Noch, ' Analysis of the Effectiveness of Tax incentives on Energy Sector Investments' Advances in TaxationResearch, 2(2)(2024),122.

1.4 Monitoring of Energy Generation Methods

For the effective operation of the energy hub, the energy generation methods used by the private actors should be closely monitored. In other words, the source of electricity generation activity benefitting from the incentives provided must be renewable. Detecting and monitoring of electricity generation methods carefully may require cooperation among regional/ local authorities and the central monitoring organisation to be set up. Different monitoring methods can be preferred by signatory states in this regard.

2. POLICY IMPLICATIONS AND RECOMMENDATIONS TAILORED TO THE MEDITERRANEAN COUNTRIES

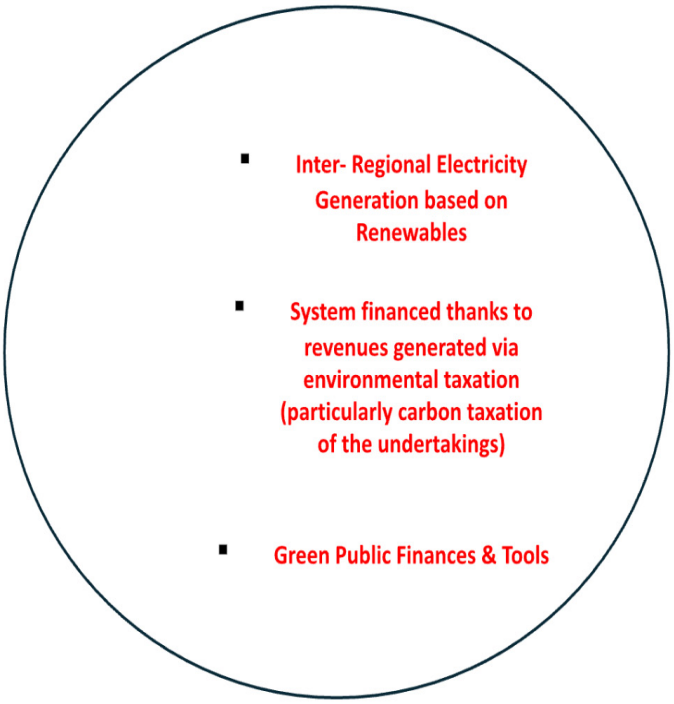


FIGURE.2 *The Model Proposed: A connected REH based on an RTA*

The establishment of a Renewable Energy Hub (REH) in the Mediterranean Region is proposed as a key strategy to facilitate the energy transition. **Technical feasibility hinges on two critical factors: geographic suitability and targeted investment**. The REH could be anchored in a Regional Trade Agreement (RTA) for electricity trade exclusively generated from renewable sources. This trade may be extended in a way to cover other Renewable Energy products.

Should the creation of a REH be centred around a Regional Trade Agreement (RTA), it may require an EU level representation of the Member States. Since the EU has the exclusive competency in this field by virtue of Article 3 of the TFEU, it will be party to the agreement, representing Member States in question. Moreover, any form of fiscal incentives to be introduced by the Member States must comply with the EU State Aid Mechanism. The questions regarding how revenues would be created and monitored are of particular importance. A new institution might need to be set up and authorised for this purpose.

Importance of International & Regional Cooperation

From a feasibility perspective, it is highlighted in the literature that the regional energy trading opportunity can be possible and sustained only if it is supported by transmission investments for the REH which is the key enabler[423].

From a legal point of view, on the other hand, a regional trade agreement (RTA) may be the legal form of this cooperation. Such agreements facilitate free trade and economic integration among the parties to the agreement, and the form of RTAs may vary depending on parties' requests and cooperation they aim to achieve. For instance, Free Trade Agreements, Customs Unions and Economic Integration Agreements are among examples of RTAs[424]. Due to the lack of multilateral international treaties which particularly deal with energy industry and trade, this area has already encountered the proliferation of bilateral treaties[425].

423 Burak Guler, Emre Çelebi, Jatin Nathwani,
'Cost-effective decarbonization through investment in transmission interconnectors as part of regional energy hubs (REH)' The Electricity Journal,Volume 34, Issue 3, 2021,383.
424 OECD Work on Regional Trade Agreeements and the environment policy persoectives (2023)4.
425 Michail Skouzes, 'Energy Transit under GATT Article V and Energy Trade Dispute Resolution in the WTO' WTI working paper no.11/2023, 1.



Although not yet realised, there are already various projects and plans related with the cross-border renewable energy trade the Mediterranean Region, such as: the UfM Mediterranean Solar Plan(MSP), The MSP-PPI which is also within the scope of the MSP(project preparation facility funded by the EU)[426].

A paradigm shift supported by coherent green economic tools

Although It is argued by some scholars that the price of oil should no longer be considered as a reference indicator, which requires the world economic order not to rely on oil[427]. This means, on the other hand, that the energy required for sustaining economic activities should not be primarily based on fossil fuels. Thanks to the REH Model, the regional energy market may start to be based on renewable energy sources.

Also, it is argued that since fossil fuels' environmental damage is global, a global environmental tax and the introduction of a global carbon price can be the right solution[428]. According to modern economics, public goods are non-excludable and non-rival, and Climate Change Mitigation is regarded as a global public good[429]. Therefore, regional cooperation should not hinder any other cooperations which may occur to support renewable energy transition globally.

International cooperation on different fiscal topics seem possible in many senses. For instance, it is seen that thanks to the OECD deal, an agreement on the minimum rate of corporate tax of

426 European Investment Bank, Mediterranean Solar Plan , Project Preparation Initiative (MSP-PPI), European Investment Bank, 2015, https://data.europa.eu/doi/10.2867/55111
427 Alberto Majocchi, 'Taxation and the Green Growth Challenge: Foreword' (2023) Critical Issues in Environmental Taxation 2023(25)XVII.
428 Alberto Majocchi, 'Taxation and the Green Growth Challenge: Foreword' (2023) Critical Issues in Environmental Taxation 2023(25)XIII.
429 World Economic Forum: Why the planet needs legally binding obligations to limit climate-mitigation 'free-riders' < https://www.weforum.org/agenda/2022/06/incentives-free-rider-problem-climate-change-mitigation/> accessed 28 July 2024.

%15 has been achieved[430]; hence, it is argued by some scholars that a global minimum level of carbon pricing should be considered with the same logic[431]. Also, a regional minimum level of carbon pricing may be considered by the Mediterranean Countries.

The best mix of policy tools and financial instruments for the Mediterranean Region

The System created could include direct forms of fiscal incentives, such as subsidies, because they are easily detected unlike other forms of fiscal incentives. Meantime, Mediterranean Countries which are part of the REH should be advised not to incentivise fossil fuel-based energy generation methods **more than** the energy generation methods which are environmentally friendly.

- **Tax Credits, Green Bonds and The Legal Guarantee of Future Tax Credits:** The importance of tax credits in the renewable energy industry cannot be ignored. For instance, in the USA, the wind tribune installations significantly dropped when existing tax credits had expired[432]. By their nature, both tax credits and tax deductions reduce tax liability; however, the former causes dollar-for-dollar reduction and are more important and valuable than deductions especially for the lower income groups[433]. Consequently, it is seen that the developers and producers are more partial to tax credits than tax deductions[434].

  The guarantee of future incentives/ economic tools has the potential to accelerate the transition process. It is essential to support and provide guarantees and foreseeability for the renewable energy industry for its growth. On the other hand, it is equally important to make sure that renewables are supported more than environmentally hazardous energy generation methods. For instance, in the USA, offshore oil and gas tax credits have had a permanent and fixed IRC (Internal Revenue Code) option while offshore wind tax credits are temporary and extended depending on circumstances[435]. It is visible that such attitudes affect the direction of investments. Thanks to the system proposed, the REH, the introduction of guaranteed green public finance options will attract investors.
- **The EU Law and the EU standards:** The TFEU and TEU includes provisions regarding both positive and negative obligations of the Member States. According to Article 4 of TEU, Member States are expected to comply with the EU law obligations and take necessary measures for this purpose[436]. Hence, there are positive and negative Union loyalties which bind Member States' authorities. In this sense, Effectiveness (the effet utile) principle is in relation with the loyalty principle. According to this, Member States are required to comply with the EU standards in administrative, judicial and legislative manners, providing the effective realisation of the EU Law[437]. Considering Articles 3 and 4 of the TFEU, there must be an EU involvement in the RTA proposed. Due to Common Commercial Policy, bilateral trade agreements between EU Member States and third countries would require EU level representation.
- **Adapting tools to the region's heterogeneous socio-economic contexts:** Cross-border electricity trade would necessitate coordination and unified regulatory and administrative frameworks to support effective operation of the energy market[438]. Striking the right balance between such tools and taxation is more critical than it may appear. Inadequately designed tools may lead to the loss of time and inefficient and ineffective results. For example, VAT incentives in China were found to fall short when assessed against equity criteria[439]. Types and

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430 OECD: The Global Minimum Tax (GMT) < https://www.oecd.org/content/dam/oecd/en/topics/policy-issues/cross-border-and-international-tax/summary-economic-impact-assessment-global-minimum-tax-january-2024.pdf> accessed 26 July 2024.
431 Alberto Majocchi, 'Taxation and the Green Growth Challenge: Foreword' (2023) Critical Issues in Environmental Taxation 2023(25)XVI.
432 Matthew Edwards, 'Windward Woes: The Misalignment of Economic Incentives and Renewable Energy Development Goals' (2024) 29 Ocean & Coastal LJ 89,99.
433 Tax Foundation: Tax Credit < https://taxfoundation.org/taxedu/glossary/tax-credit/> accessed 20 July 2024
434 Matthew Edwards, 'Windward Woes: The Misalignment of Economic Incentives and Renewable Energy Development Goals' (2024) 29 Ocean & Coastal LJ 89,98.
435 Matthew Edwards, 'Windward Woes: The Misalignment of Economic Incentives and Renewable Energy Development Goals' (2024) 29 Ocean & Coastal LJ 89,105.
436 Marjaana Helminen, EU Tax Law: Direct Taxation(2022, Amsterdam,IBFD)8.
437 Marjaana Helminen, EU Tax Law: Direct Taxation(2022, Amsterdam,IBFD)8.
438 Heymi Bahar, Jehan Sauvage, 'Cross-Border Trade in Electricity and the Development of Renewables-Based Electric Power: Lessons from Europe',OECD Trade and Environment Working Papers 2013/02, 8.
439 Yaya Sonjaya and Muhamad Yamin Noch, ' Analysis of the Effectiveness of Tax incentives on Energy Sector Investments' Advances in TaxationResearch, 2(2)(2024),121.

legal structures of financial instruments can vary significantly between countries. Therefore, financial tools must be tailored to the specific socio-economic conditions of each context. For example, tax credits are particularly important for lower-income groups, as well as for renewable energy developers and producers. Accelerating the energy transition and supporting low-carbon development requires mobilizing both public and private investment[440].

Common policy tools to attract investors include feed-in tariff schemes, green certificates, and tax incentives[441]. However, feed-in tariffs should be approached with caution, as they do not always ensure genuinely "green" outcomes and may sometimes support technologies or practices that fall short of sustainability goals, according to the contexts in which they are implemented.

Fiscal Incentives for supporting energy transition	Features of the Incentive	Evaluating the Applicability of the Incentive as a Regional Fiscal Tool in the Mediterranean Region
Tax Credits (ITCs & PTCs)	The use of tax credits in RE projects is very common[442]. Especially for the lower-income groups or investors, their effect is significant[443]. From this perspective, they differ from tax reductions or incentives.	There should be a legal guarantee for the future tax credits. Especially, the RE Projects or Investments should be able to enjoy this guarantee[444]. It is important to support renewables as much as environmentally hazardous energy generation methods or more than them. This approach should be adopted while detecting the tax rates[445] and providing the legal guarantee[446].
Other forms of Direct Grants & Subsidies(such as green bonds and the EU Innovation Fund which is funded by the ETS)	Among the instruments, green bonds are important instruments to support the RE industry[447].	It can be argued that the direct form of incentives are better suited to international design. For the indirect forms of incentives, on the other hand, a set of criteria may be suggested considering the best practices.
Carbon Taxes	Combining traditional tax incentives with carbon pricing mechanisms, such as carbon taxes, would lead to enhanced regulatory frameworks[448].	The introduction of a minimum regional carbon tax would support the energy transition in the region.

440 Joyashree Roy, Duke Ghosh, Anupa Ghosh, Shyamasree Dasgupta, 'Fiscal instruments: crucial role in financing low carbon transition in energy systems' Current Opinion in Environmental Sustainability,
Volume 5, Issue 2,2013,pages 261-269.
441 Shahrouz Abolhosseini, Almas Heshmati, 'The main support mechanisms to finance renewable energy development', Renewable and Sustainable Energy Reviews,Volume 40,2014,Pages 876-885.
442 Matthew Edwards, 'Windward Woes: The Misalignment of Economic Incentives and Renewable Energy Development Goals' (2024) 29 Ocean & Coastal LJ 89,96.
443 Tax Foundation: Tax Credit < https://taxfoundation.org/taxedu/glossary/tax-credit/> accessed 20 July 2024.
444 Matthew Edwards, 'Windward Woes: The Misalignment of Economic Incentives and Renewable Energy Development Goals' (2024) 29 Ocean & Coastal LJ 89,99.
445 Yaya Sonjaya and Muhamad Yamin Noch, ' Analysis of the Effectiveness of Tax incentives on Energy Sector Investments' Advances in TaxationResearch, 2(2)(2024),122.
446 Matthew Edwards, 'Windward Woes: The Misalignment of Economic Incentives and Renewable Energy Development Goals' (2024) 29 Ocean & Coastal LJ 89,99.
447 Taghizadeh-Hesary, F.; Yoshino, N.; Phoumin, H. Analyzing the Characteristics of Green Bond Markets to Facilitate Green Finance in the Post-COVID-19 World. Sustainability 2021, 13, 5719. https://doi.org/10.3390/su13105719
448 Yaya Sonjaya and Muhamad Yamin Noch, ' Analysis of the Effectiveness of Tax incentives on Energy Sector Investments' Advances in TaxationResearch, 2(2)(2024),124.

Tax Incentives (exemptions and deductions)	Tax incentives particularly affect financial sustainability and risk-reward ratio of energy projects, R&D initiatives and energy security objectives[449]. In the EU State Aid Mechanism, the aid concept is construed more broadly than of subsidies (as indicated in the landmark judgement, De Gezamenlijke Steenkolenmijnen in Limburg v High Authority of the European Coal and Steel Community.) Therefore, the charges which are mitigated, or similar interventions are also regarded as state aid[450].	The results-driven or performance based incentives may be effective depending on the context and whether the outcomes are measurable. In this sense, for instance, incentives may be granted to the undertakings reducing their GhG emissions or growing their Renewable power capacities[451].
Feed in Tariff Policies	FiT Schemes support the RE industry, specifically wind and solar energy projects[452].	The applicability of the FiT schemes in the EU require compliance with the state aid rules. Such schemes are suggested especially for the rapid deployment of the RE installations. But caution is needed in relation to their potential negative externalities, including on biodiversity.

TABLE 1
Assessing the applicability of incentives

Lastly, as established under the Paris Agreement, climate action must account for varying levels of development among countries. Nationally Determined Contributions (NDCs) reflect the principle of common but differentiated responsibilities and respective capabilities (CBDR-RC), as set out in the United Nations Framework Convention on Climate Change (UNFCCC)[453]. This principle should guide the formulation of both positive and negative obligations within the Mediterranean region. Given the region's economic and institutional diversity, effective climate policy must prioritize flexibility and adaptability in the design of financial instruments. However, this flexibility must not come at the expense of rigor.

Evidence-based policymaking should remain a cornerstone, ensuring that measures are informed by empirical data and capable of delivering measurable impact[454]. Evaluating the effectiveness of incentives from the outset is essential to maximize their relevance and efficiency within specific national contexts.

In conclusion, while establishing a coordinated REH in the Mediterranean, supported by the right green economic tools, presents opportunities to accelerate the energy transition, the path forward will face complex legal, economic, and political challenges. Achieving effective regional cooperation and designing fiscal policies that reflect diverse national contexts requires patience, flexibility, and sustained commitment.

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449 Yaya Sonjaya and Muhamad Yamin Noch, ' Analysis of the Effectiveness of Tax incentives on Energy Sector Investments' Advances in TaxationResearch, 2(2)(2024),121.
450 Judgment of the Court of 23 February 1961, De Gezamenlijke Steenkolenmijnen in Limburg v High Authority of the European Coal and Steel Community. Case 30-59, of 28 April 2024, < https://eur-lex.europa.eu/legal-content/EN/TXT/?uri=CELEX%3A61959CJ0030> accessed 27 April 2025.
451 Yaya Sonjaya and Muhamad Yamin Noch, ' Analysis of the Effectiveness of Tax incentives on Energy Sector Investments' Advances in TaxationResearch, 2(2)(2024),124.
452 Yaya Sonjaya and Muhamad Yamin Noch, ' Analysis of the Effectiveness of Tax incentives on Energy Sector Investments' Advances in TaxationResearch, 2(2)(2024),123.
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454 Yaya Sonjaya and Muhamad Yamin Noch, ' Analysis of the Effectiveness of Tax incentives on Energy Sector Investments' Advances in TaxationResearch, 2(2)(2024),125.

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CHAPTER 12. SOCIAL CARBON COST: MEASURING CLIMATE CHANGE'S SOCIO-ECONOMIC IMPACT IN THE MEDITERRANEAN WITH A CARBON TAX PROPOSAL

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Abstract

This chapter explores the socio-economic impact of climate change in the Mediterranean region and proposes optimal carbon tax strategies tailored to country-specific contexts. Using an extended Regional Integrated Climate Economics for mediterranean region (RICE-MED) model, the study estimates the Social Cost of Carbon (SCC) for each country, evaluates different carbon tax scenarios, and assesses their implications for emissions reductions and economic performance. Results reveal significant regional differences driven by economic structures, energy profiles, and climate vulnerabilities. While Southern European nations are equipped to adopt higher carbon taxes due to advanced renewable energy systems, North African countries require gradual approaches. Other economies are in an in-between situation, potentially benefitting from phased strategies aligned with renewable energy growth. This chapter highlights the importance of regional cooperation, harmonized carbon pricing, and shared investments in renewable energy to address shared climate challenges. Its insights aim to guide policymakers toward effective, equitable, and sustainable decarbonization strategies.

Résumé

Ce chapitre examine l'impact socio-économique du changement climatique dans la région méditerranéenne et propose des stratégies optimales de taxe carbone adaptées aux contextes spécifiques de chaque pays. En utilisant un modèle étendu d'Économie Climatique Intégrée Régionale pour la région méditerranéenne (RICE-MED), le chapitre estime le Coût Social du Carbone (CSC) pour chaque pays, évalue différents scénarios de taxe carbone et analyse leurs implications sur la réduction des émissions et la performance économique. Les résultats montrent des différences régionales significatives, liées aux structures économiques, aux profils énergétiques et aux vulnérabilités climatiques. Tandis que les pays du sud de l'Europe sont en mesure d'adopter des taxes carbone plus élevées grâce à des systèmes avancés d'énergies renouvelables, les pays d'Afrique du Nord nécessitent une approche plus progressive. D'autres économies se trouvent dans une situation intermédiaire, et pourraient plutôt bénéficier de stratégies progressives alignées sur la croissance des énergies renouvelables. Ce chapitre met en lumière l'importance de la coopération régionale, de l'harmonisation de la tarification du carbone et des investissements partagés dans les énergies renouvelables pour relever les défis climatiques communs. Ses conclusions visent à guider les décideurs vers des stratégies de décarbonation efficaces, équitables et durables.

1. BACKGROUND ON THE ROLE OF GREEN PUBLIC FINANCE IN ENFORCING ENVIRONMENTALLY RESPONSIBLE DECISION-MAKING AND ACHIEVING A SUSTAINABLE MEDITERRANEAN

Global warming caused by human activity is a pressing and irreversible issue that is expected to impact future generations even more severely than today's (Giorgi 2006, Giorgi and Lionello 2008, Tuel and Eltahir 2020, Baglivo, Congedo et al. 2022). The region's climate sensitivity, coupled with significant environmental degradation, makes the Mediterranean a "hotspot" for climate change impacts (Cramer, Guiot et al. 2018).

Addressing today's environmental challenges requires a dual approach: adaptive measures that respond to current conditions and forward-looking strategies that mitigate future risks. Policy frameworks must strike a balance between cost-efficiency and impact, ensuring progress toward sustainable development goals. In this context, green finance (GF) plays a pivotal role by channeling resources into environmentally responsible projects and promoting sustainable economic practices (Cheberyako, Varnalii et al. 2021; Wang, Zhao et al. 2022). A notable example is the 2017 One Planet Summit in Paris, where global stakeholders endorsed eco-financial instruments as essential tools for addressing environmental threats and advancing sustainability objectives.

Among the key instruments of green finance is the carbon tax (CT), which places a price on carbon emissions to incentivize reductions in greenhouse gases (Barde and Owens 1996; Marron and Toder 2014; Pigou 2017). Building on this, **the concept of the social cost of carbon (SCC) seeks to quantify the broader societal impact of emissions.** According to the Pigouvian economic framework, an optimal carbon tax should be set at a level where the marginal cost of emission abatement equals the societal benefit of reduced pollution (Farhi and Gabaix 2020; Jaeger 2012)[455]. In the literature, SCC is defined as "the impact of emitting an additional ton of carbon dioxide, or the benefit of slightly reducing emissions, when assessed along an optimal emissions trajectory."

Numerous studies have examined the application of SCC over the past decades (Tol 2011; Van den Bijgaart, Gerlagh, and Liski 2016; Nordhaus 2017; Pindyck 2019; Tol 2019). SCC also underpins the "double dividend" hypothesis, which suggests that carbon pricing can simultaneously generate public revenues and reduce the external costs of pollution. Figures 01 and 02 illustrate how an SCC-based approach might be implemented in southern Mediterranean countries and outline its potential implications for the region's socio-economic resilience.

455 An optimal tax discount is set to the level of the marginal societal damage (MSD. Measuring MSD is a separate and difficult task, it exists a wide variety of methodologies such as the costs to health, productivity, and amenities from pollution and other forms of environmental damage

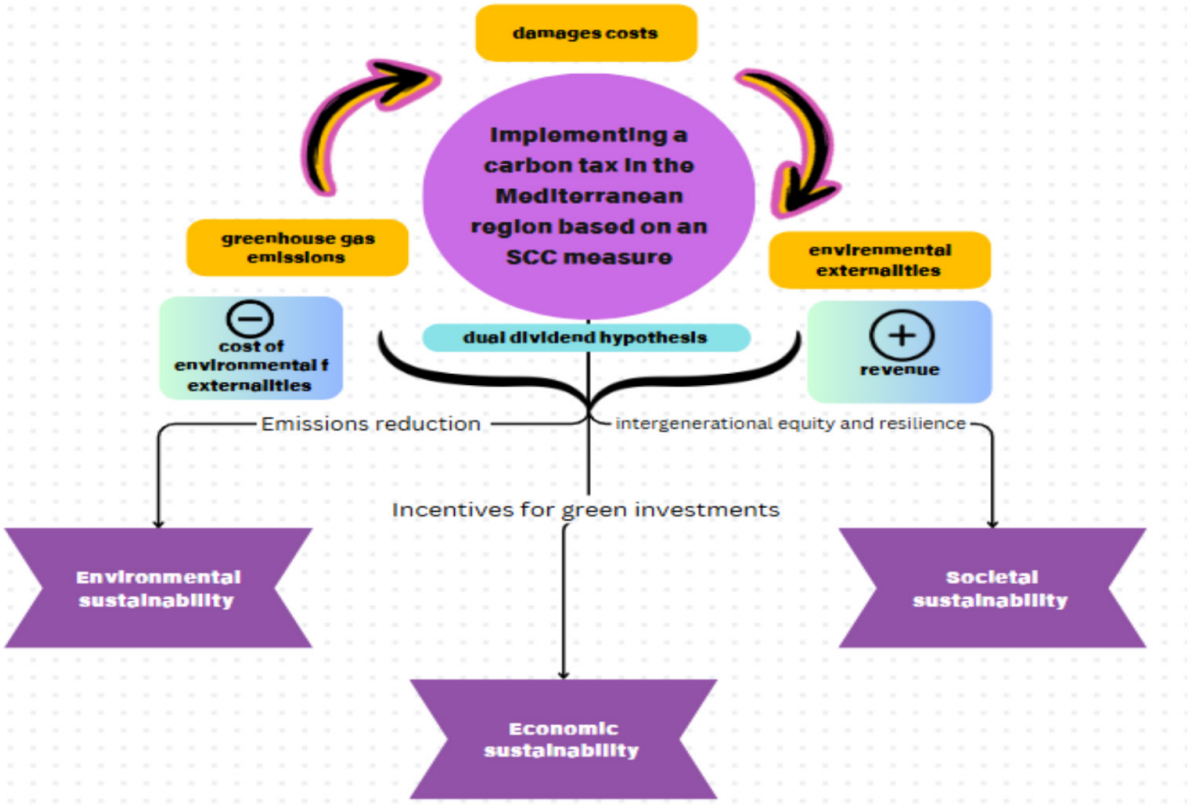


FIGURE.1 *A conceptual framework of the implementation process of carbon tax in the MED- based on the Pigouvian taxation framework and the SCC*
Source : author's own

Figure 1 presents a conceptual framework for applying the social cost of carbon (SCC) to quantify the broader damages associated with a one-ton increase in carbon dioxide emissions. These damages are expressed in monetary terms, representing the cost of environmental externalities that contribute to market failure.

By implementing an optimal carbon tax, policymakers can address these externalities and positively influence the overall well-being of the Mediterranean region, targeting three key dimensions of sustainability: environmental, economic, and social.

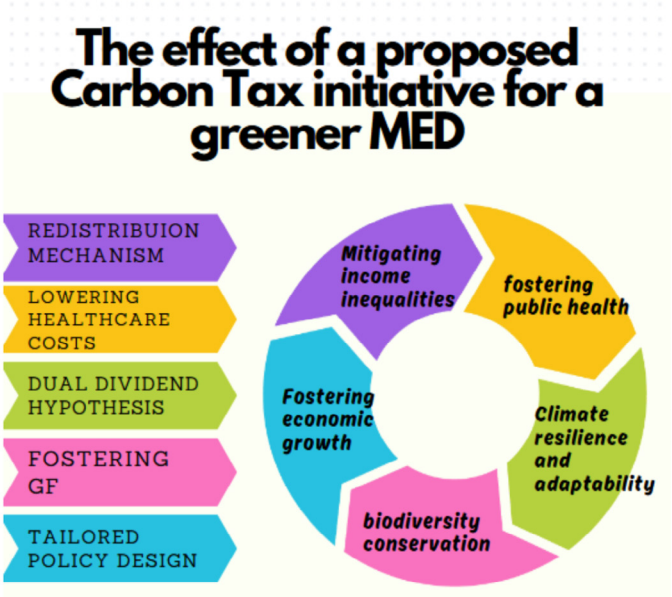


Figure 2 illustrates the potential multi-dimensional benefits of introducing a carbon tax in the Mediterranean region. It outlines how such a policy could reduce income inequality through redistributive mechanisms, lower healthcare expenditures by improving public health, strengthen climate resilience, protect biodiversity, and stimulate economic growth through green investment. The figure further underscores the importance of context-specific policy design, tailored to regional needs, and highlights the role of green finance in achieving the «double dividend» of environmental protection and economic development.

FIGURE.2 *Effect of a carbon tax reform on the socioeconomic and environmental health of the MED*
Source : author's own

2. METHODOLOGY: QUANTIFYING CLIMATE CHANGE IMPACTS AND CARBON PRICING EFFECTIVENESS IN THE MEDITERRANEAN: INSIGHTS FROM AN EXTENDED RICE-MED MODEL

Accurate measurement is essential for designing effective policies to mitigate environmental harm and promote sustainable development. In this context, calculating the Social Cost of Carbon (SCC) is a key step in setting an appropriate carbon tax that balances environmental gains with economic realities.

This paper introduces an updated and extended version of the Regional Integrated Climate Economy model[456] adapted for the Mediterranean—**RICE-MED-23**[457]—highlighting its advantages over other commonly used models. While global models such as DICE (Dynamic Integrated Climate-Economy; Nordhaus, 2017), PAGE (Policy Analysis of the Greenhouse Effect; Hope, 2011), and FUND (Climate Framework for Uncertainty, Negotiation, and Distribution; Tol, 2009) offer regional disaggregation and policy scenario analysis, RICE-MED is uniquely suited to the Mediterranean due to its ability to reflect the region's specific socio-economic and environmental characteristics.

First, the Mediterranean region is marked by a high degree of socio-economic diversity, bringing together advanced European economies, emerging economies, and countries in various stages of development, each with distinct economic structures and levels of vulnerability to climate impacts (Cramer et al., 2018; Tuel & Eltahir, 2020). While global models often aggregate such heterogeneity into broad regional categories, RICE-MED provides a more granular and country-specific representation, allowing for more precise evaluations of economic and environmental dynamics across the Mediterranean (Castelli et al., 2023).

Second, RICE-MED allows for region-specific calibrations that incorporate the Mediterranean's unique climate dynamics, such as prolonged droughts, sea-level rise, and extreme heatwaves, which have disproportionate effects on sectors like agriculture and water resources (Giorgi & Lionello, 2008; Cramer et al., 2018). This regional specificity enhances the model's precision in estimating climate-induced economic damages, outperforming other models like PAGE and FUND by integrating localized climate sensitivities into its damage functions, rather than relying solely on global averages.

Furthermore, RICE-MED supports detailed scenario analysis tailored to policy interventions relevant to the Mediterranean, including carbon pricing, renewable energy deployment, and adaptation investments. This functionality aligns closely with the objectives of the present study by allowing an evaluation of country-specific trade-offs, emission reduction pathways, and welfare impacts, critical for policymakers who must align environmental goals with economic development and social equity.

The **RICE-MED-23** model presented here builds on the original framework proposed by Castelli et al. (2023), incorporating several key enhancements. These include the integration of the most recent country-level economic and environmental data, greater sectoral and regional granularity, and advanced calibration techniques specific to the Mediterranean context. Notably, RICE-MED-23 features improved parameterization of climate damage functions, more detailed representations of national energy mixes and emissions trajectories, and refined modeling of regional economic interdependencies. These methodological improvements enable a more robust and policy-relevant analysis of climate risks and responses in the Mediterranean basin.

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456 The original RICE-MED model, recently developed by Castelli et al. (2023), further specializes the RICE model specifically for the Mediterranean basin. RICE-MED enhances regional resolution by focusing explicitly on Mediterranean socio-economic and climate characteristics, allowing tailored policy analysis and capturing region-specific climate vulnerabilities and economic structures.

457 The integrated assessment modeling framework employed in this study is originates from the Dynamic Integrated Climate-Economy (DICE) model developed by Nordhaus (2017), a global model designed to analyze climate-economy interactions and optimal emissions trajectories at the aggregate global scale. To capture regional heterogeneity, Nordhaus and Yang (1996) developed the Regional Integrated Climate-Economy (RICE) model, a disaggregated version of DICE that partitions the world economy into distinct regions, each characterized by region-specific economic and climate parameters.

Model	Scope	Regional Detail	Key Features
DICE	Global	None (single aggregated global region)	Global climate-economy interactions and aggregate emissions paths
RICE	Global (Regional Disaggregation)	Broad regional groupings	Region-specific economic and climate analysis
Original RICE-MED	Mediterranean Basin	Regional specificity for Mediterranean	Tailored economic, climatic, and policy dynamics specific to Mediterranean region
Updated RICE-MED-23 (this study)	Mediterranean Basin (Enhanced country-specific granularity)	Detailed country-level analysis within Mediterranean	Enhanced parameterization of climate damage, detailed energy and emissions pathways, and policy scenario analysis for Mediterranean countries

TABLE 1
Comparative Overview of Climate-Economy Models Relevant to the Mediterranean Region
Source : by the authors

Despite its strengths, the updated RICE-MED-23 model, like all integrated assessment models, inevitably involves uncertainties and simplifications that affect the reliability of Social Cost of Carbon (SCC) estimates. These uncertainties stem from several key assumptions, particularly regarding climate sensitivity, damage functions, and future economic growth. For example, SCC projections are highly sensitive to assumptions about how global temperatures respond to increases in greenhouse gas concentrations; even small changes in these parameters can lead to large differences in estimated economic damages (Pindyck, 2013; Nordhaus, 2017). Similarly, the damage functions, which quantify the economic impacts of climate change, carry considerable uncertainty, as they are often based on historical data or broad global averages that may not fully reflect region-specific vulnerabilities (Tuel & Eltahir, 2020; Cramer et al., 2018).

Moreover, assumptions regarding discount rates profoundly influence SCC estimates, reflecting subjective value judgments about intergenerational equity and the relative importance of future climate impacts (Stern, 2007; Nordhaus, 2017). Lower discount rates significantly increase SCC estimates by assigning higher weight to future damages, whereas higher discount rates diminish the perceived urgency of mitigation actions. Thus, the choice of discount rate introduces substantial normative uncertainty into the results.

Furthermore, economic projections within the RICE-MED-23 model rely on growth trajectories and emission pathways informed by current data and trends, which could deviate due to unforeseen economic shocks, technological advancements, or policy interventions. These uncertainties underscore the importance of regularly updating model parameters with refined data and methodologies, particularly region-specific climate and economic damage data, as they become available (Dietz & Stern, 2015).

Sample Selection

The Mediterranean region is known for its unique combination of economic, climatic, and geographic factors. The countries included in the study are:

- Southern European countries: France, Spain, Italy, Greece
- North African countries: Algeria, Tunisia, Egypt, Morocco, Libya
- Middle Eastern countries: Türkiye, Syria, Lebanon.

These countries represent a diverse mix of economic development levels, climate vulnerabilities, and policy environments, providing a comprehensive view of the potential impacts and effectiveness of carbon tax policies in the region.

Modelling Framework: An extended RICE-MED model for SCC calculation and Carbon Tax determination

Following the existing literature, we update the regionalization, calibration and initialization of the RICE-MED (23)[458], we calculate the SCC and integrate carbon taxes into the model.

By including carbon taxes, this model aims to internalize the external costs of carbon emissions, providing a robust framework for designing effective climate policies. The updated model equations, grounded in solid economic theory, reflect the principles of Pigovian taxation and intertemporal optimization.

Objective Function

Maximize the welfare function W_j over time t[459] :

$$max\left(c_j(t)\right)W_j = \sum_t U\left[c_j(t), L_j(t)\right]R(t)$$

Where :

$c_j(t)$ is per-capita consumption.

$R(t)$ is the pure time preference discount factor.

$Uc_j(t), L_j(t)=L_j(t)\log[c_j(t)]$ is the utility function, reflecting the willingness to reduce wealth disparities across generations.

Budget Constraint

The regional budget constraint is[460] :

$Q_j(t)=C_j(t)+I_j(t)$

Where :

$C_j(t)$ is aggregate consumption in region j.

$I_j(t)$ are investments.

$Q_j(t)$ is the regional aggregate GDP.

Production Function with Carbon Tax

Incorporate the cost of carbon taxes[461] into the production function:

$$Q_j(t) = \Omega_j(t)\left[A_j(t)K_j(t)^{\gamma}L_j(t)^{1-\beta_j-\gamma}ES_j(t)^{\beta_j} - c_j^E(t)ES_j(t) - \tau_j E_j(t)\right]$$

Where :

$\Omega_j(t)$ is the environmental damage factor.

$A_j(t)$ is total factor productivity.

$K_j(t)$ is capital stock.

$L_j(t)$ is labor.

$ES_j(t)$ is carbon-energy services.

$c_j^E(t)$ is the cost of producing carbon-energy.

τ_j is the carbon tax rate.

$E_j(t)$ is the carbon emissions.

Environmental Damage Function

Following Golosov et al. (2014), the environmental damage factor[462] $\Omega_j(t)$ is:

$$\Omega_j(t) = 1 - D_j(M_{AT}(t)\downarrow exp\left(-\theta_j\left(M_{AT}(t) - M^-_{AT}\right)\right)$$

Where :

$D_j\left(M_{AT}(t)\right)$ is the damage function.

$M_{AT}(t)$ is the stock of CO 2 concentration in the atmosphere.

M^-_{AT} is the pre-industrial CO 2 concentration level.

458 an adaptation of the RICE-99 model tailored for the Mediterranean region
459 This aligns with the intertemporal choice theory and the Ramsey model, which emphasize optimizing consumption over time to balance current and future welfare (Ramsey, 1928).
460 This follows the standard neoclassical growth theory, where total output (GDP) is divided between consumption and investment (Solow, 1956).
461 This equation incorporates the concept of Pigovian taxes, which are levied to correct negative externalities, such as carbon emissions, by internalizing the social cost of pollution (Pigou, 1920).
462 This follows the damage function approach, where economic damages increase with higher atmospheric CO 2 concentrations, reflecting the impact of climate change on economic output (Nordhaus, 2014).

θ_j is the regional-specific damage cost parameter.

Emissions Pathway with Carbon Tax

Adjust emissions pathway to reflect the impact of the carbon tax[463]:

$$E_j(t) = E_{BAU_j}(t)\cdot\left(1 - \eta_j \tau_j\right)$$

Where :

$E_{BAU_j}(t)$ is the business-as-usual emissions without a carbon tax.

η_j is the emissions reduction elasticity with respect to the carbon tax rate[464].

Social Carbon Cost (SCC) Calculation

The SCC is calculated as the present value of future economic damages[465] per unit of CO2 emissions[466] :

$$SCC = \frac{\sum_{t=0}^{T} \frac{D_j(t)}{(1+\rho)^t}}{\sum_{t=0}^{T} \frac{\Delta E_j(t)}{(1+\rho)^t}}$$

Where :

$D_j(t)$ represents the economic damage at time t.

$\Delta E_j(t)$ represents the change in emissions at time t.

ρ is the discount rate.[467]



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463 This is based on the elasticity of demand theory, where higher taxes on carbon emissions reduce emissions through decreased demand for carbon-intensive goods and services (Marshall, 1890).
464 The elasticity values are derived from international empirical evidence on emissions responsiveness to carbon pricing (Metcalf & Stock, 2020; Martin et al., 2014) and calibrated based on regional energy profiles and historical emission patterns specific to Mediterranean economies.
465 The RICE-MED-23 model incorporates sectoral damages indirectly within aggregate regional damage functions but does not explicitly quantify impacts for individual sectors like agriculture and tourism, despite their critical economic role in the Mediterranean (Cramer et al., 2018; Grillakis et al., 2022). Future model improvements could explicitly integrate sector-specific damages for greater accuracy.
466 This follows the concept of marginal damage, where the SCC represents the economic cost of emitting an additional ton of CO_2, internalizing future climate damages (Nordhaus, 2014).
467 **The discount rate** is set at 3% which aligns with standard practice in integrated climate-economic modeling (Nordhaus, 2017), offering a balanced compromise between present and future generations' welfare. Specifically, for the Mediterranean region, this rate appropriately reflects the region's blend of advanced, transitional, and developing economies, capturing the diverse socio-economic contexts and varying intergenerational equity considerations (Cramer et al., 2018)

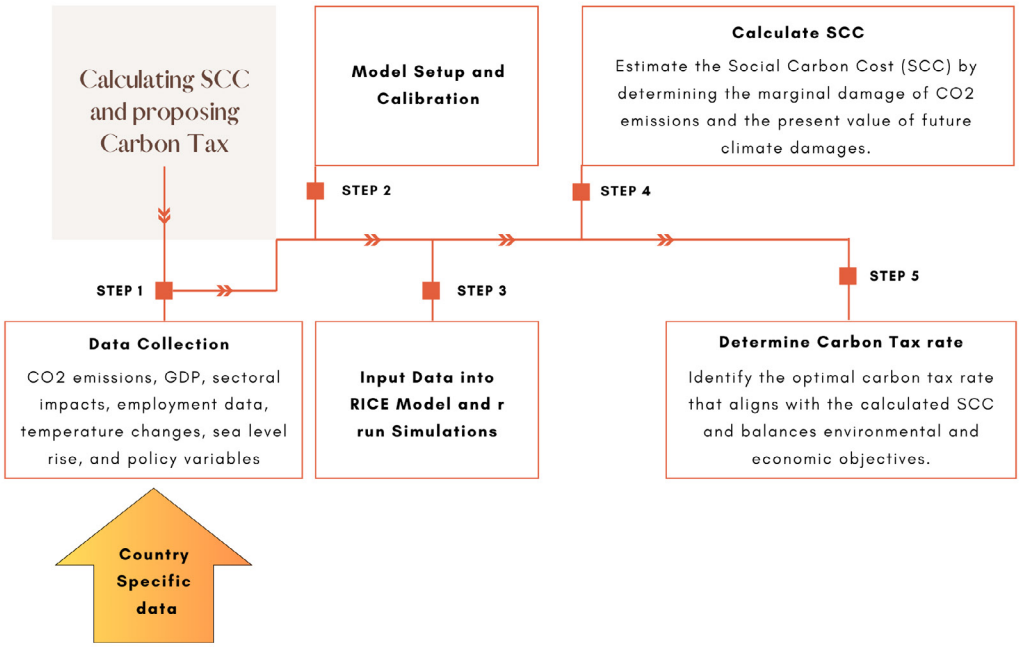


FIGURE.3 *The RICE model process*
Source : author's own

Tax scenarios

In order to evaluate the impact of carbon taxation across Mediterranean countries, three tax scenarios were developed, corresponding to 50%, 100%, and 120% of the calculated Social Cost of Carbon (SCC). These scenarios were designed to explore varying levels of policy ambition:

- **50% of SCC:** A moderate tax rate aimed at gradual emissions reductions while minimizing economic disruption.
- **100% of SCC:** The optimal tax level, fully internalizing the societal cost of carbon emissions as per Pigouvian taxation principles.
- **120% of SCC:** An aggressive approach to account for potential underestimations in SCC values and to incentivize accelerated transitions to low-carbon technologies.

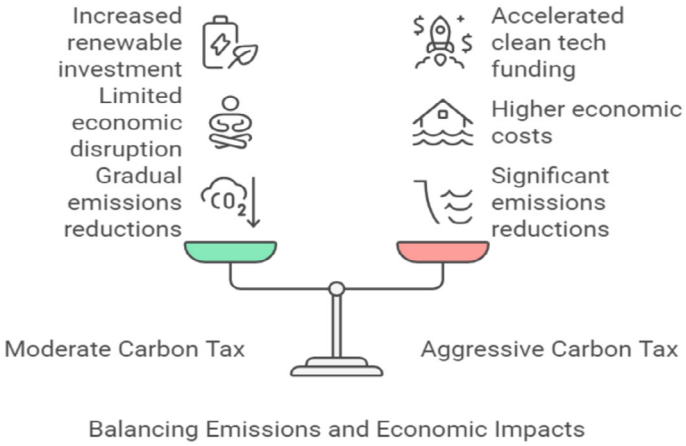


FIGURE.4 *Trade-Offs Between Moderate and Aggressive Carbon Tax Scenarios: Balancing Emission Reductions and Economic Impacts*
Source : author's own

Figure 4 illustrates the trade-offs between moderate and aggressive carbon tax scenarios while implicitly situating the optimal carbon tax scenario (100% of SCC) as the baseline. **The moderate carbon tax** (50% of SCC) emphasizes gradual emissions reductions, increased renewable energy investment, and minimal economic disruption. On the other hand, the **aggressive tax** (120% of SCC) aims for significant emissions reductions and accelerated clean technology funding but comes with higher economic costs. The 100% SCC scenario, though not explicitly shown, represents the balance point, fully internalizing the societal cost of emissions without leaning excessively toward caution or ambition.

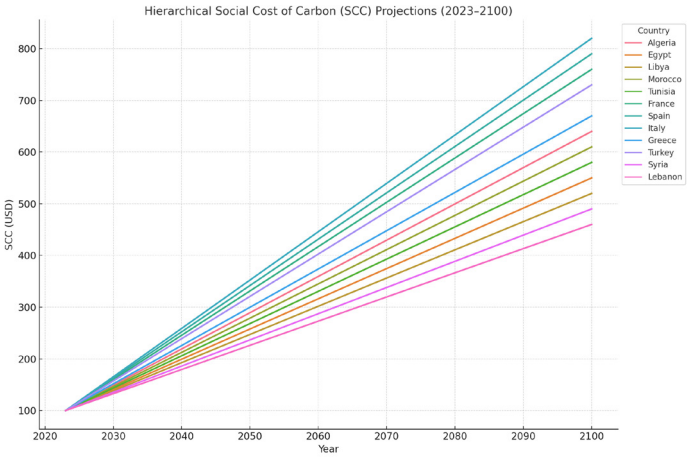


FIGURE.5 *The social carbon cost projection 2020-2100 (base year 2023)*
Source : data processing

3. RESULTS

This section unveils a nuanced understanding of the climate dynamics in the Mediterranean highlighting the critical interplay between carbon taxation and sustainable development. By leveraging the RICE-MED model, the findings focus on country-specific social costs of carbon (SCC), projected various policy scenarios and the cascading impacts of implementing carbon taxes in the region on emissions, economic performance and societal well-being.

3.1 Social Carbon Cost in the Mediterranean Countries

The estimation of the SCC across Mediterranean countries reveals significant heterogeneity in climate vulnerabilities and economic impacts. Our model provides country-specific projections from 2020 to 2100, offering insights into both temporal evolution and geographic distribution of climate-related damages.

Figure 5 shows an upward trend in all countries, reflecting growing economic and social damages from climate change as greenhouse gas emissions rise. The results also reveal a hierarchical structure in the SCC values across the Mediterranean. SCC values evolve in three phases. Initially, in 2020, all countries converge around 100 USD/tCO2, in line with global estimates. This is followed by a gradual divergence period from 2030 to 2060. From 2060 to 2100, there is an acceleration phase, where the gap between countries widens significantly. This progression mirrors the damage functions identified by Tuel and Eltahir (2020) in their Mediterranean climate vulnerability assessment. The acceleration phase reflects the compounding effects of delayed mitigation, nonlinear damage responses, and increased regional disparities. By this time, greenhouse gas concentrations cross critical thresholds, amplifying physical impacts such as extreme heat, water stress, and sea-level rise, particularly in vulnerable regions like North Africa and coastal Southern Europe (Tuel & Eltahir, 2020; Cramer et al., 2018). The SCC steepens due to saturation in adaptation and tipping points in both natural and socio-economic systems, along with widening disparities in institutional and technological capacities (Lenton et al., 2019).

A closer look at country-specific Social Cost of Carbon (SCC) projections reveals significant heterogeneity, with **European Mediterranean countries** like France, Spain, and Italy showing higher estimates, reaching $750–800 per ton of CO_2 by 2100. This is driven by their high economic activity and emissions contributions. The transport sector is a major factor, especially in France, Spain, and Italy, which together account for around 30% of European transport emissions (Cramer et al., 2018). Additionally, energy consumption patterns in these countries play a critical role in emissions. For example, Italy's heavy reliance on natural gas (38% of its energy consumption) reflects industrial demand and dependence on imported fossil fuels, leading to substantial emissions. In contrast, France's reliance on nuclear power (34.9% of consumption) supports its low-carbon energy strategy, helping mitigate emissions while sustaining high economic productivity. These energy strategies highlight the link between economic development, energy demand, and carbon footprints in Southern Europe, contributing to higher SCC projections (Statista, 2023; European Commission, 2023). These trends align with Nordhaus (2017), who notes that developed economies face greater climate-related damages due to larger capital stocks and more extensive infrastructure exposure.

In contrast, **North African and Eastern Mediterranean countries** show lower SCC values, projected to range between $400 and $600 per ton of CO_2 by 2100. This aligns with Dell, Jones, and Olken (2014), who note that developing economies generally have lower absolute SCC values due to smaller economies and emissions profiles, despite high vulnerability to climate impacts. For example, Algeria and Egypt, two of North Africa's largest CO_2 emitters, rely heavily on fossil fuels for energy. Algeria derives over 90% of its energy from natural gas, which is central to its export economy (Bouraiou et al., 2020). It should be noted here that natural gas is one of the fossil fuels with the lowest CO2 emissions. Similarly, Egypt's energy mix is dominated by oil and gas, with both countries' energy consumption and economic growth significantly influencing their carbon emissions (Nkengfack and Fotio, 2019). In Morocco, while emissions are relatively lower, the use of coal for electricity generation still has significant environmental consequences. These examples show how the dependence of North African countries' economic development on fossil fuels and the greater complexity of mitigation shape their emissions profiles, contributing to lower SCC values compared to Europe (Dell, Jones, and Olken, 2014).
Greece and Türkiye occupy an intermediate position, with SCC projections of $650–750 per ton of CO_2 by 2100. These values reflect their economic structures and geographic exposure to climate risks in both Europe and the Eastern Mediterranean. Greece relies heavily on tourism and agriculture, sectors highly sensitive to climate change impacts like rising sea levels, extreme heat, and water scarcity. Historically, Greece's energy mix has seen a non-negligeable share of lignite coal (Vlassopoulos, 2020), though recent shifts to renewable energy sources like wind and solar are helping reduce emissions. However, the moderate pace of this transition results in a mid-range SCC projection. Similarly, Turkey's rapid economic growth has increased energy demand and CO_2 emissions, primarily due to fossil fuel reliance (Kılavuz and Doğan, 2021; Karaaslan and Çamkaya, 2022). Despite substantial investments in renewable energy, such as the Karapınar Solar Power Plant, emissions continue to rise, placing Türkiye in the intermediate SCC range.

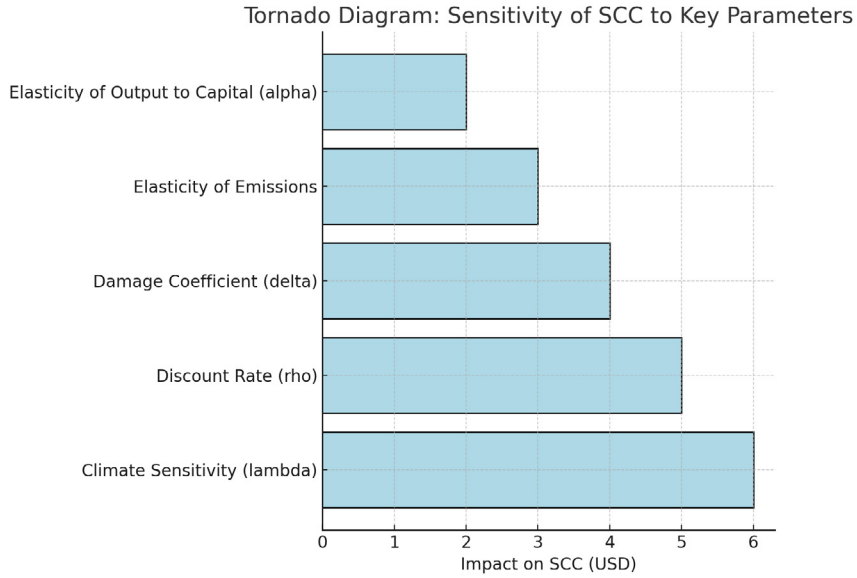


FIGURE.6 *Sensitivity of SCC to key parameters*
Source : data processing

Figure 6 illustrates the sensitivity of the Social Cost of Carbon (SCC) to key economic and climate parameters. Among these, climate sensitivity exerts the strongest influence because it determines the degree to which global temperatures respond to a given increase in greenhouse gas concentrations. In regions like North Africa and the Eastern Mediterranean, where baseline temperatures are already high and heatwaves are intensifying, small shifts in **climate sensitivity** translate into disproportionately larger damages—especially in sectors like agriculture and public health (Tuel & Eltahir, 2020).

The **discount rate** also has a substantial effect on SCC. Lower discount rates give more weight to long-term climate damages, which is particularly relevant in Southern European countries with stronger long-term climate planning frameworks. In contrast, countries facing near-term economic or social instability may favor higher discount rates, reducing the present value of long-term damages in policy design.

The **damage coefficient**, representing the economic impact of climate change, captures region-specific vulnerabilities—such as coastal exposure (e.g., Egypt, Tunisia), water scarcity (e.g., Algeria), or tourism losses (e.g., Greece, Spain). Its variation across sub-regions emphasizes the need for localized calibration of damage functions.

Meanwhile, **emissions elasticity** and **output elasticity** to capital play a smaller role in shaping SCC. These parameters are more technical in nature and tend to vary less across sub-regions, although emissions elasticity may be lower in fossil fuel–dependent economies (e.g., Algeria, Libya), where reducing emissions requires greater structural change.

3.2 Analysis of Carbon Tax Scenarios

This section presents the results and implications of implementing carbon tax scenarios across each Mediterranean country. The analysis examines the environmental and economic impacts of each tax level, focusing on emissions reductions and GDP effects. By comparing these scenarios, the study highlights the trade-offs between policy ambition and economic stability, providing actionable insights for designing effective and balanced carbon pricing strategies.

3.2.1 Emissions Without Carbon Taxation: A Baseline Benchmark

To assess the true effectiveness of carbon tax policies, it is essential to benchmark them against a business-as-usual (BAU) scenario in which no carbon pricing or climate mitigation strategies are implemented. Although the results presented at the end of this chapter demonstrate how carbon taxes based on the Social Cost of Carbon (SCC) affect emissions and economic output, these simulations do not inherently reveal what would occur in the absence of intervention. Therefore, we construct and analyze a zero-carbon-tax baseline to serve as a point of comparison.

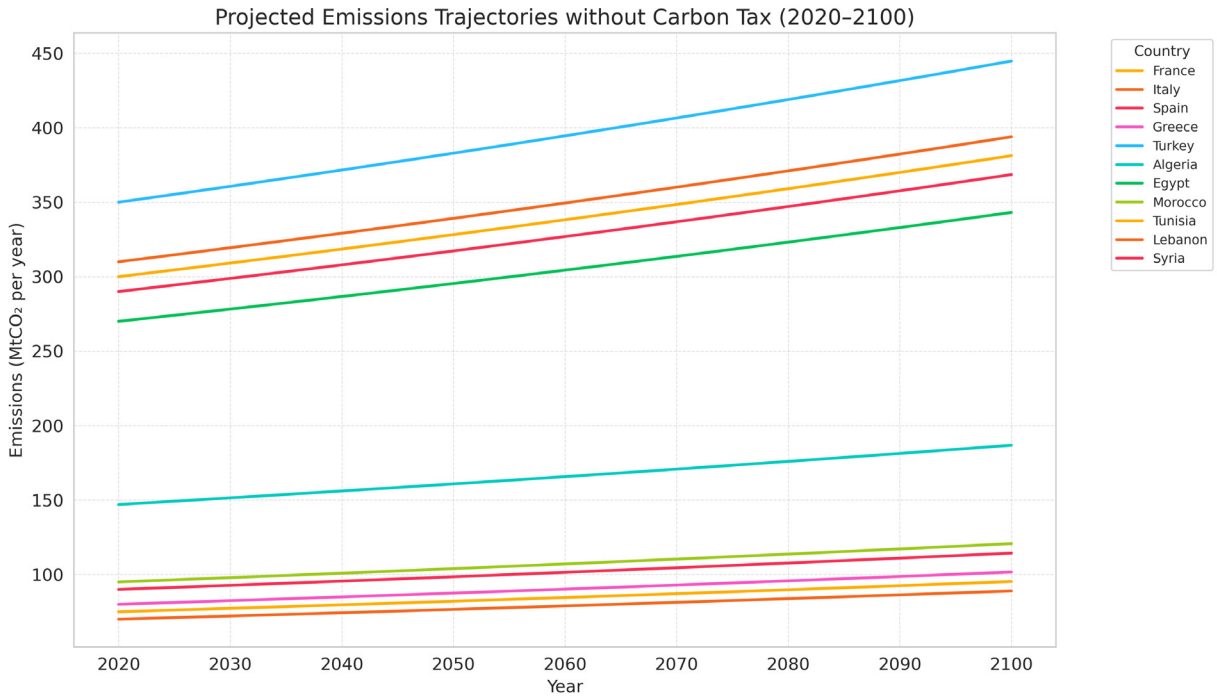


FIGURE.7 *Baseline scenario*
Source : Data processing

All countries exhibit steadily increasing emissions throughout the century. High-emitting economies such as France, Italy, Turkey, Algeria, and Egypt demonstrate emissions paths that more than double by 2100. This trend reflects the combined effect of continued economic expansion, stable or slowly improving energy efficiency, and a lack of carbon pricing signals. In line with Integrated Assessment Models like RICE, emissions grow proportionally with GDP unless counteracted by structural decarbonization policies (Nordhaus, 2017). Without a carbon tax or equivalent mitigation measure, there is little incentive to shift away from carbon-intensive production and energy systems.

In emerging economies such as Egypt, Türkiye, and Algeria, urbanization, industrial expansion, and fossil-fuel-dominated energy mixes amplify emissions growth. In Algeria's case, despite notable investments in renewable potential (notably solar), the electricity mix remains heavily reliant on natural gas, and energy subsidies continue to delay market-based transitions (IEA, 2021). Even in economically advanced economies like France and Italy, legacy infrastructure, transportation systems, and industrial practices contribute to persistently high baseline emissions. These dynamics produce near-exponential increases in annual and cumulative CO_2 emissions, consistent with "business-as-usual" projections in global modeling studies (IPCC, 2022).

Lower-emitting countries such as Lebanon, Tunisia, and Syria follow similar upward trajectories, albeit at a smaller scale. While these countries currently contribute a smaller share of regional emissions, they remain on a path of proportional growth due to rising energy demand, limited decarbonization infrastructure, and policy gaps. In many cases, energy systems are underdeveloped or reliant on imported fuels, with constrained fiscal space for investing in renewables or energy efficiency. Moreover, political instability (as in Syria and Lebanon) often deprioritizes environmental governance and climate planning. As a result, even modest eco-

nomic growth in these countries translates into steadily rising emissions when left unregulated. This baseline scenario illustrates the urgency of introducing robust carbon pricing mechanisms and complementary decarbonization strategies on a regional scale. It reinforces the broader literature highlighting the limitations of relying solely on endogenous technological change or voluntary sectoral shifts in the absence of policy intervention.

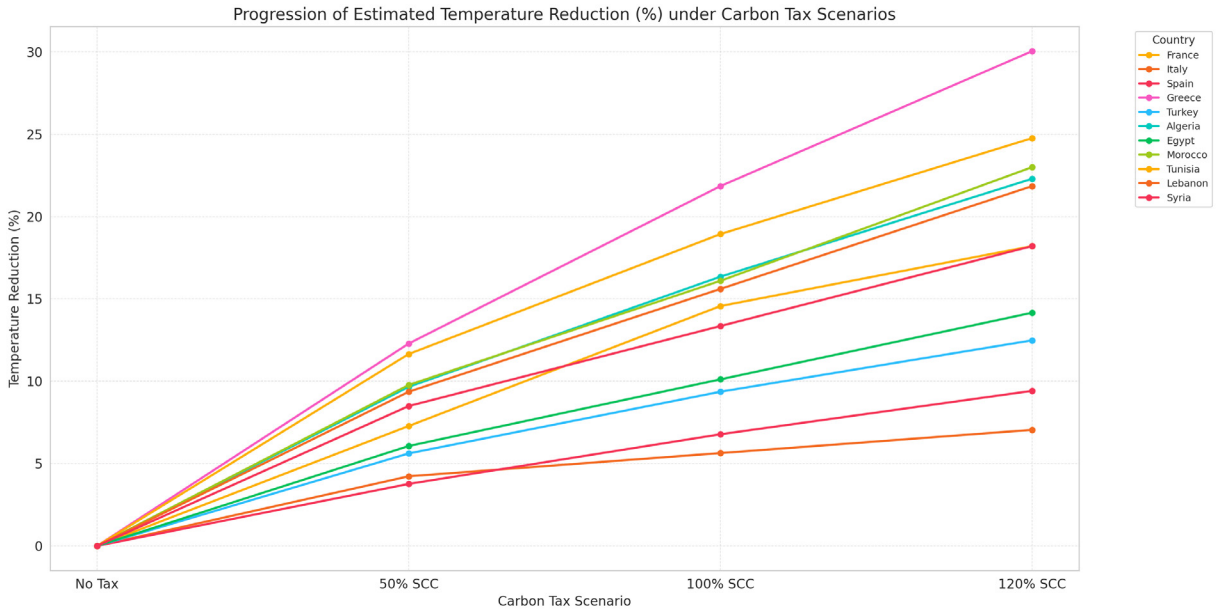


FIGURE.8 *Progression of Estimated Temperature Reduction (%) under Increasing Carbon Tax Scenarios*
Source : Data processing

The slope chart presented in Figure 08 illustrates the progressive effect of carbon taxation on cumulative emissions reductions across four policy scenarios: No Tax, 50%, 100%, and 120% of the Social Cost of Carbon (SCC). The "No Tax" scenario, serving as the reference point, reflects the business-as-usual trajectory where emissions continue to rise steadily throughout the century, resulting in 0% reduction relative to the projected baseline. This benchmark allows a meaningful comparison of the marginal gains achieved under each successive carbon pricing scenario.

This comparative analysis underscores that while all countries benefit from stronger carbon pricing, the magnitude of emissions reductions is not uniform. More ambitious tax rates (e.g., 100% and 120% SCC) yield disproportionately larger gains in high-emitting contexts, reinforcing the importance of tailoring mitigation strategies to country-specific emissions profiles and structural capacities. Importantly, the figure highlights a well-documented policy limitation: partial internalization of the SCC (e.g., 50%) yields only modest climate benefits, while full internalization (100%) remains insufficient for achieving deep decarbonization. These results align with the literature emphasizing that carbon pricing must be complemented by sectoral reforms, green investment, and innovation policies to achieve the climate targets set by the Paris Agreement.

3.2.2 Analysis of Carbon Tax Scenarios for Southern European Countries

France

France, as one of Europe's largest economies and a global leader in climate action, plays a pivotal role in addressing carbon emissions. In this section, we examine the results of three carbon tax scenarios—50%, 100%, and 120% of the Social Cost of Carbon (SCC) to assess their effectiveness in reducing emissions and their economic implications.

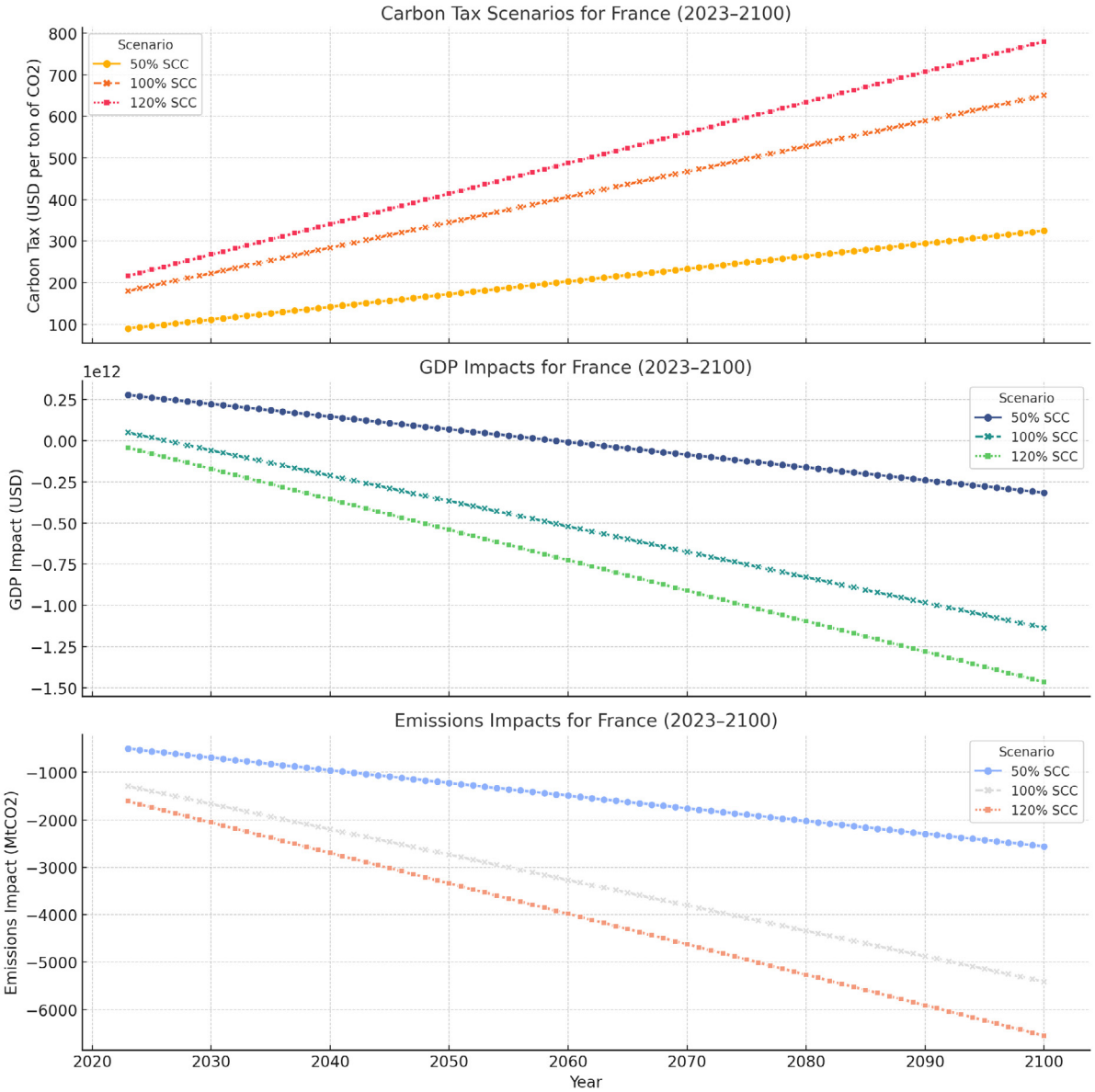


FIGURE.9 *Carbon tax scenarios and its impact in France*
Source : Data processing

Under all scenarios shown in figure 09, the carbon tax would progressively increase over time, reflecting the rising SCC as cumulative emissions exacerbate climate damages. By 2100, the 50% SCC tax would reach approximately $350 per ton of CO_2, while the 100% SCC tax would reach $700, and the 120% SCC tax would climb to $840. These tax rates would drive corresponding emissions and GDP reductions as follows:

Scenario	Emissions Reduction by 2100 ($MtCO_2$)	GDP Impact by 2100 (USD Trillion)
50% SCC	2,000	-0.5
100% SCC	4,000	-0.75
120% SCC	5,000	-1.0

TABLE 2
Carbon tax impacts in 2100
Source : by the authors

Results reveal that higher tax rates would lead to greater CO2 reductions, with the 120% scenario achieving the largest decrease. Also, economic costs would increase with more aggressive taxation, with the 120% scenario resulting in the largest GDP reduction.

France's energy mix, with a non-negligible share of nuclear power (34.9%), could provide an advantage in reducing emissions intensity compared to other European countries. This would make the carbon tax highly effective in targeting residual emissions, particularly from sectors like transportation and industry, which remain heavily reliant on fossil fuels.

While the 120% SCC scenario would achieve the largest emissions reductions, it would do so at considerable economic cost, raising questions about its feasibility where higher tax scenarios, while effective in driving emissions reductions, could disrupt industrial output, reduce competitiveness, and strain household incomes. The moderate 50% SCC tax, on the other hand, would achieve meaningful emissions reductions without imposing excessive economic costs, making it a potentially more suitable option in the short term.

The example of France can also serve as a lesson to the other countries studied, and indeed to all countries in the region, on the importance of choosing the right tax targets. Indeed, a consequent popular protest movement, known as the Gilets Jaunes movement, emerged following the rise in motor fuel prices caused by the increase in the Domestic Consumption Tax on energy products. This popular reaction highlights the risks in the event of a lack of social support for an environmental policy, such as raising taxes on emissions, and raises questions about which actors should be targeted through such a policy.

Spain

Spain's carbon tax results demonstrate how varying taxation levels impact emissions reductions and economic performance. As a country with a growing focus on renewable energy and a diversified economy, the implications of the 50%, 100%, and 120% SCC tax scenarios highlight the trade-offs between emissions reductions and GDP impacts, guiding which tax rate aligns best with Spain's economic and environmental goals.

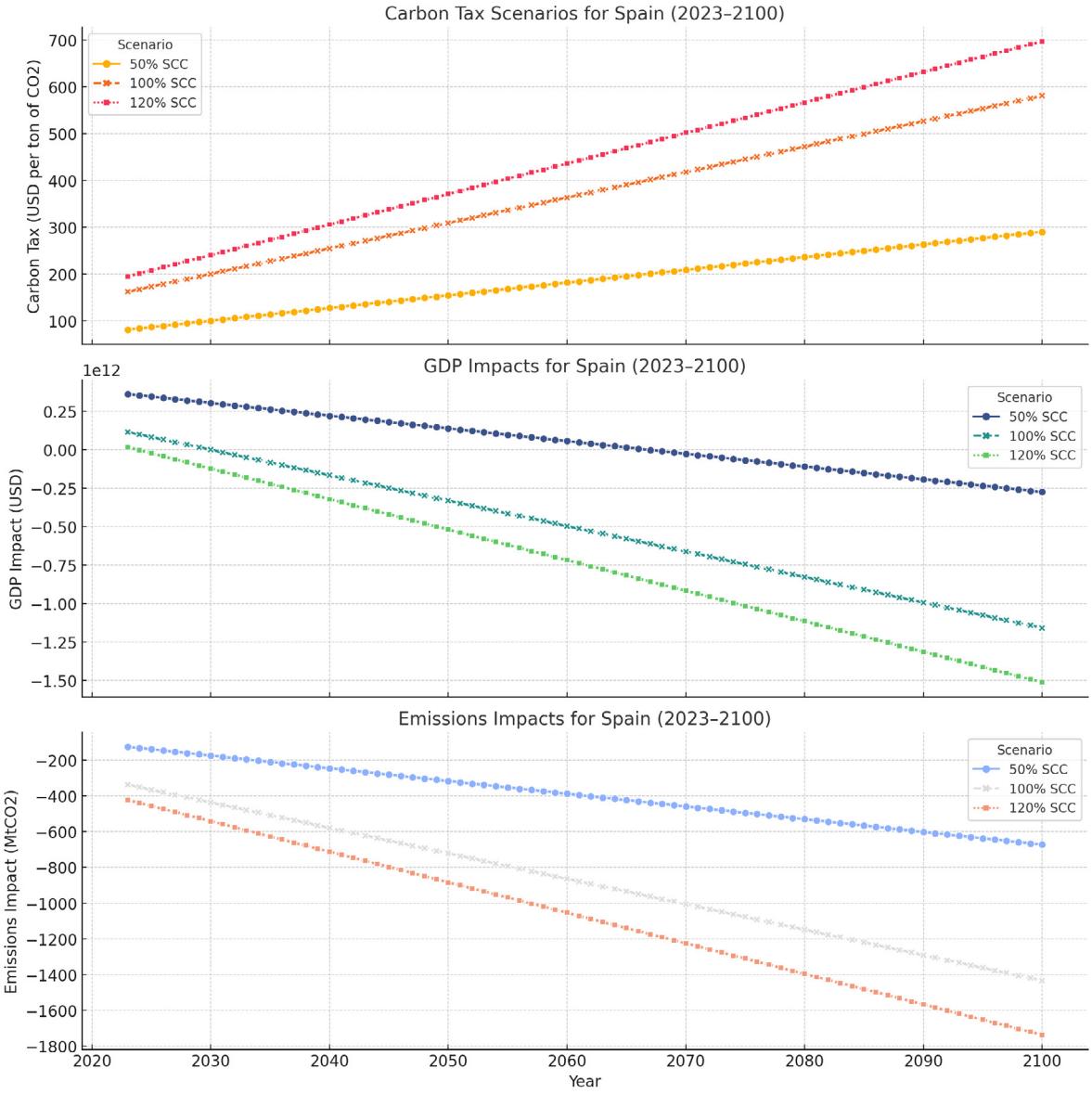


FIGURE.10 *Carbon tax scenarios and its impact in Spain*
Source : Data processing

Scenario	Emissions Reduction by 2100 ($MtCO_2$)	GDP Impact by 2100 (USD Trillion)
50% SCC	1,200	-0.4
100% SCC	1,500	-0.6
120% SCC	1,800	-1.0

TABLE 3
Carbon tax impacts in 2100
Source : by the authors

Similar to France, figure 8 shows an increase in carbon tax under all scenarios. Higher tax rates would lead to large co2 reductions, with the aggressive tax scenario achieving the largest decrease of 1800 MtCO2 and the largest economic cost (- $1 trillion) by 2100 making the moderate tax scenario more economically sustainable in the short term.

Italy

Italy is a country with a diverse industrial base and a heavy reliance on natural gas, Italy faces unique challenges in balancing economic resilience with ambitious decarbonization efforts. Figure 11 presents a detailed analysis of Italy's carbon tax scenarios.

The carbon tax levels increase steadily under all scenarios, with the 50% SCC reaching $350 per ton of CO_2 by 2100, while the 100% and 120% SCC scenarios rise to $700 and $840, respectively. In addition, GDP losses deepen with higher tax rates, ranging from less than $0.6 trillion under the 50% SCC scenario to $1.5 trillion under the 120% SCC scenario. The third graph demonstrates that higher tax rates would yield greater emissions reductions, with the 50% SCC scenario cutting emissions by 1,200 $MtCO_2$ and the 120% SCC scenario achieving reductions exceeding 2,000 $MtCO_2$. These results highlight the trade-offs between economic costs and environmental benefits, emphasizing the importance of a phased approach to carbon taxation in Italy to balance decarbonization with economic resilience.

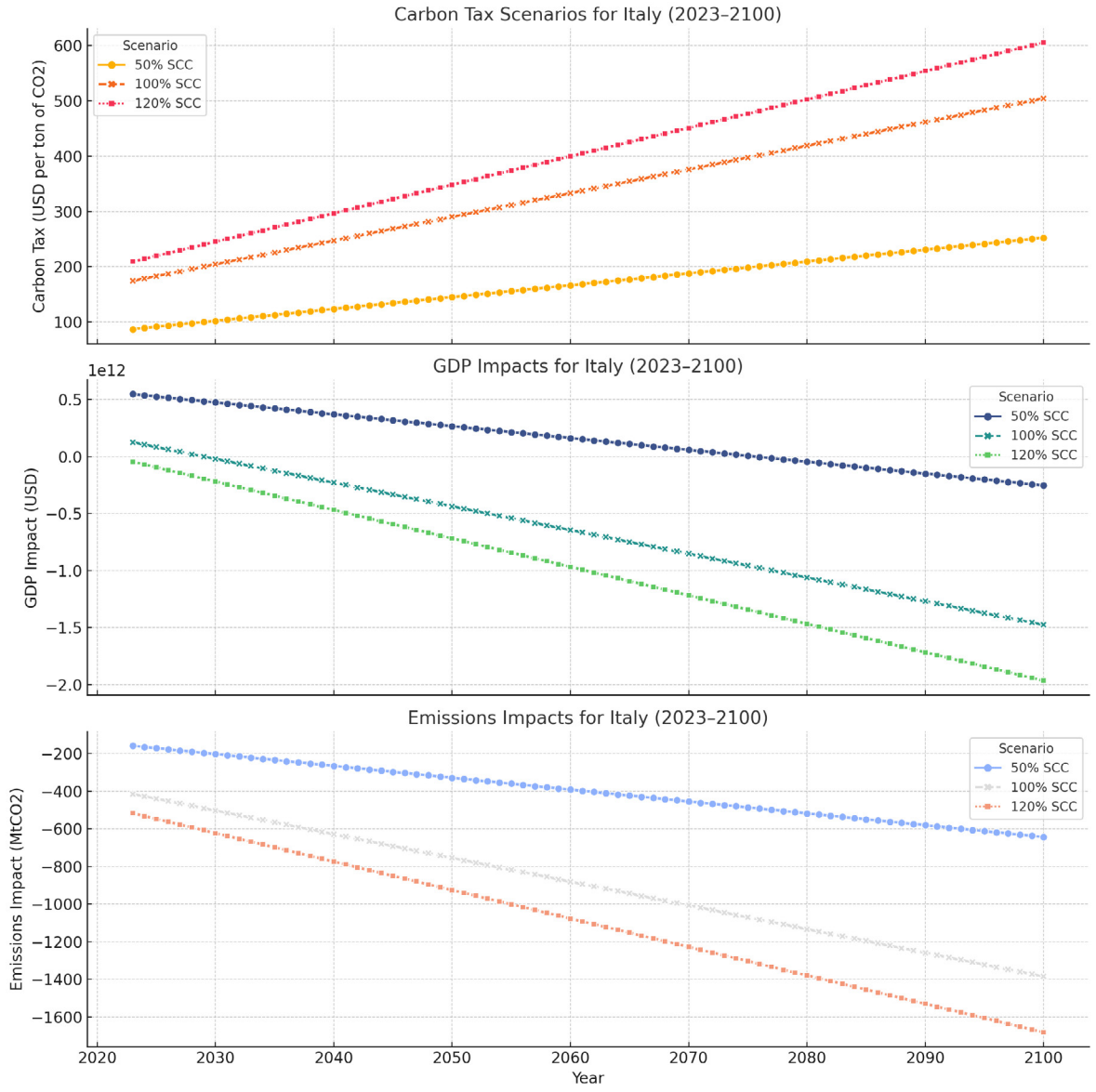


FIGURE.11 *Carbon tax scenarios and its impact in Italy*
Source : Data processing

Greece

The carbon tax scenarios for Greece illustrate the trade-offs between emissions reductions and GDP impacts, reflecting an economy that is moving toward renewable energy while still relying on traditional fossil fuels. The three tax levels provide varying outcomes, each with its implications for Greece's economic stability and decarbonization efforts.

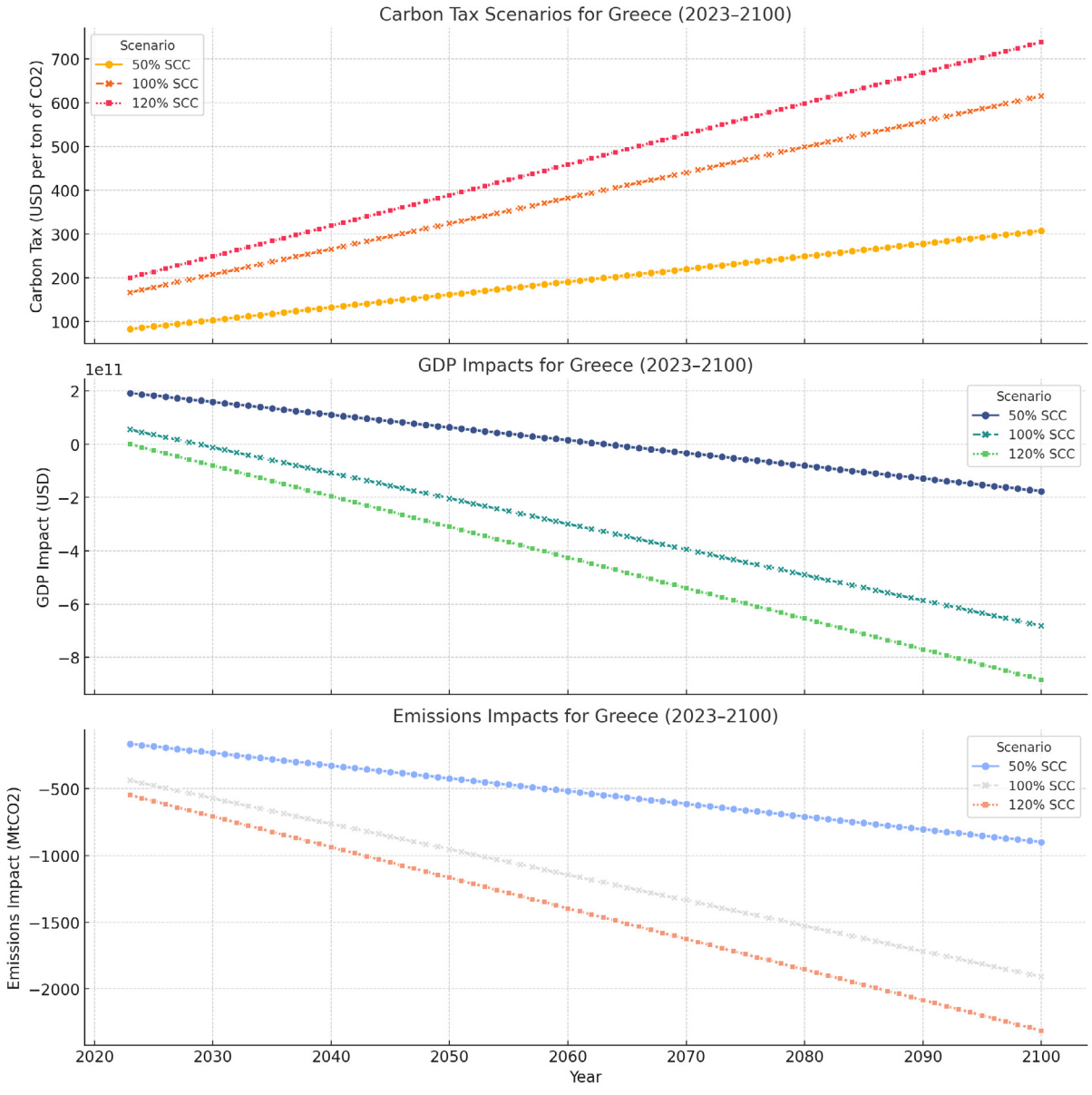


FIGURE.12 *Carbon tax scenarios and its impact in Greece*
Source : Data processing

Figure 12 illustrates that the carbon tax levels escalate over time, starting at $100, $200, and $240 per ton of CO_2 in 2023 for all scenarios respectively, and rising to $350, $700, and $840 by 2100. These tax levels correspond to emissions reductions ranging from 1,000 $MtCO_2$ under the 50% SCC scenario to 2,200 $MtCO_2$ under the 120% SCC scenario. The substantial projected reductions under the 100% and 120% SCC scenarios highlight Greece's potential to significantly decarbonize its economy, particularly through accelerated adoption of renewable energy in the electricity and transport sectors.

In addition, the projected economic impacts of carbon taxes are moderate but increase with higher tax levels. GDP losses are estimated at $0.2 trillion by 2100 under the 50% SCC scenario, $0.5 trillion under the 100% SCC scenario, and $0.8 trillion under the 120% SCC scenario. Greece's moderately diversified economy, with strong contributions from the service and tourism sectors, moderates to some extent the economic costs of carbon taxation compared to more fossil fuel-reliant economies.

3.2.3 Analysis of Carbon Tax Scenarios for North African Countries

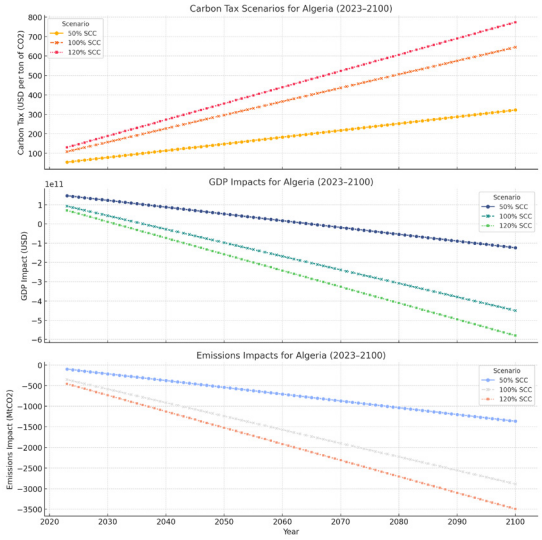
The analysis of carbon tax scenarios reveals significant variation in the economic and environmental impacts across North African countries, shaped by their distinct energy and economic profiles. Algeria, Egypt, Libya, and Morocco face unique challenges and opportunities under these tax regimes, providing a nuanced understanding of how carbon pricing affects emissions reductions and GDP. Algeria, as the largest energy producer in the region, stands out due to its heavy reliance on fossil fuels and its regional influence in energy markets.

Tables 4 and 5 show substantial differences in emissions reductions and projected economic impacts, driven by variations in their energy profiles, emissions levels, and economic structures.

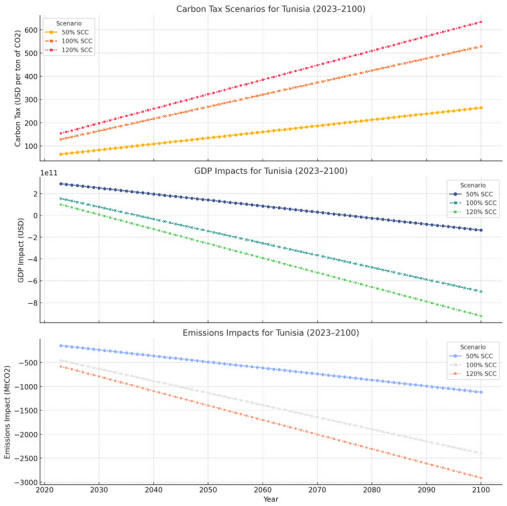
The carbon tax scenarios for North African countries represent varying levels of ambition in pricing carbon, starting at $100, $200, and $240 per ton in 2023 and rising to $350, $700, and $840 by 2100, corresponding to the moderate (50%), optimal (100%), and aggressive (120%) SCC-based rates previously defined. These tax levels are applied uniformly across the region but yield different outcomes based on each country's emissions profile, energy mix, and economic resilience.



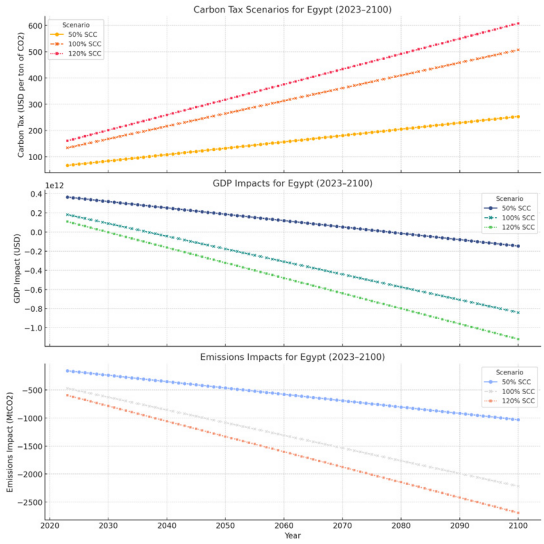
Algeria



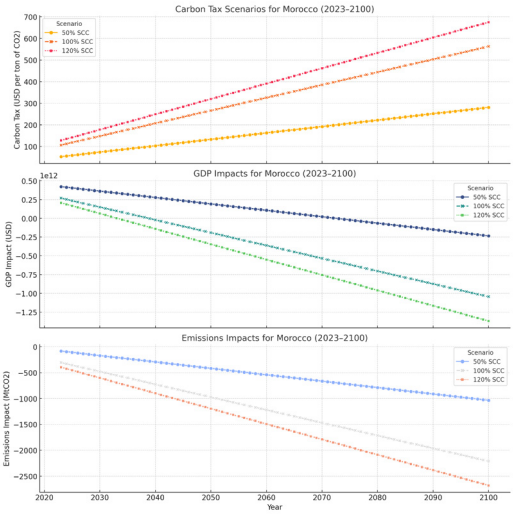
Tunisia



Egypt



Morocco



Libya

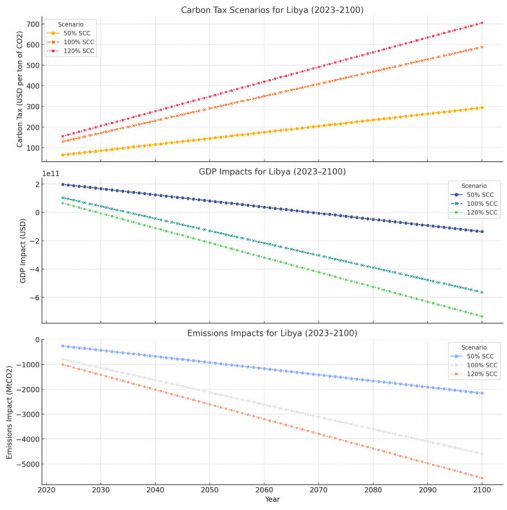


TABLE 4

Tax scenarios and impacts for the North African countries

Source : Data processing

Country	Emissions Reduction (50% SCC, $MtCO_2$)	Emissions Reduction (120% SCC, $MtCO_2$)	GDP Impact (50% SCC, USD Trillion)	GDP Impact (120% SCC, USD Trillion)
Algeria	1,800	3,200	-1.5	-5.0
Egypt	1,000	2,300	-0.4	-1.0
Libya	900	2,000	-0.6	-2.0
Morocco	700	1,800	-0.3	-1.0
Tunisia	800	2,200	-0.4	-1.5

TABLE 5
Impacts on Emissions and GDP for North African Countries
Source : by the authors

Table 4 shows that **Algeria** would lead in emissions reductions, with reductions reaching 3,200 $MtCO_2$ under the aggressive tax (120% SCC) scenario. This is largely due to its heavy reliance on fossil fuel production and exports, particularly natural gas and oil, which drive its high baseline emissions. By contrast, **Egypt** would achieve reductions of up to 2,300 $MtCO_2$, reflecting its growing industrial base and dependence on natural gas for electricity generation. **Tunisia**, with a smaller economy but significant oil reliance, would achieve reductions of up to 2,200 $MtCO_2$. **Libya** and **Morocco** would have the lowest emissions reductions, at 2,000 $MtCO_2$ and 1,800 $MtCO_2$ respectively, under the same scenario. Morocco's proactive adoption of renewable energy, such as solar power projects, limits its baseline emissions, while Tunisia's moderate reliance on natural gas leads to less pronounced reductions.

The economic impacts of carbon taxes differ significantly across the region. **Algeria** experience the largest GDP losses, ranging from $1.5 trillion under the 50% SCC scenario to $5 trillion under the 120% SCC scenario. This highlights Algeria's economic dependence on fossil fuel exports, which account for a substantial share of its GDP. The carbon tax would impose higher production costs, reduce global competitiveness, and significantly impact government revenues. The reported GDP impact for Algeria under the SCC-based carbon tax scenarios reflects the modeling assumption that the carbon tax is applied to the carbon content of fossil fuels produced within the country, consistent with the Pigouvian pricing framework adopted in the RICE model. This upstream application is a standard approach in integrated assessment modeling and is used to internalize the global external cost of emissions at the point of extraction or combustion. In Algeria's case, the observed magnitude of GDP effects is driven by the significant role of the hydrocarbon sector in national output. The model assumes no international border adjustments or revenue recycling mechanisms, which amplifies the apparent macroeconomic effect under the tax scenarios.

Egypt, with a more diversified economy, would face GDP losses ranging from $0.4 trillion to $1 trillion. **Libya**, being similarly fossil fuel-dependent, would incur substantial losses, reaching $2 trillion under the 120% SCC scenario. In contrast, **Morocco** and **Tunisia**, with their moderate reliance on fossil fuels, would experience more moderate GDP impacts. **Morocco**'s GDP losses would range from $0.3 trillion to $1 trillion, aided by its robust renewable energy initiatives, while **Tunisia**'s losses would range from $0.4 trillion to $1.5 trillion.

3.2.4 Analysis of Carbon Tax in Türkiye

As a country balancing industrial expansion with its climate commitments, Türkiye faces distinct challenges in reducing emissions without jeopardizing economic growth.

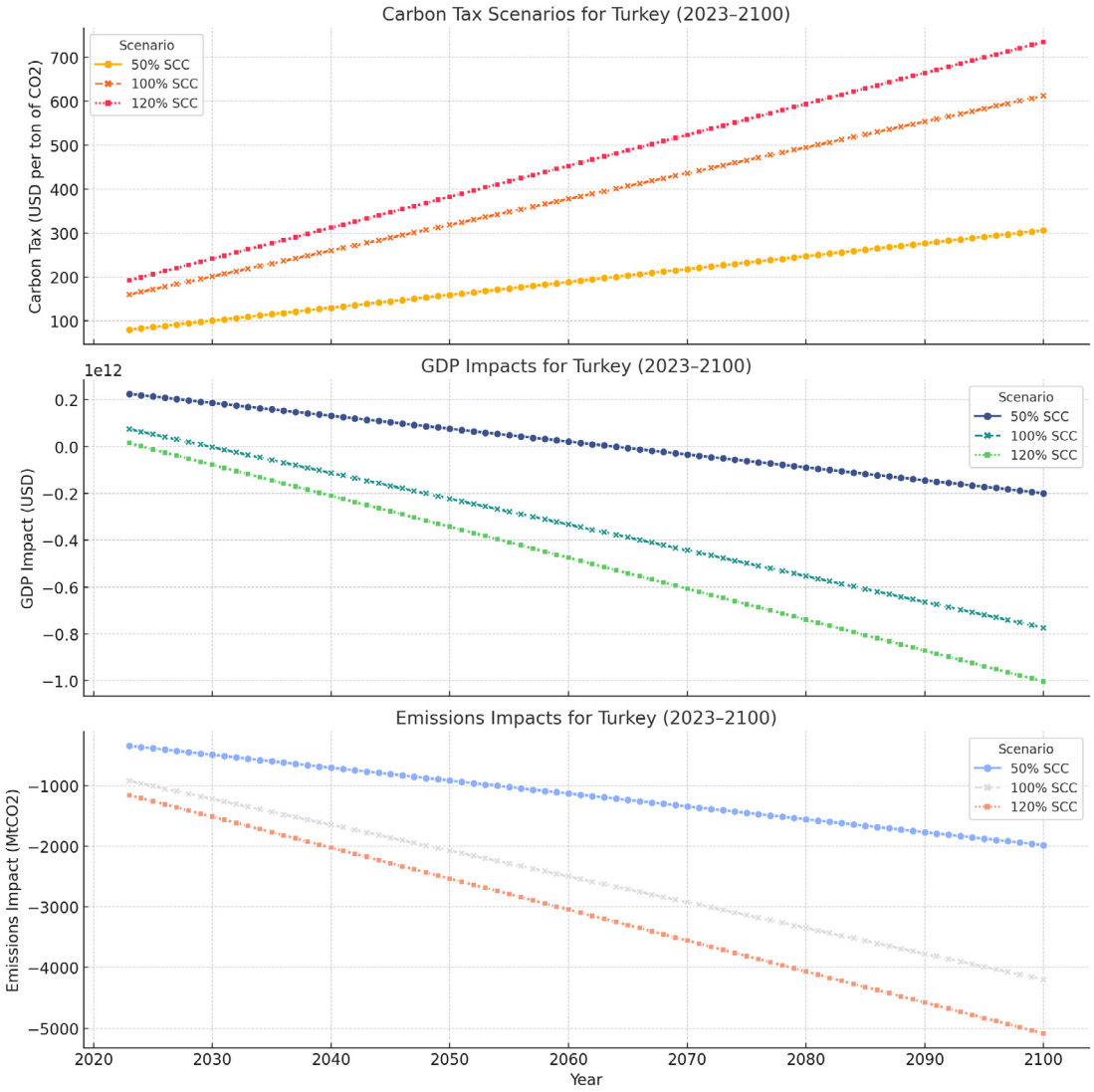


FIGURE.13 *Carbon tax scenarios and its impact in Turkey*
Source : Data processing

Scenario	Carbon Tax by 2100 (USD per ton of CO_2)	Emissions Reduction by 2100 ($MtCO_2$)	GDP Impact by 2100 (USD Trillion)
50% SCC	350	2,070	-0.32
100% SCC	700	3,200	-0.51
120% SCC	840	4,600	-1.1

TABLE 5
Impacts on Emissions and GDP for Turkey
Source : By the authors

Under the moderate tax scenario, Türkiye would achieve moderate emissions reductions of approximately 2,000 $MtCO_2$ by 2100, with relatively manageable GDP losses of $0.32 trillion. This scenario is economically feasible, imposing minimal disruption to Türkiye's energy-intensive economy.

The 100% SCC scenario would double the carbon price, resulting in substantial emissions reductions of around 3,000 $MtCO_2$, but GDP losses would increase to $0.5 trillion, reflecting the heightened costs for industries reliant on coal and natural gas.

The aggressive tax scenario would achieve the most significant emissions reductions, exceeding 4600 $MtCO_2$, but at a steep economic cost, with GDP losses reaching $1 trillion by 2100.
These results reflect the economic challenges of decarbonizing Turkey's energy sector, heavily reliant on fossil fuels (Kat, Şahin et al. 2024). Higher tax rates provide strong incentives for transitioning to renewable energy, but the economic burden suggests the need for a phased approach. Starting with the 50% SCC scenario, Turkey could initiate decarbonization while maintaining economic stability, progressing to the 100% SCC scenario in the medium term as renewable energy capacity expands and industrial efficiency improves. This balance is essential to align climate goals with sustainable economic growth.

4. RESULTS DISCUSSION AND POLICY IMPLICATIONS

The carbon tax scenarios modelled in this study (summarized in table 07) highlight a set of complex trade-offs between environmental benefits and economic costs across Mediterranean countries. These outcomes are deeply influenced by national energy profiles, fiscal structures, institutional capacities, and climate vulnerabilities. **Southern European countries**, with their diversified economies and strong renewable energy infrastructure, demonstrate resilience to higher carbon taxes. Their advanced industrial bases and alignment with EU climate policies position them to lead the region in decarbonization, with the ability to adopt ambitious tax strategies. This readiness reflects their capacity to manage economic impacts while achieving meaningful emissions reductions, supported by technological advancements and mature energy markets. In contrast, **North African countries** face distinct challenges due to their heavy reliance on fossil fuels and being less diversified economies. While these countries have significant renewable energy potential, particularly in solar and wind power, the transition to higher carbon tax scenarios requires gradual implementation to avoid economic disruption. Their economic dependency on carbon-intensive industries highlights the need for external financial and technological support to enable a shift toward low-carbon growth models. Morocco's renewable energy leadership showcases the region's potential, offering a blueprint for integrating ambitious climate policies with economic development. Further, **Türkiye**, situated between the developed economies of Europe and the fossil fuel-reliant nations of North Africa, reflects a transitional economy with a balanced approach to carbon pricing. Its growing investments in renewable energy, alongside reliance on coal and natural gas, underscore the need for a phased carbon tax strategy.

Regions	Countries	Characteristics	SCC	Plan A: Optimal Tax Scenarios	Plan B: Potential for Aggressive Tax
Southern Europe	France	High reliance on nuclear energy; strong industrial base	750–800 USD/tCO_2 by 2100	100% SCC with gradual progression	Yes; specific sectors or post-2050
	Italy	Energy-intensive industries; moderate renewable adoption	650–750 USD/tCO_2 by 2100	100% SCC; phased approach from 50%	Yes; post-2050 in energy-intensive sectors
	Spain	Growing renewable energy investments; diversified economy	650–700 USD/tCO_2 by 2100	100% SCC	Yes; feasible with existing renewable infrastructure
	Greece	Transitional economy; moderate emissions	600–700 USD/tCO_2 by 2100	100% SCC; phased approach from 50%	Moderate; dependent on renewable expansion
North Africa	Algeria	Largest fossil fuel exporter in the region; high emissions	500–600 USD/tCO_2 by 2100	50% SCC; gradual move to 100%	No; requires significant diversification and renewable capacity
	Tunisia	Moderate fossil fuel use; growing renewables	400–500 USD/tCO_2 by 2100	50% SCC progressing to 100%	Low; dependent on renewable growth
	Morocco	Renewable energy leader in the region; low emissions	450–500 USD/tCO_2 by 2100	100% SCC	High; strong renewable base supports implementation
	Egypt	Energy-intensive industrial base; natural gas reliant	450–600 USD/tCO_2 by 2100	100% SCC	Moderate; requires enhanced renewable capacity
Eastern Mediterranean	Türkiye	High reliance on coal and natural gas; emerging renewables	650–750 USD/tCO_2 by 2100	50% SCC progressing to 100%	Moderate; post-2050 or in select sectors

TABLE 7
Findings summary
Source : by the authors

Let us note that, while the RICE-MED-23 model offers a valuable framework for estimating the Social Cost of Carbon (SCC) and designing carbon pricing strategies, it is crucial to acknowledge its limitations and the broader political economy within which such policies must operate. This comparative summary highlights the diversity of national circumstances across the Mediterranean, reinforcing the need for context-specific carbon pricing approaches and socially responsive transition strategies. The following analysis builds on these differentiated profiles to reflect on broader implementation challenges and model limitations.

4.1 Scenarios Comparative Reflection: Pigouvian Limits and Policy Urgency

When contrasted with the emissions reductions achieved under the 50%, 100%, and 120% SCC scenarios (see Figures 7–12), the zero-tax baseline highlights two critical insights:
The effectiveness of carbon pricing: Even modest carbon tax levels (50% SCC) yield substantial emissions reductions relative to the baseline, and full internalization (100% SCC) results in 50–70% cumulative reductions by 2100 in several countries.

However, despite aggressive taxation (e.g., 120% SCC), emissions are not eliminated entirely. This underscores a known limitation in Pigouvian climate policy: marginal damage pricing alone is insufficient for full decarbonization, particularly when abatement costs escalate or when structural inertia in energy systems persists (Sterner & Persson, 2008).

Thus, while SCC-based carbon taxes are an essential component of the policy mix, they must be complemented by structural reforms, green investment, and innovation incentives to deliver the transformative changes required to meet climate targets.

4.2 Regional Diversity and Implementation Constraints

The Mediterranean region is highly diverse—encompassing advanced economies such as France, Spain, and Italy; emerging economies like Türkiye and Greece; and fossil fuel-reliant developing economies including Algeria, Egypt, and Libya. Uniform policy recommendations risk oversimplifying this complexity. For example, North African countries often lack the institutional infrastructure or fiscal space to impose high carbon taxes without risking economic and social instability (World Bank, 2022; IMF, 2023). Therefore, **carbon pricing strategies must be differentiated, phased, and aligned with each country's development pathway and governance capacity.

4.3 Political Feasibility and Social Acceptance

While economically optimal, high carbon taxes (e.g., 100–120% of SCC) may face political resistance, especially in countries where fossil fuel subsidies are entrenched or where public trust in government is low (Carattini et al., 2018; Dolphin et al., 2020). These situations are just as likely to be found in southern Europe as in northern Africa or the Middle East. In these contexts, gradual tax implementation, transparent revenue recycling (e.g., toward social protection or energy access), and inclusive stakeholder engagement are essential. Empirical evidence from the EU Emissions Trading Scheme (EU ETS) and fuel tax reforms in Latin America show that **political feasibility often matters more than economic efficiency in climate policy success** (Franks et al., 2018; Rafaty, 2018).

4.4 Uncertainties in SCC Projections and Modeling Assumptions

The SCC values obtained are sensitive to several core parameters, including the discount rate, climate sensitivity, and damage functions. A lower discount rate or higher climate sensitivity can significantly increase SCC estimates, changing the implied carbon tax dramatically (Nordhaus, 2017; Pindyck, 2019). Moreover, while the model includes regional calibration, **sector-specific damages—particularly in agriculture, water, and tourism—are only partially captured**. Future work should incorporate more granular data and uncertainty analysis (e.g., Monte Carlo simulations) to improve policy robustness under multiple plausible futures (Stern & Stiglitz, 2017).

4.5 Policy Priorities: Tailored and Realistic Carbon Pricing Strategies

Based on the findings, several policy priorities emerge:

- **Adjusting carbon tax levels according to national contexts,** taking into account income levels, emissions profiles, and institutional capacity. Southern European countries could implement full carbon pricing based on the Social Cost of Carbon (SCC), while North African countries might begin with lower rates or sector-specific pilot schemes.
- **Earmarking carbon tax revenues for measures with strong social and economic co-benefits,** such as investments in green infrastructure, reform of energy subsidies, or income redistribution. These approaches can help build political and public support for carbon pricing (Metcalf & Stock, 2020).
- **Promoting regional coordination while maintaining national implementation flexibility.** Mediterranean climate cooperation—through platforms like the Union for the Mediterranean or Plan Bleu—can help align

long-term objectives, even as countries tailor instruments and timelines to their own circumstances.
- **Supporting vulnerable economies through international climate finance and technology transfer**, enabling them to pursue low-carbon development pathways without compromising economic growth or social wellbeing.

5. POLICY IMPLICATIONS: ADVANCING FAIR AND FEASIBLE CLIMATE ACTION IN THE MEDITERRANEAN

This section translates modeling insights into policy directions that are equity-grounded, institutionally realistic, and regionally actionable.

Indeed, across the Mediterranean, carbon pricing can only be successful if designed explicitly to address social equity. Empirical literature shows that public acceptance of carbon taxes increases significantly when revenues are recycled transparently and fairly (Carattini et al., 2019; IMF, 2023; OECD, 2022). For instance:

- In **North African countries** (e.g., Egypt, Algeria, Tunisia), where food and energy subsidies play a central role in social stability, carbon tax revenues should be redirected toward conditional cash transfers, rural decarbonated energy access, and targeted utility subsidies, leveraging existing systems like Egypt's Takaful and Karama program or Morocco's RAMED health registry (World Bank, 2022).
- In **Southern Europe**, where public trust has been weakened by austerity and inequality issues, carbon pricing must be linked to visible co-benefits, such as home insulation retrofits, rural decarbonated mobility subsidies, and green job guarantees for youth (Douenne & Fabre, 2020; Fernández & Labeaga, 2021).

Additionally, implementing a unified carbon tax across the Mediterranean would be both ineffective and politically unviable. Countries in the region differ widely in their fiscal space, administrative capacity, energy dependence, and public support for reform. Attempting to impose a uniform carbon price would ignore these structural asymmetries and risk policy failure, as supported by both empirical studies and international policy recommendations (OECD, 2022; IMF, 2023). We propose a **tiered strategy** aligned with countries' institutional and economic capacities:

- Countries such as France and Spain for example can more easily implement full SCC-aligned carbon pricing. These countries benefit from strong administrative institutions, established social safety nets, and broad public awareness of climate risks. However, as seen in France's gilets jaunes protests, pricing must be combined with co-designed redistribution mechanisms and visible co-benefits to ensure legitimacy (Douenne & Fabre, 2020; OECD, 2022).
- Italy, Türkiye, Greece are among countries that could begin with sector-specific carbon pricing, targeting the most carbon-intensive sectors such as power generation, transport, and industry, while gradually developing the fiscal and administrative infrastructure for broader implementation. These countries often face regional disparities (e.g., Mezzogiorno in Italy, or in Eastern Türkiye) and moderate public trust, requiring a more cautious and phased rollout (IEA, 2022; IMF, 2022).
- States still largely dependent on fossil fuels (e.g., Algeria, Tunisia, Libya) should prioritize fossil fuel subsidy reform, GHG inventory systems, and institutional capacity-building before attempting to implement broad-based carbon taxation. In these contexts, premature tax reforms without foundational systems could provoke unrest or erode trust. IMF and UNDP assessments have emphasized that carbon pricing should only be introduced once credible compensation mechanisms and administrative tools exist (IMF, 2023; UNDP, 2022; Verme & Araar, 2017).

Moreover, a critical lesson from both international experience and regional analysis is that carbon pricing must not be perceived as a punishment, but **as a lever for public investment and shared prosperity**. When carbon revenues are clearly and transparently reinvested in services

and infrastructure that improve daily life, public resistance declines and legitimacy increases (Carattini et al., 2019; World Bank, 2023). This is especially relevant in the Mediterranean, where skepticism about government fairness, particularly in rural and marginalized areas, remains high.

In practical terms, this means that carbon pricing must be explicitly linked to visible, inclusive co-benefits—especially in areas where economic vulnerability and climate exposure overlap. Priority areas for reinvestment include:

- **Green employment guarantees, especially for youth.** With youth unemployment exceeding 30% in several Mediterranean countries (e.g., Tunisia, Egypt, Greece), carbon revenues should fund green public employment programs in renewable energy deployment, building retrofits, urban greening, and public transport maintenance (ILO, 2022; AfDB, 2023).
- **Rural decarbonated energy access and clean cooking solutions.** In regions where off-grid populations face energy poverty (e.g., Morocco, Türkiye, parts of Tunisia), revenues can accelerate rural solar electrification, LPG/biogas access, and clean cooking programs, which offer co-benefits in health, education, and gender equity (IEA, 2021; UNDP, 2022).
- **Climate-resilient public infrastructure.** Investments in urban cooling shelters, flood protection, sustainable irrigation systems, and heat-resilient public buildings can address escalating climate risks while creating local jobs and strengthening adaptation (IPCC, 2022; Plan Bleu, 2023). These investments also contribute to political stability by reducing the inequality of climate risk exposure across social groups and geographies.

This "carbon dividend for development" model has been successfully applied in countries such as Canada and South Africa, where earmarked revenue use improved public acceptance and strengthened social buy-in (OECD, 2022).

Meanwhile, while regional cooperation is often highlighted in Mediterranean climate discussions, implementation remains limited. Given shared vulnerabilities—rising temperatures, water scarcity, energy insecurity—coordinated action is essential. This study outlines practical avenues to operationalize regional collaboration:

- **Accelerating renewable deployment :** North African countries (Algeria, Morocco, Tunisia, Egypt) have vast solar and wind potential but sometimes face capital, grid, and market constraints. Algeria, aiming for 15 GW of renewables by 2035, has launched Sahara-based tenders and is in talks with Germany on green hydrogen (IEA, 2021; GIZ, 2023). EU-supported initiatives like the Global Gateway and Mediterranean Solar Plan could fund cross-border infrastructure—benefiting both exporters and importers (e.g. Italy, Spain).
- **Coordinated carbon pricing and CBAM alignment :** The EU's Carbon Border Adjustment Mechanism (CBAM) will impact North African exports lacking carbon pricing or emissions tracking. A regional "Carbon Pricing Corridor"—initially driven by France, Spain, Italy, and Türkiye—could enable gradual alignment through sectoral pilots (e.g. cement, electricity), MRV harmonization, and targeted capacity-building (World Bank, 2023).

Overall, our findings underscore a central insight: **there is no one-size-fits-all pathway to climate pricing in the Mediterranean.** SCC values and tax trajectories diverge significantly across countries, reflecting differences in economic structure, emissions profiles, governance capacities, and vulnerability to climate impacts. In this context, effective climate action must move toward feasible, equitable, and nationally tailored solutions.

At the same time, the Mediterranean's shared ecological risks offer a unique opportunity: regional cooperation can support nationally tailored approaches through mutual learning, joint initiatives, and trust-building—key conditions for effective and fair carbon pricing.

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CHAPTER 13. CLIMATE SCENARIOS FOR MUNICIPAL FISCAL REVENUES

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Abstract

This chapter investigates climate change's potential impacts on municipalities' fiscal revenues. Specifically, Italian municipalities are the focus of the chapter due to the availability of detailed, spatially harmonized data on public finance, tourism, land use, and local economic indicators. Recognising municipalities' critical role in delivering local services and managing infrastructure, the study addresses the gap in understanding how climate change might affect their financial stability. Although municipalities are found to be at the forefront of the climate crisis, little is known about how climate change will impact municipal fiscal revenues. These are used for various economic and social objectives at the local level, making the threat capable of hindering redistribution policies and the normal functioning of civil society, reducing local communities' capability to respond promptly against climate change.

The knowledge gap regarding the fiscal implications of climate change at the local level is characterised by two overarching layers. One is the high heterogeneity of Mediterranean cities regarding fiscal capabilities and laws impedes using one monolithic approach to data gathering and policy design. We provided a short synthesis of such differences for Italy, France, Spain, and Greece, highlighting the varying degrees of autonomy and responsibilities across levels and countries. The second limit is the gap in the literature regarding models and estimates of fiscal effects at the local level. The literature review reveals that existing studies primarily focus on the budgetary implications of climate change at the country level, neglecting the nuanced and specific challenges local governments face. The paper emphasises the need for a methodology and evidence base tailored to local fiscal revenues.

The study adopts an «open box» approach, which allows for updating scenarios based on changes in demographic trends. A statistical model identifies the most effective statistical model from observations of

tax bases capable of predicting fiscal revenues at the municipal level. Climate scenarios of these drivers are then plugged into the model to generate predictions of budgetary revenues in 2050 according to RCP and SSP scenarios. The study employs multiple econometric strategies to isolate and understand the error structure, accounting for municipal fiscal returns' peculiarities. It emphasises the importance of predicting power (external validity) and robustness (internal validity) in selecting the appropriate model. The theoretical framework that supports this strategy models tax yields at the local level in a way akin to a production function. Municipal tax revenues depend on taxed activities (tourism, land use, income), local exogenous characteristics, and institutional efficiency. The latter is captured by an error term, reflecting the reality that local administrations do not optimise their fiscal collection as a straightforward economic activity.

This approach is transparent in each step, guaranteeing modularity and adaptability to various contexts at the Mediterranean level. It contrasts with «black box» approaches that rely on machine learning models, which can become obsolete due to evolving demographic scenarios. The analysis identifies the key drivers of municipal tax revenue in Italy. These factors are proxied by the three most important taxes at the local level. These are, respectively, the share of IRPEF (personal income tax) allocated to municipalities, land taxes (IMU and TARI), and the Italian «imposta di soggiorno» (tourist tax).

The drivers of municipal fiscal revenues have been studied in the literature, and long-term climate scenarios are available. It is possible to find downscaled GDP, land use change, and tourism intensity. The latter two have been derived from previous work efforts that acknowledged recent changes in demographic scenarios, particularly concerning land use. The models implemented target municipal tax revenues in Italian municipalities between 2006 and 2050 under different climate scenarios. The analysis is grounded in economic theory and aims to provide robust and policy-relevant predictions. The modular structure uses predictions in the most relevant bases of taxation at the municipal level. The work assumes that municipal tax rates remain exogenous to climate and demographic change, given the limited authority of Italian municipalities to introduce new taxes. It also assumes that the bounds of tax rates for all three sources of taxes will not change radically between 2005 and 2050, providing a benchmark for how tax revenues will change if the changes in the fiscal determinants (tourism, land use, income) occur.

The chapter presents five detailed ones for each Italian Municipality based on SSP-RCP matching according to the likelihood of joint probabilities. In particular, a couple of simple sub-scenarios describe differences from the current path (SSP2-RCP4.5) in two simple directions. The optimistic scenario predicts an improvement from the benchmark in all cities with differences in relative magnitudes. The happening of such a scenario would implicate an increase in fiscal space of half a billion Euros for the ten biggest municipalities. The pessimistic scenario predicts a reduction from the benchmark of nearly a billion Euros. The differences are relevant regarding budget, potentially impacting expenditure voices such as education, social housing and more. The chapter concludes by discussing policy orientations, such as Pigouvian taxation, and climate-resilient cadastral reform, to mitigate the negative effects of climate change and promote sustainable development. It suggests that price signals at the local level should comprehend the costs of climate change and that adaptation plans should compensate for the marginal damage of climate change and increase land value. The paper also recommends expanding the climate tourist tax, which can reduce the climate responsibility of cities, provide additional fiscal space and fund adaptation measures.

Résumé

Ce chapitre examine les impacts potentiels du changement climatique sur les recettes fiscales des municipalités. Précisément, les communes italiennes sont au centre de cette analyse en raison de la disponibilité de données détaillées et spatialement harmonisées sur les finances publiques, le tourisme, l'utilisation des sols et les indicateurs économiques locaux. Reconnaissant le rôle crucial des municipalités dans la fourniture de services locaux et la gestion des infrastructures, l'étude aborde le manque de compréhension sur la manière dont le changement climatique pourrait affecter leur stabilité financière. Bien que les municipa-

lités soient à l'avant-garde de la crise climatique, peu de choses sont connues sur l'impact du changement climatique sur les recettes fiscales municipales. Celles-ci sont utilisées pour divers objectifs économiques et sociaux au niveau local, rendant la menace capable de freiner les politiques de redistribution et le fonctionnement normal de la société civile, réduisant ainsi la capacité des communautés locales à répondre rapidement au changement climatique.

Le manque de connaissances sur les implications fiscales du changement climatique au niveau local est caractérisé par deux couches globales. L'une est la forte hétérogénéité des villes méditerranéennes en termes de capacités fiscales et de lois, ce qui empêche l'utilisation d'une approche monolithique pour la collecte de données et la conception de politiques. Nous avons fourni une courte synthèse de ces différences pour l'Italie, la France, l'Espagne et la Grèce, mettant en évidence les degrés variables d'autonomie et de responsabilités entre les niveaux et les pays. La seconde limite est le manque de littérature sur les modèles et les estimations des effets fiscaux au niveau local. La revue de la littérature révèle que les études existantes se concentrent principalement sur les implications budgétaires du changement climatique au niveau national, en négligeant les défis nuancés et spécifiques auxquels sont confrontés les gouvernements locaux. Le document souligne la nécessité d'une méthodologie et d'une base de preuves adaptées aux recettes fiscales locales.

L'étude adopte une approche «open box», qui permet de mettre à jour les scénarios en fonction des changements des tendances démographiques. Un modèle statistique identifie le modèle statistique le plus efficace à partir d'observations des bases fiscales capables de prédire les recettes fiscales au niveau municipal. Les scénarios climatiques de ces moteurs sont ensuite intégrés dans le modèle pour générer des prévisions de recettes budgétaires en 2050 selon les scénarios RCP et SSP. L'étude utilise plusieurs stratégies économétriques pour isoler et comprendre la structure des erreurs, en tenant compte des particularités des rendements fiscaux municipaux. Elle souligne l'importance de la puissance prédictive (validité externe) et de la robustesse (validité interne) dans la sélection du modèle approprié. Le cadre théorique qui soutient cette stratégie modélise les recettes fiscales au niveau local de manière similaire à une fonction de production. Les recettes fiscales municipales dépendent des activités taxées (tourisme, utilisation des terres, revenu), des caractéristiques locales exogènes et de l'efficacité institutionnelle. Cette dernière est capturée par un terme d'erreur, reflétant la réalité que les administrations locales n'optimisent pas leur collecte fiscale comme une activité économique simple.

Cette approche est transparente à chaque étape, garantissant modularité et adaptabilité à divers contextes au niveau méditerranéen. Elle contraste avec les approches «boîte noire» qui s'appuient sur des modèles d'apprentissage automatique, lesquels peuvent devenir obsolètes en raison de l'évolution des scénarios démographiques. L'analyse identifie les principaux moteurs des recettes fiscales municipales en Italie. Ces facteurs sont représentés par les trois taxes les plus importantes au niveau local. Il s'agit respectivement de la part de l'IRPEF (impôt sur le revenu des personnes physiques) allouée aux municipalités, des taxes foncières (IMU et TARI), et de l'« imposta di soggiorno » italienne (taxe de séjour).

Les moteurs des recettes fiscales municipales ont été étudiés dans la littérature, et des scénarios climatiques à long terme sont disponibles. Il est possible de trouver des projections du PIB, des changements d'utilisation des terres et de l'intensité du tourisme. Ces derniers ont été dérivés d'efforts de travail antérieurs qui ont reconnu les récents changements dans les scénarios démographiques, notamment en ce qui concerne l'utilisation des terres. Les modèles mis en œuvre ciblent les recettes fiscales municipales dans les municipalités italiennes entre 2006 et 2050, selon différents scénarios climatiques. L'analyse est basée sur la théorie économique et vise à fournir des prévisions robustes et pertinentes pour les politiques. La structure modulaire utilise des prévisions dans les bases de taxation les plus pertinentes au niveau municipal. Le travail suppose que les taux d'imposition municipaux restent exogènes aux changements climatiques et démographiques, étant donné la compétence limitée des municipalités italiennes pour introduire de nouveaux impôts. Il suppose également que les limites des taux d'imposition pour les trois sources de taxes ne changeront pas radicalement entre 2005 et 2050, fournissant un point de référence.

Le chapitre présente cinq scénarios détaillés pour chaque municipalité italienne, basés sur l'appariement SSP-RCP selon la probabilité conjointe des événements. En particulier, deux sous-scénarios simples décrivent des écarts par rapport à la trajectoire actuelle (SSP2-RCP4.5) dans deux directions opposées. Le scénario optimiste prévoit une amélioration par rapport à la référence dans toutes les villes, avec des différences d'ampleur relative. La réalisation d'un tel scénario impliquerait une augmentation de l'espace budgétaire d'un demi-milliard d'euros pour les dix plus grandes municipalités. À l'inverse, le scénario pessimiste prévoit une diminution d'environ un milliard d'euros par rapport à la référence. Ces différences budgétaires sont significatives et pourraient impacter des postes de dépenses tels que l'éducation, le logement social et d'autres services essentiels. Le chapitre se conclut par une discussion sur les orientations politiques à adopter, notamment la taxation pigouvienne et une réforme cadastrale résiliente au climat, afin d'atténuer les effets négatifs du changement climatique et de favoriser un développement durable. Il suggère que les signaux prix au niveau local devraient refléter les coûts du changement climatique et que les plans d'adaptation devraient compenser les dommages marginaux tout en valorisant le foncier. Enfin, le chapitre recommande d'élargir la taxe climatique sur le tourisme, qui pourrait réduire la responsabilité climatique des villes, offrir un espace budgétaire supplémentaire et financer des mesures d'adaptation.

1. INTRODUCTION

Local authorities, cities and municipalities are directly connected to people and the environment they administer. Their operation includes data gathering, emergency planning, infrastructure maintenance, and risk management in the case of climate adaptation policy. Although municipalities hold heterogeneous institutional roles across the Mediterranean, we often overlook their potential in the fight against climate change. European institutions have already noticed their structural limitations in dealing with the climate transition: local institutions are the ones that might have the least amount of resources to face the transition while being the ones directly affected (European Commission, 2021). Predicting financing capabilities in the long term is crucial to understand future limitations in dealing with climate change at the local level. It provides elements of reflection for strategies to cope with structural limitations.

Groups of institutional actors from cities are collaborating to address climate change and its challenges. One of the most important is the Covenant of Majors, which comprehends hundreds of municipalities across the globe to elaborate and share strategies (Melica et al., 2022). Italy is among the countries with the highest participation and is, for its geographical position, a relevant example in the Mediterranean region (Basso & Tonin, 2022). Researchers found public financing among the barriers blocking cities and towns from implementing climate adaptation plans (Rivas et al., 2022). These plans provide a buffer and various co-benefits to avoid renown risks. There is consensus among scientists and practitioners on the adverse effects on land and ecosystems, such as desertification (Prigent et al., 2018), North-South disparities and sectorial loss of competitiveness due to climate change (Bernardini et al., 2021).

This work provides a model and estimates of the climate change implications for local communities and the finance of their public institutions, the municipalities. In particular, we will address the issue in Italy, a country with a long history of local institutions. Its relevance is to capture the effect of climate change on a variable that affects the livelihood of most Italians every day. Municipalities deal with local services and cultural events and manage the nearest infrastructure to its residents. For this reason, a drastic change in the fiscal revenues of municipalities due to climate change poses a significant threat to redistribution policies and the normal functioning of civil society. The model's predictions can speak to most Italians directly, reflecting immediate institutions rather than macro-areas or the country level.

We adopt an «open box» approach that provides scenarios that can be updated in case of changes in demographic scenarios. A «black box» approach would be using models based on machine learning that provide predictions according to available scenarios. These are robust as long as the available information around which the machine is trained does not change. This is not the case for demographic scenarios, which have evolved in the last decades and might change again. For example, the study of Santini & Valentini (2011) uses a scenario of the Italian population between 2000-2100 that predicts a growth of nearly five million additional residents to the sixty million of today from ISTAT in 2020. The most recent ISTAT predictions indicate that the Italian residents number will shrink by more than ten million by 2080 (ISTAT, 2022). In less than three decades, the expected population growth has changed so wildly that «black box» papers are methodologically robust yet have obsolete predictions. Although «open box» approaches might be relatively less precise in their assessment effects, their modularity makes them more flexible in the presence of systematic changes such as demographic collapse and climate policy uncertainty.

The structure of the study involves a brief literature analysis presenting the gap in local finance predictions. Secondly, we present the methodology steps for predictions and the main data sources. Finally, the analysis results are presented, and policy suggestions are discussed. The first is the identification of scenarios for the main drivers of the municipal tax revenue in Italy: GDP (as a proxy of income, over which weight a municipal tax), tourism (as in the structures for hosting tourists that collect visit taxes) and land use (used for residential purposes, over which land taxes such as IMU, TARI and TIE weight). GDP scenarios are available from previous research papers (Murakami et al., 2021; Murakami & Yamagata, 2019; Rizzati et al., 2023). We are currently elaborating on the scenarios on land use and tourism intensity.

2. LITERATURE

Various studies have investigated the fiscal implications of climate change. Most derive their prediction from theoretical models calibrated with available data. These studies provide an analysis of tax base changes, public debt and expected changes in public expenditure (Giovanis & Ozdamar, 2022; Zenios, 2022). Their scope is country-level finance rather than local, which is more nuanced and specific. Data on local fiscal capacity is registered differently across nations and is supported by different tax systems, making it a more complex application of the same models.

Despite such differences, the available evidence points to a common trend: climate change exposes countries and local economies to costs and damage productivity, meaning that the tax base might be reduced and expenditures rise (Barrage, 2023). Indeed, multiple studies indicate that debt-to-GDP ratios might increase due to insufficient mitigation efforts. Some explain it by reductions in productivity (Dafermos et al., 2018), and others as a form of financial risk (Kling et al., 2018). Financial markets price risks negatively, requiring higher premia for investments. In the case of climate change, countries exposed to it might experience higher financing costs in the form of higher interest rates on bonds. In developing countries, adopting long-term planning such as literacy projects and infrastructures connecting isolated communities, might be disincentivised. These projects produce relevant dividends for future generations but are difficult to actualise in monetary value. On the contrary, developed countries can actualise benefits more efficiently due to lower discount rates. Early mitigation measures benefits outweigh their costs in UK public finances exactly for this reason (Agarwala et al., 2021).

Our approach fills the gap of methodology and evidence for fiscal revenues at the local level departing from the literature of downscaling. Downscaling refers to increasing the resolution of data observation using statistical models. This method uses high-resolution regional climate models (RCMs) to simulate the climate over a specific area. The RCM takes boundary conditions from a global climate model (GCM)

and simulates climate processes over a smaller domain at a finer resolution. This method establishes statistical relationships between large-scale atmospheric variables (predictors) from GCMs and local climate variables (predictands). Historical observational data is often used to develop these relationships. It is less computationally intensive than dynamical downscaling and can be applied relatively quickly to various regions. It can incorporate local observational data to tailor results to specific areas. The validity of statistical downscaling heavily depends on the historical data quality and the assumption that relationships between predictors and predictors remain constant over time. Thus, results from downscaling are used as benchmarks for scenario analysis since policy implementation and other paradigmatic changes will affect the predicted variables. Many methodologies exist to predict local-level socioeconomic indicators departing from climate observations and country-level information. Studies have estimated energy uses (Rizzati et al., 2022), land use change (Santini & Valentini, 2011) and GDP (Wang & Sun, 2022) with an array of parametric and non-parametric approaches. This work uses a blend of the former type of methodology. Such an approach is necessary for the voluble characteristics of population changes, especially in the case of land uses. While economic activity is less dependent on population dynamics thanks to technological processes, land requires active owners. Economic activity has the flexibility to operate somewhat independently of population size due to technological advancements. For instance, automation allows for increased production with fewer workers, while digitalisation permits businesses to operate online without traditional constraints like physical storefronts or offices. Remote work enables individuals and companies to function effectively without being tied to specific locations, allowing economic activity to thrive even in areas with declining populations.

In contrast, demographic trends directly influence land use because it is inherently linked to where and how people live. A shrinking population can lead to multiple challenges regarding land use. As fewer people inhabit an area, there may be a surplus of properties, leading to abandoned buildings and underutilised land, with properties generating less tax revenue when unoccupied or used at reduced capacities. Decreased tax revenues can strain municipal budgets, affecting public services and infrastructure maintenance. For example, many regions in the Mediterranean have experienced these issues, where declining birth rates and emigration have resulted in ghost towns and deteriorating infrastructure.

Conversely, when populations increase, housing, infrastructure, and services demand rises, driving urban expansion as municipalities invest in new services to accommodate the growing number of residents. While this often results in increased tax revenues from property taxes and new businesses, it also necessitates significant investment from municipalities to develop infrastructure, such as roads, utilities, schools, and healthcare facilities. The challenge lies in balancing these investments with the anticipated growth to ensure a sustainable increase in the local tax base, which can support long-term community development. The predictions of the tax returns should, therefore, consider both demographic and climate transitions.

3. METHODOLOGY

The models we implemented target municipal tax revenues in Italian municipalities between the baseline period (2006–2018) and 2050 under different climate scenarios (RCP pathways). Revenues are modelled as a dependent variable influenced by three key factors: local economic activity, tourism intensity, and urban land use. The analysis is grounded in assumptions consistent with economic theory, ensuring robust and policy-relevant predictions. The modular structure uses predictions in the most relevant bases of taxation at the municipal level. The political economy might influence fiscal returns unpredictably; therefore, some caveats are in order.

High heterogeneity characterises Mediterranean cities in terms of fiscal capabilities and could be usefully synthesised in future academic research as well. Some adjustment is required to apply the methodology to other countries. We

provide a short comparison of how tax systems are structured following the study of Geißler et al. (2019) for Italy, France, Spain and Greece. All four countries feature multiple levels of government (central, regional, and local), although the degree of autonomy and responsibilities varies across levels and countries. The exact structure differs in each nation (e.g. the presence or absence of provinces as an intermediate tier).

Furthermore, their municipalities exhibit a significant degree of reliance on central government transfers to fund local budgets. The proportion of transfer revenue varies considerably across countries and has fluctuated over time. There is some degree of local taxation autonomy overall, but the extent varies, and municipalities typically have more local tax autonomy than regions in Europe. The implementation of tax levies and changes in the marginal rates are often influenced or even determined by central government regulations. A balanced budget requirement is a common feature regarding fiscal stability, either strictly yearly or as a medium-term target. The implementation and enforcement of this rule differ across the four countries. For synthesis, we provided a synthesis in Table 1 below.

Feature	Italy	France	Spain	Greece
Fiscal Decentralisation	Relatively high, but significant central government influence.	Traditionally low, but increasing in recent decades.	Low, with significant regional (autonomous community) influence.	Low, with a recent fundamental restructuring and centralisation of power.
Local Tax Autonomy	Regions have significant tax autonomy; municipalities have some limited control.	Relatively high; municipalities have considerable freedom to set tax rates.	Municipalities have significant freedom to impose locally determined taxes.	Limited; mainly dependent upon state transfers; municipalities control local taxes within pre-set limits.
Expenditure Share	High; regions and municipalities spend a significant share of total public expenditure.	Low in comparison to other EU countries.	Below the EU average.	Low; municipalities have a limited say in the provision of major local services.
Fiscal Crisis Response	Significant central government intervention to bail out local debt.	Some municipalities experienced fiscal difficulties; regional intervention, but no widespread bailouts.	Low debt, with some highly indebted municipalities. No widespread bailouts.	Significant central government intervention to restructure and bail out local finances.
Fiscal Oversight	Complex, involving national and regional oversight bodies and the Court of Auditors.	Prefectures as oversight bodies and central government representatives in the region.	Regional oversight by autonomous communities and national level oversight by the Ministry of Finance and the Independent Authority for Fiscal Responsibility.	Multiple agencies are involved in monitoring and enforcing fiscal rules; and conditional bailouts for municipalities in financial distress.

TABLE 1
Comparison between municipal fiscal systems across major Mediterranean EU



The institutions at the Italian Municipal level can raise taxes from tourism presence, land property, and economic activity under parameters dictated by ordinary law. The taxes levied in such manners are used freely and there is no clear mandate on earmarking them. This work considers the main sources, which changed relatively little over time. The Italian «imposta di soggiorno,» or tourist tax, is a local levy applied to tourists staying in accommodations outside their home municipality. Established through several legislative acts, primarily Decree-Law 31 May 2010, no. 78 and Legislative Decree 14 March 2011, no. 23, the tax offers municipalities a degree of fiscal independence. Its application is restricted to certain municipalities: provincial capitals, those within municipal unions, those designated as tourist destinations or cities of art by regional authorities, and island municipalities. Municipalities have considerable latitude in setting the tax rate, with guidelines suggesting a graduated system based on accommodation cost and determining exemptions and payment deadlines.

The second levy relates to all land taxes, largely influenced by the physical area of houses, offices and agricultural land. Italian municipal land taxes are complex and vary considerably across the country. The system hinges on cadastral valuation, using the estimated land value from the national «Catasto» registry as the tax base. Two main municipal taxes are relevant: the IMU (Imposta Municipale Unica), an annual property tax encompassing land, and the TARI (Tassa Rifiuti), a waste collection tax often linked to property ownership. IMU calculations involve the cadastral land value, regional or municipal surcharges, and potential deductions or exemptions, which can vary greatly between municipalities depending on the property type and the owner's situation. Outdated cadastral valuations and regional and municipal surcharges further complicate the system, creating significant differences in tax burdens across similar properties in different areas. Exemptions and deductions vary widely based on property use and the owner's characteristics. Municipalities have a degree of flexibility in setting IMU tax rates, contributing to the overall variation.

Building taxes are often assessed together with land taxes as part of the IMU calculation. The entire system operates within a framework established by national laws. Still, it is significantly shaped by regional and municipal regulations, making it crucial to consult the specific regulations of a given municipality for accurate information. The lack of consistent and up-to-date cadastral data impacts the fairness and efficiency of the entire land tax system.

Finally, we use economic activity as the third factor to predict municipal taxes. The primary source of municipal revenue from income and economic activity is the IRPEF (Imposta sul Reddito delle Persone Fisiche), Italy's income tax. While the central government collects most of the IRPEF, municipalities receive a share, usually calculated based on the population residing within their boundaries and the total amount of IRPEF collected nationally. This share represents a significant portion of municipal revenue, but it's not directly tied to income generated within the municipality itself. Therefore, a municipality with a large population but limited economic activity might receive a substantial IRPEF share, while a smaller, economically vibrant municipality may receive less. Further complicating the matter is that local regulations and practices influence the amount of IRPEF collected. Beyond the IRPEF share, municipalities can levy taxes on various types of economic activities. These include taxes on commercial activities, often linked to the size and nature of a business, as well as taxes on specific services such as advertising or waste disposal. Rates and regulations governing these taxes differ significantly among municipalities, reflecting local priorities and the specific economic characteristics of each area. Many municipalities also levy local taxes on vehicle registration or property ownership. While the national framework provides a general structure, considerable variation exists in the types of taxes, tax rates, and collection methods employed by different municipalities. The system's complexity makes it difficult to provide a comprehensive overview without delving into the specific regulations of each municipality or region. The dimension of income is a robust proxy for all these peculiarities.

3.1 Assumptions and Context

A central assumption is that municipal tax rates remain exogenous to climate and demographic change. Italian municipalities have limited authority to introduce new taxes and adjust marginal tax rates only to achieve long-term fiscal stability, even under chronic or acute climate risks (Kellner & Runkel, 2020). This constraint assumes tax rate stability plausible over the forecast horizon. Municipal Tax revenues in Italy are affected by the dynamics of three main sources: these are tourism activities (H), anthropic land use (L) and total income, proxied by local aggregated demand (Y). The administration can modify slightly certain parameters to increase the yield and differentiate the portfolio of revenues. The power to change the marginal tax rate is limited to ordinary laws, meaning that the marginal tax rate varies mainly across municipalities without external political intervention. Our model produces scenarios assuming that the bounds of tax rates for all three sources of taxes for municipalities will not drastically jump between 2005 and 2050. That is, we provide a benchmark on how tax revenues will change if the determinants change. These changes are derived from papers, models and scenarios.

3.2 Theoretical Framework

We first propose a simple theory of taxation at the local level that is akin to a production function. Municipal tax revenues depend on the taxed activities (H, L, Y), local exogenous characteristics (Z), and institutional efficiency (captured by an error term, e^{ε_i}). The latter can be seen as a form of «productivity», a tax efficiency. For example, if we had two areas practically identical for tax area and exogenous characteristics, an unobserved effect could explain the difference in revenues. This might be a form of efficiency related to local institutions, culture, and norms.

Although the theoretical model of local taxation is similar to a production function—often used in economics to describe how inputs are transformed into outputs in a firm—it is not appropriate to treat local tax revenue generation as analogous to productivity in a business. Unlike bu-

sinesses, local administrations do not optimise their fiscal collection as a straightforward economic activity. The relationship between inputs (such as taxable economic activity) and outputs (tax revenue) cannot be neatly described along a frontier of efficiency. Instead, this process is influenced by factors that are not directly observable, which we model as an idiosyncratic error structure—a unique, random component independent of the primary drivers. This idiosyncratic component reflects that most local governments share broadly similar characteristics, such as legal frameworks and resource access. At the same time, only a few might exhibit unusual levels of efficiency or inefficiency. This error term equals the differences between how much is predicted to be levied and what is levied in reality. In other words, two municipalities might have different tax returns despite potentially having identical tax bases and control information. The main difference is how effective the collection is. The statistical models assume how these errors are distributed across municipalities, meaning how we expect fiscal efficiency to differ across municipalities.

We will employ multiple econometric strategies to isolate and understand the error structure to account for municipal fiscal returns' peculiarities. The model selected in the end for the predictions and development of the scenarios must, however, suffice two characteristics that are often in competition. One is the predicting power, also called external validity. The other is robustness and fitness, meaning internal validity. We are interested in a model that is sufficiently robust in the sense that it correctly fits reality and its peculiarities. For example, it is sensible to presume that errors are non-normal: fiscal productivity could be non-random in Italy, characterised by phenomena such as North-South divides, proximity effects and other structures. Secondly, we are interested in a model with the highest predicting capability, and we will provide a validation process in the appendix in the form of internal and external fitness indicators. This process systematically evaluates how well the model performs and ensures that the findings are reliable and applicable. The theoretical model of tax revenues is structured as presented in eq.1 below.

$$T_i = e^{\varepsilon_i} H_i^{\alpha} Y_i^{\beta} L_i^{\gamma} Z_i \qquad (1)$$

The error structure is e^{ε_i}, while the local exogenous characteristics are collected in matrix Z with their respective elasticities. The elasticities of the tax sources are α, β, γ. These elasticities measure the responsiveness of tax revenues to changes in respective tax bases, such as income, property, or tourism. Each of them is always greater than 0, as the increase in the tax base is at least conducive to non-negative changes in the tax yield. Otherwise, we would observe a decrease in revenues due to tourist expansion, city construction or economic growth. Their sum should be, in theory, equal or greater than one. This is because the three factors we enlisted represent Italian municipalities' main budget sources. For this reason, their compound elasticity should not only be positive, but it should also be complementary. In an efficient system, a 1% increase in the tax base would equal at least a 1% increase in tax revenues. The elastic relation between base and revenue is also called tax buoyancy. Their value might change in the long term only if relevant reforms are implemented to change the fiscal structure or grant/restrict levy powers. Any additional difference in the relation between local institutions and fiscal revenues would be explained by the error structure, local characteristics or even tax spillovers. The model is expressed in a log-log form to simplify analysis and linearise relationships. This peculiar structural form comprehends the eventuality of non-linearity between the tax base and the revenue is non-linear.

Our predictions focus on differences in tax revenues starting from a baseline year (2005), allowing us to disregard the influence of exogenous factors that remain constant over time. However, according to the structure of the errors and the presence of spillovers, the total value from the three parameters might differ from the direct impacts; direct impacts are the effects without considering spillovers, while total impacts consider them. We will estimate the model using Ordinary Least Squares (OLS), Robust Least Squares (RLS), Feasible Generalized Least Squares (FGLS) and finally a Spatially Auto Regressive and Autocorrelated Residuals (SARAR) model. Using multiple models allows us to account for different data characteristics and potential biases, ensuring robust and reliable estimates for direct and total impacts.

While all these approaches provide direct impact estimates, only the SARAR model incorporates total effects, making it critical for understanding broader implications.

The scenario creation will be based on the predictions provided by the estimated econometric model. The dependent variable is the volume of fiscal revenues, while the independent variables will have three main drivers. These are the downscaled GDP of the nearest centroid, the urban area and the tourism intensity per square kilometre. Municipalities gather taxes from tourism presence, income additional taxes and land taxes according to the area of businesses and homes. Since we cannot predict local income in the next decades, we will adopt downscaled versions of the GDP as a proxy of local income. These values are not derived with the conventional method from national statistical offices. They are estimated by researchers and validated by peer review. Although not consolidated by official sources outside academic journals, they provide a basis for scenario analysis. They are not perfectly robust as they might contain an observation random error that cannot be controlled. However, statistical models can override this matter. We will adopt bootstrap random errors that can eliminate the noise from the observation errors that downscaled GDP can carry. The studies that provide values of downscaled GDP also carry their climate predictions. The climate scenarios for land use change and tourism originate from studies we previously carried out.

The dataset is structured as a panel to capture both cross-sectional (differences across municipalities) and temporal (changes over time) variations, with municipalities (i) observed over the years (t). The values used in the scenarios are calculated as the difference between the predictions and the average value of municipal fiscal revenues in our sample (2006-2018). The sample is constructed through the matching of various datasets: Corine[468] (land use), ISTAT[469] (economic and geographical variables), and AIDA PA[470] (fiscal revenues). Since Corine presents observations available every six years, three years of observations are available for more than municipalities. The econometric model is structured as indicated in Eq.2

$$Y_{i,t} = X_{i,t}\beta + Z_{i,t}\gamma + \varepsilon_{i,t} \quad (2)$$

Y refers to revenues. The X matrix collects the main independent variables, which differ from the Z matrix, which collects a set of variables that are geographical characteristics and are fixed in time. Bootstrapped standard errors are employed in all regression exercises to account for potential biases and variability introduced by using downscaled GDP (an estimated proxy for local economic conditions)[471]. We then calculate the values of revenues at time T as in Eq.3 using the estimated value of multiplied by the changes of matrix X from the reference time t.

$$E\left(Y_{i,T} - Y_{i,t}\right) = \left(X_{i,T} - X_{i,t}\right)\hat{\beta} \quad (3)$$

The predictions are calculated according to the matching of values from SSP scenarios of GDP, RCP scenarios of Tourism intensity and shifts in land use due to demographic changes in population density. The prediction refers to all municipalities with more than 5000 residents (more than 2500 over 7500, accounting for more than 70% of the Italian population). ISTAT provides local demographic predictions only for median probability, meaning we cannot gauge nuances due to climate changes or other factors.

The prediction of variations is consistent with matching two sources of scenarios, of which we selected mainly three possible scenarios from the works of (Meinshausen et al., 2020). Optimistic scenarios such as SSP1 are matched with RCP2.6, being the most ideal from the climate perspective. The Middle of the road is the SSP1 scenario we matched with RCP4.5, the expected path with the current climate policies. Finally, we matched the RCP8.5 climate scenario with the SSP3 being the worst match with credible co-occurrence. Although simple, this setting allows us to differentiate between optimistic and pessimistic scenarios. In particular, since most authors consider the SSP2-RCP4.5 scenario the current business as usual Baseline, we finalised two outlooks. One is the difference between the optimistic and the BAU, and the second is the

468 https://land.copernicus.eu/en/products/corine-land-cover
469 https://www.istat.it/
470 https://login.bvdinfo.com/R1/AidaPANeo?SetLanguage=en
471 Bootstrapping is a statistical technique that helps to ensure the robustness of the estimates by repeatedly resampling the data to create numerous simulated samples, which improves the accuracy of the standard errors and results.

Pessimistic minus the BAU. These are measures of divergence from the current path that already presents climate policies. We will report these scenarios in the results for Italy's ten most populated municipalities and provide a country-level loss of tax revenues for the available municipalities. We also offer the raw variations for various other scenarios.

4. DATA

The econometric model for prediction sources data from different data providers. The first we present is the dependent variable of fiscal revenues. IDA PA provides yearly observations on municipal revenues and expenditures, which were accessed for the year 2005. These data were matched using the ISTAT municipal identifier, a key variable for unifying the different data sources. Among the independent variables, we have tourism. We are interested in the supply-side information: the capability of a territory to host visitors. ISTAT collects data on tourism visits and structure size. A prediction of tourism supply is available from Mazzarano et al. (2024), where the number of beds registered for touristic activity is used as a proxy for hospitality supply. This variable collects the raw number regardless of the type of structure, such as hotels, hostels, bed & breakfast and other smaller providers. Any organisation that receives payments for visits requires to pay tax and report to local authorities the structure characteristics and any relevant changes over the year, allowing for highly detailed information about tourism at the local level.

CORINE provides land use data. Satellite observations differentiate landscape into five main distinctions. The first two types are the ones we are interested in. The first is the urbanised covered land, characterised by buildings, offices, parking lots, and other asphalted, bricked or artificial surfaces. The second type is the agricultural areas and anthropised nature. These include all the natural areas that are consistently used for human activities. The other three types are not considered here, we will list them for information. The third type of land use refers to forest and green areas not habitually used for human purposes. Wetlands and Water bodies are the fourth and fifth land use types. We are interested in the km2 of land uses from such a data provider. These amounts are calculated by clipping the CORINE shapefiles into municipalities. Secondly, we aggregate all sub-areas into the types within each city. Since data for 2005 is not available, we adopted the 2006 observations. It is worth noting that land uses change very slowly over the years. The European Union records observations every six years, and still some areas are without change. Predictions of such changes are currently being studied in a separate study, using the ISTAT forecast on the resident population for 2050 (Mazzarano, 2025).

Finally, GDP is downscaled using various methodologies. Authors have used multiple methods to project onto grids of observations the performance of countries as predicted by Integrated assessment models (Murakami et al., 2021; Rizzati et al., 2023; Wang & Sun, 2022). Such models are standard growth models that involve a climate structure and can predict the effect on an economy generated by temperature changes. Using predicting models, researchers managed to assign expectations of local gross domestic production to locations across the globe. These are interpretations of how local economies might evolve. We use the Wang and Sun (2022) estimations, who adopted values PPP of 2005 dollars: we converted its values into euros using the average exchange rate of that year of 1.24 Euro-Dollars. We matched each municipality with the nearest grid provided in the projections. We reported a summary of the statistics of this matching in table 2 below. It is possible to see that the average distance between the centroid of the municipality and the gid observation is below four hundred meters. This indicates that the data source for GDP downscaling represents local economic performance. Other control variables are used for the econometric models. ISTAT provides information on the degree of urbanisation as an integer number varying from 1 to 3, with 3 being a sparsely populated area, 2 being small-density areas, and 1 being densely-populated areas. Altitude is the average altitude of the municipality. The National Statistical Institute also provides classifications for municipalities, of which we use the Island type, a dummy that indicates whether the municipality is on an island.

Statistic	N	Mean	St. Dev.	Pctl(25)	Pctl(25)
Fiscal Returns*	7,313	10.989	128.640	1.582	6.611
Tourism Supply	7,313	533.645	3,201.074	0	173
A1	7,313	0.463	2.360	0.000	0.207
A2	7,313	21.757	41.556	2.573	23.917
Density	7,313	2.950	6.363	0.493	2.750
Urbanisation	7,313	2.601	0.548	2	3
Altitude	7,313	353.273	294.228	113	517
Island Municipality	7,313	0.003	0.054	0	0
Distance From Ports**	7,313	74.437	51.759	31.410	113.695
Distance From Airports**	7,313	74.384	46.338	38.808	101.394
GDP*	7,313	297.962	1,079.023	1.318	102.968
Distance Between Centroids	7,313	353.762	131.185	261.567	449.214

Notes: *Million Euros; **Km

TABLE 2
Summary Statistics

Eurostat provides geo-localisation of the main infrastructure. The distance between the centroid of each municipality with a port or a great airport indicates the isolation of the local population. It is a potential driver of tax inefficiency or lack of enforcement.

The average municipal tax revenue is around 10.989 million euros, with a wide standard deviation of 128.640 million euros. The distribution of municipal revenues is positively skewed, indicating that while most municipalities have relatively low revenue figures, there is a long right tail with a small number of municipalities generating exceptionally high revenues, often in the billions. This skewness suggests that a few municipalities dominate the local taxation landscape while most municipalities experience much lower fiscal revenues. Tourism is one of the sources of such revenues and has a very similar statistical distribution, characterised by an average of 533 beds available. This value falls well beyond the third quartile, indicating that tourism intensity is a characteristic of a few municipalities. The mean dimension of the urban area is 0.463 Km2 with a standard deviation of 2.360 Km2. As for previous municipal data, the average falls beyond the third quartile. The land involved in agricultural areas is, on average, 21.757 Km2, with a standard deviation of 41.556 Km.

GDP average across municipalities is 297.962 million euros, with a standard deviation of 1,079 million euros. Together with the characteristic mean falling beyond the third quartile, we can presume that Economic activity is concentrated in a few spots. It is possible to see that by dividing the average population of Italian municipalities 7561 by the average, we obtain 39405.73 euros per capita, which is not far from the World Bank's 32051.06 euros estimates. The available data tends to be higher because it excludes smaller municipalities, likely to have lower economic activity than larger ones. As a result, the average per capita GDP in the dataset is more than 5,000 euros higher than it would be if small municipalities were included. Additionally, the difference in per capita taxes is approximately 500 euros between all municipalities and those with populations exceeding five thousand residents. These variables—such as population size, economic activity, and tax revenue distribution—are key independent factors influencing total fiscal revenues at the local level.

5. RESULTS

Four regression models have been applied to the data: OLS, RLS, FGLS and SARAR. The detailed result table is available in the appendix, as we are interested in the parameter estimates. The results elasticities can be interpreted as the change occurring in the case of an increase of 100% of the variable under consideration. The first model estimated that the GDP elasticity varies from 3% in the RLS to 5% in the SARAR. The increase in urban land affects 56.1% in the OLS to 49.4% in the SARAR. Agricultural land elasticity equates to 40.6% in the SARAR, and the lowest is estimated by FGLS and OLS. It will be possible to see that land use change is the most impacting factor on municipal budgets among the four factors. Tourism is the second most important factor, which varies between 12.7% to 15.8%. The SARAR model can address tax spillovers using Lambda and Rho, the spatial lag effect and the spatial redundancy of idiosyncrasies. The estimated total impact in the SARAR model changes the elasticity into 5.2% for GDP, 46.86% for urban land, 37.7% for agricultural land and 12% for tourism.

The variables, the fixed effects and the controls employed are the same across models, yet the estimates will vary slightly. Such small differences are not negligible, as they are reflected in the climate scenarios at the end. For these reasons, we have to select the most appropriate model. There are rules to follow. There is a trade-off between internal and external validity, and estimates' robustness must be satisfied. First of all, the models present different fitness, indicating that the internal validity of the model is not homogenous. Some models may be more accurate or reliable than others in predicting the outcomes within the observed sample, others outside it. However, the purpose of this work is to elaborate long-term scenarios. Thus robustness must be kept along external validity, meaning that fitness per se is not as relevant as the capability to predict fiscal revenues out of the sample. Using the results from the external validity from the appendix, we must consider the FGLS the most apt model for predicting revenues among the ones used for the estimates.

The main independent variables presented similar magnitudes across models, and their sum should be approximately equal to 1.05-1.07. The total effects in the SARAR model include potential tax spillovers from neighbouring areas: their sum equals 1.018. The value supports the buoyancy hypothesis made in the methodology, meaning that an increase of 1% from the tax base should be equally reflected in the revenues. The methodology provides predictions that should be considered as a potential outcome based on inference: demographic shifts can occur, unexpected economic crises unfold, and political instability emerge. It is possible that fiscal reforms will occur between 2025 and 2050 insofar as changing the estimates. The results are, therefore, considered indicative of what could happen if the trajectories of development and growth do not change. The fiscal structure is also considered stable, and we presumed in the model that fiscal prerogatives will not be affected by climate change. It is possible to provide in simple and intuitive terms what happens to municipalities if we expect a divergence from the benchmark in climate change. We developed two scenarios, one optimistic and one pessimistic as differences from the current path, assumed to be the SSP2-RCP4.5. A summary of the results is available for the ten biggest cities in Italy in table 3 below.

	Optimistic Scenario		Pessimistic Scenario	
	Percentage	Euros*	Percentage	Euros
Rome	0.5%	21.566	-1%	-43.560
Milan	2.7%	252.360	-5.1%	-468.827
Naples	1.3%	24.022	-2.3%	-42.408
Turin	3.5%	80.903	-6.2%	-143.837
Palermo	1.3%	13.304	-2.3%	-22.575
Genoa	0.5%	3.482	-1.1%	-7.571
Bologna	2.5%	19.840	-4.1%	-32.537
Florence	1.9%	7.359	-3.6%	-13.895
Bari	0.8%	9.336	-1.2%	-14.075
Catania	2.6%	17.060	-4.8%	-32.034
Total	1.8%	449.232	-3.1%	-821.319

Notes:* 2005 euros

TABLE 3
Deviations from the current trend

The optimistic scenario predicts an improvement from the benchmark in all cities. The biggest increase in relative terms could be achieved by Turin, while in absolute terms, by Milan. Genoa and Rome gain relatively little with a 0.5% increase. The differences are relevant in terms of budget. For example, if we took Milan's tax revenues in 2005 (approximately 9.12 billion euros), the divergence would amount to more than 2.5% of that budget in 2005 money value. A relevant comparison would be equating such losses to expenditure voices that matter for development, redistribution and human capital development. One expenditure voice that can represent all this is indeed education, which cultivates all forms of knowledge and competences necessary to serve the countries and face the complexities of climate change, which will not disappear by 2050. This percentage quantifies a magnitude of at least five times what the city expended in education in 2021. Among these ten cities, the gains from an optimistic scenario might be in the other magnitudes of half a billion euros. The total net gain for all municipalities would be 567 million euros in 2005 value. This is an example of how robust climate policies can make a difference.
There is also the negative side. Local administration can be dramatically affected if climate policies are not stringent enough. For instance, Catania might lose 5%, Turin more than 6% and Milan

more than 5%. These values represent orders of magnitude far greater than what the cities spend on education at various times. The pessimistic scenario would imply a loss of 900 million euros for the ten cities and more than 1.2 billion euros for all municipalities. Some municipalities might perceive a different trend than others, highlighting the typical heterogeneity of economic performances at the Italian local level. We provided further detail in table 4, were we highlight five different scenarios and the prediction of changes with 2005 in the RCP4.5-SSP2 case.

COMUNE	RCP26 SSP1	RCP26 SSP2	RCP45 SSP2	RCP85 SSP3	RCP85 SSP4
Torino	20.86%	17.45%	17.39%	11.22%	18.45%
Genova	-2.30%	-2.89%	-2.81%	-3.94%	-2.69%
Milano	17.64%	14.88%	14.90%	9.80%	15.72%
Bologna	13.40%	10.98%	10.92%	6.86%	11.66%
Firenze	9.23%	7.24%	7.34%	3.77%	7.87%
Roma	-1.99%	-2.54%	-2.47%	-3.43%	-2.31%
Napoli	2.55%	1.37%	1.27%	-0.98%	1.71%
Bari	-1.65%	-2.32%	-2.41%	-3.56%	-2.20%
Palermo	2.83%	1.56%	1.49%	-0.79%	2.02%
Catania	16.23%	13.80%	13.68%	8.90%	14.55%

TABLE 4
Deviations from the current trend

Regardless of the benchmarks, some scenarios might improve some cities' conditions while being dangerous for most economies around the globe. For example, the major cities seem better off in a RCP85-SSP4 scenario, where the temperatures are far higher, and the world is less safe. These scenarios simplify a complex reality and provide the perspective of the unknown future. Looking at table 4, we must ascertain that while fiscal revenues might be higher in certain RCP85-SSP4 scenarios, the non-economic costs of climate change might far outpace the gains. Political instability and global competition carry relevant uncertainties for local populations. In summary, the table captures the heterogeneity of scenarios of our analysis, how some cities might have a better outlook in very pessimistic rather than less pessimistic scenarios. This depends on the capability to achieve a positive outcome in the SSP4 scenario, which should be taken cautiously.

6. POLICY ORIENTATIONS

The benchmarks can be a supporting tool for various climate and fiscal policies that might counteract the effect on local climate change economies. Local authorities might have more instruments than it is acknowledged in legislative propositions. Such institutions largely operate the ruling over local land and its economic value and can effectively provide tools for adaptation and mitigation policies alike. These instruments can be strictly fiscal or interventionist to benefit residents and others.

6.1 Pigouvian Taxation and Internalising Local Climate Risk

Among the most classical approaches against climate change, it is possible to find Pigouvian taxation, which refers to levies imposed on activities or products that generate negative externalities. These do not distort the market: they correct failures to provide consumers and firms with the correct price information, such as the exposure to calamity or protection from them. Climate change and its damages are a form of externality of economic activity and, therefore, constitute a problem of market failure. Carbon taxes are measures to internalise this damage and provide a correct signal for consumers. This theoretical approach can be observed from the perspective of local municipalities, which have different and exogenous exposure to climate change. Marginal damages might be irrelevant to the economic dimension of the city. Yet, adaptation measures must be implemented and po-

tentially even financed locally, where we noticed a potential loss of resources in the long run. In this context, tools such as urban tolls, already implemented in several Italian cities, could be explored. This mechanism, which aims to reduce congestion and pollution while generating revenue for municipalities, could be adapted to finance climate change adaptation initiatives. It was suggested in a previous strategic report that price signals at the local level should comprehend the costs of climate change so that public finance can support not only environmental policies but also distributional targets (UNEP/MAP, 2016). The policy recommendation departs from the renown Pigouvian efficiency graph in the presence of externality. We provide an example in figure 1.
Marginal damage from climate change affects heterogeneous land but is exogenous to the cadastral value. Without any adaptation plan, the property market provides the price signal for the quantity of land and lets consumers face the costs of adaptations. This is an inefficient solution, as the policymakers will inevitably have to compensate for climate damages with general finance.

6.2 Climate-Resilient Cadastral Reform

Cadastral reform in Italy is a complex and ongoing process addressed through legislative acts, administrative procedures, and judicial oversight. It's not a single, unified undertaking but a series of incremental reforms aimed at modernising and improving the accuracy and efficiency of the «Catasto». The legal framework for cadastral reform is primarily established through national laws and decrees. These legislative acts define the objectives of the reform, outline the procedures for updating cadastral data, and allocate the responsibilities of the relevant government agencies, primarily the «Agenzia del Territorio». These laws typically mandate updating cadastral maps and property values, often focusing on specific geographical areas or types of properties. Cadastral reforms are rare to occur due to political transition and administrative costs. A consensus that supports these types of actions is difficult to reach without concessions and monitoring costs are often not negligible. It is, therefore, important to address the potential of this type of reform in time for when times are favourable. The support in cadastral reforms delves into long-term strategy visions for the future city: climate resilience can easily partake in the reasoning.

In this case, we propose to elaborate further on one of the main elements of local finance as instruments to internalise climate risk, which is cadastral registries and the value per square metre of the cadastral income. The quantity and prices are, therefore, not sufficient to maximise the welfare of all. Adaptation plans compensate for the marginal damage of climate change and increase land value. An adjustment in cadastral income that automatically incorporates the effect of climate policies and adaptation measures would change the supply curve from S to S' and correctly price climate change locally because land taxes would increase proportionally (Abbatini et al., 2024). Policies such as afforestation to adapt against desertification are considered a form of subsidy against climate change (Kotecký, 2015; van Valkengoed & van der Werff, 2022). The loss of potential urban area is not necessarily a malus for the local economy. Although providing anthropic space might be economically feasible, adaptation measures often take up space. The city of Rimini on the northern Adriatic coast is an example of dealing with heavy inheritance. The neologism verb «Riminizzare» originated from the urban planning of the sixties and seventies based on extensive use of cement and bitumen to replace nature to support tourism development. Indeed, this approach is conducive to climate change and further exposes residents to the costs of climate change, such as heatwaves, rising sea levels, and floods, which all happened profusely in the last years. The recent years of urban planning inverted the trend by providing a barrier to the coastline and better water treatment, reducing the asphalt area and increasing the green areas around the coasts. The effect is the control of sea level rise in the next decades in addition to countless co-benefits (Amadio et al., 2022; Koks et al., 2023). A climate resilient cadastral reform would allow the municipality to reform the tax base accordingly and adjust land value.

Sustainable land management and cadastral reforms are long term actions that require relevant human capital, political support and administrative workforce to achieve. For these reasons, and others might apply, they are effective yet rare and complex. However, anthropic pressure from tou-

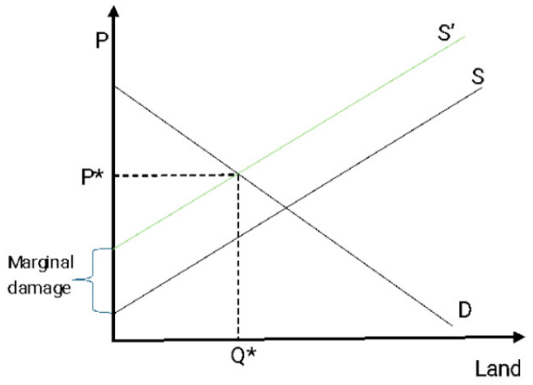


FIGURE.1 *Climate Adaptation as a Piguvian Tax/Subsidy*

6.3 Climate Tourist Tax

While the current system allocates revenue to environmental protection and services, the tax's direct contribution to climate change mitigation is limited. There's substantial untapped potential for improvement. Expanding the tax to more municipalities would boost funding for green initiatives, climate adaptation and mitigation. Implementing a tiered system that links tax rates to the accommodation's environmental impact would incentivise greener technologies and practices. Higher rates could be applied to high-energy establishments or those with poor sustainability ratings. Additional surcharges, earmarked for specific climate mitigation projects, could fund improvements in public transportation, nature restoration efforts, and renewable energy investments. The existing revenue allocation regulations must be more specific, prioritising climate-focused projects and ensuring transparent, accountable spending. Further, the tax could be used to subsidise or incentivise sustainable tourism practices for businesses and tourists, perhaps through discounts for public transportation or choosing eco-friendly lodging. Furthermore, exemptions could be made for small businesses or those that adopt carbon-neutral practices in their services.

This policy recommendation requires practices that could align with the implementation of the ETS-2, meaning that observation of the climate performance of touristic establishments could abide by international and reproducible standards. Increased transparency and reporting mechanisms are crucial for building public trust and ensuring the effective implementation of climate-focused initiatives. There are challenges, however. Broadening the tax scope may face political resistance, especially from businesses concerned about its impact. Implementing more complex rates and surcharges increases administrative costs. Finally, robust data collection and analysis are critical for monitoring the effects of the tax and the success of related green initiatives. Through these improvements, Italy can leverage its tourist tax to directly address climate change, promoting sustainable tourism and bolstering the sector's long-term viability. Successfully navigating the economic and political considerations is paramount.

6.4 Offsets and Adaptation Policies

Climate taxes are meant to limit uncompensated damages. An alternative would be to implement measures requiring actions from individuals. This approach is influenced by Coase principles and uses it to provide financing instruments for adaptation policies. We depart by looking at the unpaid benefits of local measures. The effects of climate change at local level are avoided by the intervention of the municipal authorities with adaptation measures. The initial investment supports local businesses and generates income, and there are additional positive effects if nature-based solutions are used. Such an approach might involve the implementation of adaptation measures that guarantee co-benefits in climate change. For example, using vegetation to control landslides nourishes local wildlife and corresponds to mitigation efforts, which however would be repaid in economic but not fiscal terms. There is a transfer of value from taxpayers to landowners, businesses. Unintended mitigation effects have value.

In the coming years, mitigation might become market products for organisations aiming at reducing climate footprints (Kuhn & Uler, 2019). The secondary use of adaptation measures with mitigation potential is that they can generate offsets by absorbing the emissions from parties that are willing to compensate for carbon emissions. These contracts are often called carbon offsets and at least in theory could be used to shield economic actors against the responsibility of Pigouvian taxes: the agent has already paid the price for environmental damage and will simply return the offset to the municipal authorities if they are required to pay for climate efforts, such as in the case of Pigouvian taxes. The municipality might not have a Climate tax in place but might require emission reduction from activities in other forms. As an historical example, paying taxes in "nature" is an expression referring to the action of surrendering material quantities as way to fulfil fiscal obligations, which is in this case it would be the offset. Finally, economic agents could use it to voluntarily adopt it in non-financial disclosure. As for any product with green claims, they would be affected by European Regulation (European Parliament and Council, 2024) in case the scheme was to be organized in EU. Another example is the CORSIA systems, where offsets are traded by international airline companies to compensate for emissions in the European Emission Trading System. Thus, there are already examples for which the tourism sector uses offsets. In this case, municipalities could use the adaptation measures to create a claim for climate responsibility in local businesses such as tourism and require offsets to fulfil it. Offset could then be produced by land managers (who incidentally pay taxes from on the land), other municipalities itself or other agents as well, with the demand side being whoever has a climate footprint. Such a scheme could be organized in a network of municipalities, providing and instrument for value transfer.

Local authorities, especially in low-density areas, might potentially host offsetting activities and raise fiscal resources in the long run. The demand for such contracts will increase as the objective of climate neutrality draws nigh. Furthermore, the auctioning capacity of the Emission Trading System (ETS) implies that there might be a push factor to give regulation relevance status to these contracts: the possibility of using them to compensate for legal requirements for carbon-intensive companies. This is particularly relevant given the premises of the Fit-for-55 package, which effectively anticipated the end of auctions of permits by at least a decade from 2050 (Pahle et al., 2023). These conditions are optimal for implementing adaptation policies, as they affect the long-term emissions costs, reshaping the benefit-cost analyses. Furthermore, implementing land use changes allows for new forms of entrepreneurship to flourish, especially sustainable tourism and forest-based economics.

7. CONCLUSION

To conclude, the climate scenarios presented highlight a diverse and often challenging outlook for local administrations in Italy. The model we created can be applied in other countries with elaborated databases for tax revenue, fiscal drivers and socioeconomic characteristics. It might also be possible to infer drivers through other sources, such as downscaled data currently available online. These sources might provide less precise and robust estimates of fiscal losses due to climate change but are enough to provide information where no exhaustive data collection is available.

The work also provides brief policy recommendations. They differ by degree of intervention in the market. The first and the third are relevant to classical economics and define the pillars of most climate policies worldwide. The second case is a structured policy yielding positive effects in the long term, requiring country support. The fourth is currently under experiment and has presented various shortcomings due to information asymmetries, lack of legal protection and supply fragmentation (Aldy & Halem, 2024). However, offset markets' evolution in Europe presents a different trajectory for local administrations. There is a clear policy signal and potential partners across the globe. This implies that willing partners outside Europe might freeride the evolution of regulations of the main market without having to push their enforcement in their own countries. International cooperation between local authorities could significantly increase collective action against climate change and benefit all.

UNEP/MAP can play a vital role in supporting Mediterranean municipalities—including those in Italy—in advancing key environmental reforms, with a focus on three priority areas: the implementation of Pigouvian taxes on tourism, the integration of climate risk into cadastral registry reform, and the development of effective adaptation planning.

- On tourism taxation, UNEP/MAP can provide technical assistance for the design and implementation of Pigouvian tax instruments, including guidance on rate-setting, collection mechanisms, and revenue transparency. By sharing best practices and offering impact assessment models, they can help municipalities anticipate the socio-economic effects of such measures. Capacity-building will also be crucial: training local officials on the environmental and economic rationale for these taxes can strengthen long-term institutional capabilities.
- For cadastral reform, UNEP/MAP's expertise in climate risk assessment can support the integration of environmental risks—such as sea-level rise or flooding—into land valuation processes. This could involve collaboration with national bodies such as the Agenzia del Territorio, and would include providing access to climate data, developing municipal-scale risk maps, and promoting standardized methodologies for quantifying risk exposure.
- Finally, UNEP/MAP can assist municipalities in designing and implementing adaptation plans aimed at increasing climate resilience. This includes methodological guidance, templates for vulnerability assessments, suggestions for adaptation measures, and tools for evaluating their effectiveness. UNEP/MAP can also facilitate peer learning through workshops and digital platforms, while offering targeted training to municipal staff on climate impacts and adaptive strategies.

In all these examples, UNEP/MAP's role would be to act as a facilitator, providing technical expertise, knowledge, and financial resources where possible. Rather than directly implementing reforms, the emphasis would be on empowering local governments and stakeholders to take the lead, fostering both sustainability and local ownership of the processes.

Appendix

Out-of-Sample Validation

For instance, the OLS model presents the highest value of 99.8%. This is anomalous in socioeconomic works, as R2 this magnitude is evidence of biases. Indeed, tests for autocorrelation and heteroskedasticity reject the null hypothesis, meaning that the estimates of this specific model should not be trusted. As the biases are considered in the statistical models, the R2 is reduced. In the case of RLS estimates, it is 70%. However, in the FGLS estimates, they are 89.2%; the latter model is generally more robust. Finally, the SARAR model considers spatial correlation and has the same internal validity as the FGLS. A summary of the estimates is available in Table A.1 below.

Dependent variable				
Ln(fiscal Revenues)				
	OLS (1)	RLS (2)	FGLS (3)	SARAR (4)
Lambda				-0.087*** (0.013)
Rho				0.642*** (0.015)
log(GDP_2005)	0.032*** (0.003)	0.030*** (0.003)	0.031*** (0.003)	0.050*** (0.003)
log(A1 + 1)	0.561*** (0.022)	0.557*** (0.022)	0.546*** (0.021)	0.494*** (0.023)
log(A2 + 1)	0.326*** (0.006)	0.328*** (0.006)	0.326*** (0.006)	0.406*** (0.009)
log(Value + 1)	0.158*** (0.003)	0.153*** (0.003)	0.151*** (0.003)	0.127*** (0.003)
island_municipality	0.251* (0.143)	0.276* (0.143)	0.296** (0.140)	-0.647*** (0.178)
log(altitude + 1)	-0.001 (0.007)	-0.001 (0.007)	-0.001 (0.007)	-0.059*** (0.010)
log(distance_large_airport)	0.001 (0.013)	-0.005 (0.013)	-0.019 (0.012)	-0.044* (0.026)
log(distance_ports)	0.0005 (0.010)	-0.002 (0.010)	-0.001 (0.010)	-0.049** (0.020)
factor(urbanization)1	14.477*** (0.218)	14.604*** (0.219)	14.807*** (0.210)	16.492*** (0.399)
factor(urbanization)2	13.540*** (0.215)	13.663*** (0.216)	13.835*** (0.206)	15.690*** (0.399)
factor(urbanization)3	12.814*** (0.217)	12.952*** (0.217)	13.140*** (0.207)	15.097*** (0.400)
Observations	7,313	7,313	7,313	7,313
R^2	0.998	0.706	0.892	0.892
Residual Std. Error	0.637	0.618		0.667
F Statistic	372,155.400***			

Notes: *p<0.1; **p<0.05; ***p<0.01

TABLE A1
Regression Results

The prediction models are selected according to fitness and robustness. However, statistical analysis cannot provide an absolute value for prediction goodness. A relative measure for comparison between models can be created to validate the choice between the available and robust ones. The predicting capability can be tested using a procedure called out-of-sample validation. We use available observations to see whether the different econometric modelling provides good predictions. We run the estimations N times for each of these models, equal to the number of observations. The nth observations are left out in each estimation round, and the model is estimated. We used such a model's values to predict the sample's value and calculate the deviation from the two values. Deviation is a measure of imprecision, meaning that the ideal model has a nearly null deviance at all N times. However, predictions may be more efficient around the centre of the distribution rather than the extremes. At this point, the collection of values is distributed around the distribution of original observations of fiscal revenues: we can now see which distribution areas are more difficult to predict for each model. Results of such methodology are available in table A2 below.

Quartiles	OLS	RLS	FGLS	SARAR
Q1	1036.575	1050.02	1107.066	4457.997
Q2	447.8049	436.5966	428.0255	1807.23
Q3	564.9514	552.5035	532.0198	1781.62
Q4	925.2035	936.966	916.3277	6786.947

TABLE A2
Out of sample validation

We can use the different values to compare models in terms of robustness and predictions and find the models more effective for our purposes. Indeed, we are more interested in a model that can better predict the revenues at the right side of the distribution, these being the municipalities with more inhabitants and relevant budgets. Furthermore, our data sample for prediction has only the ones with more than 5000 residents. This implies that a statistical model capable of better predicting smaller municipalities can be fascinating for scientific purposes but is irrelevant because we could not use those capabilities. In this case, we can presume that the FGLS model provides the most precise results of all three models while being the most robust.

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CONCLUSION. SUSTAINABLE FINANCE AS A CORNERSTONE FOR REGIONAL SUSTAINABILITY

Robin Degron and Constantin Tsakas



1. KEY CONCLUSIONS

The relationship between green finance, human capital, and sustainable economic growth has become increasingly central to policy debates, particularly as economies seek pathways to recover from recent crises while meeting ambitious environmental goals. As highlighted by Tufail, Song, and Khan (2024), green finance is emerging as a critical lever for advancing green growth, especially in developed economies where institutional frameworks are robust and the capacity for innovation is high. Their empirical analysis demonstrates that targeted investments in environmentally friendly projects, supported by effective green finance mechanisms, not only accelerate the adoption of clean technologies and reduce fossil fuel dependence, but also generate broader societal benefits such as employment, innovation, and enhanced stability.

A key insight from their research is that the effectiveness of green finance is amplified when paired with strong human capital. Economies with higher educational attainment and skill levels are better equipped to design, implement, and benefit from green finance initiatives. Conversely, globalization and unchecked economic growth can sometimes undermine green objectives, particularly if sustainability safeguards are weak or if financial instruments are not carefully aligned with environmental priorities. Barriers such as limited access to reliable data, insufficient understanding among financiers, and regulatory fragmentation can further impede the transformative potential of green finance.

These findings resonate strongly with the conclusions drawn throughout our Edited Volume. As demonstrated throughout our chapters, the Mediterranean region faces both opportunities and challenges in leveraging green economic tools and sustainable finance for development. The transition toward more sustainable economic models is not only feasible but within reach, provided that countries invest in strong governance, coherent policy frameworks, and the sustained development of human capital. The uneven implementation of green finance and economic tools across Mediterranean countries mirrors to an extent the disparities observed in the OECD

context, with high-income nations generally exhibiting greater institutional capacity while others make notable progress under more constrained conditions.

Our Volume's chapters have built on these themes, examining the nuanced impacts of environmental taxes, carbon pricing, green bonds, and other fiscal tools. They collectively reinforce the message that policy coherence, targeted support for innovation, and the development of context-sensitive regulatory frameworks are indispensable for scaling up green finance and achieving lasting sustainable development. Specifically:

- As seen in Chapter 1, green finance and economic tools are unevenly implemented across Mediterranean countries, with high-income nations demonstrating stronger institutional capacity, while some Southern countries are nonetheless making commendable progress. Success hinges on robust governance, inclusive stakeholder engagement, and coherence in policy design. However, regional cooperation, essential for scaling up these tools, is often hindered by geopolitical tensions. A shared vision and investment in institutional capacities remain crucial for embedding sustainability into public finance systems.
- Building on this, Chapter 2 illustrated that environmental taxes, while useful, have modest effects on emission reduction unless embedded within a robust regulatory framework. Feed-in tariffs can support renewable energy adoption but should be viewed cautiously as they may lead to unintended ecological or economic externalities. Carbon pricing and green bonds offer promise but face implementation issues such as price volatility and greenwashing. The chapter reinforced the message from Chapter 1: policy coherence, strong political will, and targeted support for small-scale renewable producers are essential for these instruments to deliver transformative impact.
- Expanding the fiscal dimension, Chapter 3 argued that aligning public finance with decarbonization goals requires deep inter-ministerial coordination and integrated carbon pricing strategies. Shadow pricing reveals how many sectors remain under-taxed, effectively subsidizing fossil fuel use. Anticipating declining revenues from fossil fuels, governments must revise fiscal frameworks and prioritize public investments based on environmental impact, job creation, and resilience, further reinforcing the importance of institutional planning seen in earlier chapters.
- In Chapter 4, this emphasis on strategic investment continued in the context of marine biodiversity restoration. The chapter found that while various financing tools, such as conservation trust funds, eco-tourism fees, and blended finance, hold great promise, their effectiveness still depends, as previously seen, on design quality, governance, and regulatory backing. For long-term results, the chapter advocates combining these tools in a tailored national mix, ideally anchored in frameworks like the EU Nature Restoration Law.
- Still on biodiversity but shifting focus, Chapter 5 explored invasive alien species (IAS) and calls for a proactive, economic instrument-based approach to management. As in previous chapters, success depends on sustained funding and inter-agency cooperation. Pigouvian taxes, targeted subsidies, and compensation mechanisms must be part of a coherent, preventive strategy. Public-private partnerships and regional mechanisms, such as those under the Barcelona Convention, are identified as essential for harmonizing fragmented efforts across the basin.
- Turning to another key resource, Chapter 6 addressed water sustainability and concluded that a diversified financial toolkit is needed. Grants and public-private partnerships offer high environmental returns, but they differ in scalability and investor appeal. Green bonds and blended finance show strong potential if regulatory support is improved. Once again, the effectiveness of these instruments rests on tailoring financial strategies to local environmental and market conditions.
- Focusing specifically on green bonds, Chapter 7 used Türkiye as a case study to show that these instruments may have limited macroeconomic impact when faced with re-

gulatory fragmentation, investor skepticism, and financial bottlenecks in renewables. Removing fossil fuel subsidies and clarifying green criteria could unlock their potential. The analysis reinforced a broader regional lesson: without a well-integrated financial architecture, the promise of green bonds remains underutilized.

- This argument was further substantiated in Chapter 8, which found that green bonds can indeed reduce air pollution, especially in high-emission sectors and when issued with medium-term maturity. However, it is not the volume but the strategic deployment of funds that drives effectiveness. As such, countries, particularly emerging economies, must ensure these tools are targeted, well-governed, and embedded in broader pollution reduction strategies.
- Yet, as Chapter 9 emphasized, the lack of Mediterranean-specific guidelines for green bonds undermines their regional effectiveness. Establishing soft-law frameworks tailored to the Mediterranean's ecological and economic specificities could enhance the visibility, credibility, and project implementation capacity of these financial instruments. This would directly address many of the structural weaknesses noted in the previous two chapters.
- Zooming in on the private sector, Chapter 10 showed that energy taxes can spur energy-efficient innovation, particularly in energy-intensive firms that have voluntary management practices. However, their effect is less pronounced in traditional manufacturing unless paired with broader fiscal reforms. This again brings to the fore the consistent message of prior chapters: aligning fiscal incentives with institutional support is key to unlocking behavioral change and scaling eco-innovation.
- Broadening the scope, Chapter 11 envisioned the creation of a regional energy hub to enable cross-border renewable energy trade in the Mediterranean. Achieving this ambitious vision will require harmonized fiscal incentives, the mobilization of green finance instruments like bonds and tax credits, and significant infrastructure investment. Institutional coordination and compliance with EU state aid rules are essential for the success of this integrated approach.
- From a social perspective, Chapter 12 used a regional model to highlight that the social cost of carbon varies widely across the Mediterranean, depending on national vulnerabilities, emissions profiles, and economic structures. This diversity implies that a one-size-fits-all carbon tax is neither feasible nor equitable. Tailored carbon pricing, linked to revenue recycling and social protection, can help balance environmental ambition with political feasibility, especially in North African countries. This complements prior chapters calling for context-sensitive fiscal reforms.
- Lastly, Chapter 13 shifted the focus to the local level, showing how climate change threatens the fiscal resilience of municipalities, particularly in Italy. Declining revenue from climate-vulnerable assets demands adaptive fiscal tools such as Pigouvian taxes, climate-linked tourist fees, and cadastral reform. Local governments must update fiscal systems to reflect environmental risks, strengthen equity, and finance resilience, bringing the analysis full circle to the need for context-aware, multi-level governance frameworks.

2. WHAT COMES NEXT: DEEPENING THE MEDITERRANEAN SUSTAINABLE FINANCE AGENDA

As the Mediterranean faces mounting environmental and socio-economic pressures, it is clear that green and sustainable finance must not be reduced to a passing trend or a rhetorical tool. Rather, it must become a lasting pillar of public policy, embedded in institutions, shielded from political cycles, and resilient to changes in government. This requires more than a patchwork of projects: it calls for a structural transformation in how we conceive and implement policies at the intersection of finance, sustainability, and governance.

Recent international developments, particularly the 2025 G20 Sustainable Finance Working Group agenda under South Africa's presidency, may offer inspiration and momentum to Mediterranean

efforts. The G20's three-pronged focus—strengthening the global sustainable finance architecture, scaling up adaptation and just transition finance, and unlocking the potential of carbon markets—resonates strongly with the challenges and priorities identified in this volume. Notably, the emphasis on improving collaboration between multilateral, national, and vertical climate funds highlights the importance of coherent and interoperable financial frameworks, a recurring theme in our analysis. The call for more effective co-financing mechanisms, but also private sector mobilisation, reinforces our findings on the critical need for blended finance models that are not only impactful but equitable and transparent. The group's plan to develop a global Common Carbon Credit Data Model also aligns with our recommendation for Mediterranean-specific guidance and standards that prevent greenwashing and enhance credibility. Moreover, the G20's focus on adaptation underscores the urgency of improving insurance mechanisms, funding resilience in vulnerable sectors such as water and agriculture, and supporting national just transition strategies. These global priorities offer both validation and inspiration for deepening the Mediterranean sustainable finance agenda in the years ahead.

Strategic Priorities for the Future: Plan Bleu's Agenda

Under the UNEP/MAP Programme of Work 2024–2025, we had the opportunity to, first, focus on the pressing need to phase out environmentally harmful subsidies. Then, building on that foundation, this volume explored how green public finance and economic tools can actively support sustainability objectives and social equity. It showed that fiscal reforms, when well-designed, can align national budgets with environmental imperatives, and that economic instruments can become powerful levers for systemic change.
Two strategic priorities emerge for the next phase of work, expected to be the focus of upcoming Edited Volume reports under the Programme of Work 2026–2027.

First, while some chapters already (briefly) touch on the role of the private sector and blended finance, this area remains underexplored. Mobilizing private capital is essential to bridge financing gaps and scale up sustainable investment. Blended finance, in particular, offers promising pathways to de-risk private sector involvement, improve project bankability, and crowd in institutional investors. However, its deployment must be carefully managed. There are real risks, such as mission drift, cherry-picking of profitable projects, and insufficient accountability, that must be addressed through strong public oversight and safeguards. As companies increasingly integrate Corporate Social Responsibility into their strategies, the interplay between voluntary commitments and structured blended finance mechanisms deserves closer scrutiny. Future analysis will seek to better define the boundaries of effective private sector engagement and clarify when and how public-private synergies can be both impactful and equitable.

This focus on blended finance and private sector mobilization is reinforced by the growing recognition that public resources alone are insufficient to meet the scale of investment required for sustainable development. The complexity of blended finance arrangements, with their multi-layered governance and potential for opacity, introduces integrity risks that must be mitigated through robust accountability mechanisms, greater transparency, and careful alignment of incentives. Best practices emphasize the need for disclosure of project-level data, stringent due diligence, and competitive procurement to ensure that the blending of public and private capital genuinely advances sustainability objectives, rather than merely subsidizing private profit or enabling mission drift. The challenge is to structure these partnerships so that they co-create value, while safeguarding the public interest and ensuring that sustainability goals are not compromised.

Second, a coherent Framework and Taxonomy for Sustainable Activities is urgently needed to ensure financial resources are directed toward genuinely sustainable outcomes. Without such guidance, there is a real danger that green finance instruments could be misused or diluted, opening the door to greenwashing. Governments, investors, and regulators across the region need a shared, science-based foundation to distinguish what is sustainable from what is

not. A Mediterranean-adapted taxonomy could reflect regional specificities, such as water scarcity, ecosystem fragility, and socio-economic disparities, while maintaining alignment with international standards. Forthcoming work on this topic can explore key sectors to include, criteria for sustainability, links to climate and biodiversity targets, and how such a taxonomy could inform public budgeting, financial regulation, and impact assessment tools.

The experience of the EU Platform on Sustainable Finance is instructive in this regard. The EU Taxonomy is recognized as a pioneering framework for translating environmental performance into financial metrics, but its complexity and operational challenges have highlighted the need for simplification and alignment with other regulatory frameworks. The latest report of the Platform emphasizes that, to unlock the full potential of such a taxonomy, targeted simplification of reporting requirements and improved data infrastructure are essential. The Platform's recommendations include reducing the reporting burden for non-financial companies by over a third, making certain key performance indicators voluntary, and enhancing coherence with other regulations such as the Sustainable Finance Disclosures Regulation and the EU Green Bond Standard. The European Commission's move to consolidate sustainability reporting into a single 'Omnibus' regulation is seen as a pivotal step to maintain the taxonomy's integrity while ensuring it remains practical and effective. Moreover, the report underlines the importance of interoperability with international taxonomies to facilitate cross-border sustainable investment and encourage broader adoption of robust standards. It also stresses the need for ongoing capacity building, improved data quality, and support for SMEs to ensure that the taxonomy is accessible and usable for all market participants. All these important developments and recommendations will be taken into careful consideration as we prepare our dedicated Edited Volume, ensuring that our analysis remains relevant and responsive to the evolving sustainable finance landscape.

Cross-cutting themes that may be revisited

In addition, we do not exclude the possibility of returning to some cross-cutting themes that emerged from this volume, which merit further investigation. These could be explored in the form of special papers, country case studies, or targeted analyses to deepen our collective understanding of the enabling conditions, blind spots, and long-term effectiveness of green (and brown) finance approaches in the Mediterranean.

First, while this volume has assessed a wide range of economic tools and sustainable public finance mechanisms, a recurring challenge is how to evaluate their real-world impact. Are we measuring what truly matters? Too often, success is defined by the amount of green bonds issued, the number of subsidies reformed, or the fiscal revenues generated from environmental taxes. However, these input-oriented metrics need to tell us more about what ultimately counts: reduced emissions, ecosystem regeneration, enhanced social equity, or long-term resilience. In future work, we may further explore more transformative and multidimensional indicators that assess not only financial performance, but also ecological, social, and institutional outcomes. This will be essential for ensuring that green finance is not only well-intentioned, but genuinely effective.

Second, the local level, particularly municipalities, emerges as both a vulnerable actor and a key driver of sustainability transitions. Our report makes it clear that climate change can significantly affect municipal fiscal health, while cities are simultaneously being called upon to implement adaptation and mitigation measures. Yet, national sustainable finance frameworks often fail to integrate the specific needs, constraints, and opportunities of local authorities. Going forward, we may revisit this issue to examine how national public finance strategies, subsidy reforms, or green bonds can better empower cities and regions. Topics such as climate-responsive intergovernmental transfers, green municipal budgeting, or city-level access to green capital markets could be the focus of further dedicated studies.

Third, across chapters, it is clear that institutional capacity is a determining factor in the success of economic tools, from carbon pricing and environmental taxation to conservation financing. But capacity gaps are not only about staff or resources, they also reflect deeper issues related to data availability, policy coordination, and access to specialized knowledge. Many Mediterranean countries face challenges in tracking environmental performance, designing effective financial instruments, or evaluating long-term impacts. These are not marginal issues, they go to the heart of green public finance governance. As such, we may also return to this topic in future papers, looking at how to strengthen technical assistance, regional learning networks, and knowledge-sharing platforms that can accompany countries, especially those with more limited fiscal space or institutional infrastructure, through complex reform processes.

Building the foundations for lasting sustainable finance in the Mediterranean

Transformation will not happen overnight. Achieving a sustainable future in the Mediterranean is a cumulative process, one that demands patience, sustained effort, and a willingness to invest in institutional capacity and public trust. Each step forward, whether through policy reform, capacity-building, or stakeholder engagement, builds the foundation for broader, more resilient change.
Within this context, the Mediterranean Strategy for Sustainable Development (MSSD) stands as a vital regional framework. It fosters convergence among diverse countries, promotes a shared vision for sustainability, and provides an institutional platform for meaningful dialogue and cooperation. The MSSD encourages countries to align their efforts, learn from each other, and collectively address the region's unique environmental and socio-economic challenges.

However, the MSSD alone is not sufficient to drive the transformation that is needed. Its real impact will depend on the political will of governments to translate its guiding principles into concrete actions, embedding sustainability into budgetary priorities, enacting regulatory reforms, and deploying operational tools such as those explored throughout this volume. Only through such grounded policymaking and decisive leadership can the region move from aspiration to achievement.

Looking ahead, the enduring success of sustainable finance in the Mediterranean will rest on three pillars: long-term commitment, evidence-based policymaking, and strong regional solidarity. These are the essential conditions not only for ensuring that green finance becomes an integral part of the region's economic landscape, but also for unlocking its full transformative potential, for ecosystems, economies, and generations to come.

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