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Unraveling the Impact of Environmentally Harmful Subsidies in the Mediterranean

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Foreword

The issue of Environmentally Harmful Subsidies (EHS) is a pressing concern for all Mediterranean countries of the Barcelona Convention. These subsidies, while often intended to support economic sectors or alleviate social issues, can have unintended negative impacts on the environment, exacerbating challenges that Mediterranean countries are already facing, such as climate change, biodiversity loss, and resource depletion. This report provides an in-depth analysis and tailored recommendations relevant to the diverse contexts and legislative frameworks across the region. Importantly, this is the first report to address the issue of EHS specifically for the Mediterranean, making it a pioneering effort in regional environmental policy.

While the Mediterranean countries share common environmental goals, they also face unique challenges. From the northern to the southern and eastern shores, these nations operate under different political, economic, and social circumstances. The report acknowledges that, also taking into account that EHS were established as economic and social support mechanisms which "made sense" from a socio-economic standpoint. Furthermore, the report notes how countries are beginning to better integrate environmental considerations into their policy frameworks.

Despite the focus on the harmful nature of these subsidies, we have adopted a positive and forward-looking narrative throughout the report. Each chapter addresses a key issue pertinent to the Mediterranean as a whole (ex. fisheries, energy transition, gender issues, monitoring framework), then delves deeper into specific case studies where applicable. The report has been drafted by authors from Mediterranean countries themselves, bringing local expertise, academic excellence and perspectives to the forefront. This enabled better access to data, particularly from countries that provide standardized information, facilitating more in-depth and empirically sound analyses. This allowed for more detailed views in countries from all shores including Türkiye, Algeria, Greece and Morocco. These insights provide a more nuanced understanding of EHS dynamics and highlight successful examples and ongoing efforts that can inspire similar actions across the region. Our approach ensures that while we speak to the region as a whole, we also provide actionable insights to make meaningful progress towards phasing out harmful subsidies.

This report aligns with global efforts, such as those led by the OECD and UNEPs work on reforming harmful subsidies. It also serves as a critical resource that will inform the revision of the Mediterranean Strategy for Sustainable Development (MSSD) under UNEP/MAP. By presenting a comprehensive overview of the state of EHS in the region and suggesting practical pathways for reform, this report contributes significantly to the broader international dialogue on sustainable development and subsidy reform.

It is important to note that this work is not being conducted in isolation. It is part of a broader strategy to identify and phase out the most impactful subsidies and to suggest alternatives particularly in sectors such as energy and fisheries which are among the most concerned. These recommendations have been carefully adapted to fit different national frameworks and circumstances. However, our work does not stop at identifying harmful subsidies. We must also focus on the positive economic tools that can replace them. Plan Bleu and UNEP/MAP are already advancing this agenda, with a second report in this series expected by the end of 2025, which will focus on «Environmentally Virtuous Economic Tools and Finances.»

We would like to extend our sincere thanks to all the authors who have contributed to this ambitious effort. Their expertise, dedication, and collaboration have made this pioneering report possible and have set a strong foundation for future work in this critical area. We also express our gratitude for the support received from UNEP/MAP and France, whose financial contributions have been invaluable in enabling this comprehensive study.

This ongoing effort to reform subsidies and promote sustainable economic tools is crucial for building a resilient and sustainable Mediterranean region. We hope that this report will serve as both a resource and a catalyst for action, guiding policymakers and stakeholders as they work towards a more sustainable and equitable future. In fact, this report is not an end in itself but the starter for a better life that integrates environmental, economic and social dimensions for all Mediterranean peoples.

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

Summary

List of Tables and Figures

Chapter 1. Measuring Progress and Accountability in Phasing Out Environmental Harmful Subsidies: A Comprehensive Framework for the Mediterranean region

Chapter 2. Fishing Subsidies and Their Impacts on Marine Ecosystem Health in the Mediterranean Sea

Chapter 3. Addressing the Link Between Fossil Fuel Subsidies and Climate Change in the Mediterranean Region

Chapter 4. Female labor inclusion and energy policies in the Mediterranean countries: Evidence from a mixed methodology approach

Chapter 5.Fueling Algeria's Future: Measuring the Footprint of Fossil Fuel Subsidies on The National Duality of "Water Stress-Energy Consumption"

Chapter 6. Water Subsidies, Desalination, and Sustainable Resource Management: Insights from Algeria

Chapter 7. "The antagonistic effects of tourism industry strategies on land use management: A comparative analysis of Toulon and Kuşadası"

Chapter 8. Tax incentives and Energy Transition from a Legal Point of View: Analysis of Best Practices Adapted to the Decarbonisation of the Mediterranean Region

SUMMARY AND KEY TAKEAWAYS

Despite international momentum for sustainable development, unsustainable practices are fueled by economic incentives that generally favour an expansion of economic activity at the expense of conservation and restoration, often causing environmental damage. Such incentives are known as environmentally harmful subsidies (EHS). They are defined as a set of aids emanating, directly or indirectly, from a public entity, which favour production or consumption that is harmful to the environment by increasing the exploitation of resources, the level of pollution or the deterioration of biodiversity. On a global scale, EHS are estimated to be 5 to 6 times higher than those that benefit the environment.

Harmful subsidies to the environment pose a significant challenge for many countries in the Mediterranean, each facing unique circumstances regarding their subsidy programs. For some, subsidizing water to ensure affordable access is the biggest issue. Others focus more on providing subsidies for fishing, aiming to boost economic activity in the maritime sector and/or employment in coastal communities. Additionally, several countries still subsidize fossil fuel production to maintain energy security, especially considering the current challenging economic context. To this day, though uneven, the Mediterranean has seen progress in efforts to identify and reform EHS. Some countries have taken proactive steps, while in other cases countries are in the early stages of learning about the issue and its impacts, highlighting the need to keep raising awareness.

Recent decisions and declarations from the UNEP/MAP system emphasize the need to promote economic instruments and reforms, such as reducing environmentally harmful subsidies (incl. Article 21 of the ICZM Protocol - 2009, Common Regional Framework for Integrated Coastal Zone Management in the Mediterranean - 2019, UNEP/MAP Medium-Term Strategy 2022-2027). Meanwhile, the reform of environmentally harmful subsidies (EHS) is an objective of the Mediterranean Strategy for Sustainable Development (MSSD) 2016-2025. Recognizing the negative impact of such subsidies on the environment, the MSSD promotes their reform to foster sustainable development. Strategic direction 5.6 of the MSSD advocates for a greener market by integrating the polluter-pays principle and extended producer responsibility. It includes actions for environmental tax reform and reviewing public subsidies to phase out EHS. Additionally, regional capacity building in market instruments is emphasized. Addressing climate change, strategic direction 4.4 also focuses on mainstreaming climate change in policies and reforming energy subsidies to reduce greenhouse gas emissions. By reforming EHS, the MSSD seeks to align economic activities with sustainability principles, promoting long-term ecological and economic health in the Mediterranean. Our report supports these foundational objectives.

Plan Bleu, recognizing the urgency of addressing environmentally harmful subsidies in the Mediterranean, embarked into the production of this Edited Volume report which seeks to better inform decision-makers across the Mediterranean. To produce this report, Plan Bleu launched a Call for Papers in 2023 as an open invitation to Mediterranean researchers, primarily from academia, diving into the intricacies of subsidies and their socioeconomic and environmental impacts in the Mediterranean. Eight paper proposals were selected and funded by Plan Bleu and are presented as chapters throughout this Edited Volume. Based on relevance and/or data availability, some chapters are regional while others are country-specific, and all provide recommendations relevant to the global Mediterranean context. This «by Mediterraneans, for the Mediterranean» approach offers precious insights, ideas and practices from diverse perspectives across the region.

The significance of these chapters lies in their collective ability to holistically address the challenges posed by environmentally harmful subsidies in the Mediterranean.

SUMMARY AND KEY TAKEAWAYS

Among the Key Takeaways:

The first chapter provides an understanding of the definitions, historical evolution, and impacts of EHS.

- The identification of Environmentally Harmful Subsidies (EHS) poses challenges due to varied definitions across organizations. The World Trade Organization (WTO) and OECD offer distinct definitions, while the World Bank defines EHS as direct fiscal outlays intended to influence production or consumption. The lack of consensus complicates reform efforts. Methods for measuring EHS include inventory, price gap, and Producer and Consumer Subsidy Equivalent (PSE-CSE) frameworks.
- Existing strategies related to EHS identification and reform are discussed including France's Green Budgeting Strategy, Italy's EHS Annual Catalogue and Indonesia's Fossil Fuels Subsidies Reform. They offer valuable lessons on EHS reform, emphasizing transparency, stakeholder engagement, and a balanced approach for achieving positive outcomes.
- The adoption of a Phase-Out and Reform Framework is recommended to aid in identifying compensation measures and ensuring a harmonized approach to environmental sustainability in the region. The framework encompasses cross-sectoral indicators that enable a holistic analysis of reform impacts across various sectors. Suggested economic indicators focus on assessing the financial implications of subsidy reform, including government expenditure, employment rates, GDP impact, private sector investment, consumer price index, and international trade impact. Environmental indicators track changes in greenhouse gas emissions, resource use efficiency, environmental quality, waste management, and adoption of eco-friendly technologies. Social indicators evaluate the impact of reform on income distribution, gender and generational equity, health outcomes, access to social services and infrastructure, and community engagement. To enhance accountability, the framework suggests mechanisms such as screening and assessment of governmental budget allocation, monitoring and reporting of reform processes, and inclusive stakeholder engagement.

The second chapter dissects the complex ties between fishing subsidies and marine ecosystems. It lays the foundation for understanding how the "wrong" subsidies may contribute to overfishing and unsustainable practices while the "right" subsidies may enhance income sources and improve fish stocks simultaneously.

- Fishing subsidies can have varied impacts on socio-ecological outcomes, depending on their type and implementation. We adopt the classification system proposed by Sumaila et al. (2010) and analyze fishing subsidies through the lens of their impact on marine ecosystem health. In that respect, fishing subsidies can be classified into capacity-enhancing, beneficial, and ambiguous categories. Capacity-enhancing subsidies, like fuel subsidies and vessel construction support, often contribute to overfishing and marine degradation. Beneficial subsidies, including fisheries management measures and support for marine protected areas, can enhance both fish stocks and socio-ecological well-being. Ambiguous subsidies represent the final category of fishing subsidies, characterized by their uncertain or unclear outcomes. For instance, direct income support for fishers, vessel buyback programs and support provided for rural small-scale fishing communities can be either beneficial or detrimental for fish stocks and marine health depending on the specifics of the context and the actual implementation. Globally, environmentally harmful subsidies in the fishing sector are prevalent, with about 60% considered detrimental due to their contribution to overfishing and marine degradation. Strategic reallocation of subsidies and focused policy efforts are needed.

SUMMARY AND KEY TAKEAWAYS

- The chapter uses data from Türkiye, a country which has made progress towards a more environmentally conscientious approach in fisheries, shifting its «subsidy-mix» towards more environmentally virtuous tools, mirroring patterns observed in other EU-Mediterranean countries. Fishing subsidies in Türkiye underwent notable changes between the periods of 2000-2011 and 2012-2020. In the earlier period, capacity-enhancing subsidies dominated, particularly fuel tax concessions, comprising 63.1% of all subsidies. Beneficial subsidies accounted for 36.9%, mainly allocated to management and enforcement expenditures. In contrast, during 2012-2020, Türkiye witnessed a decrease in the share of capacity-enhancing subsidies to 43.9%, while beneficial subsidies increased to 50.4%. Ambiguous subsidies, including income support for fishers and vessel buyback programs, emerged during this period, albeit with a smaller share.
- Challenges persist, underscoring the need for further efforts. Analysis of fishery resources reveals a nuanced picture, with a decline in marine catches and notable shifts in species composition, hinting at underlying ecosystem changes. While small-scale fishing has shown relative stability, industrial fishing has seen increased activity despite initiatives like the vessel buy-back program. Although designed to reduce fleet size, such programs may inadvertently lead to heightened fishing effort per vessel, exacerbating pressure on marine resources. The intricate interplay between fishing subsidies, fleet dynamics, and ecological indicators underscores the necessity for comprehensive subsidy reforms. The chapter discusses how focus should be (further) shifted away from harmful subsidies to those incentivizing conservation, complemented by participatory adaptive governance. Supporting Local Communities is also key, meanwhile, incentivizing responsible fishing practices is needed, through supporting the designation and management of marine protected areas (MPAs) to conserve critical habitats and vulnerable fish stocks.

The third chapter addresses a critical gap in the understanding of fossil fuel subsidies, employing economic modeling to unravel the impact of EHS on carbon dioxide emissions in the Mediterranean region.

- The escalating consumption of fossil fuels has led to a surge in carbon dioxide (CO2) and greenhouse gas (GHG) emissions, resulting in significant environmental pollution and climate change. Recent literature has shed light on the socioeconomic and environmental impacts of Fossil fuel Subsidies (FFS) at both national and global levels. Studies have found that FFS increase the cost of climate change mitigation and are associated with greater emissions. But studies on the Mediterranean region are limited.
- The chapter aims to address the gap in the literature by evaluating the impact of FFS on the transition to a low-carbon economy in Mediterranean countries, using data from the OECD inventory on FFS (which covers 8 Mediterranean countries). The research allows examining the distribution of FFS among different energy sources and beneficiaries. The analysis of FFS distribution reveals that petroleum has been the most subsidized energy source in the past 12 years among OECD members in the Mediterranean, with recent increases in subsidies for natural gas and coal combustion due to energy price surges. Notably, subsidies mainly accrued to consumers, followed by producers and general services during the 2010-2021 period. Regarding the econometric analysis, the chapter employs panel data methods to assess the link between FFS and GHG emissions per capita from 1990 to 2021. The results indicate that, indeed, an increase in FFS triggers higher emissions per capita, with natural gas subsidies having a significant positive impact on emissions. Additionally, GDP is found to contribute significantly to emissions per capita, suggesting that wealthier countries emit more GHGs per person.

SUMMARY AND KEY TAKEAWAYS

- Additionally, the chapter seeks to compile a comprehensive inventory of coal subsidies and analyze their correlation with GHG emissions. Available data for Turkiye allows doing that, detailing existing subsidy mechanisms such as direct transfers, tax exemptions, and price guarantees. Policy implications are drawn, advocating for the phased removal of such subsidies and the promotion of renewable energy sources. Key steps include announcing realistic timelines to phase out fossil fuel extraction and combustion, conducting comprehensive assessments of pre-reform subsidies, and implementing supportive policies and communication strategies. The experiences of Morocco and Egypt in reforming fossil fuel subsidies are given, as they provide valuable insights and inspiration for neighboring countries. In Morocco, a phased approach allowed for gradual adjustment of fuel prices, minimizing social and economic disruptions. In Egypt, although subsidy cuts were significant, compensatory measures such as expanded social security pensions, cash transfer programs, and new taxes on wealthier households helped mitigate adverse effects on the most vulnerable.

The fourth chapter explores the intersection of energy policies and female employment.

- Women's underrepresentation in the energy sector persists globally and in the Mediterranean region, with only around 15% of sectoral employment being female. Traditional energy sectors continue to receive subsidies which are detrimental to the environment but also disproportionately impact women, hindering their engagement with the sector. The chapter produces an empirical assessment of the relationship between energy subsidies and female employment in 18 Mediterranean countries from 2010 to 2021. Data on GDP per capita, female unemployment rate, fertility rates, and fossil fuel subsidies were analyzed to understand the dynamics of female employment within the energy sector. The analysis confirms indications that higher levels of subsidies are associated with lower rates of female employment.
- Additionally, a survey was conducted in Greece to assess female inclusion in the energy sector, providing qualitative insights to complement quantitative data. Greece serves as an illustrative case study from the Mediterranean region, as it is in the middle of the income distribution in the region, meanwhile, investments are increasing in all parts of the Greek energy sector, including conventional and renewable energy sources. While respondents generally expressed positivity regarding industry investments creating job opportunities for women and acknowledged the skills and competence of female candidates, they also echoed global findings suggesting room for progress in increasing female participation in the energy sector.
- Policy considerations stemming from the chapter include gradual elimination of inefficient subsidies while ensuring reforms do not hinder women's inclusion in the energy sector workforce. Redirecting funds from subsidies to support women-owned enterprises, providing mentorship and financing opportunities, and implementing gender-responsive policies are recommended. Collaboration between stakeholders, including governments, industry, academia, and civil society, is crucial for fostering gender diversity within the sector.

The fifth chapter seeks to provide insightful strategies by examining the influence of fossil fuel subsidies on the interplay between water stress and energy consumption.

- The interplay between water stress, fossil fuel subsidies, and energy consumption is complex and requires careful consideration in policy formulation. The relationship involves factors such as public sentiment, water usage in fossil fuel production, and the risk of water pollution from extraction activities. The chapter focuses on data from Algeria, whose political economy has historically relied on fossil fuels to drive socioeconomic stability and promote economic development through subsidies. The econometric analysis shows that an increase in FFS leads to higher water stress levels, increased energy consumption, GDP growth, and inflation.

SUMMARY AND KEY TAKEAWAYS

This highlights the trade-off between economic activities driven by fossil fuel production and environmental impacts. Meanwhile, water stress shocks influence adjustments in FFS, energy consumption, GDP, and inflation. While there is an initial conservation effect on energy consumption, the trend shifts to a positive trajectory over time, emphasizing the importance of sustainable energy practices. Lastly, energy consumption shocks impact FFS, water stress, GDP, and inflation. Initially, there is a positive response of FFS to increased energy consumption, followed by a potential policy adjustment to reduce subsidies. Energy consumption also affects water stress and GDP, indicating a multifaceted relationship.

- The responses to FFS shocks demonstrate a complex interplay between environmental and economic factors. Reducing FFS could mitigate water stress, reduce energy consumption, and stabilize national budgets, promoting sustainable economic development and reducing dependency on fossil fuels. Moreover, it could help mitigate inflationary pressures associated with high subsidies. Conclusions advocate for the gradual reduction of fossil fuel subsidies, with a reallocation of resources towards the expansion of renewable energy sources, while safeguarding vulnerable populations through social measures. Algeria's ambitious plans for solar and wind energy demonstrate a commitment to renewable energy development.

The sixth chapter aims to analyze the challenges and opportunities for simultaneously ensuring the long-term sustainability of water subsidies together with social equity.

- The chapter evaluates the viability of water subsidies and their implications for the energy-intensive desalination process. Water subsidies offer advantages, including ensuring affordable water access for the entire population, promoting agricultural development, improving water quality through desalination, reducing dependence on rainfall, and encouraging sustainability in water management practices. However, these subsidies also come with disadvantages. The high cost of water management puts significant pressure on national budgets, while the subsidy system may exacerbate inequality. Moreover, there is a dependency on government investment for maintaining water resources, and continued reliance on non-renewable resources perpetuates unsustainable development. Additionally, the desalination process can have adverse effects on marine ecosystems.
- The chapter focuses on Algeria, representative of a Mediterranean country facing challenges related to water scarcity, exacerbated by climatic aridity, population growth, urbanization, and climate change. The Algerian government has embarked on ambitious initiatives, including the installation of desalination plants and the expansion of surface water storage capacity, to mitigate the impact of water scarcity. The country's commitment to water policy is evident in its efforts to increase water supply to meet the needs of its growing population. The chapter analyzes various water pricing strategies in Algeria to assess their impact on consumer welfare. Through econometric analysis, it explores multiple scenarios, including increasing average water prices, adjusting tariff blocks, and simulating seawater desalination. Results indicate that while supply limitations can modulate water demand positively, changes in pricing policies significantly affect consumer welfare, equivalent to about 2.4% of a household's monthly income. Implementing a uniform, progressive national water pricing system could balance social equity and sustainable water management, minimizing welfare loss and encouraging contributions to the real cost of water production.
- The chapter advocates for citizen involvement in bearing water production costs, promoting rationalized consumption and efficient energy use. Practical measures recommended for Mediterranean countries include strengthening water law, reassessing urbanization policies, tariff revision, implementing solidarity water tariffs, and launching public awareness campaigns.

SUMMARY AND KEY TAKEAWAYS

The seventh chapter dissects the impacts of different tourism strategies on land use, raising questions about the potential role of specific tourism subsidies in influencing resilience to climate change.

- The chapter examines the coastal cities of Toulon and Kuşadası, both driven by tourism as their primary economic engine. Toulon, boasting picturesque natural landscapes and historical significance, attracts over 8 million tourists annually. Kuşadası, known for its bustling cruise port and UNESCO World Heritage sites, hosts up to 2 million visitors during peak seasons. Using GIS analysis and transition matrices, the analysis assesses past and potential future changes in land cover, considering IPCC climate change predictions.
- The results indicate that Toulon's long-standing urbanization practices have led to stability in land use categories along its coastal strip, supported by proactive environmental conservation efforts. As for Kuşadası, supporting tourism infrastructure has boosted the local economy leading to significant financial gains, but further environmental investments might be needed to sufficiently mitigate the impact of climate change on its natural assets. This also seems true for Toulon, though climate change effects are projected to emerge at a later stage.
- Reflecting on the impact of tourism support reveals both common traits and disparities between the coastal cities. In Toulon, some grants and subsidies are allocated to promote sustainable tourism practices, contributing to economic development while minimizing environmental impacts. Kuşadası's tourism development seems to primarily rely on subsidies aimed at expanding the tourism sector, particularly in infrastructure development. Tentative conclusions about the relationship between subsidies and tourism development are restricted due to limited comprehensive and comparable data on financial support in both regions. Future research should prioritize acquiring detailed data sets covering direct and indirect forms of support. Establishing a clearer link between tourism support and land management trends requires comprehensive data collection efforts, longitudinal studies tracking changes over time, and qualitative research methods to understand stakeholders' perceptions and behaviors. Creating a joint Mediterranean methodology to differentiate between environmentally harmful and friendly tourism support is crucial for sustainable development.

The eighth chapter is forward looking and aims to answer the question of how to effectively and efficiently use the best mix of fiscal policies to speed up the energy transition process in the Mediterranean. A particular attention has been given to the decarbonisation of the electricity supply industry because electricity is the main energy used for not only industrial production but also for the heating and transportation sectors.

- Even though one of the focus points is the European Union (EU) Legal Framework on State Aid because it is mandatory for Member States to comply with the EU State Aid Rules, the incentive schemes supported for renewable energy generation in this chapter are applicable in all Mediterranean countries. Regarding (virtuous) fiscal incentives, feed-in tariff (FIT) schemes seem to be the most efficient and effective support schemes for promoting and supporting renewable electricity. However, not all FIT programmes are successful, some could increase the financial burden on tax/rate payers. The political feasibility of schemes varies between countries; for example, RPS programs in the USA directly burden the electricity industry, while higher taxes are preferred in the EU.
- It can be argued that no scheme, on its own, would be sufficient to achieve the best outcomes for RE transition goals. In this sense, a crucial point is also pricing negative externalities thanks to carbon taxes. Findings stress how effective carbon taxes could be introduced for carbon-intensive industries. Some countries may easily introduce and apply environmental taxes, in the same manner that Finland, Sweden, Norway and Denmark introduced carbon tax

SUMMARY AND KEY TAKEAWAYS

in the early 1990s. But introducing new taxes can cause resistance. To prevent this, incentive mechanisms should also be brought together with the introduction of new taxes

- When designing fiscal incentives in the Mediterranean, the Barcelona Convention and its protocols can provide a comprehensive framework. Support for renewables seems to be the way forward, provided issues of pollution, of promoting green economy, sustainable energy, and consumption and production are always taken into account.

A conclusions chapter offers some additional reflections on how to move forward with EHS reform, and the key axes that need to be considered, and that could be further studied in future reports.

- First, there is a need to replace environmentally harmful subsidies with green economic instruments. These instruments, such as taxes, subsidies, grants, and regulatory measures, aim to internalize environmental costs, promote sustainability, and drive innovation and job creation. The transition from harmful subsidies to green instruments is crucial for correcting market distortions, promoting social equity, and stimulating sustainable economic growth in the Mediterranean region. Additionally, reform is crucial for securing the necessary financial resources for sustainable development, especially amid renewed budgetary pressures in the public sphere.
- Second, strengthening CSR among businesses operating in the region is another avenue to address challenges. CSR entails voluntary actions by companies to promote social, environmental, and economic sustainability beyond legal obligations. Governments, businesses, and civil society need to collaborate to create an enabling environment for promoting CSR through standards, incentives, and transparency.
- Lastly, Intersectoral cooperation and enforcement of regulations are crucial for successful policy implementation. Aligning with the MSSD and establishing a Green Taxonomy specific to the Mediterranean can guide investments towards environmentally sustainable projects and promote transparency and accountability in financing sustainable development initiatives. UNEP/MAP can play a leading role in developing this taxonomy by convening stakeholders and designing criteria tailored to the region's unique challenges and opportunities.

RÉSUMÉ ET PRINCIPALES CONCLUSIONS

Malgré l'élan international en faveur du développement durable, des pratiques non durables sont alimentées par des incitations économiques qui favorisent généralement une expansion de l'activité économique au détriment de la conservation et de la restauration, causant souvent des dommages environnementaux. Ces incitations sont également connues sous le nom de subventions préjudiciables à l'environnement (SPE). Elles sont définies comme un ensemble d'aides émanant, directement ou indirectement, d'une entité publique, favorisant la production ou la consommation nocive pour l'environnement en augmentant l'exploitation des ressources, le niveau de pollution ou la détérioration de la biodiversité. À l'échelle mondiale, les subventions créant des dommages environnementaux sont estimées être de 5 à 6 fois supérieures à celles bénéfiques pour l'environnement.

Les subventions préjudiciables à l'environnement posent un défi majeur pour de nombreux pays méditerranéens, chacun étant confronté à des circonstances uniques concernant leurs programmes de subvention. Pour certains, subventionner l'eau pour garantir un accès abordable est le plus gros problème. D'autres se concentrent davantage sur la fourniture de subventions pour la pêche, dans le but de stimuler l'activité économique dans le secteur maritime et/ou l'emploi dans les communautés côtières. De plus, plusieurs pays subventionnent encore la production de combustibles fossiles pour maintenir la sécurité énergétique, surtout compte tenu du contexte économique actuel difficile. À ce jour, bien que disparate, la Méditerranée a connu des progrès dans les efforts pour identifier et réformer les SPE. Certains pays ont pris des mesures proactives, tandis que dans d'autres cas, les pays en sont aux premiers stades de la prise de conscience de la question et de ses impacts, soulignant la nécessité de continuer à sensibiliser.

Les décisions et déclarations récentes du système PAM/PNUE soulignent la nécessité de promouvoir les instruments économiques et les réformes, telles que la réduction des subventions préjudiciables à l'environnement (y compris l'article 21 du Protocole sur la GIZC - 2009, le Cadre régional commun pour la gestion intégrée des zones côtières en Méditerranée - 2019, la Stratégie à Moyen Terme du PNUE/PAM 2022-2027). Par ailleurs, la réforme des subventions néfastes pour l'environnement est un objectif de la Stratégie Méditerranéenne de Développement Durable (SMDD) 2016-2025. Reconnaissant l'impact négatif de telles subventions sur l'environnement, la SMDD promeut leur réforme pour favoriser le développement durable. La direction stratégique 5.6 de la SMDD plaide pour un marché plus vert en intégrant le principe du pollueur-payeur et la responsabilité élargie des producteurs. Elle inclut des actions pour la réforme de la fiscalité environnementale et l'examen des subventions publiques afin d'éliminer progressivement les SPE. De plus, le renforcement des capacités régionales en instruments de marché est souligné. Pour faire face au changement climatique, la direction stratégique 4.4 se concentre également sur l'intégration du changement climatique dans les politiques et la réforme des subventions énergétiques pour réduire les émissions de gaz à effet de serre. En réformant les SPE, la SMDD cherche à aligner les activités économiques sur les principes de durabilité, promouvant ainsi la santé écologique et économique à long terme en Méditerranée. Notre rapport soutient ces objectifs fondamentaux.

Plan Bleu, reconnaissant l'urgence de s'attaquer aux SPE en Méditerranée, s'est engagé dans la production de ce Volume Edité qui vise à mieux informer les décideurs en Méditerranée. Pour produire ce rapport, Plan Bleu a lancé un appel à communications en 2023 comme invitation ouverte aux chercheurs méditerranéens, principalement du milieu universitaire, les invitant à plonger

RÉSUMÉ ET PRINCIPALES CONCLUSIONS

dans les subtilités des subventions et de leurs impacts socio-économiques et environnementaux en Méditerranée. Huit propositions ont été sélectionnées et financées par Plan Bleu et sont présentées comme des chapitres tout au long de ce volume édité. Basées sur la pertinence et/ou la disponibilité des données, certains chapitres sont régionaux tandis que d'autres sont spécifiques à un pays, et tous fournissent des recommandations pertinentes pour le contexte méditerranéen. Cette approche «par les Méditerranéens, pour la Méditerranée» offre de précieuses perspectives, idées et pratiques diverses à travers la région.

La portée de ces chapitres réside dans leur capacité collective à aborder de manière holistique les défis posés par les subventions préjudiciables à l'environnement en Méditerranée.

Parmi les points clés à retenir :

Le premier chapitre fournit une compréhension des définitions, de l'évolution historique et des impacts des SPE.

- L'identification des SPE pose des défis en raison de définitions variées entre les organisations. L'Organisation Mondiale du Commerce (OMC) et l'OCDE offrent des définitions distinctes, tandis que la Banque Mondiale définit les SPE comme des dépenses fiscales directes destinées à influencer la production ou la consommation. Le manque de consensus complique les efforts de réforme. Les méthodes de mesure des SPE comprennent l'inventaire, l'écart de prix et le Cadre des Subventions Équivalentes pour les Producteurs et les Consommateurs (PSE-CSE).
- Les stratégies existantes liées à l'identification et à la réforme des SPE sont discutées, y compris la Stratégie de Budgétisation Verte de la France, le Catalogue Annuel des SPE de l'Italie et la Réforme des Subventions aux Combustibles Fossiles de l'Indonésie. Elles offrent des leçons précieuses sur la réforme des SPE, en mettant l'accent sur la transparence, la participation des parties prenantes et une approche équilibrée pour atteindre des résultats positifs.
- L'adoption d'un Cadre de Suppression Progressive et de Réforme est recommandée pour aider à identifier les mesures de compensation et assurer une approche harmonisée de la durabilité environnementale dans la région. Le cadre comprend des indicateurs transversaux qui permettent une analyse holistique des impacts de la réforme dans divers secteurs. Les indicateurs économiques proposés se concentrent sur l'évaluation des implications financières de la réforme des subventions, y compris les dépenses gouvernementales, les taux d'emploi, l'impact sur le PIB, l'investissement du secteur privé, l'indice des prix à la consommation et l'impact sur le commerce international. Les indicateurs environnementaux sont proposés pour suivre les changements dans les émissions de gaz à effet de serre, l'efficacité de l'utilisation des ressources, la qualité environnementale, la gestion des déchets et l'adoption de technologies respectueuses de l'environnement. Les indicateurs sociaux sont proposés pour évaluer l'impact de la réforme sur la distribution des revenus, l'équité entre les genres et les générations, les résultats en matière de santé, l'accès aux services sociaux et aux infrastructures, et l'engagement communautaire. Pour renforcer la responsabilité, le cadre suggère des mécanismes tels que le filtrage et l'évaluation de l'allocation budgétaire gouvernementale, la surveillance et le suivi des processus de réforme, et la participation inclusive des parties prenantes.

RÉSUMÉ ET PRINCIPALES CONCLUSIONS

Le deuxième chapitre dissèque les liens complexes entre les subventions à la pêche et les écosystèmes marins. Il pose les bases pour comprendre comment les "mauvaises" subventions peuvent contribuer à la surpêche et aux pratiques non durables tandis que les "bonnes" subventions peuvent améliorer les sources de revenus et simultanément augmenter les stocks de poissons.

- Les subventions à la pêche peuvent avoir des impacts variés sur les résultats socio-écologiques, selon leur type et leur mise en œuvre. Nous adoptons le système de classification proposé par Sumaila et al. (2010) et analysons les subventions à la pêche à travers le prisme de leur impact sur la santé des écosystèmes marins. Les subventions à la pêche peuvent être classées en trois catégories : celles qui renforcent la capacité, celles qui sont bénéfiques et celles qui ont un impact ambigu. Les subventions qui renforcent la capacité, comme les subventions au carburant et le soutien à la construction de navires, contribuent souvent à la surpêche et à la dégradation marine. Les subventions bénéfiques, y compris les mesures de gestion des pêches et le soutien aux aires marines protégées, peuvent améliorer à la fois les stocks de poissons et le bien-être socio-écologique. Les subventions à impact ambigu représentent la catégorie finale des subventions à la pêche, caractérisée par leurs résultats incertains ou peu clairs. Par exemple, le soutien direct au revenu des pêcheurs, les programmes de rachat de navires et le soutien fourni aux communautés de pêche artisanale rurales peuvent être soit bénéfiques, soit néfastes pour les stocks de poissons et la santé marine, selon les spécificités du contexte et la manière dont elles sont effectivement mises en œuvre. À l'échelle mondiale, les subventions néfastes à l'environnement dans le secteur de la pêche sont courantes, environ 60% étant considérées comme préjudiciables en raison de leur contribution à la surpêche et à la dégradation marine. Une réaffectation stratégique des subventions et des efforts politiques ciblés sont nécessaires.
- Le chapitre utilise des données de la Turquie, un pays qui a fait des progrès vers une approche plus respectueuse de l'environnement dans la pêche, en modifiant son «mix de subventions» vers des outils plus vertueux, reflétant les tendances observées dans d'autres pays euro-méditerranéens de l'UE. Les subventions à la pêche en Turquie ont connu des changements remarquables entre les périodes de 2000-2011 et 2012-2020. Au cours de la période précédente, les subventions renforçant la capacité dominaient, en particulier les concessions fiscales sur le carburant, représentant 63,1% de toutes les subventions. Les subventions bénéfiques représentaient 36,9%, principalement allouées aux dépenses de gestion et de mise en œuvre. En revanche, au cours de la période 2012-2020, la Turquie a connu une diminution de la part des subventions renforçant la capacité à 43,9%, tandis que les subventions bénéfiques ont augmenté à 50,4%. Les subventions ambiguës, y compris le soutien aux revenus des pêcheurs et les programmes de rachat de navires, ont émergé au cours de cette période, bien que avec une part moins importante.
- Des défis persistent, soulignant la nécessité d'efforts supplémentaires. L'analyse des ressources halieutiques révèle une image nuancée, avec un déclin des captures marines et des changements notables dans la composition des espèces, laissant présager des changements sous-jacents dans l'écosystème. Alors que la pêche artisanale a montré une relative stabilité, la pêche industrielle a vu une activité accrue malgré des initiatives telles que le programme de rachat de navires. Bien que conçus pour réduire la taille de la flotte, de tels programmes peuvent involontairement entraîner une augmentation de l'effort de pêche par navire, exacerbant la pression sur les ressources marines. L'interaction complexe entre les subventions à la pêche, la dynamique de la flotte et les indicateurs écologiques souligne

RÉSUMÉ ET PRINCIPALES CONCLUSIONS

la nécessité de réformes complètes des subventions. Le chapitre discute de la manière dont l'accent devrait être mis sur les subventions qui encouragent la conservation en diminuant davantage les subventions nocives, complétées par une gouvernance adaptative participative. Soutenir les communautés locales est également essentiel, tandis que des incitations aux pratiques de pêche responsables sont nécessaires, en soutenant la désignation et la gestion des aires marines protégées (AMP) pour conserver les habitats critiques et les stocks de poissons vulnérables.

Le troisième chapitre aborde une lacune critique dans la compréhension des subventions aux combustibles fossiles, en utilisant une modélisation économique pour démêler l'impact des SPE sur les émissions de dioxyde de carbone dans la région méditerranéenne.

- La consommation croissante de combustibles fossiles a conduit à une augmentation des émissions de dioxyde de carbone (CO2) et de gaz à effet de serre (GES), entraînant une pollution environnementale significative et contribuant au changement climatique. La littérature récente a mis en lumière les impacts socio-économiques et environnementaux des subventions aux combustibles fossiles (SCF) tant au niveau national que mondial. Des études ont montré que les SCF augmentent le coût de l'atténuation du changement climatique et sont associées à des émissions plus importantes. Mais les études sur la région méditerranéenne sont limitées.
- Le chapitre vise à combler cette lacune dans la littérature en évaluant l'impact des SCF sur la transition vers une économie bas-carbone dans les pays méditerranéens, en utilisant les données de l'inventaire de l'OCDE sur les SCF (qui couvre 8 pays méditerranéens). La recherche permet d'examiner la répartition des SCF entre différentes sources d'énergie et entre type de bénéficiaires. L'analyse de la répartition des SCF révèle que le pétrole a été la source d'énergie la plus subventionnée au cours des 12 dernières années parmi les membres de l'OCDE dans la région méditerranéenne, avec des augmentations récentes des subventions pour le gaz naturel et la combustion du charbon en raison de la hausse des prix de l'énergie. Notamment, les subventions ont principalement profité aux consommateurs, suivis par les producteurs et les services généraux au cours de la période 2010-2021. En ce qui concerne l'analyse économétrique, le chapitre utilise des méthodes de données de panel pour évaluer le lien entre les SCF et les émissions de GES par habitant de 1990 à 2021. Les résultats indiquent qu'une augmentation des SCF entraîne en effet des émissions par habitant plus élevées, les subventions au gaz naturel ayant un impact positif significatif sur les émissions. De plus, le PIB contribue de manière significative aux émissions par habitant, suggérant que les pays plus riches émettent plus de GES par personne.
- De plus, le chapitre cherche à compiler un inventaire complet des subventions au charbon et à analyser leur corrélation avec les émissions de GES. Des données disponibles pour la Turquie permettent de le faire, en détaillant les mécanismes de subvention existants tels que les transferts directs, les exonérations fiscales et les garanties de prix. Des implications politiques sont tirées, plaidant pour le retrait progressif de telles subventions et la promotion de sources d'énergie renouvelables. Les étapes clés comprennent l'annonce de délais réalistes pour éliminer progressivement l'extraction et la combustion des combustibles fossiles, la réalisation d'évaluations complètes des subventions préalables à la réforme et la mise en œuvre de politiques de soutien et de stratégies de communication. Les expériences du Maroc et de l'Égypte dans la réforme des subventions aux combustibles fossiles sont évoquées, car elles fournissent des informations précieuses et une inspiration pour les pays voisins. Au Maroc, une approche progressive a permis un ajustement progressif des prix des carburants, minimisant les perturbations sociales et économiques. En Égypte, bien que les réductions

RÉSUMÉ ET PRINCIPALES CONCLUSIONS

de subventions aient été importantes, des mesures compensatoires telles que l'extension des pensions de sécurité sociale, les programmes de transferts monétaires et de nouveaux impôts sur les ménages plus aisés ont contribué à atténuer les effets négatifs sur les plus vulnérables.

Le quatrième chapitre explore l'intersection des politiques énergétiques et de l'emploi féminin.

- La sous-représentation des femmes dans le secteur de l'énergie persiste à l'échelle mondiale et dans la région méditerranéenne, avec seulement environ 15 % de l'emploi sectoriel occupé par des femmes. Les secteurs énergétiques traditionnels continuent de recevoir des subventions qui sont préjudiciables à l'environnement mais qui impactent également de manière disproportionnée les femmes, entravant leur engagement dans le secteur. Le chapitre produit une évaluation empirique de la relation entre les subventions énergétiques et l'emploi féminin dans 18 pays méditerranéens de 2010 à 2021. Les données sur le PIB par habitant, le taux de chômage féminin, les taux de fécondité et les subventions aux combustibles fossiles ont été analysées pour comprendre les dynamiques de l'emploi féminin dans le secteur de l'énergie. L'analyse confirme les indications selon lesquelles des niveaux plus élevés de subventions sont associés à des taux d'emploi féminin plus faibles.
- De plus, une enquête a été menée en Grèce pour évaluer l'inclusion des femmes dans le secteur de l'énergie, fournissant des informations qualitatives pour compléter les données quantitatives. La Grèce sert d'étude de cas illustrative de la région méditerranéenne, car elle se situe au milieu de la distribution des revenus dans la région, tandis que les investissements augmentent dans toutes les parties du secteur de l'énergie grec, y compris dans les sources d'énergie conventionnelles et renouvelables. Bien que les répondants aient généralement exprimé une opinion positive quant aux investissements de l'industrie créant des opportunités d'emploi pour les femmes et aient reconnu les compétences et la compétence des candidates féminines, ils ont également fait écho aux conclusions mondiales suggérant qu'il y a des progrès à faire pour accroître la participation des femmes dans le secteur de l'énergie.
- Les considérations politiques découlant du chapitre comprennent l'élimination progressive des subventions inefficaces tout en veillant à ce que les réformes n'entravent pas l'inclusion des femmes dans la main-d'œuvre du secteur de l'énergie. Il est recommandé de rediriger les fonds des subventions pour soutenir les entreprises appartenant à des femmes, de fournir un mentorat et des opportunités de financement, et de mettre en œuvre des politiques sensibles au genre. La collaboration entre les parties prenantes, y compris les gouvernements, l'industrie, le milieu universitaire et la société civile, est cruciale pour favoriser la diversité de genre au sein du secteur.

Le cinquième chapitre cherche à fournir des stratégies éclairantes en examinant l'influence des subventions aux combustibles fossiles sur l'interaction entre le stress hydrique et la consommation d'énergie.

- L'interaction entre le stress hydrique, les subventions aux combustibles fossiles et la consommation d'énergie est complexe et nécessite une considération prudente dans la formulation des politiques. La relation implique des facteurs tels que le sentiment public, l'utilisation de l'eau dans la production de combustibles fossiles et le risque de pollution de l'eau par les activités d'extraction. Le chapitre se concentre sur des données de l'Algérie, dont l'économie politique a historiquement reposé sur les combustibles fossiles pour stimuler la stabilité socio-économique et promouvoir le développement économique grâce aux subventions. L'analyse économétrique indique qu'une augmentation des subventions aux

RÉSUMÉ ET PRINCIPALES CONCLUSIONS

combustibles fossiles entraîne des niveaux de stress hydrique plus élevés, une consommation d'énergie accrue, une croissance du PIB et une inflation. Cela souligne le compromis entre les activités économiques stimulées par la production de combustibles fossiles et les impacts environnementaux. Pendant ce temps, les chocs de stress hydrique influencent les ajustements des subventions aux combustibles fossiles, de la consommation d'énergie, du PIB et de l'inflation. Bien qu'il y ait un effet initial de conservation sur la consommation d'énergie, la tendance évolue vers une trajectoire positive avec le temps, soulignant l'importance des pratiques énergétiques durables. Enfin, les chocs de consommation d'énergie affectent les subventions aux combustibles fossiles, le stress hydrique, le PIB et l'inflation. Initialement, il y a une réponse positive des subventions aux combustibles fossiles à une consommation d'énergie accrue, suivie d'un ajustement politique potentiel pour réduire les subventions. La consommation d'énergie affecte également le stress hydrique et le PIB, indiquant une relation multifacette.

- Les réponses aux chocs des subventions aux combustibles fossiles démontrent une interaction complexe entre les facteurs environnementaux et économiques. La réduction des subventions aux combustibles fossiles pourrait atténuer le stress hydrique, réduire la consommation d'énergie et stabiliser les budgets nationaux, favorisant un développement économique durable et réduisant la dépendance aux combustibles fossiles. De plus, cela pourrait aider à atténuer les pressions inflationnistes associées aux subventions élevées. Les conclusions préconisent la réduction progressive des subventions aux combustibles fossiles, avec une réallocation des ressources vers l'expansion des sources d'énergie renouvelable, tout en protégeant les populations vulnérables par le biais de mesures sociales. Les plans ambitieux de l'Algérie pour l'énergie solaire et éolienne démontrent un engagement envers le développement des énergies renouvelables.

Le sixième chapitre vise à analyser les défis et les opportunités pour garantir simultanément la durabilité à long terme des subventions à l'eau ainsi que l'équité sociale.

- Le chapitre évalue la viabilité des subventions à l'eau et leurs implications pour le processus de désalinisation intensif en énergie. Les subventions à l'eau offrent des avantages, notamment en assurant un accès abordable à l'eau pour l'ensemble de la population, en favorisant le développement agricole, en améliorant la qualité de l'eau par la désalinisation, en réduisant la dépendance aux précipitations et en encourageant la durabilité dans les pratiques de gestion de l'eau. Cependant, ces subventions présentent également des inconvénients. Le coût élevé de la gestion de l'eau met une pression significative sur les budgets nationaux, tandis que le système de subventions peut exacerber les inégalités. De plus, il existe une dépendance aux investissements publics pour maintenir les ressources en eau, et la dépendance continue aux ressources non renouvelables perpétue un développement non durable. En outre, le processus de désalinisation peut avoir des effets néfastes sur les écosystèmes marins.
- Le chapitre se concentre sur l'Algérie, représentative d'un pays méditerranéen confronté à des défis liés à la pénurie d'eau, exacerbés par l'aridité climatique, la croissance démographique, l'urbanisation et le changement climatique. Le gouvernement algérien a entrepris des initiatives ambitieuses, notamment l'installation d'usines de désalinisation et l'expansion de la capacité de stockage des eaux de surface, pour atténuer l'impact de la pénurie d'eau. L'engagement du pays en matière de politique de l'eau est évident dans ses efforts pour augmenter l'approvisionnement en eau afin de répondre aux besoins de sa population croissante. Le chapitre analyse diverses stratégies de tarification de l'eau en Algérie pour évaluer leur

RÉSUMÉ ET PRINCIPALES CONCLUSIONS

impact sur le bien-être des consommateurs. À travers une analyse économétrique, il explore plusieurs scénarios, notamment l'augmentation des prix moyens de l'eau, l'ajustement des blocs tarifaires et la simulation de la désalinisation de l'eau de mer. Les résultats indiquent que si les limitations d'approvisionnement peuvent moduler positivement la demande d'eau, les changements dans les politiques de tarification affectent significativement le bien-être des consommateurs, équivalant à environ 2,4 % du revenu mensuel d'un ménage. La mise en œuvre d'un système de tarification de l'eau national uniforme et progressif pourrait équilibrer l'équité sociale et la gestion durable de l'eau, minimisant la perte de bien-être et encourageant les contributions au coût réel de production de l'eau.

- Le chapitre plaide pour la participation des citoyens aux coûts de production de l'eau, promouvant une consommation rationalisée et une utilisation efficace de l'énergie. Les mesures pratiques recommandées pour les pays méditerranéens comprennent le renforcement du droit de l'eau, la réévaluation des politiques d'urbanisation, la révision tarifaire, la mise en place de tarifs d'eau solidaires et le lancement de campagnes de sensibilisation du public.

Le septième chapitre dissèque les impacts de différentes stratégies touristiques sur l'utilisation des terres, soulevant des questions sur le rôle potentiel de subventions spécifiques au tourisme dans l'influence de la résilience au changement climatique.

- Le chapitre examine les villes côtières de Toulon et de Kuşadası, toutes deux animées par le tourisme comme moteur économique principal. Toulon, avec ses paysages naturels pittoresques et son importance historique, attire plus de 8 millions de touristes chaque année. Kuşadası, connue pour son port de croisière animé et ses sites classés au patrimoine mondial de l'UNESCO, accueille jusqu'à 2 millions de visiteurs pendant les saisons de pointe. À l'aide de l'analyse SIG et des matrices de transition, l'analyse évalue les changements passés et potentiels dans l'occupation des terres, en tenant compte des prédictions du GIEC sur le changement climatique.
- Les résultats indiquent que les pratiques d'urbanisation de longue date de Toulon ont conduit à la stabilité des catégories d'utilisation des terres le long de sa bande côtière, soutenues par des efforts proactifs de conservation de l'environnement. En ce qui concerne Kuşadası, le soutien à l'infrastructure touristique a stimulé l'économie locale, entraînant des gains financiers significatifs, mais des investissements environnementaux supplémentaires pourraient être nécessaires pour atténuer suffisamment l'impact du changement climatique sur ses atouts naturels. Cela semble également vrai pour Toulon, bien que les effets du changement climatique soient projetés pour se manifester à un stade ultérieur.
- En réfléchissant à l'impact du soutien au tourisme, on observe à la fois des traits communs et des disparités entre les villes côtières. À Toulon, certaines subventions sont allouées pour promouvoir des pratiques touristiques durables, contribuant au développement économique tout en minimisant les impacts environnementaux. Le développement touristique de Kuşadası semble principalement reposer sur des subventions visant à développer le secteur du tourisme, en particulier dans le développement de l'infrastructure. Les conclusions provisoires sur la relation entre les subventions et le développement touristique sont limitées en raison de l'insuffisance de données complètes et comparables sur le soutien financier dans les deux régions. De futures recherches devraient donner la priorité à l'acquisition de jeux de données détaillés couvrant les formes de soutien direct et indirect. Établir un lien plus clair entre le soutien au tourisme et les tendances en matière de gestion des terres nécessite des efforts de collecte de données complets, des études longitudinales suivant les changements au fil du temps et des méthodes de recherche qualitative pour comprendre les perceptions et les

RÉSUMÉ ET PRINCIPALES CONCLUSIONS

comportements des parties prenantes. La création d'une méthodologie méditerranéenne commune pour différencier entre le soutien au tourisme nocif pour l'environnement et celui favorable est crucial pour un développement durable.

Le huitième chapitre est tourné vers l'avenir et vise à répondre à la question de savoir comment utiliser de manière efficace et efficiente le meilleur mélange de politiques fiscales pour accélérer le processus de transition énergétique en Méditerranée. Une attention particulière a été accordée à la décarbonisation de l'industrie de l'approvisionnement électrique car l'électricité est la principale source d'énergie utilisée non seulement pour la production industrielle mais aussi pour les secteurs du chauffage et des transports.

- Bien que l'un des points de focalisation soit le Cadre juridique de l'Union européenne (UE) sur les aides d'État car il est obligatoire pour les États membres de se conformer aux règles de l'UE en matière d'aides d'État, les régimes d'incitation soutenus pour la génération d'énergie renouvelable dans ce chapitre sont applicables dans tous les pays méditerranéens. En ce qui concerne les incitations fiscales (vertueuses), les systèmes de tarifs de rachat (FIT) semblent être les régimes de soutien les plus efficaces pour promouvoir et soutenir l'électricité renouvelable. Cependant, tous les programmes FIT ne sont pas réussis, certains pourraient augmenter la charge financière des contribuables. La faisabilité politique des programmes varie selon les pays ; par exemple, les programmes RPS aux États-Unis chargent directement l'industrie de l'électricité, tandis que des taxes plus élevées sont préférées dans l'UE.
- On peut soutenir qu'aucun régime, à lui seul, ne serait suffisant pour atteindre les meilleurs résultats pour les objectifs de transition vers les énergies renouvelables. Dans ce sens, un point crucial est également de fixer le prix des externalités négatives grâce aux taxes sur le carbone. Les résultats de la littérature soulignent à quel point les taxes sur le carbone pourraient être efficaces pour les industries intensives en carbone. Certains pays peuvent facilement introduire et appliquer des taxes environnementales, de la même manière que la Finlande, la Suède, la Norvège et le Danemark ont introduit la taxe sur le carbone au début des années 1990. Mais l'introduction de nouvelles taxes peut susciter des résistances. Pour prévenir cela, des mécanismes incitatifs doivent également être associés à l'introduction de nouvelles taxes.
- Lors de la conception d'incitations fiscales en Méditerranée, la Convention de Barcelone et ses protocoles peuvent fournir un cadre complet. Le soutien aux énergies renouvelables semble être la voie à suivre, à condition que les problèmes de pollution, de promotion de l'économie verte, d'énergie durable et de consommation et de production soient toujours pris en compte.

Un chapitre de conclusions offre quelques réflexions supplémentaires sur la manière de faire avancer la réforme des subventions nuisibles à l'environnement, ainsi que sur les axes clés à prendre en compte et qui pourraient être étudiés plus en détail dans de futurs rapports.

- Tout d'abord, il apparaît nécessaire de remplacer les subventions nuisibles à l'environnement par des instruments économiques verts. Ces instruments, tels que les taxes, les subventions (vertueuses) et les mesures réglementaires, visent à internaliser les coûts environnementaux, à promouvoir la durabilité et à stimuler l'innovation et la création d'emplois. La transition des subventions nocives aux instruments verts est cruciale pour corriger les distorsions du marché, promouvoir l'équité sociale et stimuler une croissance économique durable dans la région méditerranéenne. De plus, la réforme est cruciale pour garantir les ressources financières nécessaires au développement durable, surtout face aux pressions budgétaires renouvelées dans la sphère publique.

RÉSUMÉ ET PRINCIPALES CONCLUSIONS

- Deuxièmement, renforcer la responsabilité sociale des entreprises (RSE) parmi les entreprises opérant dans la région est une autre voie à explorer pour relever les défis. La RSE implique des actions volontaires des entreprises pour promouvoir la durabilité sociale, environnementale et économique au-delà des obligations légales. Les gouvernements, les entreprises et la société civile doivent collaborer pour créer un environnement favorable à la promotion de la RSE grâce à des normes, des incitations et une transparence.
- Enfin, la coopération intersectorielle et l'application des réglementations sont cruciales pour la mise en œuvre réussie des politiques. L'alignement avec la SMDD et l'établissement d'une taxonomie verte spécifique à la Méditerranée peuvent orienter les investissements vers des projets écologiquement durables et promouvoir la transparence et la responsabilité dans le financement des initiatives de développement durable. Le PNUE/PAM peut jouer un rôle de premier plan dans l'élaboration de cette taxonomie en réunissant les parties prenantes et en concevant des critères adaptés aux défis et aux opportunités uniques de la région.

INTRODUCTION : UNRAVELING THE IMPACT OF ENVIRONMENTALLY HARMFUL SUBSIDIES IN THE MEDITERRANEAN

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Fishing boats at the fishing port in Mahdia, traditional Tunisian architecture
Credit : Istock

The Mediterranean region boasts remarkable richness and biological diversity, yet it also grapples with considerable fragility, standing as a vulnerable region in the face of global changes. The State of the Environment and Development report (SoED) for the Mediterranean, published by UNEP/MAP and Plan Bleu in 2020, underscores the accelerated and profound nature of these changes in the region. The Mediterranean emerges as a focal point for climate change, experiencing shifts at a pace surpassing global averages, particularly evident in the rapid warming of air and ocean temperatures throughout all seasons (UNEP/MAP and Plan Bleu, 2020)[1]. The ramifications of these changes are keenly felt by Mediterranean populations, manifesting in events such as droughts, water scarcities, diminished agricultural outputs, natural disasters, and escalating sea levels.

These transformations primarily arise from human-induced causes, originating from unsustainable production and consumption behaviors. The First Mediterranean Assessment Report of the Mediterranean Expert Network on Climate and Environmental Change (MedECC) underlines that «virtually all continental and marine sub-regions of the Mediterranean basin are impacted by recent anthropogenic changes in the environment» (MedECC, 2020)[2]. In the Mediterranean, these activities impose significant stress on ecosystems, leading to the depletion of natural resources and widespread environmental degradation (UNEP/MAP and Plan Bleu, 2020).

Such changes call for the mobilization of expertise that extends beyond the realm of ecologists alone. Economists also play a crucial role, as economic tools are deeply intertwined with environmental challenges and solutions. Right now, despite international momentum for sustainable development, unsustainable practices are further fueled by economic incentives that «generally favour an expansion of

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

economic activity at the expense of conservation and restoration, often causing environmental damage» (IPBES, 2019)[3]. Indeed, a significant portion of the financial support provided by public authorities, which may be beneficial from an economic perspective, is detrimental from an environmental perspective.

Such incentives are also known as environmentally harmful subsidies (EHS). In the global struggle for ecological balance and sustainability, the emergence of EHS stands as a pressing concern with far-reaching consequences.

BOX 1.

IMPLICATIONS OF EHS, BY TYPE OF SUBSIDY

Subsidies in natural resource sectors, whether explicit or implicit, have substantial economic, environmental, and societal implications, highlighting the need for policy reforms to address these issues effectively. Some examples include :

Fossil Fuel Subsidies:

- Governments worldwide often opt to subsidize fossil fuels, contrary to economists' recommendations of implementing price-based policy instruments to account for the societal costs associated with these fuels.
- Explicit subsidies for fossil fuels reached approximately US$577 billion in 2021, significantly surpassing subsidies to the renewable energy sector and climate financing commitments.
- Producer subsidies, which include preferential treatments like grants and low-interest loans, are more challenging to quantify but are estimated at around US$444 billion in 2014, with a significant portion coming from state-owned enterprises' investments.

Implicit Fossil Fuel Subsidies:

- The failure to price externalities, such as air pollution and climate change impacts, results in implicit subsidies estimated at a staggering US$5.4 trillion in 2020, predominantly stemming from local air pollution and global climate change impacts.

Agricultural Subsidies:

- Global agricultural support, including both explicit and implicit subsidies, is substantial, amounting to approximately US$635 billion annually between 2016 and 2018.
- Explicit agricultural subsidies mainly benefit producers, with the bulk of support being coupled, leading to environmental degradation.
- The magnitude of implicit agricultural subsidies, particularly related to greenhouse gas emissions and environmental damages, is challenging to estimate but likely ranges from US$548 billion to US$1.5 trillion per year.

Fishery Subsidies:

- Explicit subsidies in the fishery sector total around US$35.4 billion annually, with a significant portion contributing to overfishing.
- Implicit subsidies, such as the lack of regulations enabling overfishing, result in economic losses estimated at US$83 billion per year, nearly 20% of the total sector's size.

Source: Damania et al (2023)

3 IPBES. (2019). Summary for policymakers of the global assessment report on biodiversity and ecosystem services of the Intergovernmental Science-Policy Platform on Biodiversity and Ecosystem Services. (p. 56). IPBES secretariat. Bonn, Germany.

Tunisia
Credit : Pixabay

These incentives typically prioritize expanding economic activities without due consideration for conservation and restoration efforts, leading to environmental degradation. They are defined as a set of aids emanating, directly or indirectly, from a public entity, which favour production or consumption that is harmful to the environment by increasing the exploitation of resources, the level of pollution or the deterioration of biodiversity. They can be measured through several approaches and methodologies (inventory, price gap, producer and consumer subsidy equivalent) that are presented in Chapter 1. They are therefore opposed to subsidies and economic tools that are environmentally friendly, which contribute to environmental protection.

The Scale of EHS

According to a recent World Bank report by Damania et al (2023)[4], subsidies for fossil fuels, agriculture, and fisheries exceed $7 trillion in explicit (direct government spending) and implicit (impact on people and planet) forms, representing around 8% of global GDP (see also Box 1). Explicit subsidies total about $1.25 trillion, while implicit subsidies amount to over $6 trillion annually, with the burden falling mostly on poorer populations.

On a global scale, subsidies that create environmental damage are estimated to be 5 to 6 times higher than those that benefit the environment (OECD, 2020)[5]. Despite numerous multilateral agreements advocating for EHS reform, their implementation remains elusive. The perpetuation of EHS creates a vicious circle, expanding activities that subsequently contribute to environmental degradation, thereby jeopardizing the very industries and communities that depend on them. According to the World Bank (2023), fossil fuel use incentivized by subsidies is a key driver of 7 million premature deaths from air pollution annually. Meanwhile, fisheries subsidies exceeding $35 billion per year contribute to depleted fish stocks, oversized fleets, and falling profitability.

Repurposing such subsidies can enable a green and equitable transition that creates jobs and

4 Damania, Richard, Esteban Balseca, Charlotte de Fontaubert, Joshua Gill, Kichan Kim, Jun Rentschler, Jason Russ, and Esha Zaveri. 2023. Detox Development: Repurposing Environmentally Harmful Subsidies. Washington, DC: World Bank. doi:10.1596/978-1-4648-1916-2.
5 OECD. (2020a). Aperçu général du financement de la biodiversité à l'échelle mondiale, (p. 48). OECD.

opportunities for all. Progressively eliminating EHS presents a significant opportunity to mitigate climate change, including by reducing CO2 emissions and by respecting biodiversity. While public support for certain sectors may be deemed necessary for strategic reasons, it is crucial to evolve the way support is provided. This evolution could involve transitioning towards more sustainable alternatives and practices. Successful compensation strategies can help maintain the purchasing power of households while facilitating the transition away from harmful subsidies. Considering the current strained budgets, rising debts, growing inequalities, and environmental degradation, redirecting these funds can unlock significant resources for sustainable development.

1. The Significance in the Mediterranean Context

The Mediterranean basin, with its unique ecological characteristics and socio-economic dynamics, faces particular challenges exacerbated by harmful subsidies. This region, celebrated for its rich biodiversity, delicate marine ecosystems, and pivotal role in climate regulation, grapples with environmental threats that jeopardize both its ecosystems and the well-being of its populations. Key Environmental Challenges in the Mediterranean include:

- Marine Biodiversity and Overfishing: The Mediterranean Sea, a biodiversity hotspot, faces the perilous threat of overfishing driven by certain types of fishing subsidies. These subsidies, while intended to bolster the fishing industry, often inadvertently fuel unsustainable practices, disrupting marine ecosystems and impacting coastal communities.
- Climate Change Vulnerability: Mediterranean countries, already vulnerable to climate change, face exacerbated impacts due to energy subsidies promoting fossil fuel consumption. Greenhouse gas emissions contribute to rising temperatures, reduced rainfall, and extreme weather events, intensifying the region's vulnerability.
- Water Resources and Agriculture: Water scarcity in the Mediterranean is exacerbated by agricultural subsidies promoting inefficient water usage. Unsustainable agricultural practices, encouraged by harmful subsidies,

Pollution - Lebanon
Credit : ShutterStock

contribute to soil degradation, erosion, and pollution, threatening food security and necessitating a transformative approach to global agricultural systems.
- Tourism and Coastal Development: Tourism-related subsidies may contribute to unsustainable coastal development, habitat destruction, and increased waste generation. Unchecked expansion of infrastructure disrupts the delicate balance between human activities and the environment, threatening biodiversity and compromising the natural beauty that attracts tourists.
- Economic Resilience and Social Equity: Reliance on harmful subsidies can hinder economic diversification and innovation, perpetuating dependence on environmentally harmful industries. Moreover, these subsidies often disproportionately affect vulnerable communities, exacerbating social inequalities and hindering sustainable development goals.

Harmful subsidies to the environment pose a significant challenge for many countries in the Mediterranean, each facing unique circumstances regarding their subsidy programs. For some, subsidizing water to ensure affordable access is the biggest issue. Others focus more on providing subsidies for fishing, aiming to boost economic activity in the maritime sector and/or employment in coastal communities. Additionally, several countries still subsidize fossil fuel production to maintain energy security, especially considering the current challenging economic context.

Transitioning to more sustainable policies is a complex process that requires careful consideration of economic, social, and environmental factors. While subsidies may initially serve important economic and social objectives, they often come at the expense of environmental sustainability. However, achieving subsidy reform requires navigating political and social challenges, as well as addressing entrenched interests that benefit from existing subsidy programs. Governments must strike a balance between short-term economic imperatives and long-term environmental sustainability goals. This may involve phasing out harmful subsidies while simultaneously investing in alternative, environmentally friendly sectors. Realistic timelines are needed, additionally, international cooperation and knowledge sharing among Mediterranean countries can facilitate the transition to more sustainable subsidy policies, leveraging successful experiences and best practices from across the region.

To this day, though uneven, the Mediterranean has seen progress in efforts to identify and reform EHS. Some countries have taken proactive steps, for example, Italy developed a comprehensive catalogue of environmentally friendly and harmful subsidies in 2016, providing a framework for classifying and assessing them. This type of detailed mapping exercise is a crucial first step towards reform. Another positive example comes from Morocco, which in 2014 cut down on government support for fossil fuels, reinvesting the proceeds in renewable energy projects. Morocco implemented gradual reforms, tailored to local conditions, and provided targeted support for vulnerable groups to mitigate social and economic impacts. Other Mediterranean countries are in the middle of the process, working to better understand the landscape of EHS within their borders. Gaps in data and analysis often hinder progress, as decision-makers may have the willingness but lack the full picture needed to drive meaningful change. In other cases, countries are in the early stages of learning about the issue and its impacts, highlighting the need to keep raising awareness.

The reform of environmentally harmful subsidies (EHS) is an objective of the Mediterranean Strategy for Sustainable Development (MSSD) 2016-2025. The strategy recognizes the negative impact of such subsidies on the environment and the importance of their reform to promote sustainable development in the region. Strategic direction 5.6 promotes a greener and more inclusive market in the region by integrating the polluter-pays principle, extended producer responsibility, and payment for ecosystem services based on economic valuation. Specifically, the Strategy includes national actions to promote environmental tax reform to reduce tax on labor and integrate the polluter-pays principle and extended producer responsibility into finance policy (5.6.1). Furthermore, it includes an action to carry out reviews on the environmental impacts of public subsidies with

a view to phasing out environmentally harmful subsidies (5.6.2). Meanwhile, at a regional level, capacity building in market instruments is also envisaged.Meanwhile, addressing climate change is a priority for the MSSD, and part of this involves reforming subsidies that contribute to greenhouse gas emissions. Strategic direction 4.4 addresses mainstreaming climate change at the legislative and policy levels, seeking, amongbother things, to reform energy subsidies. By addressing the reform of EHS, the MSSD aims to align economic activities with the principles of sustainability, thereby promoting long-term ecological and economic health in the Mediterranean region.

BOX 2.

KEY EFFORTS AND COMMITMENTS TO ADDRESS EHS

International Commitments :

- International commitments like the Rio Conference in 1992, the Aichi Targets of the Convention for Biological Diversity (CBD) in 2010, and the Sustainable Development Goals (SDGs) in 2015 emphasize the need to reform environmentally harmful subsidies.
- Studies by intergovernmental bodies such as the Organisation for Economic Co-operation and Development (OECD), the Institute for European Environmental Policy (IEEP), and the IMF further underscore the importance of addressing EHS.

The Role of the Mediterranean Action Plan (MAP):

- Adopted in 1976, the Mediterranean Action Plan (MAP) under the Barcelona Convention is part of the United Nations Environment Programme (UNEP) and aims to guide the Mediterranean region towards sustainable development. It involves 21 Mediterranean countries and the European Union, committing them to implement measures for the protection of the marine environment.
- Recent decisions and declarations from the MAP system emphasize the need to promote economic instruments and reforms, such as reducing environmentally harmful subsidies.
- Article 21 of the ICZM Protocol (2009) states "For the implementation of national coastal strategies and coastal plans and programmes, Parties may take appropriate measures to adopt relevant economic, financial and/or fiscal instruments intended to support local, regional and national initiatives for the integrated management of coastal zones."
- The Activity Report of the Compliance Committee for 2018-2019 stresses the need «To urge and recommend the Contracting Parties concerned to promote the sharing of information and experience among them to enhance the use of economic instruments in Mediterranean region (...) to take appropriate measures to adopt relevant economic, financial and/or fiscal instruments intended to support local, regional and national initiatives for ICZM[6].»
- The Common Regional Framework for Integrated Coastal Zone Management in the Mediterranean (2019) further indicates that, in line with Article 21 of ICZM Protocol, Contracting Parties are encouraged to «Gradually reduce environmentally harmful subsidies while putting in place compensatory measures to address socio-economic losses that might occur».
- The Naples Declaration in its paragraph 9.c) calls to "Boost capacity building and involvement of a range of actors – particularly the scientific community, private sector and civil society – in designing and implementing adaptation strategies, and mobilizing funding resources, inter alia, through subsidies' reforms and efficient green tax collection[7]".
- An exploratory study by Plan Bleu on environmentally harmful subsidies (EHS) in the Mediterranean raises awareness and aims to integrate the topic into the next MAP work programme and medium-term strategy, with the long-term goal of informing decisions to reform EHS and achieve sustainable development in the region.
- The UNEP/MAP Medium-Term Strategy 2022-2027 underscores how "Limiting environmental degradation largely relies on proper planning of the use of coastal and marine space and resources. Instruments such as land stewardship, environmental fiscal instruments, payment for ecosystem services, compensation schemes, etc., come to support policy- and decision making processes; this calls for a detailed elaboration of these instruments, economic analysis for the assessment of various policy options and measures, and strengthening of the Mediterranean stakeholders' capacities to use them[8]".

6 https://wedocs.unep.org/bitstream/handle/20.500.11822/31699/19ig24_22_2401_eng.pdf
7 https://wedocs.unep.org/bitstream/handle/20.500.11822/6446/21wg503_6_eng.pdf?sequence=1&isAllowed=y
8 https://wedocs.unep.org/bitstream/handle/20.500.11822/37123/21ig25_27_2501_eng.pdf

Plan Bleu, aligning with the foundational objectives of the MSSD, recognizing the urgency of addressing environmentally harmful subsidies in the Mediterranean and as part of global efforts and commitments to address EHS in the Mediterranean (Box 2), had undertaken an exploratory study[9] to illuminate the landscape of this pressing issue, advocating for the inclusion of EHS as a vital topic within the framework of the Mediterranean Action Plan (MAP). The primary objective was to provide decision-makers with a first glimpse of environmentally damaging subsidies in the Mediterranean, focusing on the fisheries and tourism sectors within the MAP framework, underscoring the need for a coordinated and coherent action for EHS reform.

Plan Bleu exploratory study laid the foundation for a longer-term perspective, stressing the need for thorough data-driven analysis encompassing more impacts and to extend the exploration of EHS to other critical sectors, to provide a more holistic picture that could facilitate their phasing-out.

2. Moving Forward: A Call for Collaborative Action

As a result, Plan Bleu embarked into the production of this thorougher Edited Volume report which seeks to better inform decision-makers across the Mediterranean. By providing a more comprehensive overview of EHS and their consequences, the report aims to equip leaders with the knowledge and impetus needed to accelerate reform efforts. Aligning with the founding objectives of the MSSD, the report takes into consideration not only the environmental and economic dimensions, but also the social/pro-poor aspects related to subsidies reform. Overall, whether a country is just beginning to explore the issue or has already made strides, this analysis can serve as a valuable resource in the path towards intelligently phasing out environmentally harmful subsidies.

To thoroughly explore the issue, Plan Bleu launched a Call for Papers in 2023 as an open invitation to Mediterranean researchers diving into the intricacies of subsidies and their socioeconomic and environmental impacts in the Mediterranean. This call seeked papers that provide evidence-based contributions with tangible policy recommendations. It centered on critical issues, exploring success stories and responsible practices in the Mediterranean, both in the South, East and North, urging papers to uncover EHS precise impacts across the region. Eight paper proposals were selected and funded by Plan Bleu, and are presented as chapters throughout this Edited Volume. These chapters include a strong participation of South Mediterranean researchers and especially women among the contributing authors (13 women out of a total of 18 authors/co-authors), reinforcing the value of diversity and inclusion in addressing these pressing regional challenges. This «by Mediterraneans, for the Mediterranean» approach offers precious insights, ideas and practices from diverse perspectives across the region, which are valuable for ensuring the continued relevance and effectiveness of the Mediterranean Strategy for Sustainable Development (MSSD).

Draft versions of the chapters underwent thorough scrutiny and refinement during a Plan Bleu Regional Workshop (January 30th 2024). This collaborative effort aimed to enhance the quality and relevance of the chapters before their inclusion in the final report. The workshop provided an invaluable platform for authors to receive feedback from Plan Bleu but also from a diverse audience comprising 120 individuals. Among these participants were representatives from non-governmental organizations (NGOs), international organizations like the OECD, and experts in green taxation. Their insights and comments contributed significantly to strengthening the final versions of the chapters, ensuring that the report presents a comprehensive and well-informed perspective on the subject matter. An additional peer-reviewing process was provided by the Plan Bleu bureau.

As we navigate this series of chapters, each dedicated to unraveling specific facets of environmentally harmful subsidies in the Mediterranean, we embark on a journey to foster

9 Plan Bleu (2023), "Technical report: Exploratory study on environmentally harmful subsidies in the Mediterranean", by Melina Roditis, Guillaume Sainteny, Aldo Ravazzi Douvan, François Guerquin, Frans Oosterhuis, Kai Schlegelmilch, Lina Tode, and Constantin Tsakas. Available at : https://planbleu.org publications/rapport-technique-etude-exploratoire-sur-les-subventions-publiques-dommageables-a-lenvironnement-en-mediterranee/

understanding, propose solutions, and cultivate a shared commitment towards a more sustainable and resilient future for this vital region. Each chapter focuses on a distinct aspect, shedding light on the nuanced relationship between subsidies and environmental degradation while presenting tailored recommendations to drive positive change. Specifically:

Chapter 1: Measuring Progress and Accountability in Phasing Out Environmental Harmful Subsidies: A Comprehensive Framework for the Mediterranean Region : This first chapter provides an understanding of the definitions, historical evolution, and impacts of EHS. It underscores the importance of systematically measuring and monitoring the reform or phase-out process of EHS. Starting from the premise that reforming EHS should encompass socio-economic considerations alongside environmental goals, it seeks to address the following research question: What framework can be employed in the Mediterranean region to comprehensively measure the multidimensional impacts of phasing out EHS, while simultaneously enhancing social and political accountability? It then proposes the Euro-Mediterranean EHS Phase-Out and Reform Framework (EHS-MedFRAME), a strategic framework complete with key indicators and accountability mechanisms. It also provides an analysis of existing strategies related to EHS identification and reform in countries both within and outside of the Mediterranean.

Chapter 2: Fishing Subsidies and Marine Ecosystems : This chapter, dissecting the complex ties between fishing subsidies and marine ecosystems, lays the foundation for understanding how the "wrong" subsidies may contribute to overfishing and unsustainable practices while the "right" subsidies may enhance income sources and improve fish stocks simultaneously, if implemented carefully and in a transparent participatory manner. By leveraging ecological indicators, economic insights, and empirical evidence, the paper unveils the intricacies of the fisheries sector, looking at the case of Türkiye, which has made notable strides towards a more environmentally conscientious approach by shifting its «subsidy-mix» towards more environmentally virtuous tools, mirroring patterns observed in other EU-Mediterranean countries. The chapter's recommendations, tailored for the region, provide a blueprint for rationalizing subsidies, promoting sustainable practices, and ensuring the long-term health of marine ecosystems.

Chapter 3: Fossil Fuel Subsidies and Climate Change in the Mediterranean : While these subsidies aim to reduce energy costs and benefit consumers and producers alike, an honorable objective from a social perspective, they have been criticized for exacerbating resource depletion, increasing greenhouse gas emissions, and undermining the competitiveness of clean energy technologies. Addressing a critical gap in the understanding of fossil fuel subsidies, this chapter employs economic modeling and national assessments to unravel their impact on carbon dioxide emissions in the Mediterranean region. It also aims to conduct a detailed examination of coal subsidies in Turkiye, chosen as a case study due to its breadth of available data. By filling this knowledge void, the paper aims to guide policymakers in reshaping tools for climate change mitigation and transitioning to renewable energy, highlighting the potential of these subsidies to hinder progress towards a low-carbon economy. The findings emphasize the need for policy reform in the Mediterranean to transition to renewable energy sources and mitigate climate change. In that respect, the reform experiences of Morocco and Egypt are also discussed, as they are South Mediterranean countries which embarked into such an ambitious process several years ago. They show how while subsidy reform can be politically and socially challenging, it is possible to mitigate adverse effects through designed compensatory measures.

Chapter 4: Female Labour Inclusion and Energy Policies in the Mediterranean Countries : Exploring the intersection of energy policies and female employment, this chapter utilizes a mixed-methodology approach. By conducting a systematic literature review, empirical assessment, and survey analysis, the chapter sheds light on the links between energy subsidies and female labor force participation. Empirical results confirm the negative links between hydrocarbon subsidies and female labor force participation in the region. Survey results drawing from the energy sector in Greece, an illustrative case study from the Mediterranean as it is in the middle of the income distribution in the region,

indicate the positive perception of women's competence, yet also reveal an opportunity for improvement in aligning industry investments with enhanced job opportunities for women. This chapter emphasizes the need for policymakers not only to reevaluate existing policies, but more importantly, to develop policies with a gender-responsive dimension in all phases of design, implementation, monitoring, and evaluation. Leveraging expertise from Plan Bleu's Observatory, common methodologies can enable cross-country comparability of data on energy subsidies and women's participation. Gender-inclusive energy policies, skills development initiatives, efforts to address information asymmetries, and collaboration between the relevant stakeholders, are crucial for fostering female empowerment and addressing gender disparities in the energy sector.

Chapter 5: Measuring the Footprint of Fossil Fuel Subsidies on The National Duality of "Water Stress-Energy Consumption" : this chapter seeks to provide insightful strategies by examining the influence of fossil fuel subsidies on the interplay between water stress and energy consumption, using data for Algeria. Drawing from robust econometric analysis and empirical evidence, the chapter offers actionable policy recommendations. It advocates for a gradual reduction of fossil fuel subsidies, with a reallocation of resources towards the expansion of renewable energy sources like solar and wind power, which are plentiful in the region. Additionally, it proposes targeted support measures, including direct subsidies for renewable energy access and bolstered social safety nets, to safeguard vulnerable populations during the transition. Lessons from other countries, such as Spain, Mexico, and Indonesia, offer valuable insights into gradual subsidy reforms coupled with robust social welfare support.

Chapter 6: Water Subsidies, Desalination, and Sustainable Resource Management : This chapter aims to analyze the challenges and opportunities for simultaneously ensuring the long-term sustainability of water subsidies together with social equity, a dual objective that Algeria has been prioritizing and which serves as a representative case study. By analyzing recent water resource regulations, the chapter evaluates the viability of water subsidies and their implications for the energy-intensive desalination process. Results show there is a need for comprehensive policies that consider the environmental impacts of water subsidies, ensuring they align with broader resource management goals. Introducing user fees or tariffs for water consumption can encourage responsible water usage while also generating revenue to support water infrastructure and management. Policymakers would need to ensure that water tariffs are affordable for low-income households while also reflecting the true cost of water production. An optimal and practical pricing scenario concerns adopting a policy that aligns the second tariff block with production costs, balancing social equity and sustainable water management. By adopting such an approach, authorities can effectively manage water resources, promote social welfare, and encourage sustainable practices among the population.

Chapter 7: Tourism Industry Strategies and Land Use : A comparative analysis of tourism policies forms the core of this chapter. By dissecting the impacts of different tourism strategies on land use, in Toulon and Kuşadası, it emphasizes the need for sustainable policies that balance economic gains with environmental preservation. Additionally, it raises questions about the potential role of specific tourism subsidies in influencing resilience to climate change, underscoring the need for a more nuanced classification of financial support to the tourism sector.

Chapter 8: Tax Incentives and Energy Transition from a Legal Point of View: Analysis of Best Practices Adapted to the Decarbonisation of the Mediterranean Region : Shifting the focus to legal perspectives, this final chapter aims to answer the question of how to effectively and efficiently use the best mix of fiscal policies to speed up the energy transition process in the Mediterranean Region. A particular attention has been given to the decarbonisation of the electricity supply industry because electricity is the main energy used for not only industrial production but also for the heating and transportation sectors. Mediterranean countries exhibit diverse legal systems, necessitating tailored fiscal approaches based on socio-political and geo-political factors. To expedite Renewable Energy (RE) deployment, the preference for Feed-in Tariff

(FIT) schemes is recommended, emphasising efficient price control and administrative simplicity. Acknowledging the political feasibility of schemes, the adoption of diversified, market-based incentives is also essential, recognizing variations between countries. Introduction of effective carbon taxes is encouraged, with coverage tailored to the majority of greenhouse gas emissions in each country. To mitigate resistance to new taxes, their combination with incentive mechanisms is proposed, along with an exploration of ancillary benefits beyond primary objectives.

Conclusions Chapter: A final chapter focuses on conclusions, outlining the adverse impacts of EHS that were identified and advocating for comprehensive policies (sectoral and cross-cutting) focusing on legal commitments, transparency, stakeholder engagement, and gradual transition with compensation.

While the report covers numerous issues related to environmentally harmful subsidies, there are still some issues that remain unexplored, such as subsidies in Protected Areas, linkages between Agricultural Subsidies and Marine Environments, Transportation Subsidies and Linkages with Air Pollution. They could warrant attention in potential future reports.

3. Towards a Unified Approach for EHS phase-out

Considering the interconnectedness of Mediterranean ecosystems and the shared responsibility of countries bordering the Mediterranean Sea, collaborative efforts to address environmental harmful subsidies are crucial. A unified approach towards phasing out or reforming these subsidies can bolster regional environmental resilience, promote sustainable economic growth, and protect the natural heritage that defines the Mediterranean region.

Meanwhile, the public sphere, including in EU countries, is returning to a field of budgetary pressure that it had thought it could abandon. Reforming these economic tools to align with environmental objectives is thus also essential for unlocking necessary financial resources and redirecting investments towards sustainable development.

The significance of these chapters lies in their collective ability to holistically address the challenges posed by environmentally harmful subsidies in the Mediterranean. By offering a nuanced understanding of regional dynamics, these papers equip policymakers, stakeholders, and the public with the insights needed to make informed decisions. As we progress through this report, we invite readers to engage with the issues explored, fostering a collective commitment to preserving the ecological integrity of the Mediterranean region for generations to come.

This initiative signifies a strategic and ongoing commitment for Plan Bleu, emphasizing its efforts that extend beyond a singular Edited Volume. Plan Bleu aspires to keep engaging in addressing relevant issues, including the internalization of environmental externalities with a focus on economic instruments. This entails treating green expenditures as a pivotal counterpart to "brown" (harmful) expenditures. Plan Bleu's dedication extends to actively contributing to the evolution of green financing mechanisms, especially in the context of funding resources for the ecological transition in the Mediterranean region, an issue that will be explored in a future report. By adopting a sustained approach, Plan Bleu aims at championing lasting solutions for a more sustainable future in the Mediterranean region.

Power plant pollution
Credit : FreePik

CHAPTER 1. MEASURING PROGRESS AND ACCOUNTABILITY IN PHASING OUT ENVIRONMENTAL HARMFUL SUBSIDIES: A COMPREHENSIVE FRAMEWORK FOR THE MEDITERRANEAN REGION

AUTHORS : ROBERTA MILO & JÉRÉMIE FOSSE

Overfishing trawler net
Credit : ShutterStock

This chapter provides a comprehensive understanding of the definitions, historical evolution, and impacts of environmentally harmful subsidies (EHS). It then proposes a comprehensive framework for monitoring, assessing, and ensuring accountability in the phase-out process of EHS within the Mediterranean region. The proposed framework, named the Mediterranean EHS Phase-Out and Reform Framework (EHS-MedFRAME), introduces cross-sectoral and multi-dimensional indicators to monitor the socio-economic and environmental impacts resulting from the reform process. Moreover, it incorporates mechanisms aimed at enhancing political and social accountability.

Emphasizing the importance of conducting EHS reforms in a manner that not only benefits the environment but also minimizes social and economic externalities, this analytical framework serves as a tool to assess and monitor the impacts of reform across these three dimensions. It enables the potential deployment of supporting and compensatory measures to mitigate negative socio-economic impacts on concrete sectors, organizations or individuals, aligning with the principles of a just, fair and inclusive transition.

This common framework is designed to streamline the subsidy reform process, providing policymakers in the Mediterranean region with a standardized toolkit for effectively monitoring the impacts of EHS reform. The adoption of robust accountability mechanisms is also recommended to enhance transparency and societal support. The adoption of this framework at the regional level is expected to harmonize reform efforts, increase regional collaboration, enhance social and political accountability, and achieve environmental goals while ensuring social equity and a just transition.

1. Introduction

Environmentally Harmful Subsidies constitute a significant challenge to the Mediterranean region, known for its ecological diversity and global significance in biodiversity conservation and climate stability. Despite the increasing acknowledgment of the necessity to phase out EHS, a key obstacle in reforming them is identifying what constitutes a subsidy. While different definitions have been proposed, a widely accepted definition conceives a subsidy as a result of a government action that confers an advantage on consumers or producers, in order to supplement their income or lower their costs[10]. It can take the form of incentives, benefits, subsidized loans, exemptions from taxes directly related to environmental protection. The OECD classifies subsidies as environmentally harmful if they contribute to higher levels of waste and emissions, including those in the earlier stages of production and consumption, than what would be the case without the support measure[11].

Spanning sectors such as agriculture, energy, fisheries, transport, and fossil fuels, these subsidies generally aim to achieve economic objectives while inadvertently contributing to ecological degradation[12]. Nonetheless, evidence showed that EHS can also result in significant socio-economic externalities. In particular, increased environmental pollution associated with EHS can adversely affect public health, while also diverting public resources away from vital sectors such as infrastructure, healthcare, and education[13]. Economically, these subsidies can distort prices and resource allocation decisions, altering the pattern of production and consumption in an economy[14].

Redirecting these subsidies represents a crucial opportunity to unlock significant funds for sustainable purposes, facilitating a green and just transition. Despite broad consensus on the necessity of EHS reform to achieve climate goals, efforts thus far have been fragmented. Moreover, emphasis has been put on addressing the challenges hampering reform efforts while insufficient attention has been directed towards monitoring the post-reform impacts comprehensively. Acknowledging the importance of monitoring the environmental, economic, and social repercussions of EHS reform, this chapter advocates for the development of a robust monitoring framework to ensure that reform strategies not only align with environmental goals but also with social and economic objectives.

Building upon a comprehensive literature review and analysis of existing strategy for EHS reform, this chapter proposes the Mediterranean EHS Phase-Out and Reform Framework (EHS-MedFRAME). Designed to evaluate and monitor the socio-economic and environmental impacts of EHS reform, the framework incorporates cross-sectoral and multidimensional indicators for broad applicability. Furthermore, it integrates mechanisms for ensuring transparency in the reform process, thereby enhancing social and political accountability. By monitoring the multidimensional impacts of reform and enhancing accountability, this framework allows policymakers to undertake the reform process in a way that not only ensures environmental sustainability, but also social justice. Moreover, the EHS-MedFRAME can serve as a standardized toolkit for policymakers across the Mediterranean region, facilitating holistic assessment and cross-national comparison of reform efforts. By streamlining the reform process, promoting knowledge sharing, collaboration, and enhancing synergies, the adoption of this framework has the potential to foster regional cooperation and accelerate progress toward sustainability goals.

While the EHS-MedFRAME provides a foundational tool for assessing reform efforts, it acknowledges certain limitations. Specifically, the framework's focus on cross-sectoral indicators omits sector-specific metrics that could offer tailored insights. Furthermore, its untested practical implementation underscores potential challenges in data gathering. Nonetheless, the framework remains invaluable for identifying areas of improvement and gaining clarity on the impacts of EHS reform.

10 OECD. (2005). Environmentally Harmful Subsidies: Challenges for Reform, OECD Publishing, Paris.
11 OECD. (2005). Environmentally Harmful Subsidies: Challenges for Reform, OECD Publishing, Paris.
12 Koplow, D., & Steenblik, R. (2022). Protecting nature by reforming environmentally harmful subsidies: The role of business.
13 World Bank. (2023). Detox Development: Repurposing Environmentally Harmful Subsidies.
14 Matthews, A., & Karousakis, K. (2022). Identifying and assessing subsidies and other incentives harmful to biodiversity: A comparative review of existing national-level assessments and insights for good practice.

2. Literature Review

This section provides a comprehensive review of existing literature on EHS and subsidy reform. It aims to consolidate and analyze existing scholarly works, research papers, and reports that focus on EHS and their phase-out. By synthesizing diverse perspectives, this review intends to provide a comprehensive understanding of the definitions, historical evolution, and impacts of EHS. Moreover, it highlights challenges and proposed solutions associated with the EHS reform.

2.1. The Problematic Identification of EHS

One of the main issues concerning the subsidies debate is what constitutes one. Various definitions have been proposed, ranging from as narrow as a direct budgetary payment by a government to a producer or consumer to as broad as any government intervention that affects prices or costs[15].

For instance, the World Trade Organization (WTO) defines subsidies as a financial contribution by a government that confers a benefit and (a) involves (i) a direct transfer of funds (e.g. grants, loans, and equity infusion), potential direct transfers of funds or liabilities (e.g. loan guarantees); (ii) foregone government revenue (e.g. tax credits); (iii) government-provided goods or services other than general infrastructure; or (b) income or price support. This definition, however, does not cover price support conferred to producers by import tariffs[16]. OECD estimates measure those for agriculture. The broader IMF definition of "post-tax subsidies", and the FAO definition of fish subsidies, includes estimates of non-internalised externalities[17].

The OECD defines a subsidy as the result of a government action that confers an advantage on consumers or producers, in order to supplement their income or lower their costs. A subsidy is categorized as environmentally harmful if the negative environmental impacts are increasing due to the existence of the subsidy. This definition is also recognized by the European Commission[18].

Meanwhile, EHS have been defined by the World Bank as follows:
i. Direct fiscal outlays from the government to producers or consumers that are intended to affect the production or consumption of goods and services.
ii. Expenditures on the provision of public goods if they are intended to benefit producers in a particular industry. For instance, research and development (R&D) of sectoral technologies, construction and maintenance of sectoral infrastructures like irrigation systems and ports, and even expenditures to provide services or information on their uses are provided at below-market price and they benefit private producers.
iii. Broader definitions would include external costs that a person or firm generates and some other entity pays for. They can be monetary (such as expenditures made to mitigate damages) as well as non monetary (such as health damages from air or water pollution)[19].

Each organization's approach to defining a subsidy and whether it is environmentally harmful provides interesting insights, while also highlighting a problematic lack of a universally accepted definition. This lack of consensus complicates the identification of EHS and, consequently, hinders efforts toward reform.

2.2. Methodologies for Measurement

EHS have been measured through several approaches and methodologies. These include inventory, price gap, producer and consumer subsidy equivalent[20].

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15 Asmelash, H. (2022). The regulation of environmentally harmful fossil fuel subsidies: From obscurity to prominence in the multilateral trading system. European Journal of International Law, 33(3), 993-1023.
16 World Trade Organization (WTO). WTO ANALYTICAL INDEX SCM Agreement – Article 1 (DS reports).
17 OECD. (2017). Removing Environmentally Harmful Subsidies: an exploration of the issues. G7 Workshop on Environmentally Harmful Subsidies and Environmental Fiscal Reforms, Rome.
18 European Commission, Directorate-General for Environment. (2022). A toolbox for reforming environmentally harmful subsidies in Europe - Final Report. Brussels.
19 World Bank. (2023). Detox Development: Repurposing Environmentally Harmful Subsidies.
20 Koplow, D., & Steenblik, R. (2022). Protecting nature by reforming environmentally harmful subsidies: The role of business.

Inventory quantifies value of specific government programmes to particular industries and then aggregates programmes into overall level of support. Transfers include reductions in mandatory payments (e.g. tax breaks) and shifting of operating risks to the public sector, not just cash[21]. The inventory approach has been effectively employed in the energy sector. The OECD Inventory of Support Measures for Fossil Fuels identifies, documents, and estimates government support measures that encourage fossil-fuel production or consumption. The latest edition of the Inventory includes 1 654 support measures in 51 OECD, G20, and EU Eastern Partnership economies[22]. A similar work has been undertaken by the International Institute for Sustainable Development (IISD), resulting in the publication of the G20 scorecard on fossil fuel funding, which tracks each of the G20 countries' progress in ending government support to fossil fuels.

The **price gap** approach measures the difference between market prices and prices paid or received by producers or consumers, indicating the extent of artificial market distortions caused by subsidies. It also evaluates the economic benefit received by consumers or producers due to subsidies, calculated by comparing market prices to subsidized prices[23]. It has been widely used by entities such as the IEA to measure price support to consumers of fossil fuels and electricity. Each year the IEA undertakes a global survey to identify countries that subsidize fossil-fuel consumption through reduced end-user prices, resulting in the Fossil Fuels Consumption Subsidies Report[24]. Moreover, recognizing the traditional price gap approach's limitations in accounting for environmental factors in fossil fuel subsidy calculations, the IEA developed the «price gap-plus approach.» This innovative method aims to overcome this limitation by incorporating environmental aspects, offering a more comprehensive understanding of the true costs and implications of fossil fuel subsidies[25]. The price gap approach has also been used by some researchers in the water sector[26]. One limitation of this approach is that it only captures the net effects of government policies, such as import or export taxes or domestic price regulations, that induce changes in prices, leaving out the value of subsidies that do not result in price changes[27].

The Producer Subsidy Equivalent and Consumer Subsidy Equivalent (PSE-CSE) framework addresses the limitation of the price gap approach by measuring both price support and the value of grants, input subsidies and other subsidies that do not directly affect prices. The latter are reported on an individual policy or program basis, and separately for producers and consumers[28]. The PSE-CSE framework was first applied internationally to agriculture and informed the OECD's work on measuring government support to fisheries and to fossil fuels. However, market price support to producers was not included in the OECD's fisheries support estimates, primarily because of the difficulty in obtaining suitable producer prices, reference prices, or both[29].

2.3. Environmental, Social, and Economic Impacts

Subsidies are typically implemented with good intentions, such as to alleviate poverty or promote economic development. However, evidence suggests that EHS perform poorly at achieving these objectives and are generally detrimental to the economic, social, and environmental dimensions of sustainable development[30].

21 Koplow, D., & Steenblik, R. (2022). Protecting nature by reforming environmentally harmful subsidies: The role of business.
22 OECD. (2023). OECD Inventory of Support Measures for Fossil Fuels: Country Notes, OECD Publishing, Paris.
23 Koplow, D., & Steenblik, R. (2022). Protecting nature by reforming environmentally harmful subsidies: The role of business.
24 IEA. (2023). Fossil Fuels Consumption Subsidies 2022. IEA, Paris.
25 IEA. (2023). Fossil Fuel Subsidies in Clean Energy Transitions: Time for a New Approach? IEA, Paris.
26 Koplow, D., & Steenblik, R. (2022). Protecting nature by reforming environmentally harmful subsidies: The role of business.
27 Koplow, D., & Steenblik, R. (2022). Protecting nature by reforming environmentally harmful subsidies: The role of business.
28 OECD. (2008). OECD's Producer Support Estimate and Related Indicators of Agricultural Support: Concepts, Calculations, Interpretations, and Use (The PSE Manual), July. Paris: OECD.
29 Cox, A., & Schmidt, C. C. (2002). Subsidies in the OECD fisheries sector: a review of recent analysis and future directions. Background paper for the FAO expert consultation on identifying, assessing and reporting on subsidies in the fishing industry, 3(6).
30 Parry, I., S. Black, and N. Vernon. (2021). "Still Not Getting Energy Prices Right: A Global and Country; Update of Fossil Fuel Subsidies." IMF Working Paper WP/21/236, International Monetary Fund, Washington, DC.
Rentschler, J., and M. Bazilian. (2017). "Reforming Fossil Fuel Subsidies: Drivers, Barriers, and the State of Progress." Climate Policy 17 (7): 891–914.

Environmental consequences encompass unsustainable resource extraction, pollution, and ecological unbalance. Subsidized industries often engage in excessive resource extraction, depleting natural resources beyond sustainable limits, jeopardizing ecosystems and biodiversity[31]. Hundreds of billions of dollars also flow each year to industries and activities responsible for large environmental footprints – money that could be tapped to help solve the problem. Annually, countries spend six times more on subsidizing fossil fuel consumption than their commitments made under the Paris Agreement to tackle climate change. For instance, global agriculture subsidies are responsible for the loss of 2.2 million hectares of forest per year - or 14% of global deforestation[32]. Fisheries subsidies, which exceed $35 billion each year, are a key driver of dwindling fish stocks, oversized fishing fleets, and falling profitability[33]. This demonstrates the interconnectedness of different environmental consequences, whereby subsidies in one sector can have ripple effects across multiple sectors by impacting ecosystems and biodiversity.

Socially, EHS can exacerbate inequalities, reduce aggregate welfare, and compromise public health. Literature has shown how, even subsidies intended to support the poor and reduce inequalities, often result in benefiting the rich, thereby exacerbating social inequalities. According to a 2015 review by the IMF, the richest 20% of households receive six times more benefits in fuel subsidies than the poorest 20% globally[34]. This is because, while poor and lower-middle-class households do benefit from subsidized fuel, middle-class and wealthier households tend to buy more fuel. This makes such subsidies highly inefficient as they achieve small energy access benefits at exorbitant costs[35]. Moreover, subsidies often consume large parts of public budgets, crowding out other productive public investments. EHS can also impact public health and increase the risk of premature death and diseases due to increased pollution[36]. For example, fossil fuel usage, incentivized by subsidies, is a key driver of the 7 million premature deaths each year due to air pollution.

Economically, EHS can be distortive by reducing economic efficiency and exacerbating negative externalities. Subsidies can reduce total factor productivity by shifting resources to less productive sectors. They can also send wrong economic signals, indicating, for example, that scarce natural resources, like water, are abundant. The consequence is overuse and inefficient use, which can result in resource deficit and slowed economic growth[37]. A recent study from the World Bank demonstrates how agricultural subsidy programs, intended to improve agricultural productivity and provide support to poor farmers, do not deliver those goals[38]. On the contrary, while agricultural subsidies may lead to higher output and yields overall, they tend to reduce technical efficiency. Moreover, subsidies cause farmers to use more inputs in less efficient ways. The evidence strongly points to subsidies lowering total factor productivity, which is a concern in a resource-constrained world where the demand for food is projected to increase by more than 50 percent by 2050[39].

2.4. Efforts and Strategies for EHS Reform

Efforts for reforming EHS span over three decades, marked by pivotal contributions from international institutions, policymakers, and advocacy groups. The World Bank's early explorations into the relationship between fossil fuel subsidies (FFS) and CO2 emissions laid the foundation for subsequent inquiries[40]. In the mid-

32 World Bank. (2023). Detox Development: Repurposing Environmentally Harmful Subsidies.
33 Ibid.
34 Coady, M. D.; Flamini, V. & and ìSears, L. (2015). The unequal benefits of fuel subsidies revisited: Evidence for developing countries. International Monetary Fund.
35 Coady, M. D.; Flamini, V. & and ìSears, L. (2015). The unequal benefits of fuel subsidies revisited: Evidence for developing countries. International Monetary Fund.
36 World Bank. (2023). Detox Development: Repurposing Environmentally Harmful Subsidies
37 Ibid.
38 Ibid.
39 Ibid.
40 European Commission, Directorate-General for Environment. (2022). A toolbox for reforming environmentally harmful subsidies in Europe - Final Report. Brussels.

1990s, the OECD conducted studies on subsidies across various sectors, catalyzing discussions and calls for their reduction or elimination. Initially, the impetus for subsidy reforms was primarily driven by fiscal considerations. The prospect of cost savings coupled with environmental benefits, such as reduced use of pesticides and fossil fuels, spurred policymakers to recognize the potential for «double wins» in their respective countries. This dual advantage of economic and environmental benefits propelled reformist agendas[41].

In recent years, there has been a growing pressure on governments to repurpose EHS in light of the increasingly evident consequences of climate change and the resulting climate goals. Critical milestones in EHS reform were witnessed in 2009, when the OECD Council Ministers emphasized avoiding policies, including subsidies, hindering green growth. Later, the G20, APEC, and the Convention on Biological Diversity called for phasing out inefficient fossil fuel subsidies, aligning with the UN's Sustainable Development Goals targeting agricultural, fossil fuel, and fisheries subsidies. In 2016, G7 Leaders committed to eliminating ineffective fossil fuel subsidies by 2025, marking a collective push for subsidy reform toward environmental sustainability[42].

To operationalise identifying EHS and assessing EHS impacts on the environment and the economy, international institutions have developed various analytical tools, such as the OECD Quick scan model, Checklist and Integrated Assessment Model. In addition, different models, such as the OECD Environment-Linkages model and other general equilibrium or regression models, are used to estimate the impact of subsidy removal on the economy and the environment. Specifically concerning fossil fuel subsidies, the OECD proposed a framework for their phase out, including analytical and modelling tools for assessing potential impacts of reform[43]. In parallel, the European Union has published documents for the efficient design of EHS phase-out, including a toolbox for reforming EHS in Europe[44].

2.5. A Regional Comprehensive Framework for EHS Reform

Existing literature has shed light on the detrimental environmental effects of EHS and identified challenges with advancing subsidy reform. Entities such as the OECD and the EU have also proposed frameworks and tools that can guide the phase-out of EHS. However little attention has been paid to methodologies for monitoring the impacts resulting from EHS reform. This is especially relevant to ensure that, in addition to aligning with environmental objectives, the reform process does not result in significant social and economic externalities. Tracking the impacts of EHS reform in a comprehensive way allows the design of compensation measures to mitigate potential negative socio-economic impacts. In this way, the reform process can be undertaken in a way that promotes social equity and justice.

Consequently, this chapter aims to bridge this gap by proposing a framework that can guide EHS reform in the Mediterranean area. This framework, namely the **Mediterranean EHS Phase-Out and Reform Framework (EHS-MedFRAME)**, suggests multi-dimensional and cross-sectoral indicators, as well as accountability mechanisms, to undertake subsidy reform in the Mediterranean region.

3. Methodology

Starting from the premise that reforming EHS should encompass socio-economic considerations alongside environmental goals, we seek to address the following research question: What framework can be employed in the Mediterranean region to comprehensively measure the multidimensional impacts of phasing out EHS, while simultaneously enhancing social and political accountability?

The hypotheses guiding this research are the following:

41 European Commission, Directorate-General for Environment. (2022). A toolbox for reforming environmentally harmful subsidies in Europe - Final Report. Brussels.
42 European Commission, Directorate-General for Environment. (2022). A toolbox for reforming environmentally harmful subsidies in Europe - Final Report. Brussels.
43 OECD. (2021). Update on recent progress in reform of inefficient fossil-fuel subsidies that encourage wasteful consumption 2021. Climate and Energy Joint Ministerial Meeting, Naples.
44 OECD. (2021). Update on recent progress in reform of inefficient fossil-fuel subsidies that encourage wasteful

1. The implementation of a comprehensive framework for monitoring EHS reform in the Mediterranean region positively correlates with improved effectiveness and efficiency in achieving environmental goals while enhancing social justice and equity.
2. The integration of socio-economic and environmental key indicators and reporting mechanisms within the framework will result in heightened transparency, thereby enhancing social and political accountability and support in the process of EHS reform.
3. Lessons learned from existing strategies related to the identification and phase-out of in various countries can offer valuable insights and best practices for developing and refining the comprehensive framework, facilitating its successful implementation and adaptation to the Mediterranean context.

This research employs a multifaceted approach to comprehensively address the given research question and hypotheses. Initially, a comprehensive review of existing literature on EHS and subsidy reform is conducted, based on academic articles, reports, and policy documents related to EHS. Concurrently, an analysis of existing frameworks developed for measuring EHS is undertaken to identify gaps and limitations in the literature. Moreover, case studies are analyzed to examine existing efforts for identifying and reforming EHS.

Drawing from the literature review and case studies, this paper develops a comprehensive framework for monitoring and assessing EHS reform and phase-out in the Mediterranean region. This framework includes economic, social, and environmental indicators, in addition to suggestions for accountability mechanisms. The chosen methodology ensures that the resulting framework is both regionally relevant and actionable.

4. Strategies Related to EHS Phase-Out

This section provides an analysis of existing strategies related to EHS identification and reform in countries both within and outside of the Mediterranean region. Case studies include France's Green Budgeting Strategy, Italy's EHS Annual Catalogue, and Indonesia's fossil fuels subsidies reform. Existing strategies related to the identification and phase-out of EHS in various countries offer valuable insights for developing the comprehensive framework, facilitating its successful implementation and adaptation to the Mediterranean context.

4.1. France's Green Budgeting Strategy

France's Green Budgeting strategy represents a comprehensive and transparent approach to evaluating fiscal expenses and subsidies through an environmental lens. The exercise assesses what share of the French budget is environmentally favourable or unfavourable, based on fiscal expenses' impacts on six key criteria. The assessment tags all French fiscal expenses within the Total Central Government Expenditures (ODETE), including the Recovery Plan budget[45].

Developed in 2019 by the General Financial Inspection (IGF) and the General Council for the Environment and Sustainable Development (CEGDD), the green budgeting exercise involves multiple stakeholders. A report is prepared by the General Commission for Sustainable Development (CGDD) of the Ministry of Ecological Transition and Solidarity, the budget department (DB), the tax legislation department (DLF), and the general management of the treasury (DGT), who are attached to the Ministry of the Economy, Finances and Recovery (MEFR)[46]. The quality of Green Budget tagging is further enhanced by the

45 Ministère de l'Économie, des Finances et de la Souveraineté industrielle. (2021). Report on the Environmental Impact of the Central Government Budget.

46 European Commission, Directorate-General for Environment. (2022). A toolbox for reforming environmentally harmful subsidies in Europe: detailed

input from think-tanks, agencies, and institutions specialized in environmental issues. This approach makes the Green Budgeting exercise, which is publicly available, an effective tool for enhancing transparency and accountability concerning environmental information by the Parliament, civil society and citizens[47] [48].

While the Green Budgeting strategy primarily focuses on evaluating the environmental status of French fiscal expenses, it does not provide recommendations for reforming subsidies or the budget itself or result in any political commitment to reform EHS[49]. Despite the publication of the environmental report, there remains an opportunity to further integrate its insights into the budgetary decision-making process to drive more impactful environmental policies[50]. Nonetheless, it represents a pioneering initiative in mainstreaming environmental considerations into the broader budgeting process. On one hand, it serves as a valuable tool for policymakers to understand the environmental impacts of budget expenditures and provides insights into potential areas for reform. On the other hand, through its comprehensive evaluation, public disclosure, and multi-stakeholder engagement approach, it increases transparency of public expenditure[51].

4.2. Italy's EHS Annual Catalogue

Italy developed a comprehensive approach to identify environmentally friendly (EFS) and harmful subsidies (EHS) through a regularly published Catalogue of Environmentally Damaging Subsidies and Environmentally Advantageous Subsidies[52]. The Catalogue maps all existing subsidies and provides detailed information about each identified subsidy (also referred to as "identity card"), including a description, its classification into direct, indirect, or implicit subsidy, whether it is funded by the EU, the type of governance level for reform (national/EU/international), and fiscal impacts, among others. The environmental assessment is based upon literature studies, manuals and data taken from official statistics[53].

The framework aims to equip decision-makers with critical information for potential EHS removal and EFS adoption, supported by quantification methodologies. Similar to the French Budgeting Strategy, also the Italian Catalogue requires the engagement of several actors. The analysis is carried out by the OECD for the Italian Ministry for Ecological Transition (MITE) and the Ministry of Economy and Finance (MEF), funded by the European Commission and managed by the Directorate General for Structural Reform (DG REFORM). In addition, a special inter-ministerial Committee for the Ecological Transition (CITE) has been appointed in 2021, tasked with yearly elaboration of the Catalogue of Environmentally Harmful and Friendly Subsidies[54].

The catalogue recognizes that certain subsidies might serve social and economic purposes, hence acknowledges the need for potential compensatory measures, such as providing direct subsidies to lower-income groups affected by the reform. Even if the catalogue itself does not list such measures, it is suggested that when a given subsidy is identified for reform, a detailed assessment of the impacts this would have on different categories of stakeholders (workers, industry, citizens etc.) should be carried out[55].

47 RPA Europe. (2021). Mapping objectives in the field of environmental taxation and budgetary reform: Environmentally harmful subsidies.
48 Cour des Comptes. (2023). La prise en compte de l'environnement dans le budget et les comptes de l'État.
49 European Commission, Directorate-General for Environment. (2022). A toolbox for reforming environmentally harmful subsidies in Europe: detailed annexes - Final Report.
50 Cour des Comptes. (2023). La prise en compte de l'environnement dans le budget et les comptes de l'État.
51 Kete, H. (2022). Green Budgeting: France and Italy Practices. Uluslararası Sosyal, Siyasal ve Mali Araştırmalar Dergisi,(2), 2, 102-115.
52 Ministero dell'Ambiente e della Sicurezza Energetica. (2022). Catalogo dei Sussidi Ambientalmente Dannosi e dei Sussidi Ambientalmente Favorevoli 2022 (Dati 2021).
53 Ministero dell'Ambiente e della Sicurezza Energetica. (2022). Catalogo dei Sussidi Ambientalmente Dannosi e dei Sussidi Ambientalmente Favorevoli 2022 (Dati 2021).
54 Ministero dell'Ambiente e della Sicurezza Energetica. (2022). Catalogo dei Sussidi Ambientalmente Dannosi e dei Sussidi Ambientalmente Favorevol 2022 (Dati 2021).
55 Ministero dell'Ambiente e della Sicurezza Energetica. (2022). Catalogo dei Sussidi Ambientalmente Dannosi e dei Sussidi Ambientalmente Favorevol 2022 (Dati 2021).

The Italian Catalogue has paved the way for sound reform proposals to be put forward and discussed. Based on the information provided, policy-makers can use the Catalogue as a tool to identify EHS and design a socially just reform process.

4.3. Indonesia's Fossil Fuels Subsidies Reform

The fossil fuel subsidies reform in Indonesia in 2014-2015 aimed to address several economic and environmental issues associated with subsidizing fossil fuels. Indonesia has a long history of subsidizing fossil fuels, originally introduced to make them affordable for the population, but they became a significant burden on the government budget due to rising global oil prices and domestic consumption[56]. By the early 2010s, Indonesia's fossil fuel subsidies were consuming a large portion of the government's budget, draining resources that could be allocated to other critical sectors such as education, healthcare, and infrastructure. Moreover, the subsidies were promoting wasteful consumption and hindering efforts to reduce greenhouse gas emissions[57].

The reform process was a government-led initiative, carried out by multiple ministries, such as the Ministry of Finance and Ministry of Energy and Mineral Resources, and other relevant stakeholders, including the National Agency Council. The reform involved a gradual reduction and restructuring of fossil fuel subsidies rather than an immediate removal to minimize social and economic disruptions. Key measures included price adjustments, with the government gradually increasing the prices of subsidized fuels to bring them closer to market levels. The provision of social assistance as a buffer to poor populations against the negative externalities of fuel subsidy reform is the most important factor in its success[58]. Compensatory measures such as cash transfer programs were introduced to mitigate the impact of subsidy reductions on low-income households[59]. Despite some initial resistance from the public, these compensatory measures helped alleviate the burden on vulnerable households. An important role was also played by efforts to raise public awareness through communication campaigns, which aimed at informing the public about the negative impacts of fossil fuel subsidies and expected benefits derived from reform[60].

The Indonesia case study is a demonstration of how to undertake EHS reform effectively. It suggests that gradual reform, compensation measures and a good communication strategy are determining factors for enhancing the success of the reform process. Moreover, it also demonstrates that the reform of fossil fuel subsidies delivered important environmental, social, and economic benefits[61]. The reforms also helped ease the strain on the government budget and allowed for increased investment in priority areas, including renewable energy, infrastructure and social welfare programs, all while reducing waste in energy consumption[62].

5. COMPREHENSIVE FRAMEWORK DEVELOPMENT

This section proposes a comprehensive framework for monitoring and assessing EHS reform and phase-out in the Mediterranean region, namely the **Mediterranean EHS Phase-Out and Reform Framework (EHS-MedFRAME).** This framework includes economic, social and environmental cross-sectoral indicators, in addition to suggestions for mechanisms that enhance the political and social accountability of

56 Ministry of Energy and Mineral Resources and Ministry of Finance Republic of Indonesia. (2019). Indonesia's Effort to Phase Out and Rationalise Its Fossil-Fuel Subsidies.

57 Chelminski, K. (2016). Redefining success in the fossil fuel subsidy reform in Indonesia.

58 UNEP. (2016). Redefining Success in the Fossil Fuel Subsidy Reform in Indonesia. Geneva: United Nations Environment Programme.

59 Ministry of Energy and Mineral Resources and Ministry of Finance Republic of Indonesia. (2019). Indonesia's Effort to Phase Out and Rationalise Its Fossil-Fuel Subsidies.

60 Ministry of Energy and Mineral Resources and Ministry of Finance Republic of Indonesia. (2019). Indonesia's Effort to Phase Out and Rationalise Its Fossil-Fuel Subsidies.

61 Pradiptyo, R., Susamto, A., Wirotomo, A., Adisasmita, A., & Beaton, C. (2016). Financing development with fossil fuel subsidies. Winnipeg: International Institute for Sustainable Development.

62 UNEP. (2016). Redefining Success in the Fossil Fuel Subsidy Reform in Indonesia. Geneva: United Nations Environment Programme.

the reform process. During the Plan Bleu Regional Workshop (January 30th 2024)[63], participants engaged in a fruitful discussion surrounding the framework and its array of indicators. Following insightful comments and discussions at the workshop, the EHS-MedFRAME underwent refinement, enriching its capacity to capture the multidimensional impacts of EHS reform.

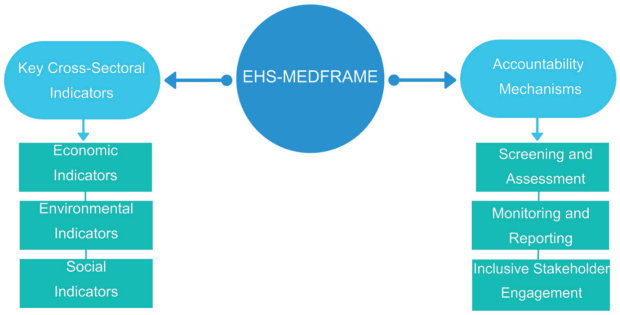

Figure 1. *The Mediterranean EHS Phase-Out and Reform Framework (EHS-MedFRAME)*

5.1. The Mediterranean EHS Phase-Out and Reform Framework (EHS-MedFRAME)

Examining the multifaceted impact of EHS reform within the Mediterranean region requires comprehensive analysis of the resulting multidimensional impacts. This section provides an overview of cross-sectoral economic, environmental, and social indicators that constitute the EHS-MedFRAME. These indicators are applicable across the majority of sectors aiming to enhance a comparison of reform impacts across sectors. The possibility of combining them with sectoral indicators, which specifically analyze concerned sectors, is acknowledged; however, such integration falls outside the scope of this paper. Moreover, the list of indicators may not be exhaustive and could be updated when testing the practical implementation of the framework.

5.1.1. Economic indicators

Specific economic indicators can assess the financial implications of EHS reform. These include:

- **Government expenditure:** This indicator is crucial to understanding the fiscal impact of the subsidies on the government's budget. A reduction or distributional change in expenditure indicates that public resources are being reallocated, potentially towards more sustainable and environmentally friendly initiatives. Budgetary analysis and financial reports are the main tools to track whether this is the case. Metrics could encompass total subsidy expenditure, subsidy expenditure as a percentage of GDP, and change in subsidy expenditure over time.
- **Employment rates:** Changes in employment rates across sectors suggests the extent to which subsidy reform leads to increased job opportunities in sectors aligned with sustainability goals, while potentially reducing jobs in industries affected by subsidy cuts. After defining what green sectors encompass, metrics to evaluate the impacts of reform could include the number of jobs in green industries, as opposed to those in less environmentally friendly industries (e.g. renewable energy versus fossil fuels industries).
- **Gross domestic product (GDP) impact:** Understanding the impact of reform on GDP helps evaluate the broader economic consequences of the subsidy phase-out. GDP growth rate, sectoral GDP changes, and input-output analysis could be employed to monitor this process.
- **Private sector investment:** Changes in private sector investment indicate the market's response to the reform. It reflects a reevaluation of investment opportunities, with sectors previously subsidized potentially becoming less attractive, favoring greener sectors. Shifts in private sector investments could be measured through a combination of financial metrics, market indicators, and industry-specific data.
- **Consumer price index (CPI):** Monitoring the impact on subsidy reform on consumer prices is pivotal to understanding how subsidy reform affects the cost of goods and services. Tracking CPI trends and comparing price indices for goods and services should be conducted.
- **International trade impact:** This indicator shows how EHS reform influences international trade dynamics. Monitoring

63 https://planbleu.org/en/page-actualite/return-to-the-workshop-dedicated-to-harmful-subsidies-and-the-mediterranean/

changes in sectoral trade flows, trade balances, and trade competitiveness can provide insights into the effects of EHS reform on a country's position in the global market and its trade relations with other nations. Analysis of trade data and trade agreements could be done by considering export volume and value, import volume and value, and trade balance, among others.

5.1.2. Environmental indicators

Environmental indicators are crucial for monitoring EHS phase out, as they directly align with the overarching goal of fostering ecological sustainability. These include:

- **Greenhouse gas emissions (GHGs):** Phasing out EHS can lead to a reduction in emissions, especially in the case of subsidies supporting industries with high carbon footprints (e.g. fossil fuels subsidies). Conversely, without proper policies, there might be an increase if energy-intensive sectors, such as manufacturing or heavy industries, face challenges in adopting cleaner technologies. More specifically, changes in GHGs, such as carbon dioxide (CO2), methane (CH4), and nitrous oxide (N2O), resulting from industrial activities affected by subsidy reform should be monitored.
- **Resource use efficiency:** This indicator provides insights on how efficiently natural resources are used. EHS reform seeks to encourage sustainable resource use, making this indicator crucial in assessing the effectiveness of specific subsidies reform. Useful metrics include resource productivity ratio (e.g., GDP per unit of resource use), resource intensity per unit, and waste intensity per unit, among others.
- **Environmental quality:** Removal of subsidies can lead to reduced pollutants, resulting in improved environmental quality. The latter should be monitored following EHS reform to assess the environmental benefits derived from it. Indexes for air, water, and soil quality could be employed as metrics to monitor changes in environmental quality.
- **Waste management:** Waste reduction rates reflect improvements in resource efficiency, support the adoption of circular economy principles, and signify a commitment to environmentally responsible production. To understand how this is affected by EHS reform, it would be useful to check waste management reports, recycling facility records, landfill monitoring data, focusing on metrics such as the percentage change in waste generation, recycling rate (percentage of total waste recycled), and landfill diversion rate.
- **Eco-friendly technologies:** EHS reform can encourage industries across different sectors to adopt eco-friendly practices and technology. Monitoring the use of cleaner production technologies is pivotal for assessing the environmental impact derived from EHS phase-out. One way of measuring this could be to track the number of eco-certifications obtained by industries, as well as the percentage of industries adopting eco-friendly technologies[64].

5.1.3. Social indicators

The following set of indicators is essential to assess the impact of EHS reform on societies. While environmental benefits are an inevitable result derived from EHS phase out, the same cannot always hold true in respect to the social dimension. In certain instances, EHS have been implemented to support specific segments of society, particularly lower-income groups. Therefore, it is particularly important to integrate the following social indicators in the regional framework. Having an overview of potentially damaging social effects derived from EHS reform can allow the development of complementary measures that can safeguard the most vulnerable parts of society, thereby mitigating poverty and inequality. Social indicators include:

- **Income distribution:** the impact of subsidy reform on income distribution is a key indicator for ensuring that benefits reach all socioeconomic groups and minimizing disparities. Historically, certain subsidies may have disproportionately favored specific industries or income groups, contributing to economic imbalances. The phase-out of these subsidies presents an opportunity to address such disparities and foster a more equitable distribution of resources and opportunities. This can be measured through metrics such as the Gini coefficient and income quintile distribution.

64 Consensus is needed on what technologies can be considered as 'eco-friendly'.

- **Gender and generational equity:** to ensure that EHS reform is undertaken in a way that promotes gender and generational equity, it is essential to align reforms with social justice goals. Metrics include employment rates among different gender and age groups in sectors affected by subsidy reform. It is also useful to compare income distribution, disaggregating income data by gender (male, female) and generation (youth, adult, elderly).
- **Health impacts:** the phase-out of EHS can positively impact health outcomes by reducing exposure to harmful pollutants and environmental stressors. As subsidies are often linked to industries with negative health externalities, their removal contributes to improved air and water quality, ultimately benefiting public health. Health indicators, such as reduced rates of deaths and illnesses derived from environmental pollution, as well as life expectancy rates, can provide insights on the health benefits derived from EHS reform.
- **Social services and basic infrastructures:** EHS reform can influence social services and infrastructure development. As subsidies are reallocated, there may be opportunities to invest in community development projects, healthcare facilities, and education initiatives. Monitoring the positive social outcomes resulting from subsidy phase-out could rely upon metrics such as percentage of GDP allocated to social services and infrastructure, percentage of the population with access to healthcare, education, clean water, sanitation, and electricity, level of investments in investment in infrastructure projects, including transportation, energy, water supply, sanitation, among others.
- **Community engagement**: Assessing the extent to which communities are involved in discussions, consultations, and policy formulation provides insights into the inclusiveness of the reform process. Specifically, it is crucial for ensuring transparency, accountability and social inclusivity. Although difficult to quantify, community engagement can be assessed by employing qualitative indicators such as stakeholder consultations, surveys, participation rates to political processes. Transparency and democracy indexes can also be employed.

5.2. Accountability mechanisms

As highlighted during the Plan Bleu Regional Workshop, enhancing transparency in the process of EHS reform is crucial for ensuring political and social accountability and support. The latter refers to the responsibility of governments and policymakers to justify their decisions, actions, and policies related to subsidy reform to the public and various stakeholders. The responsibility lies in creating mechanisms enabling citizens to hold decision-makers accountable and ensuring policies align with the public interest and societal values. This section proposes a series of mechanisms complementing cross-sectoral indicators to enhance the effectiveness of the EHS-MedFRAME, with a focus on fostering transparency and accountability.

5.2.1. Screening and Assessment of Governmental Budget Allocation

As a starting point for enhancing accountability in the process of subsidy reform, it is pivotal to obtain and disclose information concerning governmental budget allocations and their environmental impacts. This would entail conducting an annual screening and environmental assessment of governmental budget allocation, leveraging upon existing initiatives such as France's Green Budgeting Strategy and the Italian Catalogue of Environmentally Damaging Subsidies and Environmentally Advantageous Subsidies. These screening and assessment processes should be carried out at the national level with an annual frequency, providing a thorough evaluation of fiscal expenses across Mediterranean countries through an environmental lens.

Moreover, to advance the effectiveness of EHS reform, these processes could extend beyond mere assessment to the identification of priority areas for reform. While current methodologies play a vital role in pinpointing EHS, they may fall short in providing actionable reform recommendations. To enrich these methodologies and enhance accountability, criteria could be established to prioritize subsidies for reform. For instance, subsidies with the highest environmental impact or those perpetuating the most significant social and economic externalities could be targeted first. Criteria such as contribution to greenhouse gas

EHS-MedFRAME Cross-sectoral Indicators		
Economic	**Environmental**	**Social**
Government expenditure	*Greenhouse gas emissions (GHGs)*	*Income distribution*
Employment rates	*Resource use efficiency*	*Gender and generational equity*
Gross domestic product (GDP) impact	*Environmental quality*	*Health impacts*
Private sector investment	*Waste management*	*Social services and basic infrastructures*
Consumer price index (CPI)	*Eco-friendly technologies*	*Community engagement*
International trade impact		

TABLE 1

EHS-MedFRAME cross-sectoral and multi-dimensional indicators
Source : *own production*

emissions, depletion of natural resources, or exacerbation of income inequality could guide decision-making, ensuring that reform efforts address the most pressing issues.

To foster accountability, a collaborative approach in this process is imperative. A diverse array of stakeholders could be engaged, ranging from governmental bodies like the Ministry of Environment and the Ministry of Economy and Finance to international organizations such as the OECD and Plan Bleu (UNEP/MAP). These stakeholders contribute invaluable technical expertise and capacity building.

5.2.2. Monitoring and Reporting of the Reform Processes

Monitoring and reporting processes are integral components for enhancing transparency and accountability in the reform of EHS. In order to effectively track and report on progress in reforming EHS, a robust monitoring and reporting mechanism monitoring the multidimensional impacts of reform, such as the EHS-MedFRAME, should be employed. This would also allow for the identification of compensatory measures to mitigate potential socio-economic externalities deriving from reform.
Each Mediterranean country would benefit from establishing a dedicated catalogue at the national level. Such catalogue would meticulously track the reform process of identified harmful subsidies, utilizing a standardized evaluation framework such as the EHS-MedFRAME. To ensure the reliability and independence of this information, independent bodies could be tasked with monitoring this process. Examples are entities with expertise in auditing governmental finances and evaluating government spending, such as the EU Court of Auditors or France's Cour des Comptes. Collaboration with think tanks, NGOs, and universities to produce unbiased reports is crucial. International intergovernmental institutions such as the OECD, IMF and World Bank can also play a pivotal role, not only in providing technical support and capacity building but also in facilitating cooperation and knowledge exchange among these independent bodies.

This monitoring process serves as a social and political accountability mechanism, holding governments and policymakers accountable for their decisions and actions concerning subsidy reform. It allows for public oversight and scrutiny, ensuring that decision-makers are responsive to societal interests. Additionally, the regional comparison of reform efforts across countries, enhanced by the use of a standardized methodology, can enhance the identification of best practices and facilitate peer learning and benchmarking.

5.2.3. Inclusive Stakeholder Engagement

Inclusive stakeholder engagement is a fundamental component to enhance accountability in the EHS reform process. This approach ensures that the reform process is transparent, inclusive, and responsive to the diverse needs and perspectives of stakeholders. In this way, it also facilitates the identification of compensatory measures to mitigate social and economic externalities when reforming EHS.

The first step towards fostering inclusive stakeholder engagement is conducting a comprehensive mapping of stakeholders involved in EHS reform. This involves identifying governmental bodies, civil society organizations, academic institutions, and other relevant actors whose input is essential for informed decision-making. By incorporating diverse viewpoints, decision-makers can better address the social implications of reform initiatives and ensure that all stakeholders are represented in the process.

Facilitating dialogue and collaboration among stakeholders is crucial for building consensus and advancing reform efforts. This can be achieved by leveraging existing policy frameworks and mechanisms, such as the Mediterranean Strategy for Sustainable Development (MSSD) and the Barcelona Convention, to provide platforms for discussion and cooperation. By strengthening regional cooperation, stakeholders can exchange knowledge, share best practices, and coordinate efforts to address common challenges related to EHS reform.

Additionally, dedicated digital platforms can enhance transparency and accountability throughout the reform process. The creation of a regional platform for disclosure, where national reports on subsidy reform efforts are made publicly available, would further enhance social accountability by promoting transparency and enabling public oversight of government actions. By providing access to information, these platforms empower citizens to monitor progress, hold decision-makers accountable, and actively participate in the reform process.

6. CHALLENGES IN SUBSIDY REFORM

This section outlines the factors that can represent a challenge to the process of EHS phase-out, drawing from concrete examples. Identified challenges include the lack of a shared definition, public resistance, political willingness, external shocks, transparency and data availability.

6.1. Absence of a Universally Accepted Definition of EHS

To begin with, a fundamental challenge hindering EHS reform is the a**bsence of a universally accepted definition** and precise identification criteria. As highlighted in the literature, what constitutes subsidies and what makes them environmentally harmful is difficult to assess. Different definitions proposed by institutions, such as the OECD, World Bank, WTO represent a good starting point for discussion on what is the most appropriate definition. However, the current lack of consensus on the adoption of a specific definition is still a crucial gap that needs to be addressed.

As a result, the ambiguity surrounding the identification criteria for EHS complicates reform initiatives and hampers cross-country cooperation. Divergent methodologies for assessing environmental impact and inconsistent classification practices make it challenging to compare subsidy regimes and evaluate reform progress. Moreover, the lack of an established definition of what constitutes a subsidy and unclear classification criteria may give countries an "escape route" from their obligations[65].

6.2. Public Resistance

Another potential challenge to subsidy reform lies in the possibility of encountering **public resistance.** This resistance often stems from factors such as a lack of awareness regarding the necessity for reform, especially when they perceive that this would impact them negatively.

65 Asmelash, H. (2022). The regulation of environmentally harmful fossil fuel subsidies: From obscurity to prominence in the multilateral trading system. European Journal of International Law, 33(3), 993-1023.

For example, individuals and communities dependent on industries benefiting from EHS may fear job losses or economic instability if subsidies are reduced or eliminated. This fear can lead to resistance as they prioritize short-term economic concerns over long-term environmental sustainability.

The case of the «Yellow Vest» protests in France serves as an example of the complexities associated with subsidy reform[66]. Other Mediterranean countries have also grappled with subsidy reform challenges, particularly in the energy sector. This underscores the importance of acknowledging public sentiment and of effective communication as a means to limit disinformation, to ensure the success of such reforms and the progress towards environmental sustainability goals.

6.3. Political Willingness

Political willingness plays a crucial role in the success of subsidy reform efforts, and its absence or resistance can hinder the process of phasing out EHS. The reluctance to pursue reform may arise from a variety of factors, including potential negative impacts on vested interests and industries heavily reliant on subsidies. Political leaders may be hesitant to implement reforms that could jeopardize support from influential interest groups or key constituents. Moreover, political leaders are sensitive to public opinion and pressure, making the likelihood of reform dependent on public awareness and support for EHS phase-out. Therefore, in the case of strong public demand for environmental protection and reforming harmful subsidies, policymakers are more likely to prioritize these issues. Conversely, if there is insufficient public awareness or support, policymakers may not prioritize EHSeform.

The importance of political willingness for advancing EHS reform has been highlighted by the Indonesian case. Indonesian policymakers acknowledged that fossil fuel subsidies were imposing a substantial fiscal burden on the government budget, diverting resources away from essential social programs and infrastructure projects. Despite the strong social and political challenges associated with subsidy reform, Indonesian policymakers engaged in extensive consultations with stakeholders, including civil society organizations, industry representatives, and the public, to build consensus and mitigate social unrest. They also designed an effective communication strategy to raise awareness on the need for reform. This proactive approach underscored the political willingness to overcome resistance and push forward with the reform agenda[67].

6.4. External Shocks and Context

External shocks, such as unforeseen events or crises, can pose significant challenges to the process of phasing out EHS. These shocks can arise from various sources, including economic downturns, social upheavals, natural disasters, and geopolitical conflicts. When governments are confronted with such crises, their immediate priority often becomes addressing the pressing socio-economic needs of their populations, sometimes at the expense of environmental considerations.
For example, the global COVID-19 pandemic presented an unprecedented crisis that prompted governments worldwide to roll out economic stimulus packages to mitigate the socio-economic impacts of the pandemic. These packages often included subsidies to support struggling industries, such as aviation or fossil fuels[68] [69]. While these subsidies were crucial for preventing widespread job losses and economic collapse, many of them were not aligned with sustainable environmental practices. Similarly, following the war in Ukraine and the resulting disruptions in energy supply, fossil fuel subsidies were double their 2021 levels, which were

68 Holden. E. (2020). $2tn US coronavirus relief comes without climate stipulations. The Guardian.
69 IISD. (2020). G20 Governments Have Committed USD 151 Billion to Fossil Fuels in COVID-19 Recovery Packages.

already almost five times those seen in 2020[70]. This is because, in response to energy insecurity and rising fuel prices, governments resorted to subsidies to stabilize energy markets and shield consumers from price shocks. However, these subsidies may inadvertently perpetuate reliance on fossil fuels and hinder progress towards renewable energy transition and environmental sustainability.

6.5. Transparency and Data Availability

Transparency and data availability are integral to effective EHS reform. When subsidy information is made transparent and accessible to the public, it fosters accountability, promotes public awareness, and facilitates informed policy discussions. Moreover, comprehensive data on subsidies is necessary for evidence-based decision making. The availability of accessible and comprehensive data enables policymakers to assess the environmental impact of EHS and design targeted reform measures to address them effectively, alongside potential compensatory measures to address negative social and economic externalities.
However, many countries still lack robust systems for collecting, analyzing, and disseminating subsidy information, making it challenging to assess the full extent of environmentally harmful practices and their impact on the environment. Nevertheless, there are notable exceptions where efforts to improve transparency allowed for effective reform. The aforementioned cases of Italy and France are exemplary initiatives of comprehensive methodologies for data gathering and disclosure. These methodologies enhance evidence-based reform on one hand, while fostering social and political accountability on the other hand.

7. Policy Implications

This section delves into the policy implications related to the monitoring of EHS subsidies. Based on the literature review, case studies, and framework development provided in this chapter, four practical and actionable policy suggestions are provided.

7.1. Establishing a Regional Definition and Identification of EHS

The absence of a universally accepted definition and criteria for identifying EHS presents a significant obstacle to subsidy reform efforts. Currently, different countries utilize disparate definitions and criteria, leading to challenges in comparing subsidies and coordinating reform efforts. In the past, this has also hindered any efforts for establishing legally binding agreements. To address this challenge, it is essential to establish a common regional definition and criteria for identifying EHS.

One approach to tackling this issue is to evaluate existing options for defining and identifying EHS comprehensively. Considering existing definitions that assess EHS comprehensively, such as the OECD's definition, would facilitate the discussion. Existing regional forums, such as the components of the Barcelona Convention[71] or the Union for the Mediterranean (UfM), present an opportunity to convene Mediterranean countries and address the establishment of a regional definition and criteria for identifying EHS. These forums provide platforms for dialogue, cooperation, and consensus-building among participating countries, facilitating meaningful discussions and exchanges of best practices.

Ideally, these fora could serve as a means for formalizing the agreement on a regional definition and criteria through regional treaties, agreements, or declarations. This formalization would ensure commitment and adherence from participating countries, fostering consistency and coherence in subsidy reform efforts across the Mediterranean region.

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70 Muta, T. and Erdogan, M. (2022). The global energy crisis pushed fossil fuel consumption subsidies to an all-time high in 2022. IEA.

71 The Barcelona Convention and its seven Protocols adopted in the framework of the Mediterranean Action Plan (MAP) constitute the principal regional legally binding Multilateral Environmental Agreement (MEA) in the Mediterranean. The main aim of the convention and the protocols is to protect the marine environment and the coastal region of the Mediterranean Sea.
The Convention for the Protection of the Mediterranean Sea Against Pollution (Barcelona Convention) was adopted on 16 February 1976 in Barcelona and entered into force in 1978. The Barcelona Convention was amended in 1995 and renamed as the Convention for the Protection of the Marine Environment and the Coastal Region of the Mediterranean. The amendments to the Barcelona Convention entered into force in 2004.

7.2. Integrating EHS Reform into Regional Sustainability Agendas

Currently, there is no established regional protocol or specific agenda addressing the reform of EHS in the Mediterranean region. However, given the pressing need to address environmental challenges and promote sustainable development, integrating EHS reform into regional sustainability agendas presents a strategic opportunity.

Expanding existing political frameworks to incorporate EHS reform efforts is crucial. The Barcelona Convention, for instance, provides a strategic entry point for mainstreaming EHS reform within regional sustainability frameworks. This Convention, with its dedicated focus on safeguarding the marine and coastal environment, serves as a robust platform for dialogue and collaboration among Mediterranean countries regarding EHS issues. Leveraging existing mechanisms under the Convention, such as the Mediterranean Action Plan (MAP) and its network of Focal Points, offers a structured approach to incorporate EHS reform into national and regional strategies.

The Mediterranean Strategy for Sustainable Development (MSSD) may be a significant avenue for integrating EHS reform. Designed to address sustainability challenges comprehensively, the MSSD focuses on promoting economic, social, and environmental sustainability across various sectors. It provides a platform for multi-stakeholder engagement and collaboration, involving governments, civil society organizations, international institutions, and other relevant stakeholders. By incorporating EHS reform into the MSSD, countries can leverage this collaborative platform to foster dialogue, share knowledge, and build consensus on the importance of subsidy reform for achieving sustainability goals.
Furthermore, the MSSD offers a framework for setting specific targets and indicators to measure progress towards sustainability goals. By including EHS reform goals, countries can establish clear benchmarks for phasing out harmful subsidies and transitioning to sustainable economic practices, driving action and accountability.
In this context, the role of international intergovernmental institutions active in the Mediterranean region such as OECD, IMF, Plan Bleu & UNEP/MAP or UfM; or Regional organizations or Think Tanks such as Euromesco, FEMISE or others is essential for facilitating exchange, providing technical support, and capacity building to maximize synergies between environmental protection, economic development, and social equity. These organizations can play a pivotal role in facilitating cooperation among Mediterranean countries and ensuring that EHS reform remains a priority within the broader sustainability agenda.

7.3. Strengthening Monitoring and Reporting Mechanisms for EHS Reform

To address the fragmented and inadequately reported nature of reform efforts concerning EHS, there is a critical need to enhance national monitoring and reporting mechanisms. Currently, reform initiatives primarily focus on the environmental dimension, while little attention is paid to socio-economic externalities. Therefore, it is imperative to adopt measures that comprehensively monitor and report on the multifaceted impacts of EHS phase-out.

In light of this, national governments are advised to adopt the EHS- MedFRAME for effectively monitoring the environmental, social, and economic dimensions of subsidy reform. By integrating cross-sectoral indicators into monitoring processes, policymakers can obtain a holistic understanding of the reform's impacts, which ensures that all relevant aspects are adequately addressed. This also allows policy makers to design specific compensation measures to mitigate the socio-economic externalities identified during this monitoring process, fostering social equity and accountability in the reform process.

Strengthening monitoring and reporting mechanisms through frameworks such as the EHS-MedFRAME also implies the active involvement of diverse stakeholders, including government entities, civil society organizations, and international partners. Collaborative efforts should be encouraged for collecting, analyzing, and disseminating accurate data on EHS reform, facilitating evidence-based decision-making and enhancing transparency.

In addition to increasing accountability and effectiveness of EHS reform, robust monitoring and reporting can also prevent the emergence

of new EHS. By transparently tracking fiscal expenditures and their environmental, social, and economic repercussions, policymakers can make informed decisions to avoid introducing subsidies that may necessitate future reform efforts. This proactive approach contributes to the prevention of further environmental degradation and reinforces the sustainability of subsidy policies.

7.4. Undertaking Gradual Reform with Compensation Measures and Support Mechanisms

Abrupt and extensive reforms often encounter significant opposition from affected stakeholders, leading to challenges in implementation and sustainability. Therefore, adopting compensation measures alongside gradual reform approaches is crucial to mitigate public resistance and ensure the success of reform efforts. As demonstrated by the successful reform experience in Indonesia in 2015, implementing reforms in a step-by-step manner minimizes disruptions to affected industries and communities, fostering smoother transitions and greater acceptance among stakeholders.

Compensation measures play a crucial role in addressing socio-economic externalities arising from subsidy reform. In the Indonesian case, the implementation of social safety nets and targeted assistance programs helped mitigate the adverse effects of subsidy reduction on vulnerable segments of society. Similar measures, tailored to the specific needs and circumstances of each country, can be implemented to ensure that no group is disproportionately affected by reform efforts. Examples of compensation measures may include income support programs, job retraining initiatives, or investment in alternative livelihood opportunities for affected communities.

Raising awareness among the population about the need for subsidy reform is also paramount. Effective communication campaigns can help dispel misconceptions and build support for reform initiatives. By highlighting the environmental, social, and economic benefits of phasing out harmful subsidies, policymakers can garner public endorsement and create momentum for change.

Therefore, by combining compensation measures with gradual reform strategies and effective awareness-raising campaigns, policymakers can enhance the likelihood of successful EHS subsidy reform. These measures not only help minimize resistance but also promote social equity and ensure the sustainability of reform efforts in the long term.

8. CONCLUSIONS, LIMITATIONS AND SUGGESTIONS FOR FUTURE RESEARCH

This chapter sought to tackle the multifaceted challenges associated with reforming EHS in the Mediterranean region. Drawing upon an extensive literature review, in-depth case studies, and the proposition of the EHS-MedFRAME, the study provides a practical tool for guiding subsidy reform efforts. It underscores the significance of adopting a multi-dimensional approach to EHS reform, coupled with robust accountability mechanisms, to foster equitable and socially just outcomes.

While this paper makes strides in advancing the discourse on EHS in the Mediterranean, it also acknowledges its limitations and offers suggestions for future research.

Firstly, it recognizes that the list of cross-sectoral indicators forming the EHS-MedFRAME framework may not be exhaustive. There is room for further refinement and expansion of these indicators to ensure they adequately capture the diverse impacts of subsidy reform across various sectors. Additionally, the metrics proposed within the framework may require updates to maintain their relevance and effectiveness in assessing reform outcomes accurately.

Secondly, while the framework proposed with cross-sectoral indicators allows for the comparison of impacts of reform across different sectors, there is room for further development. Integrating sector-specific metrics could provide a more comprehensive overview of the impacts on each sector, enhancing the analytical depth of the framework. Therefore, future research could explore the inclusion of sector-specific indicators to tailor assessments to the unique characteristics of different industries.

Finally, the practical implementation of the EHS-MedFRAME has not been tested in real-world settings. There may be challenges associated

with data availability and reliability, which could affect the feasibility of implementing the framework effectively. Moreover, some countries within the Mediterranean may have different capacity in gathering and reporting data. Future research efforts could focus on evaluating the practicality of the framework and addressing any constraints related to data collection and analysis, taking into account differences among countries.

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CHAPTER 2. FISHING SUBSIDIES AND THEIR IMPACTS ON MARINE ECOSYSTEM HEALTH IN THE MEDITERRANEAN SEA

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Fishing port of Dives-sur-MerCredit : Adobe Stock

Over the past two decades, environmentally harmful fishing subsidies, particularly capacity-enhancing ones, have posed significant threats to marine fish stocks worldwide, including the Mediterranean Sea. Despite the global attention paid to harmful fishing subsidies, studies focusing on their impacts in specific regions, especially in the Mediterranean, remained limited. Today, scientists agree on the need to remove harmful fishing subsidies, as they damage marine environmental health and unevenly benefit the industrial fishing fleet. This study delves into the repercussions of fishing subsidies on the marine ecosystem health of Türkiye, a pivotal player in Mediterranean fisheries. In recent years, Türkiye has made progress towards a more environmentally conscientious approach, shifting its «subsidy-mix» towards more environmentally virtuous tools, mirroring patterns observed in other EU-Mediterranean countries.

Leveraging data from relevant sources (monetary amounts of fishing subsidies from the OECD, changes in commercial marine species catch and fishing fleets from TURKSTAT and FAO, ecological indicators for marine ecosystem health and GPS-based fishing vessel track from the Global Fishing Watch database), our findings demonstrate that capacity-enhancing subsidies, including fuel tax concessions and infrastructure support, have primarily supported industrial fishing, but did not correspond to higher catch rates. Conversely, Türkiye has shown a significant commitment to beneficial subsidies aimed at resource conservation, comprising the majority of its subsidy allocation in more recent years. However, these subsidies have primarily been channeled towards enforcement measures rather than research initiatives. While this allocation has its merits, there is potential for further enhancing their efficacy by allocating a portion towards research endeavors. Ambiguous subsidies, like vessel buy-back programs and income support for fishers, have played a complex role. While income support for small-scale fishers could potentially support sustainable fishing practices, the effectiveness of vessel buy-back programs in reducing overall fishing pressure remained limited. Overall, the patterns observed in the Turkish fisheries, particularly the persistent decline in the average catch and the downward shift in the mean trophic level of catches, with the intensified fishing effort despite the decreased fleet size, indicate an opportunity for further optimizing the allocation of fishing subsidies towards more sustainable fisheries management practices.

As the patterns in Turkish fisheries are similar to those observed in other EU-Mediterranean countries, we underscore the need for a paradigm shift in the Mediterranean towards sustainable fishing practices by redirecting fishing subsidies towards conservation, research and development, participatory and adaptive governance and integration of advanced technologies to enhance data transparency and monitoring of fishing activities. Implementing such a shift could be complemented by participatory adaptive governance of different stakeholders such as fishers, scientists, and local coastal communities, mobilizing the traditional ecological knowledge of coastal artisanal fishers, and supporting their capacity and capabilities for community-based management. This may potentially alleviate any negative effects of a subsidy reform on fisheries incomes and may enable a "just transition" of the fishing sector in terms of socio-economic outcomes.

1. Introduction

Fishing subsidies, in general, are defined as direct or indirect transfers from public institutions to the private sector, the fishing industry, that benefit these private entities financially (OECD, 2005). Subsidies supporting research for and the practice of ecologically responsible fishing, monitoring and enforcement of the fishing industry, artisanal small-scale fisheries and participatory ecosystem-based governance, for instance, can lead to better socio-ecological outcomes. However, by artificially decreasing the costs and increasing the fishing industry's profits, fishing subsidies such as fuel tax concessions lead to overcapacity and increase the likelihood of overfishing of stocks (Skerritt et al., 2020). They can also have adverse impacts in terms of climate change by increasing greenhouse gas emissions of the fishing sector (Machado, et al., 2021). Identification and categorization of different types of fishing subsidies are necessary while evaluating their socio-ecological impacts across different regions, marine habitats, and governance types. In the present chapter, we adopt the classification system proposed by Sumaila et al. (2010) and analyze fishing subsidies based on capacity-enhancing, beneficial, and ambiguous categories.

Capacity-enhancing subsidies consist of fuel subsidies, tax exemptions granted to the fishing sector, subsidies provided for boat construction, renovation and modernization, as well as for the construction of fishing ports and marketing infrastructure (Sumaila et al., 2019). Fuel costs constitute one of the biggest categories of operational costs of a fishing vessel, estimated to be around 25% of all operational costs (Sumaila et al. 2008), as such, subsidies reducing fuel costs are substantially increasing profits, and they also support less efficient vessels in terms of engines (Machado et al., 2021). Support to port construction and vessel modernization benefit fishing vessels in terms of increasing fishing capacity, at the expense of fish stocks and marine health. Another type of capacity-enhancing subsidies often ignored pertains to fishing access agreements between different countries, such as the bilateral fishing agreements granting fishing rights to the EU vessels in the exclusive economic zones of a non-EU country.

Beneficial subsidies consist of fisheries management measures, support for research and development, education and training, and government support and incentives for establishing and protecting marine protected areas. These can enhance income sources of fishers and improve fish stocks simultaneously, if implemented carefully and in a transparent participatory manner (Sumaila et al., 2019). Fisheries management measures often include coastal surveillance and more effective enforcement of laws, as such, they often benefit marine ecosystems as well as the fishers, in that they tackle overfishing and can also reduce GHG emissions by reducing fishing effort by illegal, unreported, and unregulated (IUU) fishing. Support for research activities for advancing marine sciences can also contribute positively to nature conservation, development of more eco-friendly fishing techniques, and a more thorough evaluation of different policy measures. Implementation of marine protected areas, if complemented by participatory adaptive governance by engaging diverse set of stakeholders, such as small-scale fishers and the tourism sector, can also benefit fish stocks, fishers and the society at large. Hence, beneficial subsidies can support marine ecosystem health and socio-ecological justice, simultaneously.

Ambiguous subsidies represent the final category of fishing subsidies, characterized by their uncertain or unclear outcomes. For instance, direct income support for fishers, vessel buyback programs and support provided for rural small-scale fishing communities can be either beneficial or detrimental for fish stocks and marine health depending on the specifics of the context and the actual implementation (Sumaila et al., 2010). Artisanal small-scale fishers often adopt more environmentally-benign fishing techniques, with less GHG emissions, and contribute substantially to local employment and food security (Pauly, 2018). Hence, support for small-scale artisanal and subsistence fishing communities may lead to positive socio-ecological outcomes. However, a precondition to its success is better documentation and sufficient scientific knowledge about different small-scale fishing practices in each region and habitat. Vessel buyback programs, on the other hand, are supposed to reduce fishing efforts by decreasing the number of vessels in the fishing sector, however, their final outcome hinges upon the specifics of their implementation as well as the presence of other complementary programs and fishing measures. If other fisheries measures are simultaneously in place, for instance, which support modernization of the existing vessels, then overall fishing effort may increase, despite the decreasing number of vessels, rendering any vessel buyback program ineffective.

1.1 A global overview of harmful fishing subsidies

Environmentally harmful fishing subsidies have received much scientific and public attention in the last 20 years. About 60 per cent of the global fishing subsidies are estimated to be of harmful nature, as they lead to over-capacity and over-fishing by artificially increasing the revenues or reducing the costs of the fishing sector, hence, they are often categorized as capacity-enhancing subsidies (Skerritt et al., 2023; Sumaila et al., 2019; Plan Bleu, 2023). Developed countries are responsible for most of these harmful fishing subsidies, with a share of 67% globally (Sumaila et al., 2010; Sumaila et al., 2016). While harmful subsidies benefit the industrial fishing sector in the short-run, in the long-run, they can in turn create a vicious circle where degradation of marine health and reduced fish stocks threaten the fishing sector, and other marine sectors such as tourism (Plan Bleu, 2023). Harmful or capacity- enhancing subsidies are also positively correlated with increased greenhouse gas emissions, further exacerbating climate change (Machado et al., 2021). Another category of harmful fishing subsidies are subsidies for foreign access agreements enabling distant-water fishing. These are often economically and socially inefficient, and their removal would not only enhance fish stocks, but also improve well-being of fishers and reduce inequities related with income and consumption (Villasante et al., 2022).

In 2018, around 80% of fishing subsidies have been estimated to benefit industrial fishers, while only 19% are provided to small-scale fishers (Schuhbauer et al., 2020), who are often fishing in more environmentally sustainable ways (Pauly, 2018). In the European Union (EU), a recent analysis by Skerritt et al. (2020) demonstrates that in the in 2003, at least 54% of the fishing subsidies were of capacity-enhancing nature, and this was reduced to 46% in 2009 and 40% in 2018, while the share of beneficial subsidies increased from 25% in 2003, to 28% in 2009 and reached 52% in 2018. However, despite this favorable reduction in the share of capacity-enhancing subsidies over the last 20 years, the authors underline that capacity-enhancing subsidies are still quite persistent in the EU fisheries policy making. For instance, while fisheries policy in the EU aimed to reduce the number of fishing vessels, there was simultaneous political effort to support construction of new vessels and technological modernization of the existing ones. Moreover, the EU fishing fleet is supported to operate in world's oceans, for example, in African waters, through fishing access agreements where overfishing prevails (Skerritt et al., 2023).

Today, scientists call for a reform for the reduction and even complete removal of the environmentally harmful fishing subsidies (Sumaila et al., 2024). However, eliminating harmful fishing subsidies can have negative effects on certain economic sectors, in the short-term, for instance, on the employment in the fishing sector and seafood processing (Florido and Rosa, 2023). These potential negative effects across different sectors and regions need to be estimated via strategic reallocation of these subsidies and focused policy efforts to mitigate their impacts. Recently, the debate on harmful

fishing subsidies has led to an international agreement, WTO Agreement on Fisheries Subsidies, in June 2022, to ban environmentally detrimental subsidies for overfished stocks, illegal, unreported and unregulated (IUU) fishing, and fishing on unregulated high-seas (WTO, 2024a). The agreement is considered a first step towards limiting economic incentives that lead to overcapacity and overfishing, even though scholars point out the presence of important gaps and loopholes in the agreement, such as not addressing harmful subsidies leading to overfishing and overcapacity (Cisneros-Montemayor et al., 2022). In order for the agreement to come into effect, 110 WTO member countries need to ratify it, yet, as of 2024, only 72 member countries had formally accepted the agreement (WTO, 2024b).

1.2. An overview of the global trends in the fishing and seafood sector

According to most comprehensive report on the state of the world fisheries and aquaculture by UN Food and Agricultural Organization (FAO, 2022), marine capture fisheries have remained relatively stable at around 80 million tonnes, with minor annual fluctuations since the late 1980s. However, the sustainability of marine fish stocks has declined, and the percentage of stocks fished at biologically unsustainable levels has increased since the late 1970s, reaching 35.4% in 2019. The global fishing fleet has seen a trend towards larger and more powerful vessels, jeopardizing the sustainability of fisheries despite a decreasing number of vessels. In 2020, the majority of the motorized fishing vessels globally were under 12 meters, i.e. small-scale fisheries typically represented a significant portion of the global fleet capacity (FAO, 2022). In 2020, approximately 58.5 million people were employed in the primary fisheries and aquaculture sector, with 21% being women fishers or fish workers. Despite the overall growth in the sector, there has been a shift towards aquaculture, which now accounts for 35% of the employment within the sector. This is related to the stagnation in marine capture fisheries after decades of sustained growth, where marine capture was the primary source of seafood production. Hence, world aquaculture production has overtaken capture fisheries, with its share reaching 57% in 2020 (FAO, 2022). There is also a notable trend in the utilization of fish for non-food purposes, primarily for the production of fishmeal and fish oil, which are typically processed to become animal feed and fish feed to be used in aquaculture. In 2020, for instance, over 20 million tonnes of aquatic animals were used for non-food purposes, with the majority being processed into fishmeal and fish oil (FAO, 2022).

The Mediterranean Sea, one of the important global biodiversity hotspots, is at the same time one of the most vulnerable marine ecosystems subject to severe overfishing and climate change effects (Pita et al., 2021). The Mediterranean and the Black Sea have the highest percentage of unsustainably fish stocks in the world, with 58% of stocks being fished at unsustainable levels (FAO, 2022). Marine capture fisheries production experienced fluctuating trends since 1970, and in 1988 marine capture production reached nearly 1.8 million tonnes, followed by a sharp decline in the early 1990s, mainly due to the collapse of pelagic fisheries in the Black Sea, and is now stagnating around 600-800 thousand tonnes in the last decades. The ongoing challenge of overfishing is reported for most stocks fished beyond biologically sustainable limits. Although there has been a reduction in the fishing pressure (FAO, 2023), signifying progress towards sustainability, the majority of stocks remain overexploited (Froese et al., 2018). The most comprehensive report for comparative dynamics of marine capture and fleet characteristics among the Mediterranean countries is published by FAO General Fisheries Commission for the Mediterranean (FAO, 2023). According to the report, the total revenue from marine capture fisheries in the Mediterranean is estimated over US$3 million with significant share of Italy (29%) followed by Türkiye, Tunisia, Spain, Greece, Egypt, and Algeria account for 90% of the total. For marine capture fisheries, Türkiye's contribution is particularly significant, amounting to 27%, while Italy and Tunisia follow with 11% and 10%, respectively. The fishing fleet operating actively in the Mediterranean consists of over 80,000 fishing vessels, while small scale vessels (those below 12 meters) have a share of 82% of the total fleet. For overall fleet size, Türkiye has the biggest share with 17%, followed by Tunisia and Greece, each with 14.5% while for larger vessels, Egypt holds a share of 20% of the fleet above 12 meters, followed by Italy (16%), Türkiye (12%) and Tunisia (11%), signifying a strategic position of those countries in terms

of fleet capacity. The Mediterranean fisheries sector has around 183,000 fishers employed on fishing vessels, comprising both part-time and full-time jobs. Around 90% of the total employment originates from just six countries with significant share of Tunisia (22%) followed by Türkiye (19%), Egypt, Italy, Greece, Morocco, and Algeria. Small-scale fisheries contribute significantly to employment, accounting for 61% of the total onboard vessel employment, around 15% of marine capture production and 26% of total revenue in the region (FAO, 2023).

2. MOTIVATION

The complex marine ecosystems of the Mediterranean necessitate a multifaceted approach to fisheries management. The implementation of catch quota systems is advocated as a method for effective direct management of fisheries (Pope, 2009; Cardinale et al., 2017), complemented by policies designed to reduce fishing efforts (Vasilakopoulos et al., 2014; Merino et al., 2015; Froese et al., 2018; Demirel et al., 2020), which include limitations based on factors such as who is fishing, when, where, and how (Morrison, 2004, p. 412). However, managing the multi-species, multi-fleet fisheries in the Mediterranean is complex, particularly due to species interactions and the indirect interactions of mixed fisheries (FAO, 2022). The challenge also lies in the diversity of governance systems, socio-economic priorities, and development objectives among the Mediterranean countries sharing fishery resources (Micheli et al., 2013). Several EU countries are located on the Mediterranean Sea; hence, they are subject to the Common Fisheries Policy (CFP) and EU regulation 1967/2006 with the aim to reduce overfishing, yet, they have mostly failed to achieve sustainability in Mediterranean waters (Froese et al., 2018; Cardinale et al., 2013). While extensive literature addresses fishing subsidies at a global level (Skerritt et al., 2023; Sumaila, Ebrahim, et al., 2019), both Mediterranean and more localized studies are sparse. Furthermore, capacity-enhancing subsidies continue to exist, despite international efforts to regulate them (Villasante et al., 2022).

Against this background, the present study aims to assess Türkiye's position within the broader Mediterranean context, offering policy suggestions to improve both ecological effects and socio-economic outcomes in the fishing industry. The observed decline in the health of marine ecosystems and fishery resources in Türkiye (Demirel et al., 2023; Ulman et al., 2020) requires an examination of the diverse impacts of fishing subsidies both on fishing communities and on marine ecosystems. Hence, we hypothesized that the existing structure and allocation of fishing subsidies in Türkiye are linked to increased fishing effort and subsequent ecological degradation in its marine ecosystems. Catch trends and ecological indicators such as trophic measures provide empirical evidence of marine ecosystem health, while an assessment of fishing subsidies offers insights into the socio-economic drivers behind fishing practices. Adding fishing effort assessment to our analysis bridges the gap between impacts of subsidies and changes in fishery status. More specifically, we focus on the following main factors in this study:

- **Fishing Subsidies:** Monetary amounts of fishing subsidies (in US$) from the literature review and OECD Reports (2000-2011) and OECD Fisheries Support Database for 2012-2020
- **Fishery Dynamics:** Changes in commercial marine species catch and fishing fleets for the period of 2000-2020, utilizing data from TURKSTAT, FAO, and Sea Around Us (seaaroundus.org).
- **Ecological Indicators for Marine Ecosystem Health:** Through marine trophic structure, including mean trophic level of the catch and fishing in balance index (Pauly et al., 1998; Pauly et al., 2000).
- **Fishing Effort:** GPS-based fishing vessel track from the Global Fishing Watch database (2013-2020).

3. EVALUATION OF FISHING SUBSIDIES IN TÜRKIYE

3.1. Fishing subsidies for the periods of 2000-2011 and 2012-2020

The fishing sector has always had a unique role in Türkiye's local economy and culture. Efforts to develop fisheries were perceived as crucial to advancing the country's development initiated through fishing subsidy programs starting from the 1940s. The OECD's Fisheries Support

Classification based on Sumaila et al. (2010)	OECD FES Classification	Total 2000-2011 (M US$)	Share 2000-2011 (%)	Total 2012-2020 (M US$)	Share 2012-2020 (%)
Capacity-enhancing subsidies		*666.4*	*63.1*	*619.7*	*43.9*
Fuel subsidies	Fuel tax concessions	486.4	46.2	491.3	34.8
Boat construction, renewal and modernization programs	-			-	-
Fishing port construction and renovation programs	Provision of infrastructure (Capital expenditures)	180.0	17.1	128.4	9.1
Price and marketing support, processing and storage infrastructure programs	-		-	-	-
Fishery development projects and support services	-		-	-	-
Foreign access agreements	-			-	-
Beneficial subsidies		*385.8*	*36.9*	*712.9*	*50.4*
Fisheries management programs and services	Management expenditures	19.3	1.8	28.8	2
	Enforcement expenditures	366.5	34.8	655.6	46.4
Fishery research and development (R&D)	Research and development	-	-	28.5	2
Marine Protected Areas (MPA)	-	-	-	-	-
Ambiguous subsidies		*0*	*0*	*80.3*	*5.7*
Fisher assistance programs	Transfers based on fishers' income (Income support)	-	-	7.83	0.6
Vessel buyback programs	Transfers based on the reduction of productive capacity	-	-	72.5	5.1
Rural fishers' community development programs		-	-	-	-
	TOTAL	**1,052.20**	**100**	**1,412.93**	**100**

TABLE 1

Fishing subsidies in Türkiye for the periods 2000-2011 and 2012-2020.

Estimates (FES) dataset (OECD, 2023) is the most comprehensive and detailed source for tracking the trends of fishing subsidies in Türkiye for the last 25 years. We used this dataset and another complementary source (Toplu Yılmaz, 2021), for categorizing fishing subsidies in Türkiye into capacity-enhancing, beneficial and ambiguous subsidies, based on the classification of Sumaila et al. (2010), for the periods of 2000-2011 and 2012-2020 (Table 1).

2000-2011 period: Capacity-enhancing subsidies (fuel tax concessions and capital expenditures) made up the biggest part of the fishing subsidies, amounting to 63.1% of all fishing subsidies documented in this period. A smaller share, namely, 36.9% of all governmental support, was of beneficial nature, as it was spent for the management and enforcement of the sector in the same period. However, financial support for research and development for the fishing sector was not documented in this period. Fisher assistance and vessel buyback programs was not initiated in this period either, hence, there was no subsidy attributable to the ambiguous subsidies category in the period 2000-2011.

2012-2020 period: In the following period, between 2012 and 2020, Türkiye made a shift in its "subsidy-mix" towards more environmentally virtuous tools. The share of capacity-enhancing subsidies fell from 63.1% to 43.9%, while the share of beneficial subsidies rose from 36.9% to 50.4%. This changing trend was very much in line with the EU fishing subsidies policy (Skerritt et al., 2020). However, capacity-enhancing subsidies still persisted to an extent, especially, the fuel tax concessions had a big role in this with 34.8% of all fishing subsidies provided in this period. The substantial allocation of US$491.3 million towards fuel tax concessions over eight years highlights an attempt to alleviate operational costs for fishing activities, especially, that of industrial-fishers. In this period, direct income support to fishers amounted to US$7.8 million (2017-2020), transfers to reduce the productive capacity of the fishing sectors (vessel buy-back program) to US$72.5 million (2013-2018), fuel tax concessions to US$491.3 million, capital expenditures for the provision of infrastructure to US$128.4 million, research and development to US$28.5 million, management expenditures to US$28.8 million, and finally, enforcement expenditures amounted to US$655.6 million between 2012 and 2020.

The official figures provided by the OECD do not include data on each category of capacity-enhancing subsidies, for instance, there is no data for foreign access agreements (Sumaila et al., 2010). However, this is identified as one of the crucial harmful subsidies globally, as they lead to overcapacity and overfishing in vulnerable marine ecosystems of the world. Türkiye has signed, for instance, bilateral fishing agreements with the West African countries such as Gambia, Somalia and Mauritania, which has provided the Turkish fishing fleet fishing rights and quotas in the seas of these countries. However, scientific studies and reports by nature conservation organizations suggest such subsidies for distant-water operations via fishing agreements are often of harmful nature for marine ecosystems and local food security and must be removed (Kaczynski et al., 2022; Villasante et al., 2022).

On the other hand, the share of beneficial subsidies had a remarkable share (50.5%) of the total fishing subsidies and vastly increased between the two time-periods, a testament of Türkiye's journey towards a more environmentally conscious approach. However, a breakdown of this figure demonstrates that these funds were mostly used for enforcement of fishing regulations, while research received a small share (only 2%). Any expenditures for establishing marine protected areas were not included in the OECD figures, either.

Ambiguous subsidies had a relatively small share in total fishing subsidies in this period. Income support program for coastal small-scale fishers (with vessels smaller than 10 meters) had been initiated in 2017 in order to increase the number of registered small-scale fishers. Within this program, currently, fishers with vessels smaller than 12 meters are supported with differing rates depending on the length of the vessel on a yearly basis. However, the yearly rates paid are quite small, vessels smaller than 5 meters receive one-third of the minimum wage (once a year), and vessels between 10-12 meters half of the minimum wage (once a year). Fisher women can receive 25 percent more in case they can prove that they own or co-own the fishing vessel. This subsidy can have positive impacts on marine sustainability, given that small-scale, artisanal fishers often use more eco-friendly fishing techniques by using less fossil fuel per tonnes of fish landed (Pauly, 2018) and are important actors for local food security. The vessel buy-back

program, started in 2012 for vessels larger than 12 meters, on the other hand, is a strategic effort to manage overcapacity within the fishing fleet. Expanded in 2013 to include vessels 10 meters and larger, approximately US$72.5 million has been spent on this program (Table 1). However, the buy-back program's overall impacts on the size of the fishing fleet and fishing effort are ambiguous given that it may instead promote the use of new and modernized vessels in the long-term (Göktay et al., 2018).

3.2. Challenges and Choices: Relating Türkiye's Fishing Subsidies to Ecological Impacts

Similar to the previous findings (Demirel et al., 2020), examination of the status of fishery resources in Türkiye indicates a gradual decrease of marine catches in the last two decades (Figure 1a). Our analysis of the interplay between the number of fishing vessels and total marine captures suggests a complex relationship where increases in fleet size are not consistently leading to proportional rises in catches (Figure 1a). A notable reduction in the amount of average catch, alongside a downward shift in the mean trophic level of the catch (mTLc), signaling potential changes in the composition of marine species being captured and in the ecosystem structure (Figure 1b). Decline in the mTLc may point to a shift in the ecosystem towards smaller prey species (Figure 1b). Small pelagic species consistently make up the largest proportion of landings, followed by invertebrate species which represent a small fraction of the total catch but showing a gradual increase over time (Demirel et al., 2023). Decline in larger predatory fish, both pelagic and demersal, potentially leading to reduced predation pressure on their prey, such as small pelagic fish and invertebrates (Saygu et al., 2023). The Fishing in Balance (FiB) index fluctuates around zero, with periods of negative values indicating periods where fishing pressure is unsustainable (Figure 1e). The observed fluctuations in ecological indicators mirror broader ecological changes reported in other parts of the Mediterranean (Dimarchopoulou et al., 2021), reflecting the effect of poorly regulated fisheries on the structure and functioning of the ecosystem (Colloca et al., 2017).

The fishing subsidies in Türkiye seem to follow similar patterns like in other EU-Mediterranean countries in that a significant share is still provided in form of capacity-enhancing subsidies (Roca Florido and Padilla Rosa, 2023; Gambino et al., 2022; Skerritt et al., 2020). Industrial fisheries disproportionately benefit from these subsidies, if compared to small-scale coastal fishers, both in Türkiye and other EU-Mediterranean countries (Gambino et al., 2022). According to fleet capacity results, small-scale fishing (SSF) has maintained a relatively steady course with minor fluctuations in the number of vessels, while medium- and large-scale fishing (M-LSF) has seen a great increase during 2000s followed by a decrease in the last decade (Figure 1d). A sustained SSF effort reflects a possible adherence to traditional and potentially more sustainable practices over the years. In contrast, the industrial fishing sector shows incremental growth in fleet size, a trend indicative of intensifying fishing efforts (Figure 1d). The vessel buy-back program in Türkiye had ambiguous effects, as was the case in the EU for similar programs, as reduced fleet capacity was not associated with reduced fishing pressure due to improvements in technology and modernization of the remaining vessels (Skerritt et al., 2020). Despite a reduction in the fleet size following the vessel buy-back program in 2013 (Figure 1c), the overall fishing effort has paradoxically intensified (Figure 1d), pointing towards an increase in fishing effort per vessel. The impact of this subsidy on reducing fishing pressure and improving marine health could not be achieved, as the program did not consider factors such as the fishing capacity (Göktay et al., 2018) and the average fishing effort of each vessel in the last five years (Figure 1d). This significant financial subsidy demonstrates a true commitment to supporting the fisheries sector, yet it failed due to interrelation among different subsidy types and their wider implications (Isaksen et al., 2015). Because fuel subsidies continue to have a significant share in parallel to the global trends (Sumaila, et al., 2016), and this has a great role in increasing fishing pressure by allowing fishers to spend more time at sea.

Evaluating overall fishing subsidies allocated in the Mediterranean by each country would be highly beneficial for understanding their clear impact on the social-ecological context and for designing a subsidy reform. Unfortunately, collecting those data in the Mediterranean requires reviewing dispersed information from both international publications and grey literature (including local languages), as it is

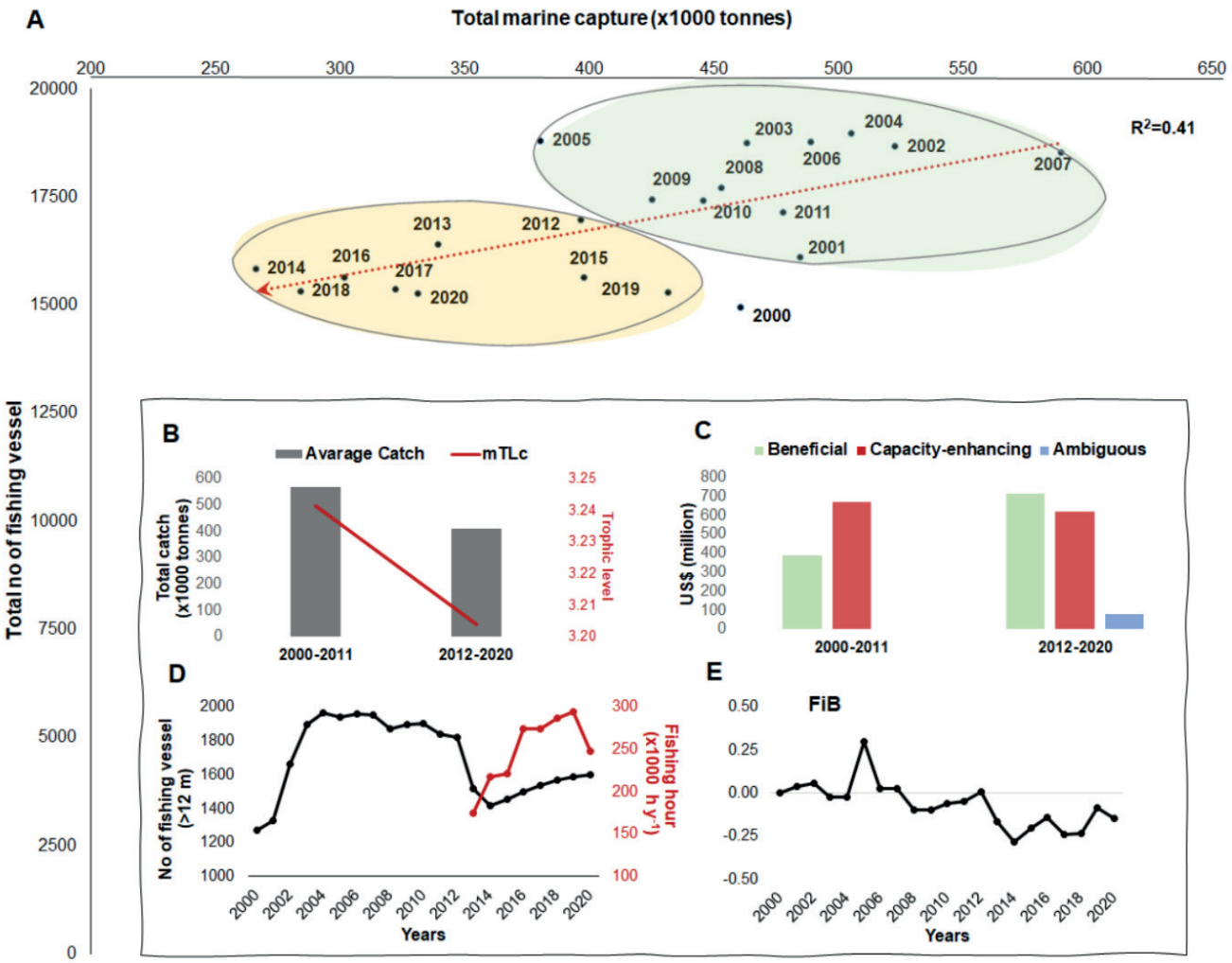

Figure 1. *Comparing two time periods for A) Trend in total marine capture (in '000 tonnes) and total number of fishing vessels, (green ellipse with higher values in 2000-2011; yellow ellipse with lower values in 2012-2020), B) Average catch (grey) against the mean trophic level of catch (mTLC, red), C) Distribution of subsidies by type—beneficial (green), capacity-enhancing (red), and ambiguous (grey); Times series of D) Number of vessels greater than 12 meters (black) versus fishing effort (in 1000 hours per year, red), and E) Fishing in Balance (FiB) index values between 2000 and 2020.*

beyond the scope of this study. Some databases, such as the European Maritime and Fisheries Fund for EU member-states, and the OECD FES only include datasets for Italy, Spain, France, Greece, Slovenia, and Türkiye. Since Spain and France also have coastlines along the Atlantic, it is difficult to discern from these databases how much of their fishing subsidies are specifically allocated for Mediterranean fisheries. Additionally, Greece and Italy are subject to the CFP as members of the EU, which regulates fisheries management and subsidies within its member states. Furthermore, data on subsidies from key Mediterranean players such as Tunisia, Egypt, Algeria, Libya and Morocco are not available as they are not members of the OECD, making a comprehensive evaluation challenging. In light of these complexities and limitations, we refrain from comparing country-specific fishing subsidies.

3.3 An overlooked subsidy category: Aquaculture subsidies

Subsidies provided for the growing aquaculture sector in Türkiye are not reported as a separate category in the OECD FES database. Yet, such subsidies potentially constitute a form of harmful fishing subsidies because the sector utilizes marine fish catches (both domestically and overseas) in farmed fish production. Especially, the seabass and sea bream sectors have high export potential, which is why government support for them has been quite substantial.

In response to declining marine fish catches, the central government started to support the export-oriented marine aquaculture sector in 2003. Between 2003-2019 total subsidies provided to aquaculture amounted to US$743 million (Atalay and Maltaş, 2020). Türkiye became the major producer of the farmed fish

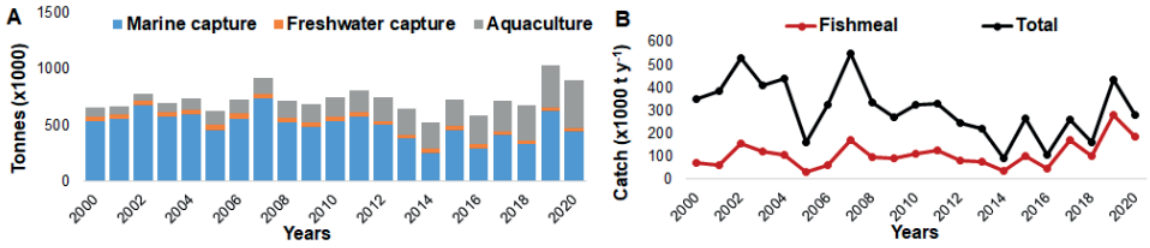

Figure 2. *A) Amounts of fisheries production, marine versus freshwater capture and aquaculture, B) Total landings of anchovy (black) and the amount of anchovy used for fish meal (red) in Türkiye between 2000 and 2020.*

species of gilthead sea bream (Sparus aurata) and European seabass (Dicentrarchus labrax) in the Mediterranean, and exports to the main international trade partners, the EU and the UK, continue to be substantial (Özden et al., 2020; WWF, 2021). Subsidies provided for the production of seabass and sea bream had to be discontinued in 2016, as these contradicted the WTO rules, yet, this sector continues to be important.

The European anchovy (Engraulis encrasicolus), a prominent small pelagic species, accounts for 22% and 70% of the total annual catches in the Mediterranean and Turkish fisheries, respectively (FAO, 2022). Due to the rapid growth of the aquaculture industry in the last decade in Türkiye (Figure 2a), a significant trend has emerged where a large proportion of anchovy catches are allocated to fish meal production (Figure 2b). This situation highlights that the aquaculture sector heavily depends on wild anchovy catches. From 2000 to 2022, the amount used for fish meal production closely followed the total catches of anchovy (Figure 2b), implying that the demand of the aquaculture sector for fish meal directly influences the intensity of anchovy fishing activities. Therefore, aquaculture subsidies can place undue pressure on anchovy, leading to overfishing and potential stock depletion if not managed sustainably.

4. Policy reccomendations

In the following, we propose specific policy recommendations for the reallocation of subsidies to responsible fishing practices and sustainable fisheries management for the case of Turkish fisheries. Even though these recommendations are formulated for the case of Türkiye, they could potentially apply to several other Mediterranean countries, with further adjustments and catering to the local context in line with specific fisheries characteristics and marine ecosystems.

4.1. Understanding the Socio-Ecological Impacts of Subsidy Reforms

Maintaining ecosystem health and ensuring a continuous provision of ecosystem services, along with long-term economic benefits, can be achieved through ongoing assessment, adaptive policy-making, and frequent adjustments to subsidy programs. Responsible fishing, as outlined in the Code of Conduct for Responsible Fisheries (FAO, 1995), can be defined as practices for preserving marine biodiversity, ensuring the long-term viability of fish stocks, and maintaining the health of ocean ecosystems while supporting the livelihoods of those reliant on fishing. However, realizing responsible fishing practices requires concerted efforts at multiple levels, from individual fishers to international regulatory bodies. The Ecosystem Approach to Fisheries (EAF), developed to align with sustainable development principles (UNEP, 1992; FAO, 1995), emphasizes the sustainable use of ecosystem resources and the role of

social actors in this process (Garcia et al., 2003). Although, EAF is a powerful policy instrument by focusing on risk management, advocating a precautionary and adaptive approach to decision-making (Nomura, 2008), operationalizing EAF in law and practice faces challenges, particularly due to uncertainties around its meaning and implementation (Enright and Boteler, 2020). The

Complex Adaptive Systems (CASs) approach further complements this by treating ocean ecosystems as interconnected with social and economic systems, complex and adaptive in nature (Folke, 2007; Lubchenco et al., 2016). It recognizes that actions at the local level impact broader regional or global scales (Levin, 1998). According to CASs, fisheries management is a collective action, and incentivizing responsible fishing to balance conservation and economic interests is achievable through the introduction of well-designed, rights-based, or secure-access fisheries (Lubchenco et al., 2016).

In this context, shifting the focus from harmful subsidies to those that incentivize conservation and responsible fishing is a necessary step. Implementing such a shift should be complemented by participatory adaptive governance, which does not only "consult" different stakeholders such as fishers, scientists, and local coastal communities, but instead, empower them to genuinely contribute to decision-making, mobilizing the traditional ecological knowledge of coastal artisanal fishers, for instance, and supporting their capacity and capabilities for community-based management. This could potentially alleviate any negative effects of a subsidy reform of fishing subsidies on fisheries incomes and could enable a "just transition" of the fishing sector in terms of socio-economic outcomes.

A recent study investigating a fishing subsidy reform for Spain was carried out by Florido and Rosa (2023), indicating that the economic impacts of eliminating harmful fishing subsidies in Spain could have significant negative effects on certain sectors, particularly seafood processing, however, strategic reallocation of these funds could mitigate these impacts. Similarly particular emphasis should be given to the overall impacts on both formal and informal employment in the sector, as informal employment is especially high for the agriculture, forests and fisheries sector in Türkiye, with around 84% of total employment being informal in this sector (Ministry of Employment and Social Security, 2023). Specific and transparent data on different categories of fishing subsidies could facilitate more meaningful public and scientific discussions. These discussions would focus on the potential phase-out or reform of environmentally harmful fishing subsidies, ensuring they align with international sustainability commitments. Hence, research and development subsidies can support evaluating the effectiveness of subsidy reforms in achieving their intended objectives such as reducing overcapacity, improving sustainability, or enhancing social equity, by analyzing trends in fishing activity before and after subsidy implementation. This would enable policymakers to assess whether subsidies have led to desired outcomes or unintended consequences.

International collaboration among Mediterranean countries within the UNEP/ Mediterranean Action Plan framework can help with the exchange and sharing of best practices and fisheries data to harmonize fisheries policies and subsidy reform beyond national borders; and also advocate for more inclusive governance structures and support the implementation of existing agreements and conventions.

4.2. Supporting Local Communities

SSF constitute an integral part of coastal cultures in the Mediterranean countries and often use traditional low-intensity techniques (Lloret et al., 2018). While their contribution to food security and employment is quite large, their environmental footprint is much smaller than industrial fisheries (Pauly, 2018). Productivity of SSF is reported 16 percent higher than industrial fishers in the Mediterranean and the Black Sea, and even 200 percent higher in the North Atlantic (Villasante et al., 2022). Yet receiving a small portion of fishing subsidies globally (Schuhbauer et al., 2020) distorts the efficient allocation of financial resources, leads to overcapacity and overfishing, while increasing the economic and political marginalization of SSF (Villasante et al., 2022). Policies that could be implemented and enhanced include proposing transitional support mechanisms for artisanal, small-scale fishing communities, and promotion of and support for alternative livelihoods like eco-tourism, artisanal small-scale aquaculture and "pescatourism" to supplement fishing incomes without compromising small-scale, artisanal fishers' identity and culture (Ünal et al., 2022)
Fisheries policies also need to address the rights of fisherwomen, who have an important role in the fishing sector both in the Mediterranean and the EU (Göncüoğlu and Ünal, 2011; Frangoudes, 2011). As outlined in the UN Sustainable

Development Goals, particularly Gender Equality (SDG5), effective fisheries policies should: i) recognize the diverse role of women in fisheries from harvesters to entrepreneurs, ii) ensure equitable access to resources such as fishing rights, boats, and gear, iii) promote the inclusion of women in leadership roles within fisheries management bodies and decision-making forums to ensure that their perspectives and needs are considered, and iv) address specific health and safety concerns that affect women in the sector, including providing appropriate gear and addressing harassment issues.

4.3. Improving Data Availability and Transparency

Accurate and comprehensive data on fisheries are crucial for safeguarding aquatic ecosystems and managing marine resources sustainably (Simmonds et al., 2011). By providing subsidies for data collection infrastructure and equipment, the accuracy and reliability of fisheries data can be enhanced, enabling more informed decision-making and adaptive management strategies. In general, monitoring data by fleets including electronic vessel monitoring systems, log-books, or onboard observers are not publicly available (Kroodsma et al., 2018), or they are limited and disorganized, endangering transparency in decision-making processes. The integration of novel technologies in fisheries management enables improvement of the quality of official data, and better management decisions due to increased transparency, and more effective enforcement of regulations. Beneficial subsidies should be provided for the modernization of fisheries monitoring programs, including the deployment of electronic monitoring systems, onboard observers, and remote sensing technologies.

Vessel Tracking: Monitoring compliance with subsidy regulations and conditions allows authorities to analyse fishing vessel movements and activities to verify whether subsidized vessels adhere to relevant regulations such as fishing quotas, gear restrictions (identified fishing technique), or area closures, which can be supported by specific subsidy programs, to assess the ecological and socio-economic impacts of subsidies on fisheries and marine ecosystems (Merten et al., 2016; Drakopoulos et al., 2022). Governments can invest in the development and operation of satellite-based surveillance systems, such as Automatic Identification System (AIS) and Vessel Monitoring Systems (VMS), to monitor vessel movements, detect illegal fishing, and enforce maritime regulations. Subsidies can facilitate the adoption of satellite technologies, data subscriptions, equipment installation, and training for fishers and enforcement agencies for real-time monitoring of fishing activities and vessel tracking (Lemoine et al., 2014). As used in our analysis for uncovering the spatio-temporal distribution of fishing effort, the Global Fishing Watch (GFW), an international non-profit innovative platform, uses satellite technology to monitor and track fishing vessels worldwide in near real-time (Kroodsma et al., 2018). By analyzing AIS data and other satellite data sources, GFW provides valuable insights into fishing activities, including vessel movement patterns, fishing effort, and potential instances of illegal, unreported, and unregulated (IUU) fishing (Park et al., 2023; Paolo et al., 2024). The transparency provided by these innovative platforms empowers countries to enforce marine regulations in compliance with international agreements, regional cooperations and national regulations.

Blockchain Technology: Blockchain technology integration into fisheries management systems can enhance traceability and transparency throughout the seafood supply chain (Blaha and Katafono, 2020). Subsidies can support i) the development and implementation of blockchain-based platforms, which record and authenticate data related to fishing activities, catch documentation, and origins (Ismail et al., 2023), ii) the costs of technology adoption such as hardware, software, and data management systems, training, and infrastructure upgrades necessary for fishers, processors, and retailers to participate in blockchain networks.

Environmental-DNA: (e-DNA) technologies use genetic markers to identify species from environmental samples, such as seawater or sediment, providing an unharmful and cost-effective method for monitoring biodiversity, identifying endangered or protected species, and detecting illegal fishing activities (Deiner et al., 2017; Turner et al., 2015; Taberlet et al., 2012). Subsidies can be directed towards the deployment of e-DNA monitoring systems to improve species identification and compliance monitoring in

fisheries (Willette et al., 2023). Governments can invest in research and development to enhance the accuracy, sensitivity, and scalability of e-DNA technologies, and support the integration of e-DNA monitoring into existing fisheries management frameworks.

4.4. Incentivizing Responsible Fishing Practices

Environmentally-friendly fishing methods: Providing economic support and subsidies for encouraging innovation in fishing gear technology towards environmentally-friendly modifications to reduce the incidental capture of non-target species (bycatch) and minimize habitat impact is a recommended strategy (Jenkins and Garrison, 2013). Selective gears such as circle hooks, escape panels in trawl nets, and size-selective mesh, allows fishers to target specific species/size while avoiding the capture of undersized or non-target species (Valdemarsen and Suuronen, 2013). Fishers can be supported to invest in selective gear and equipment, offsetting the costs associated with gear modification or replacement, alongside providing training programs and technical assistance to aid fishers in adopting and effectively using selective fishing gear. In this context, beneficial subsidies can be allocated for research and innovation in fishing techniques, gear technology, and resource assessment methods. Funding scientific research projects may help identify and develop innovative solutions such as reducing gear entanglement of endangered species or improving the efficiency of fishing operations (Free et al., 2023). Eco-labeling for sustainably caught seafood, can stimulate demand for products sourced from environmentally-friendly fishing practices.

MPA designations: Spatial management measures can be subsidized by the central government, such as marine protected areas (MPAs), seasonal closures, and habitat restoration zones to conserve critical habitats and safeguard vulnerable fish stocks (Kriegl et al., 2021). By designating areas where fishing activities are restricted or prohibited, fishing pressure can be reduced and fish populations can be allowed to recover (Langton et al., 2020). Subsidies can be allocated to support the establishment and "management" of MPAs, encompassing surveillance and enforcement efforts to prevent illegal fishing activities within protected areas, while also providing financial incentives to fishers who voluntarily participate in MPA management or adopt sustainable fishing practices in adjacent areas. Associated technical measures that can be supported by governments can be area closures for undersized fishes and sorting devices which can help mitigate the negative impacts of fishing on larger species (Caddy, 1999; Russo et al., 2016).

Supporting Sustainable Seafood

Market-based solutions including seafood certification and ratings systems are implemented to promote sustainable production, yet, their impacts are quite limited due to geographical and ecological mismatches, and a lack of adoption in artisanal and small-scale fisheries (Kittinger et al., 2021). Making seafood sustainable necessitates a broader definition: the focus must shift from a singular emphasis on ocean health to encompassing the entire global value chain, from production to consumption (Tlusty et al., 2019). This expanded view recognizes the diversity of seafood and its environmental, nutritional, and social impacts (Hallström et al., 2019), linking it to terrestrial systems and emphasizing waste reduction and circular use of by-products (Stevens et al., 2018).

Certification schemes: Subsidies can be allocated to support fisheries that participate in credible certification programs, such as the Marine Stewardship Council (MSC) or Aquaculture Stewardship Council (ASC) (FAO. 2018). These programs certify fisheries and aquaculture operations that meet rigorous standards for sustainability, traceability, and social responsibility (Packer and Beukers, 2023). Subsidies can cover the costs associated with certification assessments, audits, and compliance requirements, making certification more accessible to fishers and aquaculturists, particularly small-scale operators who may face financial barriers. Authorities can incentivize participation in certification programs by offering subsidies for certified products, providing market advantages and premium prices, thereby encouraging sustainable practices and rewarding responsible fishing and aquaculture activities. There is also an increasing need for considering consumer behavior and demand for

seafood (Yıldız et al., 2023) to increase societal awareness for implementing sustainable fishing practices. Promoting the consumption of diverse, lower trophic level seafood species and support for small-scale fisheries to reduce environmental impact and to support local economies is recommended as beneficial for sustainable Mediterranean fisheries (Altiok et al., 2021).

Sustainable aquaculture feed: Feeds used in aquaculture require a significant amount of the global fishmeal and fish oil supply, with 71.0% of fishmeal and 73.9% of fish oil being derived from marine catches (Boyd et al., 2022). In the Northeast Atlantic of the European Union, the fish species primarily landed for fishmeal and fish oil production include small pelagic species like sprat, herring, sandeels, and blue whiting (EC, 2023). However, given the uncertainty of their fluctuations amidst the climate crisis, recent research has focused on improving the composition of aquaculture feed. Efforts are directed towards replacing marine ingredients with substantial plant-based components, though this transition faces challenges in maintaining feed quality (EC, 2023).

5. Conclusion

This study provided a critical examination of the impacts of fishing subsidies on marine ecosystems with a particular focus on Türkiye, which is making progress towards a more environmentally mindful approach, and a broader applicability to the Mediterranean fisheries. Our findings demonstrated that capacity-enhancing subsidies, including fuel tax concessions and infrastructure support, have primarily supported the growth of industrial fishing but did not correspond to higher catch rates in recent decades. Beneficial subsidies, aimed at the conservation of resources, have vastly increased but could be allocated more towards research, to further maximize their effectiveness in sustainable fishery management. Ambiguous subsidies, like income support for small-scale fishers and vessel buy-back programs, have played a complex role. While income support for small-scale fishers could potentially support sustainable practices, the effectiveness of vessel buy-back programs in reducing overall fishing pressure remained limited. Overall, the patterns observed in the Turkish fisheries, particularly the persistent decline in the average catch and the downward shift in the mean trophic level of catches, with the intensified fishing effort despite the decreased fleet size, indicate an opportunity for further optimizing the allocation of fishing subsidies towards more sustainable fisheries management practices.

Looking forward, it is evident that further research is needed to refine our understanding of the multifaceted effects of fishing subsidies. Future studies should aim to i) develop more refined models that correlate subsidy types with specific ecological outcomes, facilitating targeted reforms, ii) investigate the long-term effects of subsidy-driven changes in fishing effort on marine trophic dynamics, iii) explore the social dimensions of subsidy allocation, particularly how subsidies influence the livelihoods of small-scale fishers and the related socio-economic structure, iv) employ advanced technologies for data collection and analysis to enhance the transparency and effectiveness to track subsidies and enable a deeper policy evaluation. Finally, interdisciplinary research that combines ecological, economic, and sociological perspectives is important to inform a holistic approach to fisheries management. Integrating such research with active stakeholder participation, including local communities, policymakers, and fishery managers, could lead to more equitable and effective subsidy reforms.

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CHAPTER 3. ADDRESSING THE LINK BETWEEN FOSSIL FUEL SUBSIDIES AND CLIMATE CHANGE IN THE MEDITERRANEAN REGION

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Credit : Adobe Stock

Although fossil fuel production has not been a crucial element of every country in the Mediterranean, many countries in the region continuously support fossil fuels by providing a range of state incentives and subsidies to the sector. On one hand, fossil fuel subsidies (FFS) are provided with the honorable intention of lowering the cost of fossil fuel energy production, increasing the price received by energy producers, or decreasing the price paid by energy consumers. On the other hand, FFS have been blamed for accelerating the depletion of natural resources, leading to higher greenhouse gas emissions and global warming as well as local atmospheric pollution and health issues, and undermining the competitiveness of clean energy technologies.

Studies examining the impact of these subsidies on greenhouse gas (GHG) emissions in the Mediterranean from an economic point of view are quite limited in numbers and scale. Therefore, this study first aims to fill in this gap by employing the OECD inventory on FFS in order to detect whether FFS hinder the transition to a low-carbon economy in Mediterranean countries employing a panel data modeling approach. The second aim of the proposed research is to conduct a finer analysis, digging into the specific types and quantities of coal subsidies in a country where energy supply is largely based on fossil fuels. For this reason, Turkiye has been selected as a case study, as it offers a breadth of available government databases, literature, legislation, sector reports and technical projections to capitalize-on, allowing us to closely look into the relationship between FFS and GHG emissions. Thirdly, the aim is to guide policy-makers in the Mediterranean in reshaping the policy tools that are intended to contribute to climate change mitigation and a transition to renewable energy. To this end, experiences of Morocco and Egypt are also discussed, as they are South Mediterranean countries which embarked into such a reform process several years ago.

Overall, our results show that FFS have the potential to increase GHG emissions in the Mediterranean. Despite intentions that may be noble from a social perspective, FFS fall short of achieving their desired objectives. Our conclusions highlight the pivotal role Mediterranean countries can play in shaping their energy future amidst climate challenges. Clear and realistic timelines to end fossil fuel extraction and combustion are needed, backed by robust policies and regulation. Measures, like phasing out fossil fuel subsidies (FFS), particularly for coal, petroleum, and natural gas, can significantly curb greenhouse

gas emissions and accelerate the adoption of renewable energy sources. Reform of taxation systems to discourage fossil fuel consumption may be required, however, measures must also be taken to mitigate the impact of subsidy removal on vulnerable groups reliant on fossil fuels for heating and cooking. Complementary policy reforms, such as targeted energy subsidies and employment programs, can help alleviate welfare losses and ensure a just transition. Finally, regional and international collaboration opportunities can be seized through joint initiatives with neighboring countries to leverage collective resources for energy policies. The MSSD's Regional Action Plan on Sustainable Consumption and Production in the Mediterranean could be a framework to initiate FFS phase-out.

1. Introduction

The primary driver behind the surge in carbon dioxide (CO2) and greenhouse gas (GHG) emissions is the escalating consumption of fossil fuels. This trend has led to profound alterations in global climate patterns and significant environmental pollution. Governments typically prioritize energy security and economic growth in their energy policies, often relegating climate change to a secondary concern. As a result, fossil fuel subsidies (FFS) have emerged as a prominent policy tool since the 1970s to bolster energy security and address escalating energy needs.

The OECD Inventory of Support Measures for Fossil Fuels reports that direct transfers and tax expenditures associated with support measures for fossil fuels amounted to 427.9 billion USD in 2022 (OECD, 2023a). Furthermore, the IEA estimates that fossil fuels sold below market prices amounted to 1,126.6 billion USD in the same year (IEA, 2023). In recent years, there has been a notable expansion of carbon pricing mechanisms worldwide, including carbon cap-and-trade schemes and carbon taxes. This trend began in the 1990s and gained momentum in the 2000s. However, despite this proliferation, global carbon pricing revenue has significantly lagged behind subsidies to the fossil fuel sector, as illustrated in Figure 1 using data from the OECD, IEA, IMF, and WB. For example, in 2020, total fossil fuel subsidies exceeded 375 billion USD, whereas global carbon pricing revenue amounted to only 50 billion USD. Additionally, EU ETS carbon prices have not always been discouraging for GHG emissions either.

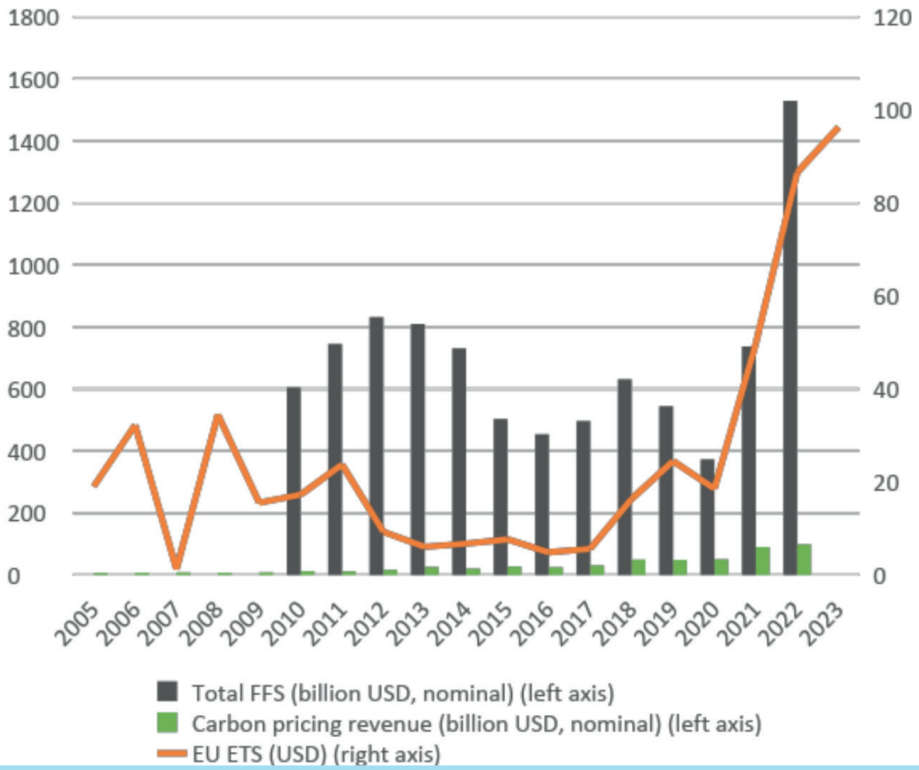

Figure 1. *Global FFS estimates versus carbon pricing data*
Source: Author's illustration based on data from OECD, IEA, IMF, and WB.

Historically, countries such as Algeria, Libya, and Egypt have been among the top producers of both gas and oil. More recently, due to concerns regarding energy security and to issues that have arisen following the war in Ukraine, the importance of energy supply has increased throughout Mediterranean countries. For instance, countries such as Israel have accelerated their efforts to explore oil and natural gas both onshore and offshore. Meanwhile, supported by the Petroleum Market Law through incentives for investors to explore and produce oil, Turkiye has been pursuing oil exploration activities in the Black Sea.

The focal point of this research is on fossil fuel subsidies (FFS) allocated to the energy sector in selected Mediterranean countries. It is widely acknowledged that FFS typically entail adverse economic ramifications, being both costly and prone to fostering wasteful consumption and market distortions. Despite these disadvantages, governments deploy these incentives with the intention of safeguarding vulnerable social groups, promoting economic development, and ensuring energy security. Despite these noble intentions from a social perspective, FFS often fall short of achieving their desired objectives. Given the global imperative to address climate change, there is a pressing need to conduct thorough evaluations of FFS, analyzing their impacts on both macroeconomic and environmental indicators, particularly greenhouse gas emissions.

This study is original in its goals. Firstly, it seeks to address a notable gap in the literature by utilizing the OECD inventory on fossil fuel subsidies (FFS) to ascertain whether FFS impede the transition to a low-carbon economy in Mediterranean countries. Secondly, it aims to compile a thorough inventory detailing the types and quantities of coal subsidies in Turkiye, drawing from government databases, existing literature, current legislative frameworks, sector reports, and technical projections. Additionally, it endeavors to examine the correlation between these subsidies and greenhouse gas (GHG) emissions in Turkiye.

2. Literature Review

Previous literature has adopted various approaches to quantifying various energy support mechanisms. There are three main sources of inventories at the global level: the IEA, the IMF and the OECD. The IEA's definition of an energy subsidy is "any government action that concerns primarily the energy sector that lowers the cost of energy production, raises the price received by energy producers or lowers the price paid by energy consumers" (IEA, 2006). The OECD uses a bottom-up method to estimate government support for fossil fuels by identifying and measuring individual policy measures. This approach measures fossil fuel support as all direct budget transfers and tax expenditures that provide benefits or preferences for fossil fuel production or consumption. In 2011, the OECD published an inventory of all types of FFS (both consumer and producer) in 24 of its member countries. The OECD-IEA combined estimates now cover 82 economies, representing the total resulting from merging IEA price-gap estimates and OECD Inventory estimates from OECD, G20 and Eastern Partnership (EaP) countries and identifies more than 1,100 support mechanisms (https://www.oecd.org/fossil-fuels/). OECD data includes both producer and consumer support as well as a disaggregation of subsidies with respect to fuel type.

Van Asselt and Kulovesi (2017) argue that historically, parties to the UNFCCC have tended to overlook the causal relationship between global warming and fossil fuel subsidies. Alongside with it, there is a limited literature that attempts to assess the socioeconomic and environmental impacts of FFS at national and global levels. For instance, according to the findings of Kovacevic (2011), FFS have the potential to increase the cost of climate change mitigation by five times or 20-25% of a country's GDP. Solarin (2020) finds that an increase in FFS is associated with an increase in ecological footprint. Accordingly, a 10% increase in FFS will increase the ecological footprint by between 0.3% and 1.5% in the selected 35 emerging and developing countries. Arzaghi and Squalli (2023) find that high FFS are associated with greater emissions, and calculate that high-subsidy countries emit about 11.4% more emissions than high-tax countries. As a

solution, they propose transitioning from a high-subsidy to a high-tax regime, which could reduce emissions by 1.28%.

There is a more fertile literature on the impacts of FFS removal or phase-out on emission and other socio-economic indicators. For instance, Monasterolo and Raberto (2019) confirm the positive effects of gradual FFS phase-out on the green economy, and specifically on emissions. Besides, they note that FFS have higher distributive effects than green subsidies. Similarly, Adekunle and Oseni (2021) demonstrates an inverse relationship between fuel subsidy removal and carbon emissions in Nigeria in the short run and long run. Antimiani et al. (2023) show that the combined use of all instruments under the EU climate strategy including the removal of FFS and the reuse of revenues to foster the technological transition of the energy system is crucial for a sustainable and decarbonised EU economy.
A few studies have focused on FFS in Turkiye, such as the IEA's energy policy review and the Turkiye section of the OECD inventory. Additionally, a report authored by Acar et al. (2015) and published by the IISD-GSI provides a comprehensive examination of incentives for coal and renewable energy in Turkiye, with a particular focus on the externalities associated with coal. However, it is noted that the data covered in this report needs to be updated to include information up to 2022. Regarding the climate impacts of FFS, a study conducted by Acar and Yeldan (2016) investigates the macroeconomic and environmental effects of coal subsidies in Turkiye. Their findings suggest that removing production and investment subsidies for coal could lead to a significant decline in CO2 emissions in both high- and low-income regions of Turkiye by 2030, resulting in a 5.4% reduction in emissions compared to the base scenario at the national level.

3. Analysis of OECD member states in the Mediterranean region

The aim of this section is to conduct a panel data analysis in order to detect the causal relationship between FFS (in the form of direct transfers) and GHG emissions per capita in the Mediterranean region using the OECD FFS inventory. For this purpose, eight OECD countries in the region are included in the analysis due to FFS data availability in the OECD database for the period 2010-2021. These countries are France, Greece, Israel, Italy, Portugal, Slovenia, Spain, and Turkiye (it is acknowledged that there are also other Mediterranean countries that typically rely on fossil fuel subsidies; however, they were not included in the analysis due to their absence from the OECD database which allows for harmonized and comparable data). According to the OECD FFS Inventory, nationally estimated FFS are the sum of subsidies to End-use electricity + Natural gas + Petroleum + Coal. Alternatively, the inventory disaggregates FFS with respect to beneficiary into Producer Support Estimate + Consumer Support Estimate + General Services Support Estimate. (See Appendix A0 for a detailed OECD Glossary of FFS.) Making use of this disaggregation, the following research questions are answered:
1. Which energy source do the incentives favor more in the region?
2. Is it the consumers, producers, or general services that acquire more FFS?
3. Does the total amount of FFS matter in determining the level of GHG emissions per capita in the region?
4. Does the type of energy source subsidized make a significant difference in GHG emissions per capita in the region?
5. Does it make significant a difference in GHG emissions per capita whether FFS are provided to production, consumption, or general services?
6. Additionally, once GDP is used as a control variable, does GDP significantly increase GHG emissions per capita in the region?

Section 3.1. undertakes a thorough review of subsidies provided to fossil fuels in the eight OECD countries in the Mediterranean region, whereas Section 3.2 explores the link between FFS and GHG emissions per capita in the Mediterranean for the period 2010-2021.

3.1. FFS in the Mediterranean

This section reviews all forms of FFS (in constant 2010 prices) in the Mediterranean region using OECD data for the period 2010-2021, and for

2022, where data is available. The abbreviations used for the FFS categories in the figures and tables are provided below:
FFS: Total FFS
FFS_EL: FFS to end-use electricity
FFS_GAS: FFS to natural gas
FFS_OIL: FFS to petroleum
FFS_COAL: FFS to coal
FFS_PSE: Producer Support Estimate
FFS_CSE: Consumer Support Estimate
FFS_GSSE: General Services Support Estimate

To begin with, it is worth reminding that key gas and oil producers like Algeria, Libya, and Egypt are not accounted for in the OECD database. Yet, the FFS support they provided is sizable as we can sse when consulting alternative databases. For instance, it appears that among non-OECD countries in the region, Algeria extends fossil fuel incentives of a magnitude similar to those of Italy. According to FossilFuelSubsidyTracker.org, FFS in Algeria and Italy amounted to around 50 billion USD (nominal) in 2022. Meanwhile, Egypt provided substantially higher incentives to fossil fuels, totaling 66 million USD in the same year.
When looking solely at the eight Mediterranean countries featured in the OECD database, Italy and France are the ones exhibiting the highest levels of fossil fuel subsidies (FFS) over the 2010-2022 period, measured in million USD at constant prices, whereas Slovenia displays the lowest (refer to Figure 2)[72].

In the past 12 years, it has been petroleum that has been mostly subsidized in the OECD members in the region (Figure 3). With the recent surge in energy prices, several countries have started to increasingly subsidize natural gas and coal combustion. For instance, in France and Italy, FFS to natural gas more than doubled from 2017 to 2018. In Portugal, subsidies to coal doubled between 2016 and 2017, whereas subsidies to oil and gas almost tripled from 2021 to 2022. The acceleration of FFS in 2022 is attributable to the energy price crisis, which was further deepened by the war in Ukraine, as EU Member States implemented more than 230 temporary subsidy measures to protect households and industries (European Environment Agency, 2023)[73].

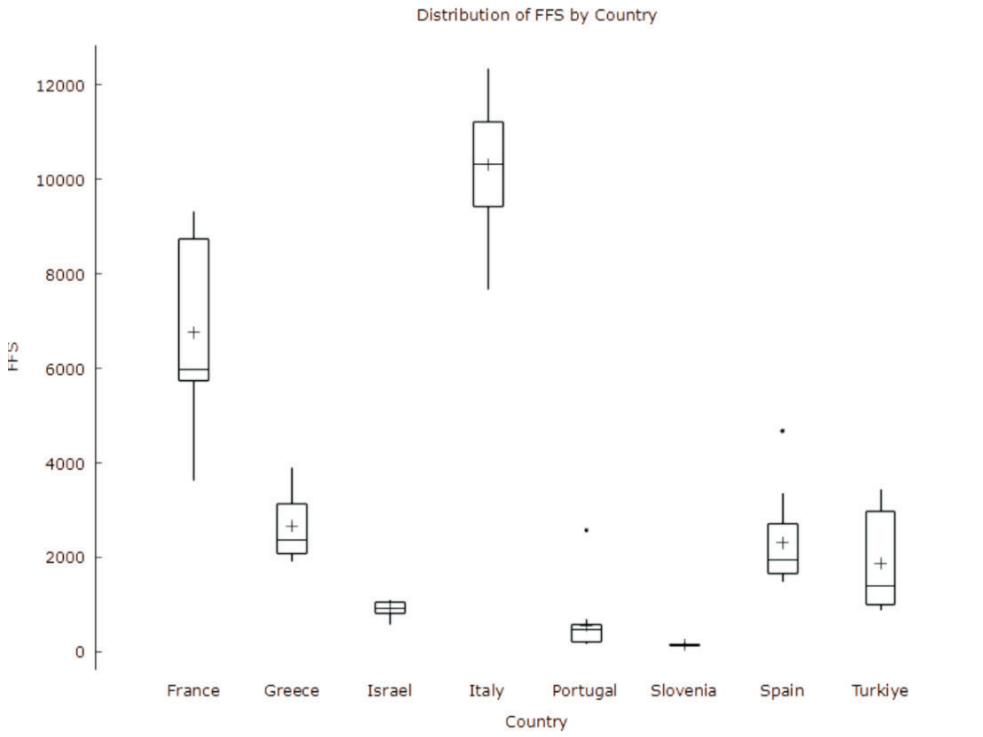

Figure 2. *Distribution of FFS by country (in million USD, constant prices)*
Source: Author's illustration using OECD data

72 How to interpret the boxplots: The line within the box is the median, the plus sign within the box is the mean, and the dots are the outliers. Each box includes the middle 50 percent of the data.

73 See Appendix 1 - Figure A1 for an illustration of fossil fuel subsidies in the 27 EU Member States, 2015-2022.

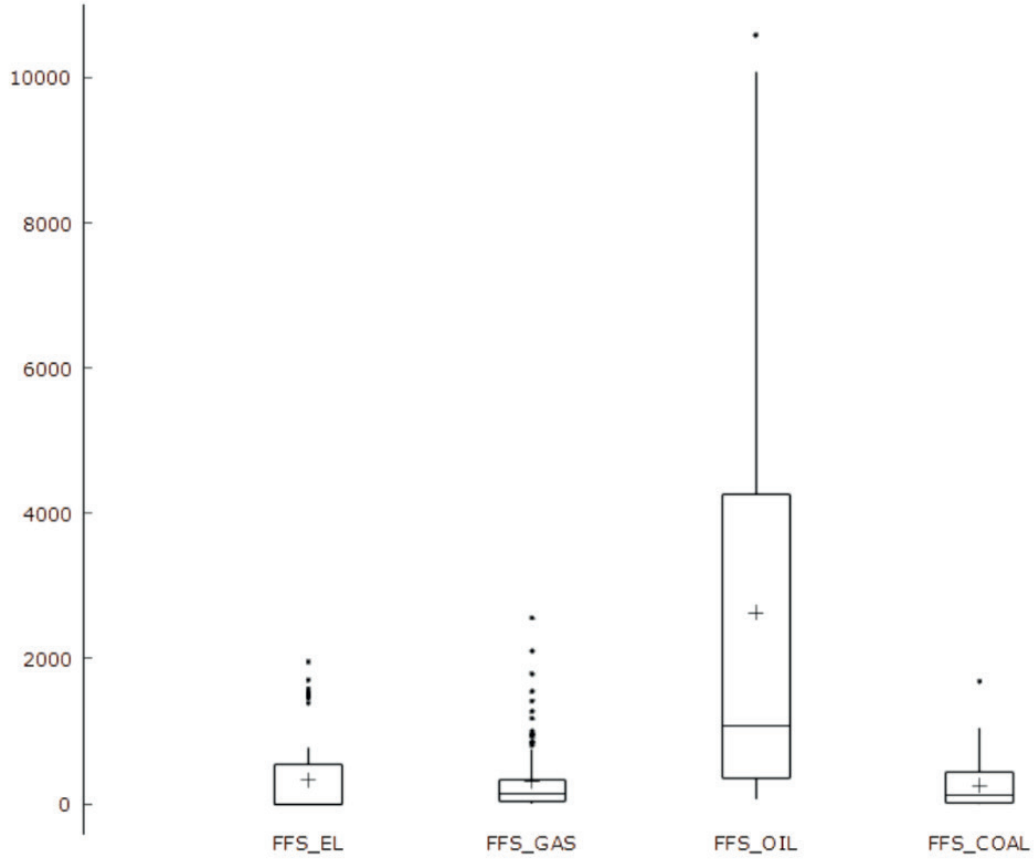

Figure 3. *Distribution of FFS by fuel type in the region (in million USD, constant prices)*
Source: Author's illustration using OECD data

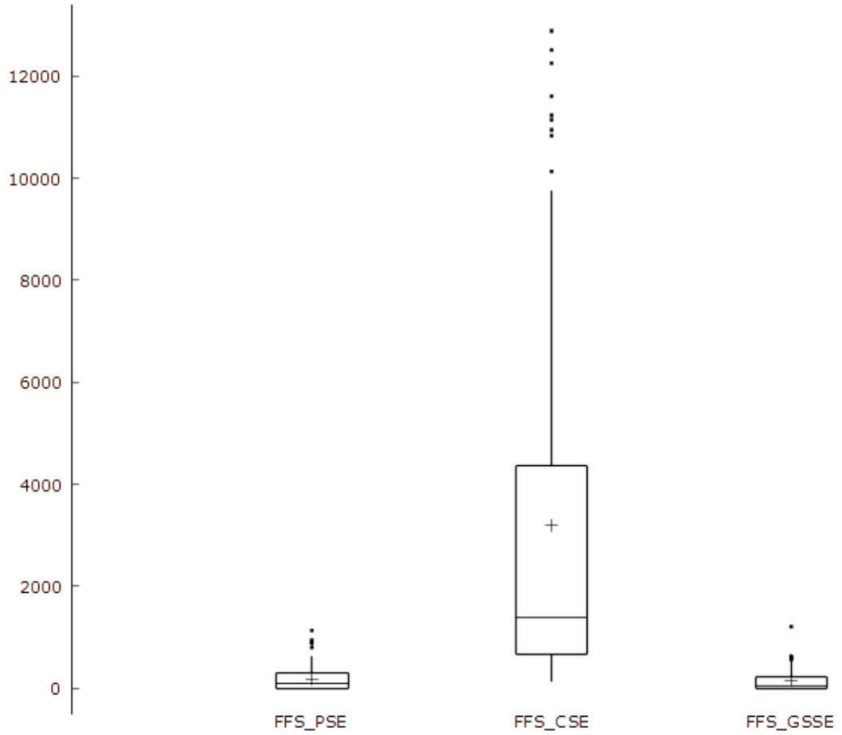

Figure 4. *Distribution of FFS by type of direct beneficiary in the region (in million USD, constant prices)*
Source: Author's illustration using OECD data

Finally, in the 2010-2021 period, FFS mainly accrued to consumers in the OECD members in the Mediterranean region, which is followed by subsidies to producers and general services (Figure 4).

3.2. Econometric methodology : FFS and GHG emissions link in the Mediterranean

This section answers whether the amount and type of FFS matters in determining the level of GHG emissions in the Mediterranean. The data for FFS (in million USD, corrected for inflation using the national consumer price indices) and GHG emissions per capita (in tonnes) for the period 1990 – 2021 are extracted from the OECD database (2023a and 2023b, respectively), whereas GDP data (in constant 2015 USD) is extracted from the World Bank.

The econometric analysis is conducted using panel data methods. Panel data is a set of data in which the behavior of entities (i) over time (t) is observed. These units may consist of individuals, families, businesses, or nations. If the same observation units from a cross-section sample are examined twice or more, the resulting observations constitute a panel or longitudinal data set (Dougherty, 2016). The panel structure of the data used in this study enables us to examine the effects of FFS on GHG emissions per capita both on a country level and over a time span (2010-2021). 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 this formula, for i= 1,..., N and t= 1,..., T, where yit is the dependent variable, Xi' is the vector of independent variables, is the coefficient vector of independent variables, and uit is the composite error, in the following form:

$$u_{it} = \mu_i + v_{it}$$

where μi is the unobservable individual-specific effect, and vit is the remainder disturbance. μi is time-invariant, and it takes into account any individual-specific impact that is left out of the regression. vit differs from individual to individual and time and can be considered the usual disturbance in the regression. The fixed effects model is preferred as all independent variables are conditionally related to individual effects (Mundlak, 1978). Heteroskedasticity-corrected standard errors are estimated using the robust estimator of the covariance matrix proposed by Arellano, which take into account both heteroskedasticity[74] and autocorrelation[75]. Table 1 displays the results of the panel data regressions.

Overall:

- Model 1 reveals that an increase in country-level direct FFS triggers GHG emissions per capita in the region. A 1% increase in FFS leads to 0.04% increase in emissions per capita. In the same analysis, GDP makes a significant contribution to emissions per capita; i.e. being a wealthier country implies an increase in the GHG each person emits. To be more precise, a 1% increase in GDP leads to 0.5% increase in emissions per capita.
- In Model 2, FFS is disaggregated with respect to fuel type. It is found that FFS to natural gas has a significant and positive impact on emissions, where a 1 million USD increase in FFS to gas leads to a 0.00005% increase in emissions per capita. Thus, spending more on natural gas, does (to some extent) contribute to increased GHG per person. All other FFS categories by fuel type prove, according to our analysis, to have insignificant effects. In Model 2, GDP also has an emissions-triggering effect as expected.
- Finally, in Model 3, FFS is categorized with respect to direct beneficiary. FFS to producers makes a positive impact on emissions, whereas the two other FFS categories by beneficiary have insignificant effects according to our analysis. A 1 million USD increase in FFS to producers leads to a 0.0001% increase in emissions per capita (see Appendix 2, Table A2.1, A2.2, and A2.3). The results are in similar directions when the

74 Heteroskedasticity is an issue encountered in regression analysis when the variance is not constant along the line.

75 Autocorrelation is an issue encountered in regression analysis when error terms in a time series data are transferred from one-time period to another.

	Model 1 LNGHGPC	Model 2 LNGHGPC	Model 3 LNGHGPC
Variable	Coefficient (Standard error)	Coefficient (Standard error)	Coefficient (Standard error)
LNGDP	0.471** (0.184)	0.570** (0.198)	0.064 (0.242)
LNFFS	0.0396* (0.016)		
FFS_EL		−4.18344e-05 (3.14421e-05)	
FFS_GAS		4.90812e-05*** (1.17744e-05)	
FFS_OIL		5.47655e-08 7.97136e-06	
FFS_COAL		−1.90221e-05 (5.26576e-05)	
FFS_PSE			0.0001** (5.63578e-05)
FFS_CSE			−1.5460e-05 (1.63741e-05)
FFS_GSSE			9.41301e-05 (5.72169e-05)
Constant	−10.777* (4.887)	−13.198** (5.317)	0.304 (6.510)
Time dummies	yes	yes	yes
Observations	96	96	96
Number of countries	8	8	8
LSDV R-squared	0.953878	0.955087	0.999452

Robust standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1

TABLE 1

Panel data estimation results for Mediterranean countries

same explanatory variables are regressed on country-level GHG emissions instead of GHG emissions per capita. GDP is a significant factor in explaining total emissions in two of the three model specifications.

Though there is no agreed-upon definition for environmentally harmful subsidies, expert opinion is that FFS are environmentally harmful and pose a net negative impact, both in individual countries and globally (OECD, 2013). FFS lower the cost of fossil fuel production, leading to market distortions that have consequences far beyond the specific policy goal for which the subsidy is intended. In such ways, FFS increase energy production and consumption and hence contribute to GHG emissions, astringe government budgets, divert funds that could be spent for social purposes (such as health or education), and strain the profitability of alternative energy sources (OECD, 2013). The results of our analysis for producer FFS are supportive of these expert opinions for the OECD members of the region. Consumer FFS is not found to have a significant impact in our analysis, yet this could also be due to the fact that the selected eight countries constitute a limited subset of the Mediterranean region. As a result, the findings may not capture the full extent of the impact of consumer FFS on greenhouse gas emissions.

4. An in-depth focus on Turkiye's FFS and its relationship with GHG emissions

As is the case with other countries facing challenges due to factors like population growth and urbanization that lead to increased energy demand, Turkiye has an important reliance on fossil fuels for its energy supply. As highlighted

in the 2013 OECD inventory, fossil fuel subsidies (FFS), particularly directed towards the coal industry, emerge as a significant issue in Turkiye. This section aims to provide a detailed examination of fossil fuels in the country, with a specific focus on coal. It highlights aspects such as coal-powered electricity generation, coal mining activities, and the various incentive mechanisms that promote coal mining and the operation of coal-fired power plants. Following the guidelines outlined in the 2009 Electricity Energy Market and Supply Security Strategy Document, Turkiye has identified domestic and renewable resources as «priority resources» for meeting its electrical energy needs. In alignment with this strategy, several incentive mechanisms have been implemented, particularly revolving around domestic coal, particularly lignite. These mechanisms include fixed price guarantees, tax exemptions, and the establishment of capacity mechanisms.

This section aims to highlight the actual cost of energy incurred by the government through various forms of subsidies. In order to understand the effects of these policies, it is crucial to reveal incentive costs with numerical data as much as possible. Specific research objectives in this section are as follows:
1. Quantifying the total amount of government incentives and subsidies to coal in Turkiye
2. Comparison of the actual costs of renewable energy and coal via subsidies in Turkiye
3. Cost of tax expenditures to the general budget in Turkiye
4. Detecting the relationship between FFS and GHG emissions in Turkiye

Within the scope of this research, we elaborate on the following incentive mechanisms :

- Aid to hard coal in the form of direct transfers from the Treasury: Turkiye's hard-coal reserves are relatively small compared with those for lignite. Production costs for hard-coal of the state-owned Turkish Hard-Coal Enterprises (TTK) have been high, with an (weighted) average of TRY 1347 per tonne in 2017. Meanwhile the average selling price (TRY 309 in 2017) has been much lower than the average production costs throughout the years. Enterprise losses have been compensated by the Treasury (Ministry of Treasury and Finance, OECD (2023a)).
- Coal aid to poor families: This programme was initiated in 2003 by the Ministry of Energy and Natural Resources to assist poor families, an initiative that could be seen as positive from a social perspective as it helps ensure that vulnerable households have access to heating fuel, especially in regions where alternative energy sources may be limited or expensive. In Turkiye, a significant number of households still burn lignite for heating purposes. Coal is supplied by Turkish Coal Enterprises (TKI) and Turkish Hard-Coal Enterprises (TTK) and distributed by local governments. The Undersecretariat of Treasury funds the programme within duty loss payments. In 2017, more than 2 million families received coal aid (Ministry of Treasury and Finance, Strategy and Budget Office of Presidency of Turkiye, OECD (2023a)).
- R&D expenditures: The five-year Strategic Plans of the Ministry of Energy and Natural Resources (MENR) outline the planned expenditures of the Turkish government for R&D supporting the production, manufacturing, and supply of energy. According to the plans, priority is given to the utilisation of domestic resources and technologies supporting energy production planning. Funding is also provided to improve the capacity of the Technology Development Centres, bringing together universities and the private sector, and the development of hydrogen-based energy (Acar, Challe, Christopoulos and Christo (2014), MENR (2019-2023), OECD (2023a)).
- Exploration subsidies: The five-year Strategic Plans of the Ministry of Energy and Natural Resources outline the planned expenditures of the Turkish government to reach its target of increased domestic oil, natural gas and coal explorations. In the recent 2019-2023 Strategic Plan, it is indicated that oil and natural gas exploration and production activities, especially offshore, will be accelerated and sustained (Acar, Challe, Christopoulos and Christo (2014), MENR (2019-2023), OECD (2023a)).
- Investment incentive schemes (e.g. Region V incentives for coal investments): Investments in coal mining and coal-fired power plants have been subsidized within the Investment Incentives Scheme since 2012. Coal is categorized as one of the 'priority investment'

areas and investments in coal benefit from various tax subsidies that are quantified under the Tax expenditures category in the current work.

- Tax expenditures (reduced tax rates, tax exemptions, etc.): Tax expenditures are laws, rules or regulations that lead to a loss of revenue by allowing certain taxpayers to pay lower taxes or no taxes at all, in order to achieve certain social and economic goals. Tax concessions such as tax deductions, exceptions and exemptions that cause deviations from normal tax liabilities are called 'tax expenditures' in the literature (Ates and Acar, 2019). Various types of tax incentives are available. Tax incentives such as direct financial transfer, trade restrictions, regulations on the energy sector, and direct provision of energy-related services at a cost cheaper than the actual cost of the state are also among these types. Yet, it is not easy to quantify these tax incentives. In Turkiye, the need to report tax expenditures and disclose foregone tax revenues to the public was recognized for the first time by the Public Financial Management and Control Law No. 5018 dated December 10, 2003. Thus, it is aimed to effectively measure and evaluate tax expenditures as well as public expenditures in order to ensure transparency and accountability in public finance (Ministry of Treasury and Finance, 2018). In the current report, tax expenditures to the coal sector are estimated based on the data from Tax Expenditure Reports of the Ministry of Treasury and Finance.

Price guarantee: The state-owned Electricity Generation Company (EÜAŞ; previously TETAŞ), leaning on the grounds that the costs of electricity production from domestic coal resources are higher than the electricity sales prices in the market, started to purchase electricity from domestic coal-fired power plants at above-market prices. The starting (base) purchase price for the first quarter of 2018 was determined as 201.35 TL per megawatt hour (MWh). The price in question is subject to an increase in each quarter at the rate of increase in the consumer price and electricity supply price indices of the previous quarter announced by TurkStat.

Capacity mechanism: The Regulation on the Electricity Market Capacity Mechanism entered sufficient installed power capacity, including the into force in 2018 with the aim of establishing reserve capacity, for the assurance of security of supply in the electricity market and to protect the installed reliable power capacity for the assurance of long term system security. With an amendment in the Regulation, hydroelectric power plants were excluded from the scope of the mechanism while coal-fired and natural gas-fired power plants will continue to remain within the mechanism. TEİAŞ announces monthly payments on plant basis (Durmaz, Acar and Kizilkaya, 2020; TEİAŞ, 2023).

There are also other forms of subsidies that have been introduced recently. For instance, end-use electricity started to be subsidized in 2019, when the Government extended its regular social assistance payments to vulnerable households for covering their electricity consumption up to 150 kWh. The OECD database reports the quantities of this support item under the title "Cash transfers for vulnerable households (electricity)" as follows: around 299 million TL in 2019, 525 million TL in 2020, 556 million TL in 2021, and 2 billion TL in 2022. Besides, in 2022, the Government introduced a cash transfer program for vulnerable households to match their heating bills in order to fight against the increasing energy prices. The total budget of the Natural Gas Consumption Support Program was announced as 3 billion TL. In 2022, the value of the cash transfer was reported as 517 million TL[76] in Ministry of Family and Social Services budget reports.

Section 4.1. undertakes a thorough review of all forms of subsidies provided to fossil fuels, mainly to the coal sector in Turkiye, whereas Section 4.2 explores the link between FFS and GHG emissions in Turkiye for the period 2010-2021.

4.1. FFS in Turkiye

Under current economic and market conditions, there is de facto moratorium in coal investments; that is, no international and national investor is attracted to new coal projects in Turkiye.

76 In the OECD database, this item is called "Cash transfers for vulnerable households (heating)" and amounts to 402.6 million TL in 2022.

However, on the policy level, subsidies for coal are maintained through legislative and regulatory measures, along with discourse aimed at creating public support for coal investments. Moreover, the Regulation on the Electricity Market Capacity Mechanism entered into force in 2018 with the aim of establishing sufficient installed power capacity, including the reserve capacity, for the assurance of security of supply in the electricity market and to protect the installed reliable power capacity for the assurance of long term system security. According to the regulation, coal-fired and natural gas-fired power as well as hydro power plants were able to benefit from the capacity mechanism, unless they did not violate the participation requirements for the mechanism. Nevertheless, in 2018, only fossil fuel power plants were funded by the mechanism. Furthermore, in 2019, it is estimated that 94% of the funding was channeled to support fossil fuel energy generation. The amount paid to companies within the scope of this mechanism in 2023 reached 3.5 billion TL. Hydroelectric power plants received 8.5% of this amount, while coal and gas-fired power plants received the rest. With the regulation published in the Official Gazette dated 31 December 2023, an amendment was made to the Electricity Market Capacity Mechanism Regulation. With the changes made, hydroelectric power plants were excluded from the scope of the mechanism while coal-fired and natural gas-fired power plants will continue to remain within the mechanism. The exclusion of diverse capacity providers, such as renewable energy generators and demand-side response operators, may impact market competition while aiming to ensure energy supply security. In addition to the subsidies received by fossil fuel power generators using domestic coal and natural gas, payments through the capacity mechanism in Turkey could encourage further investments in fossil fuel power stations, which can operate for up to 50 years (Kharecha and Hansen, 2013). Financing such long-term infrastructures might result in a lock-in effect, posing challenges to transitioning towards a cleaner energy infrastructure.

Acar et al. (2015) reveal that the incentives provided to coal in Turkiye were significant, and with a conservative evaluation, the estimated level of these incentives was in the range of USD 0.011-0.025 per kWh in 2013. According to the report, the total amount of quantifiable incentives given to the coal industry in 2013 was approximately 730 million USD. This amount includes direct transfers to the hard coal industry, incentives for the exploration of coal resources, improvement of power plants and coal aid to poor families. Apart from these, there are other incentives that can be identified but not quantified. The estimated value would increase considerably if unquantifiable investment guarantees, customs duty and value added tax (VAT) exemptions, social security premium support, land allocation and below-market interest rates were also taken into account. A more recent study, SHURA (2019), shows that annual subsidies for the energy sector amount to about 8 billion USD, of which approximately 3.8 billion USD accrues to fossil fuels. While this amount is approximately 0.5% of the 2018 national income, when divided by the total electricity production of the same year, it corresponds to a support of 0.01-0.02 USD/kWh. As such, Acar et al. (2015) and SHURA (2019) analyses provide similar estimates per unit of electricity generation. The subsidy quantity that is estimated for Turkiye in this study is calculated by updating the assumptions adopted by Acar et al. (2015). All the incentive forms considered in IISD (2015) are still available and have been most likely increasing. First of all, it is predicted that only some of the coal incentives taken into account by Acar et al. (2015) were reflected in electricity production. It is assumed that 50% of the support allocated from the MENR budget for oil, natural gas and coal mine exploration is given to Turkish Coal Enterprises (TKI). In addition, it is assumed that half of the direct transfers from the Treasury to the coal sector are allocated to lignite, and on this occasion, 70% of the support given to TKI is the incentive provided to electricity production from coal. Second, although coal aid provided to poor households since the beginning of the 2000s is not directly considered as support for electricity production, 20% of it can be considered as profit for coal companies. It can be assumed that coal distribution to the poor creates an additional "market" for these companies and that they are supported through the "additional profit" they earn (which is reflected in electricity prices). By this calculation, $78.5 million of the 2013 coal aid can be considered as support for electricity production.

When the support items except capacity remunerations and price guarantees are added together (lignite exploration incentives, direct

Treasury transfers, rehabilitation aid to power plants in the privatization process, budget expenditures for new coal power plants, profits transferred to coal enterprises through coal aid to the poor) and divided by the amount of electricity produced from domestic coal, the subsidy amount for domestic coal is found to be 0.0074 USD/kWh for the year 2018.

Furthermore, the current evaluation further intends to include capacity mechanism payments for domestic coal-fired power plants, which were introduced in 2018, and the price guarantees to domestic coal. To begin with, capacity mechanism payments for coal-fired thermal power plants reached 688.9 million TL in 2018, according to TEİAŞ data. About 655 million TL of this was given to domestic coal-fired power plants, and the remainder was given to imported and domestic coal-fired power plants. This makes 49% of the total capacity payments provided to the electricity generators in that year, whereas the remaining 51% was given to gas-fired power generators. In the same year, the electricity produced by domestic coal-fired power plants was at 50,389.34 GWh (Energy Market Regulatory Authority, 2019).

Therefore, the capacity mechanism incentive amount per kWh was of USD 0.003[77] in the year 2018[78]. Accordingly, price guarantee support per kWh for domestic coal-fired power plants was calculated as ((1 billion TL* 0.213 USD/TL) / 50,389.34 GWh) USD 0.004 for 2018. In 2019, price guarantee support for domestic coal reached 2.1 billion TL in total.

In a study conducted by Aytaç (2020), the additional payment amount for the purchase of electricity from domestic coal power plants at a fixed price was calculated as 1 billion TL in 2018[79].

Finally, the tax expenditures to coal have been calculated using the Tax Expenditures Report (2018) of the Ministry of Treasury and Finance, which includes tax expenditure realization figures for 2018 and expenditure estimates for the following four year-period by considering the changes in macroeconomic indicators and nominal GDP growth rates determined in medium-term programs. These include, for instance, income tax withholding support for employees working in underground enterprises incentive certificates.

	Costs of coal, 2018
*LCOE**	*0.055*
*Subsidies including lignite exploration incentives, direct Treasury transfers, rehabilitation aid to power plants in the privatization process, budget expenditures for new coal power plants, profits transferred to coal enterprises through coal aid to the poor***	*0.007*
*Capacity mechanism remuneration****	*0.003*
*Purchase guarantee for domestic coal at a price above the market price*****	*0.004*
*Tax expenditures to the coal sector******	*0.0008*
Total	0.0708

TABLE 2

Costs of electricity production from coal, 2018 (USD/kWh).

Source : *Author's calculations from the following sources: * SHURA (2020) Optimum Capacity Mix Report, ** Acar et al. (2015), *** TEİAŞ and Durmaz, Acar and Kizilkaya (2020), **** Aytaç (2020) and SHURA (2019), ***** Author's own calculations.*

77 USD/TL exchange rates for 2018 and 2023 were taken as 0.2132255 and 0.0419928108 respectively.

78 In 2023, domestic coal generators received 1,160 million TL. Taking into account that the TL depreciated considerably from 2018 to 2023 and assuming that the electricity produced by domestic coal-fired power plants was almost the same amount as in 2018, the capacity mechanism incentive per kWh was at USD 0.001 in the year 2023.

79 Shura (2019, p.36) makes a similar estimate for the price guarantee support item. The theoretical purchase ceiling for electricity produced from domestic coal was 39 gigawatt hours (GWh) per year, equal to roughly 13% of total production in 2017. Based on the assumption that, again, 13% of total generation in 2018 benefited from fixed price support, 50,389 GWh*0.13=6,550 GWh could be purchased by EÜAŞ, which amounts to 6,550 GWh*201.35 TL=1.3 billion TL price support in 2018.

According to our calculations, tax expenditures for coal realized in 2018 are estimated to be at 195 million TL [42 million USD] (Acar and Kizilkaya, 2021).

When the levelized costs of electricity (LCOEs) and the above-mentioned incentive amounts are brought together, it is estimated that, in the year 2018, the cost of generating electricity from coal (LCOE + incentives) was of 0.071 USD/kWh in Turkiye (Table 2). According to the calculations of Durmaz, Acar and Kizilkaya (2020), this cost was closely followed by those of wind and solar, which were of 0.073 and 0.133 USD/kWh, respectively in the same year.

To sum up, subsidies to the use of domestic coal in electricity generation amounted to 747 million USD in 2018. It corresponds to at least 0.1% of the Turkish GDP in 2018.

If 'environmental permit' incentives provided to coal power plants and flexibility in compliance with environmental legislation provided to privatized domestic coal power plants could be added to the figures reported in Table 2, it would become evident that coal-based energy is subsidized at higher levels than currently estimated. Besides, negative externalities generated by coal combustion such as health costs and environmental costs (e.g. carbon dioxide and carbon monoxide emissions) have not been accounted in the current analysis. As the estimates shared in Table 2 are for electricity generation from domestic coal, they present a rather conservative figure for fossil fuel subsidies in Turkiye.

The OECD Inventory of Support Measures for Fossil Fuels reports that direct transfers and tax expenditures associated with support measures for fossil fuels amounted to 4.7 billion USD in Türkiye as of 2018. Of this amount, 488 million USD was estimated to go to the coal sector. After 2018, total support slightly decreased, but support to coal roughly remained at similar levels (Figure 5). (Data for the other years are reported in Appendix 3 -Table A3 and Figures A3). The current estimate for FFS to coal surpasses the OECD estimate by almost 300 million USD probably because the current estimate is more comprehensive of the subsidies provided to the sector in Türkiye.

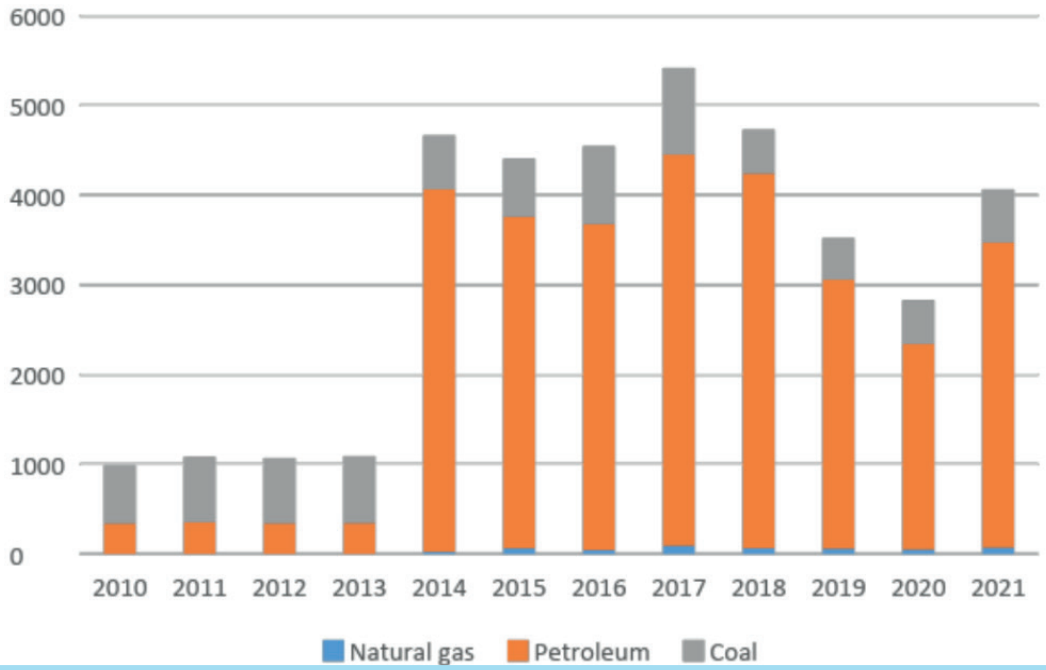

Figure 5. *Components of FFS in Turkiye according to OECD.Stat (in million USD)*
Source: Data extracted on 18 Sep 2023 12:05 UTC (GMT) from OECD.Stat

4.2. FFS and GHG emissions link in Turkiye

According to the "Greenhouse Gas Emissions Statistics, 1990-2021" released by TurkStat (2023), total GHG emissions were 564.4 million tonnes (Mt) CO2 equivalent (eq.) in 2021. The greenhouse gas inventory results revealed that overall GHG emissions as CO2 eq. for the year 2021 compared to the previous year increased by 7.7% to 564.4 Mt. Total GHG emissions per capita were calculated at 4 tonnes CO2 eq. for 1990, 6.3 tonnes CO2 eq. for 2020 and 6.7 tonnes CO2 eq. for 2021. In 2021, the energy sector had the largest share of total GHG emissions with 71.3%. The energy sector was followed by the industrial processes and product use sector with 13.3%, the agriculture sector with 12.8%, and waste sector with 2.6% (see Appendix 4- Table A4 for further detail.)

The energy sector emissions were calculated at 402.5 Mt CO2 eq. in 2021, which increased by 188.4% compared to 1990 and also increased by 9.8% compared to the previous year. Emissions from the industrial processes and product use sector were calculated at 75.1 Mt CO2 eq. in 2021, which increased by 228.7% compared to 1990 and also increased by 10.6% compared to the previous year.

Although it is hard to conduct a causality analysis for GHG emissions and FFS quantities with limited data, the correlation between the two indicators has a lot to say about the possible effects of FFS on triggering emissions. Figure 6 reveals the trends of and links between emissions and FFS types with respect to energy source. Apparently, FFS to coal and natural gas are more likely to move in parallel to total GHG emissions in Turkiye, whereas emissions seem to evolve irrespective of FFS to petroleum. The co-movement of FFS to coal and gas with emissions from energy is even more obvious in Figure 7.

OECD data for Turkiye shows that PSE consists of support to coal only, whereas CSE includes mostly support to petroleum followed by support to coal. GSSE consists of support to coal, petroleum, and natural gas, in an ascending order. Sector-wise, most support goes to transportation, followed by fossil fuel production. When one focuses on the link between emissions from energy and FFS components, the most prevalent link is associated with FFS_PSE as shown in Figure 8.

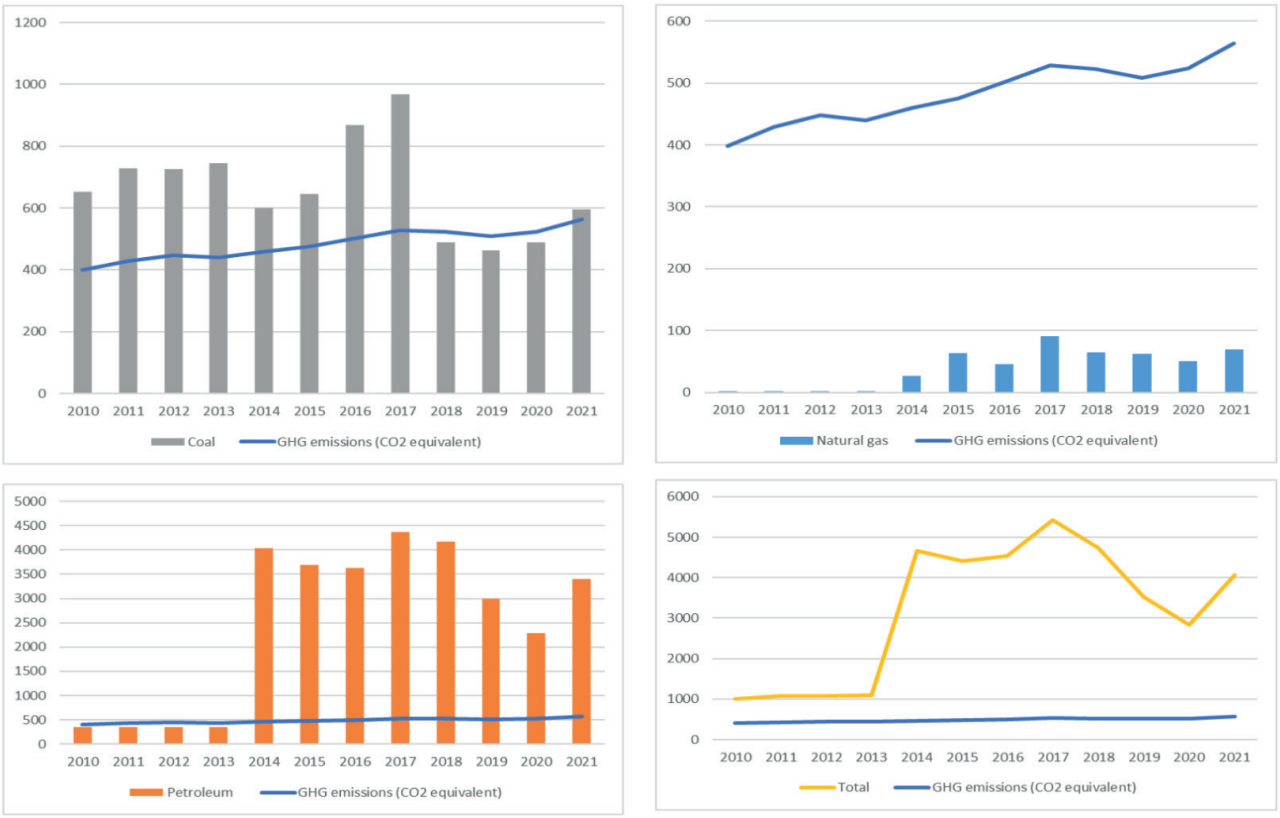

Figure 6. *GHG emissions versus FFS types with respect to energy source*
Source: Author's illustration using OECD and TurkStat data

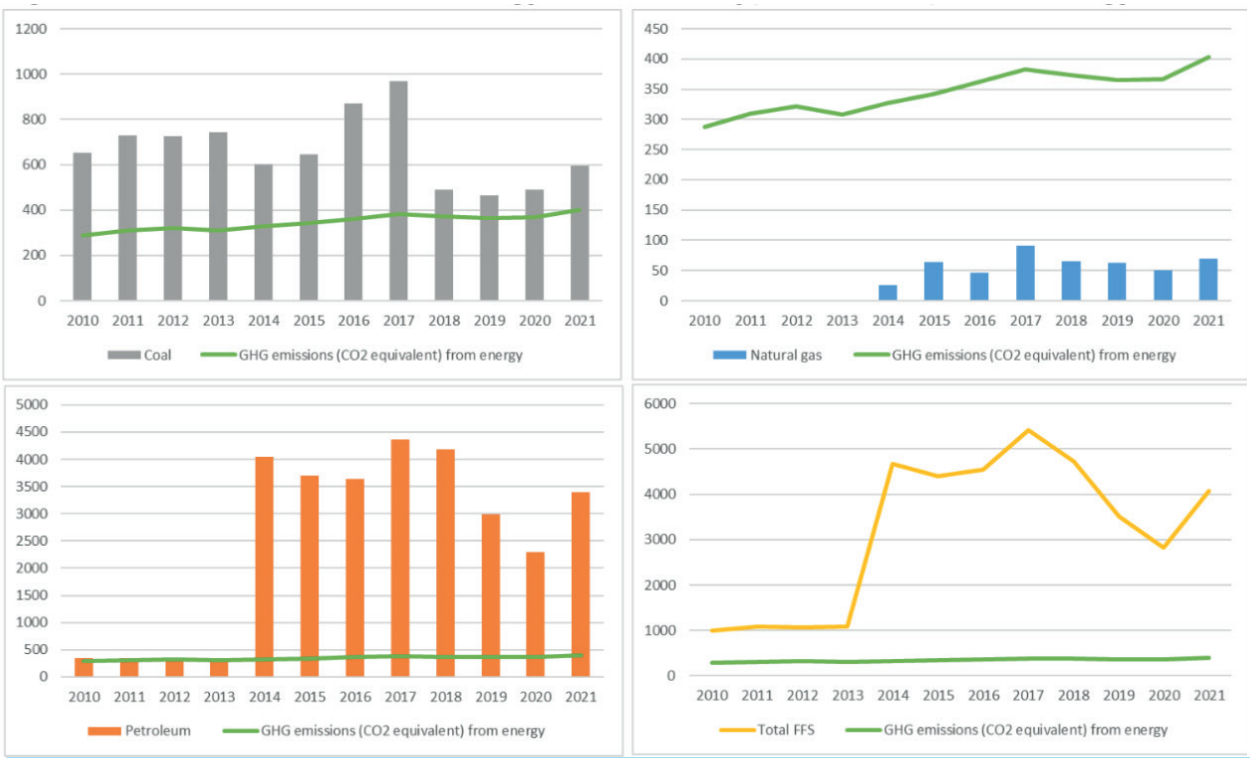

Figure 7. *GHG emissions from energy versus FFS types with respect to energy source*
Source: Author's illustration using OECD and TurkStat data

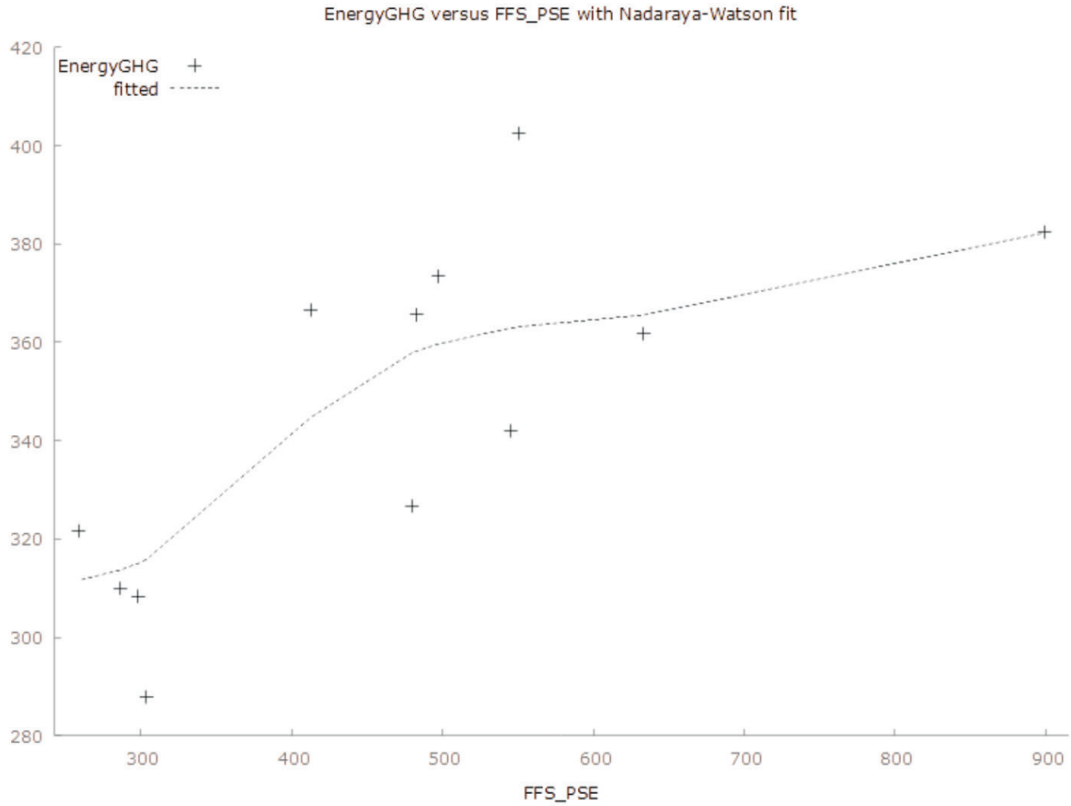

Figure 8. *GHG emissions from energy versus FFS_PSE*
Source: Author's illustration using OECD and TurkStat data

5. RESULTS AND POLICY IMPLICATIONS

The results of the current analysis show that FFS have proven to be detrimental for climate in the Mediterranean by leading to an increase in GHG emissions, thereby bearing a cost on the attempts to mitigate climate change. **The most harmful types occur to be FFS to producers (by beneficiary) and to gas (by energy source)**. As expected, there is no FFS category that proves to be beneficial for climate mitigation. Mediterranean countries have a real opportunity to develop environmentally friendly and secure energy systems and to create an economic structure based on sustainability principles. Countries are increasingly aware of the true cost of fossil fuels and are implementing policies to limit their consumption (see Box 1).

Mediterranean countries that heavily rely on FFS face a crucial decision in determining their energy resource composition for electricity production and future development policies. Short-term measures, such as eliminating FFS, especially those for coal, petroleum, and natural gas, provided to producers as well as consumers, could help mitigate GHG emissions, enhance energy efficiency and promote the adoption of renewable energy sources. This, in turn, would contribute to the energy transition efforts and the global fight against climate change. Mediterranean countries have to make a choice regarding the composition of energy resources in electricity production and the development policies they will follow. Yet, they have the chance to join the club of countries that are leading the green transition. There are a number of steps that can be taken in the short term to achieve the goals of energy security, cost-competitive energy and clean energy supply.

First and foremost, **governments should announce viable timelines to phase out fossil fuel extraction and combustion.** Concrete pledges to discontinue fossil fuel generation, supported by relevant policies and regulations, are essential. For instance, Greece has committed to ending coal generation by 2025, while Portugal has already closed down coal-fired power plants in 2021 and plans to decommission natural gas plants by around 2040. Ambitious efforts are needed to eliminate subsidies to fossil fuels.

The World Bank (2019) outlines three main steps for fossil fuel subsidy (FFS) reform. Firstly, there needs to be a comprehensive assessment of pre-reform subsidies, including monitoring and reporting mechanisms at national or regional levels. Secondly, a technical analysis of the effects of FFS and their removal should be conducted, considering options for reallocating fiscal gains. For example, eliminating subsidies and cutting fossil fuel consumption could reduce global air pollution and enhance human health. Besides, FFS removal can facilitate the uptake of new low-carbon technologies, which otherwise would be hindered as FFS lead to increasing stranded asset risks (UNEP, 2019). Apart from the positive impacts of FFS elimination, there are also adverse effects (e.g. distributional effects) that need to be investigated. Subsidy reforms, aligned with targeted social welfare programs, can alleviate poverty and empower women once distributional effects of subsidy elimination are known. Thirdly, creating a supportive political context and implementing communication strategies are crucial for stakeholders to understand and adapt to changes.

Reforming the taxation system to remove tax breaks for fossil fuels and related sectors could serve as a starting point. The United States (US) pledged to stop financing new fossil fuel projects abroad in 2021 by setting a goal of achieving net-zero emissions from its investments in developing countries by 2040 (Brind'Amour, 2024). However, the US has already committed more than 1.8 billion USD to fossil fuels for several projects abroad through the U.S. International Development Finance Corporation (DFC) and the US Export-Import Bank. The Biden-Harris Administration's Fiscal Year 2024 budget request would eliminate 13 fossil fuel tax preferences and tax credits, such as the tax credit for oil and natural gas extracted from marginal wells and the treatment of coal royalties as long-term capital gains that benefit from lower tax rates. These proposed changes would reduce the federal budget deficit by almost 31 billion USD over 10 years. In addition, the budget also proposes changes to taxation rules for foreign income of US oil and gas companies (Brind'Amour, 2024).

However, **on the consumption side, it is essential to consider the potential detrimental effects of FFS removal, especially on vulnerable groups who are dependent on fossil fuels for various purposes (e.g. heating, cooking, etc.) and who do not have the opportunity to switch to alternative fuels.** These groups usually have low income levels and lack the ability or the capacity to organize for their own interests while there is a loss of welfare. Especially in periods of high energy prices, vulnerable populations need to be supported and compensated for their welfare losses. Complementary policy reforms might be needed to correct for the detrimental effects of FFS removal. Such policy reforms could include improved provision of basic services, cash transfers, social security payments, tax reforms, targeted energy subsidies and employment programmes. For instance, in Indonesia and France, minimum wages have been increased as a supportive mechanism to subsidy removal (UNDP, 2021). Just transition mechanisms of the European

Green Deal as well as the fossil fuel exit processes accompanied by just transition policies all over the world serve as good practice examples that provide alternative ways and measures (support programs, etc.) to ensure a fair transition.

As climate is a global public good, regional and international collaboration opportunities can be seized through joint initiatives with neighboring countries to leverage collective resources for energy policies. Energy transition processes could be pursued and clean energy technologies could be deployed collaboratively to ensure just transitions towards climate neutrality. Several countries in the Mediterranean region are facing significant financial and political barriers in facilitating the energy transition. Such barriers could be overcome on the grounds of regional cooperation with the help of a true commitment to climate mitigation by each country. **The Mediterranean Strategy for Sustainable Development (MSSD) could provide an opportunity for all the Mediterranean countries in fueling such cooperation.** The MSSD highlights that economic growth should be compatible with the protection of natural resources and that the welfare benefits of the economic development process should be distributed to the entire society. Investment in the environment is recognized as the best way to secure long-term, sustainable employment creation and socio-economic development and as a fundamental process in ensuring long-term development for current and future generations. Two of the six MSSD objectives are directly related with climate mitigation, namely "Addressing climate change as a priority" and "Transition towards a green and blue economy". FFS reform could contribute to achieving these objectives first by disincentivizing the production and consumption of fossil fuels, and second, by correcting for competitiveness distortions in the energy market towards the advantage of renewable energy deployment. The MSSD's Regional Action Plan on Sustainable Consumption and Production in the Mediterranean (Decision IG.22/5 - 2016) could be adopted as a framework to initiate FFS phase-out. Operational Objective 1.2 of the Plan embodies the action of eliminating "harmful"[80] subsidies in the region. Although its main focus with this objective is food, agriculture and fisheries production and consumption, harmful energy subsidies could also be addressed as FFS alter the costs of producing (and hence, consumer prices) in these sectors as energy is a vital input for them. FFS removal could also be a significant promoter of the 13th action of the Operational Objective 2.1, which is about sustainable production in goods manufacturing and the provision of alternative services such as renewable energy.

Pollution
Credit : Play Ground

80 Under Operational Objective 1.2: "Promote "Green Financing" for the food, agriculture and fisheries consumption and production areas by facilitating access to loans and grants for farmers and fishermen to start sustainable agriculture and fishing activities, introducing fiscal instruments favouring sustainable agriculture and fisheries practices, like elimination or reduction of deemed "harmful" subsidies on water and energy consumption, and providing incentives for good environmental practices like Integrated Pest Management (IPM) and organic farming"

Box 1

Phasing-out Fossil Fuel Subsidies : Insights from the experiences of Morocco and Egypt by Eloïse Leguérinel (Plan Bleu)

i. Morocco's Reform of Fossil Fuel Subsidies: A Success Story

Context : The history of fossil fuel subsidies in Morocco traces back to the 1930s, initially aimed at safeguarding vulnerable population segments and promoting domestic industries. However, by 2007-2008, at this juncture, approximately three quarters of subsidies were benefitting the wealthiest 20% of the population, revealing inherent inequities in the subsidy framework. Morocco had long subsidised the prices of fossil fuels, with the subsidy bill reaching 5% of the country's GDP in 2012[81]. This placed a significant strain on public finances and encouraged excessive and inefficient consumption of these energy sources, posing environmental concerns. Confronted with this unsustainable scenario, the Moroccan government embarked on an ambitious reform of the subsidy system in 2012[82].

Timing of the Reform : The reform was implemented gradually, with different types of fuel being subjected to price increases at different times, between 2012 and 2015[83], in order to limit the social and economic impact of the removal of subsidies. This step-by-step approach allowed for a smooth transition towards prices that better reflect the real costs of fuel production and importation. In 2013, a new pricing system was put in place for gasoline, diesel, and fuel oil, allowing local prices to rise with price changes on world markets[84]. The final removal of subsidies was then carried out, first for gasoline and industrial fuel oil, followed by diesel, which was phased out over a period of several months[85]. By 2015, subsidies for these products were entirely removed[86]. Despite price increases, consumer opposition remained minimal[87], aided by relatively low global energy and food prices[88]. By 2021, all subsidies had been removed except those on LPG, flour, sugar, and water, which are primarily consumed by low-income groups[89]. This approach helped to reduce the fiscal burden and promote more efficient energy consumption.

Compensatory Measures : To mitigate the impact on vulnerable groups, Morocco's subsidy reform exempted prices for LPG, crucial for poor households and the agricultural sector, a major source of income and jobs[90]. Moreover, to mitigate the effects of rising prices on the most vulnerable households, the government implemented a targeted cash transfer program and expanded existing social protection programs[91]. Pre-reform, Morocco's direct cash transfer schemes were limited, covering only 15% of the poorest households[92]. To address these issues, the government developed specific measures to compensate professional categories most significantly hit by subsidy reforms, such as passenger/merchandise transporters and the industrial

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84 WRI (2021). "Morocco: Fuel Subsidy Reform Designed to Support a Just Transition to Renewable Energy". Available at: https://www.wri.org/update/morocco-fuel-subsidy-reform-designed-support-just-transition-renewable-energy

85 UNDP (2021). "Fossil Fuel Subsidy Reform: Lessons and Opportunities". Available at: https://www.undp.org/publications/fossil-fuel-subsidy-reform-lessons-and-opportunities

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87 ibid.

88 ibid.

89 ibid.

90 Royaume du Maroc, Cour de Comptes. (2014). "Rapport sur le Système de Compensation au Maroc: Diagnostic et Propositions De réforme". Available at: https://www.courdescomptes.ma/wp-content/uploads/2023/01/RapportSystemeCompensationMaroc_2014_Fr.pdf

91 Bousselmame, H. (2017). "A phased approach to energy subsidy reform: the Morocco experience", Energy Sector Management Assistance Program ESROC Practitioner Exchange Series. Available at: https://www.esmap.org/sites/default/files/Practitioners%20Exchange%20Series%20Morocco_v2.pdf

92 Silva, J., Levin, V., and Morgandi, M. (2013). "Inclusion and Resilience: The Way Forward for Social Safety Nets in the Middle East and North Africa". MENA Development Report. Washington: World Bank. Available at: http://hdl.handle.net/10986/14064

sector[93]. In addition, two existing nationwide social protection programs were expanded : the Tayssir (cash transfers to poor families) and the RAMED (Régime d'Assistance Médicale pour les Économiquement Démunis) programs. This included support for school-age children, medical assistance for the poor, and the introduction of new programs for low-income widows and the physically disabled[94]. As a result, the overall coverage of the Tayssir program extended its outreach from 80,000 families in 2009 to 466,000 families in 2014[95] and the coverage of social health insurance increased from 23% of the population in 2012 to 63% in 2018[96]. The government also provided additional support for public transport to compensate for the higher cost of fuel and limit fare increases[97]. These initiatives helped offset the purchasing power decline among the poorest, encouraging sustainable behaviors.

Inspiration for Neighboring Countries : Morocco's experience in reforming fossil fuel subsidies is considered a success story that could inspire other countries in the Mediterranean region facing similar challenges. Its gradual approach and social support measures have made it possible to reduce subsidies from $6.5 billion (56.6 billion dirhams) in 2012 to $1.1 billion (10.7 billion dirhams) in 2016, while preserving economic and social stability[98]. The Moroccan government implemented a comprehensive communication strategy, channelled through public TV and radio discussions, newspaper articles targeted to different audiences including educated youth, advertisements, and debates[99]. This campaign explained the scale and distribution of subsidies, the economic reasons for reform, the different reform steps, and ways to shelter the poor from negative effects. The government promised the population that they would increase energy prices only gradually and continue the subsidisation of LPG, sugar, and flour, which is particularly important for the poor[100]. The incremental nature of the subsidy cuts, combined with public awareness campaigns and stakeholder consultations, helped soften the blow for consumers and maintain public acceptance[101]. Moreover, the government launched initiatives to promote energy efficiency and encourage the adoption of renewable energy sources. This included subsidies for solar water heaters and energy-efficient appliances, as well as investments in renewable energy projects[102]. The government's clear policy signals, backed by commitments to renewable energy and energy efficiency, also prompted private-sector actors to engage in the country's energy transition and create green jobs[103]. In these regards, Morocco's reforms have served as an example for other countries. The country's efforts to reduce its reliance on fossil fuels and invest in renewable energy have been welcomed by the international community, with Morocco's NOOR CSP project showcasing the potential for clean energy solutions[104]. Morocco's

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98 WRI (2021). "Morocco: Fuel Subsidy Reform Designed to Support a Just Transition to Renewable Energy". Available at: https://www.wri.org/update/morocco-fuel-subsidy-reform-designed-support-just-transition-renewable-energy

99 El-Katiri, L., and Bassam, F. (2017). "A Brief Political Economy of Energy Subsidies in the Middle East and North Africa", International Development Policy. Available at : https://journals.openedition.org/poldev/2267

100 Vidican Auktor, G., and Loewe, M. (2022). "Subsidy Reform and the Transformation of Social Contracts: The Cases of Egypt, Iran and Morocco". Social Sciences 11: 85. Available at: https://doi.org/10.3390/socsci11020085

101 Bousselmame, H. (2017). "A phased approach to energy subsidy reform: the Morocco experience", Energy Sector Management Assistance Program ESROC Practitioner Exchange Series. Available at: https://www.esmap.org/sites/default/files/Practitioners%20Exchange%20Series%20Morocco_v2.pdf

102 Peszko, G., Black, S., Platonova-Oquab, A., Heine, D., and Timilsina, G. (2019). "Environmental Fiscal Reform in Morocco: Options and Pathways", World Bank Publications - Reports 34030, The World Bank Group. Available at : https://documents1.worldbank.org/curated/ru/450501560190965482/pdf/Environmental-Fiscal-Reform-in-Morocco-Options-and-Pathways.pdf

103 RI (2021). "Morocco: Fuel Subsidy Reform Designed to Support a Just Transition to Renewable Energy". Available at: https://www.wri.org/update/morocco-fuel-subsidy-reform-designed-support-just-transition-renewable-energy

104 Gass, P., and Echeverría, D. (2017). "Fossil fuel subsidy reform and the just transition: Integrating approaches for complementary outcomes". Global Subsidies Initiative Report. Geneva, Switzerland: International Institute for Sustainable Development. Available at : https://www.iisd.org/system/files/publications/fossil-fuel-subsidy-reform-just-transition.pdf

success in energy subsidy reform underscores the feasibility of such endeavors, especially when addressing social and political challenges is a priority in the implementation strategy[105]. By tailoring measures to local conditions, maintaining targeted support for vulnerable groups, and providing clear policy signals for a just energy transition, other countries can overcome potential blockages and follow Morocco's path towards a more sustainable energy future.

ii. Egypt's Reform of Fossil Fuel Subsidies

Context : Egypt's economic landscape in the early 2010s was marked by significant fiscal challenges, including a high budget deficit and growing public debt, exacerbated by political instability and economic stagnation[106]. The government's expenditure on fossil fuel subsidies was particularly burdensome, consuming a substantial portion of the national budget. Historically, Egypt has spent a substantial portion of its public expenditure on fuel subsidies, which in 2013 accounted for more than a fifth of the budget (USD 21 billion, equivalent to 22% of the government's total expenditure)[107] and for about 7% of GDP, which was greater than the combined expenditures on health and education (5%)[108]. Cost recovery in the power sector was only at 30%, particularly low in liquefied petroleum gas (6%), diesel (22%), and gasoline (23-31%)[109]. Recognizing the unsustainable nature of this expenditure, the Egyptian government began a reform of its fossil fuel subsidies.

Timing of the Reform : The reform process began in 2014, a strategic move following the regional turmoil of the Arab Spring. This timing was crucial as it provided the government with the political mandate to implement important reforms[110]. The reforms were part of a broader economic strategy to stabilise and revitalise Egypt's economy, which also included measures like the introduction of a value-added tax and the free-floating of the Egyptian pound in subsequent years[111]. The initial comprehensive reforms were publicly announced on July 4, 2014[112], with the government increasing gradually the price of widely consumed petroleum products, including gasoline (by 78%), diesel (by 64%) and kerosene (by 64%)[113], with the most significant increase taking place during the period of 2014-2017[114]. Moreover, the timing of the reform was influenced by the country's economic situation, with high budget deficits and public debt, as well as the need to meet the requirements for a USD 12

105 WRI. (2021). "Egypt: Transitioning Away from Subsidizing Fossil Fuels". Available at : https://www.wri.org/update/egypt-transitioning-away-subsidizing-fossil-fuels#:~:text=Egypt%20had%20longstanding%20fossil%20fuel,stalled%20due%20to%20political%20instability

106 WRI. (2021). "Egypt: Transitioning Away from Subsidizing Fossil Fuels". Available at : https://www.wri.org/update/egypt-transitioning-away-subsidizing-fossil-fuels#:~:text=Egypt%20had%20longstanding%20fossil%20fuel,stalled%20due%20to%20political%20instability

107 WRI. (2021). "Egypt: Transitioning Away from Subsidizing Fossil Fuels". Available at : https://www.wri.org/update/egypt-transitioning-away-subsidizing-fossil-fuels#:~:text=Egypt%20had%20longstanding%20fossil%20fuel,stalled%20due%20to%20political%20instability

108 ESMAP. (2017). "Energy Subsidy Reform Facility Country Brief : Egypt". Energy Subsidy Reform Facility (ESRF) Country Brief, World Bank Group. Available at : http://documents.worldbank.org/curated/en/873871506492500301/Energy-subsidy-reform-facility-Egypt

109 ibid.

110 Moerenhout, T. S. H. (2018). Reforming Egypt's Fossil Fuel Subsidies in the Context of a Changing Social Contract. In J. Skovgaard & H. van Asselt (Eds.), The Politics of Fossil Fuel Subsidies and their Reform (pp. 265–282). chapter, Cambridge: Cambridge University Press. Available at : https://www.cambridge.org/core/services/aop-cambridge-core/content/view/E727C65B18B2A1907627EB903F10F910/9781108416795c15_265-282.pdf/reforming-egypts-fossil-fuel-subsidies-in-the-context-of-a-changing-social-contract.pdf

111 ibid.

112 James, L.M. (2015). "Recent Developments in Egypt's Fuel Subsidy Reform Process," International Institute for Sustainable Development. Available at : https://www.iisd.org/gsi/sites/default/files/ffs_egypt_lessonslearned.pdf

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114 Breisinger, C., Mukashov, A., Raouf, M., Wiebelt, M. (2019). "Energy subsidy reform for growth and equity in Egypt: The approach matters", Energy Policy, 129. Available at : https://doi.org/10.1016/j.enpol.2019.02.059.

115 ESMAP. (2017). "Energy Subsidy Reform Facility Country Brief : Egypt". Energy Subsidy Reform Facility (ESRF) Country Brief, World Bank Group. Available at : http://documents.worldbank.org/curated/en/873871506492500301/Energy-subsidy-reform-facility-Egypt

billion loan from the IMF and bilateral donors[115]. As a result, Egypt's fossil fuel subsidies decreased from 7% in 2013 to 2.7% in the budget for 2017[116] [117].

Compensatory Measures : To mitigate the impact of subsidy cuts on the population, especially the poor, the Egyptian government implemented several compensatory measures. These included expanding social security pensions in the 2014-2015 budget to cover an additional 825,000 families for a total of 2.3 million families, increasing the public-sector minimum wage (financed by a USD 12 billion support package from Gulf countries)[118], and extending food subsidies to include 20 new products (including bread, rice, sugar, tea, flour, oil, certain meats, vegetables, and other dairy products), in June 2014, one month before the reform[119], and maintaining subsidies on LPG, a fuel widely used by poorer households. To offset the negative impacts of fuel price increases on the most vulnerable populations, the Egyptian government introduced two new cash transfer programs, Takaful and Karama, in June 2015, with the support of a USD 400 million World Bank program[120]. Takaful is a conditional cash transfer program aimed at supporting poor households with children, providing monthly payments of 325 EGP per family, that vary based on the number of children (plus 60-140 EGP for every child up to three) and on the condition that children go to school regularly[121]. Compliance with health check-ups and school attendance is required to receive benefits. Karama, on the other hand, offers unconditional cash transfers of 350 EGP per person per month for those aged 65 and above and for persons living with disabilities, ensuring a basic income for those who are most vulnerable[122]. These programs were designed to provide support to those most affected by the subsidy reforms, ensuring that they were not left worse off than before. As a result, in 2020, these two programs covered about 2.26 million households, which accounted for 10% of the population[123]. Additionally, the government introduced new taxes on wealthier households and businesses to redistribute the economic burden more equitably[124]. Some free transport in army buses was also provided, following an important increase in transport fares[125]. These measures were important in cushioning the lower-income segments of the population from the immediate economic shocks of the subsidy reforms. The introduction of these measures reflects a shift from price subsidies to direct social assistance, which can be more effectively targeted and controlled[126]. the lower-income segments of the population from the

116 Ibid.

117 However, it's important to consider that the Egyptian government responded to the increase in oil and natural gas prices caused by disruptions in Russian and Ukrainian supply chains by raising allocations for subsidising petroleum products. In the fiscal year 2022/23 budget, approximately EGP 28.094 billion was allocated for petroleum subsidies, marking a 52.6% increase compared to the previous year's budget of EGP 18.411 billion for petroleum subsidies in 2021/22.
Samir, S. (2022). "Egypt's Petroleum Subsidies Stand at EGP 28B in 2022/23 Budget". Egypt Oil & Gas, May 16. Available at : https://egyptoil-gas.com/news/egypts-petroleum-subsidies-stand-at-egp-28b-in-2022-23-budget/

118 WRI. (2021). "Egypt: Transitioning Away from Subsidizing Fossil Fuels". Available at : https://www.wri.org/update/egypt-transitioning-away-subsidizing-fossil-fuels#:~:text=Egypt%20had%20longstanding%20fossil%20fuel,stalled%20due%20to%20political%20instability

119 ibid.

120 Egypt Today Staff. (2020). "2.5 million families benefit from Takaful and Karama program". Egypt Today, February 23. Available at: https://www.egypttoday.com/Article/1/81927/2-5-million-families-benefit-from-Takaful-and-Karama-program

121 Vidican Auktor, G, Loewe, M. (2022). Subsidy Reform and the Transformation of Social Contracts: The Cases of Egypt, Iran and Morocco. Social Sciences 11: 85. Available at: https://doi.org/10.3390/socsci11020085

122 Ibid.

123 Egypt Today Staff. (2020). 2.5 million families benefit from Takaful and Karama program. Egypt Today, February 23. Available at: https://www.egypttoday.com/Article/1/81927/2-5-million-families-benefit-from-Takaful-and-Karama-program

124 WRI. (2021). "Egypt: Transitioning Away from Subsidizing Fossil Fuels". Available at : https://www.wri.org/update/egypt-transitioning-away-subsidizing-fossil-fuels#:~:text=Egypt%20had%20longstanding%20fossil%20fuel,stalled%20due%20to%20political%20instability

125 Moerenhout, T. S. H. (2018). Reforming Egypt's Fossil Fuel Subsidies in the Context of a Changing Social Contract. In J. Skovgaard & H. van Asselt (Eds.), The Politics of Fossil Fuel Subsidies and their Reform (pp. 265–282). chapter, Cambridge: Cambridge University Press. Available at : https://www.cambridge.org/core/services/aop-cambridge-core/content/view/E727C65B18B2A1907627EB903F10F910/9781108416795c15_265-282.pdf/reforming-egypts-fossil-fuel-subsidies-in-the-context-of-a-changing-social-contract.pdf

126 ILO. (2015). "Social Protection and Climate Change How has the removal of fuel subsidies in Egypt affected its people and the climate?". Available at : https://webapps.ilo.org/wcmsp5/groups/public/---africa/---ro-abidjan/---sro-cairo/documents/publication/wcms_467290.pdf

immediate economic shocks of the subsidy reforms. The introduction of these measures reflects a shift from price subsidies to direct social assistance, which can be more effectively targeted and controlled[127].

Inspiration for Neighboring Countries : Egypt's experience with fuel subsidy reform has been closely watched by neighbouring countries in the Middle East and North Africa (MENA) region, many of which face similar economic and social challenges. The Egyptian model demonstrates that while subsidy reform can be politically and socially challenging, it is possible to mitigate adverse effects through designed compensatory measures. Moreover, Egypt's experience underscores the importance of political stability and public acceptance in implementing such reforms[128]. Neighbouring countries might draw inspiration from Egypt's ability to implement these reforms, despite challenging circumstances.

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Appendix

A0. OECD Glossary of FFS (Source: https://www.oecd.org/fossil-fuels/methodology/)

General definitions

Support: budgetary transfers and tax expenditures that provide a benefit or preference for fossil-fuel production or consumption.

Subsidy (WTO definition): in the Agreement on Subsidies and Countervailing Measures (ASCM) under the World Trade Organization (WTO), a subsidy shall be deemed to exist:

1. if there is a financial contribution by a government or any public body within the territory of a country, i.e. where:

i. a government practice involves a direct transfer of funds (e.g. grants, loans, and equity infusion), potential direct transfers of funds or liabilities (e.g. loan guarantees);
ii. government revenue that is otherwise due is forgone or not collected (e.g. fiscal incentives such as tax credits);
iii. a government provides goods or services other than general infrastructure, or purchases goods;
iv. a government makes payments to a funding mechanism, or entrusts or directs a private body to carry out one or more of the type of functions illustrated in (i) to (iii) above which would normally be vested in the government and the practice, in no real sense, differs from practices normally followed by governments.

2. Or if there is any form of income or price support in the sense of Article XVI of GATT 1994.

3. And if a benefit is thereby conferred.

Support Mechanism

- **Direct budgetary transfers:** payments made by governments, or bodies acting on behalf of governments, to individual recipients. This includes direct spending, e.g. for specific support programmes, and government ownership (fully or through equity shares) of energy-related enterprises.
- **Tax expenditures:** tax concessions that are typically provided through lower rates, exemptions, or rebates of consumption taxes on fossil fuels (mainly value-added taxes and excise taxes) or measures to reduce the cost of the extraction of fossil fuels (including accelerated-depreciation allowances for capital expenditure, investment tax credits, deductions for exploration and development expenses, and preferential capital-gains treatment). Tax expenditures can also take less visible forms such as the special treatment of income from state-owned enterprises, tax relief for income earned on industry sinking funds (e.g. for site remediation), tax exempt bonds, the use of foreign tax credits for what may be considered royalty payments, or preferential tax rates on fuels used as inputs in fossil-fuel production. Tax expenditures are often premised on providing government support to activities or entities deemed to be socially beneficial; or on concerns relating to risk and uncertainty, energy security, capital intensity, high upfront costs, and long project timelines. Various approaches of varying levels of difficulty are used to derive estimates of the cost of tax expenditures. The revenue forgone approach is the most straightforward and the most commonly used in OECD countries. Revenue forgone is the difference between the tax revenue raised with and without the tax expenditure, all else being equal. The revenue forgone approach is a static measure. In other words, it does not account for behavioural responses related to the removal of the tax expenditure.
- **Induced transfers (or price support or price-gap):** estimated subsidies due to market regulation and price support for lower end-user price relative to the full cost of supply. It refers to a change in prices received by producers and paid by domestic consumers as a consequence of government interventions, such as through direct price regulation, pricing formulas, border controls or taxes, and domestic purchase or supply mandates. The difference between the end-use price and the reference price (reflecting the full cost of the supply, which would prevail in a competitive market) amounts to the price gap or induced transfer. For countries that import a given product, consumer subsidy estimates derived through the measurement of price-gaps are explicit. That is, they represent net expenditures resulting from the domestic sale of imported energy at lower,

regulated prices. In contrast, for countries that export a given product – and therefore do not pay world prices – subsidy estimates are implicit and have no direct budgetary impact. Rather, they represent the opportunity cost of pricing domestic energy below market levels. For countries that produce a portion of their fossil-fuel consumption themselves and import the remainder, the estimates represent a combination of opportunity costs and direct government expenditures.

Beneficiaries

- Producer Support Estimate (PSE): transfers or expenditures from consumers and taxpayers to producers of fossil fuels. Fossil-fuel production encompasses the following activities along the supply chain: exploration and extraction; bulk transportation and storage; and refining and processing.
- Consumer Support Estimate (CSE): transfers or expenditures in favour of consumers of fossil fuels. Consumption of fossil fuels refers to the stage at which fuels are combusted or used as raw materials by various end-use sectors, whether it occurs in motor vehicles, stationary engines, heating equipment or power plants. Consumption encompasses the following activities: the use of fossil fuels in power and heat generation; their use in industrial processes and activities outside of the energy sector; and all other final uses of fossil fuels, whether in the transport sector, the residential sector, or primary industries outside of the energy sector (e.g. agriculture and forestry).
- General Services Support Estimate (GSSE): transfers or expenditures arising from policy measures that create enabling conditions for the fossil-fuel sector through the development of private or public services, institutions and infrastructure (regardless of their objectives and impact on fossil-fuel production and or consumption). It includes policies where fossil fuels are the main beneficiaries, but does not include any payments to individual producers. GSSE transfers do not directly alter producer receipts or costs, or consumption expenditures, although they may affect production or consumption of fossil fuels in the long term.

See the OECD's PSE-CSE accounting framework for more details.

Fuel type

The range of fuels covered by the Inventory comprises both primary fossil-fuel commodities (e.g. crude oil, natural gas, coal, and peat) and secondary refined or processed products (e.g. diesel fuel, gasoline, kerosene, and coal briquettes). Primary fuels include in particular those fossil fuels that are extracted from unconventional sources, such as oil extracted from bituminous sands, shale-based natural gas, or coal-bed methane. Measures supporting the production or use of biofuels are not, however, included in the Inventory.

- **Coal:** including hard coal and briquettes, and peat.
- **Natural gas:** both liquefied and in the gaseous state.
- **Petroleum:** petroleum oils and oils obtained from bituminous minerals, crude oil as well as secondary refined or processed products (e.g. diesel fuel, gasoline, kerosene).
- **End-use electricity:** electricity for end-user consumption of fossil-fuel origin. Support under end-use electricity includes measures providing electricity tariffs below cost recovery or annual average-cost pricing for electricity end-users and only includes the fossil-fuel component of the support (i.e. renewables and other non-fossil-fuel sources are excluded). Amounts related to cross-border power exchanges are also excluded due to the technical difficulties in determining the traded electricity's ultimate generation origin. Support amounts benefiting fossil fuels as power generation inputs are aggregated under their respective fuel type, i.e. petroleum, coal or natural gas.

Sectors

The Inventory adopts the IEA's World Energy Balances categorisation of fossil-fuel production and consumption sectors.

- **Production sector:** includes measures that support the production, exploration, trade, storage and transportation of fossil fuels.
- **Transportation sector:** includes measures that support the final uses of fossil fuels in the transport sector, including domestic aviation, domestic navigation, road, and rail.

- **Residential sector:** includes measures that support the final uses of fossil fuels in the residential sector, including consumption by households.
- **Electricity generation sector:** includes measures that support the use of fossil fuels in electricity and heat generation. This includes fossil-fuel inputs to electricity and heat plants, both main and auto producers.
- **Other sectors:** includes measures that support the use of fossil fuels in the energy transformation sector other than electricity and heat generation; industrial and manufacturing sector; commercial and public services; agriculture, forestry and fisheries sector; non-energy use.

Source: https://www.oecd.org/fossil-fuels/methodology/

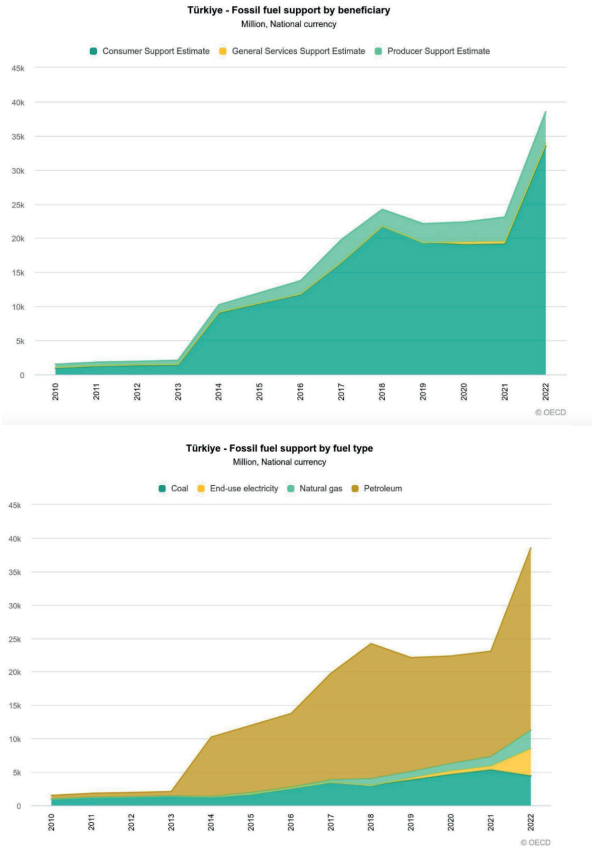

Figure A2. *FFS by beneficiary and fuel, Turkiye (million TL)*
Source: OECD Inventory of support measures for fossil fuels (2023)

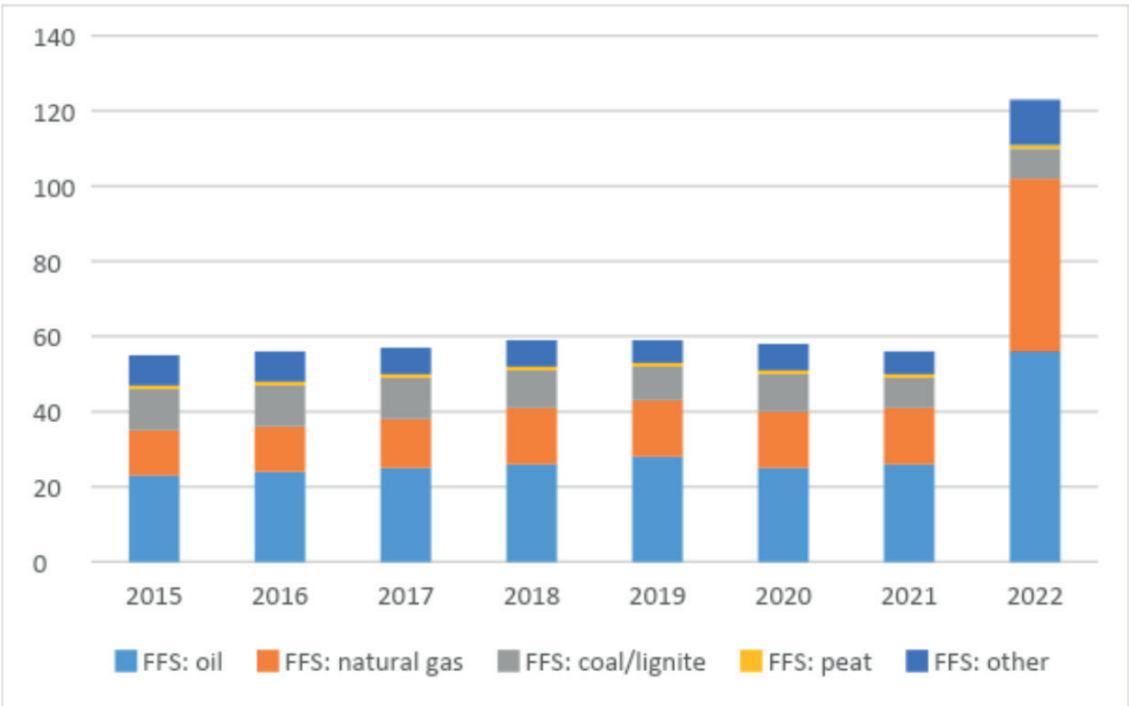

Figure A1. *Fossil fuel subsidies in the 27 EU Member States, 2015-2022 (in billion EUR, 2022 prices)*

	Coefficient	Std. Error	Std. Error	t-ratio	p-value
const	−10.7765	4.88614	−2.206	0.0632	*
LNGDP	0.471246	0.184295	2.557	0.0377	**
LNFFS	0.0395697	0.0165628	1.906	0.0983	*
dt_2	−0.0168890	0.0125184	−1.349	0.2193	
dt_3	−0.0146286	0.0160601	−0.9109	0.3927	
dt_4	−0.0725249	0.0135548	−5.350	0.0011	
dt_5	−0.117935	0.0236828	−4.980	0.0016	
dt_6	−0.106956	0.0267807	−3.994	0.0052	***
dt_7	−0.121833	0.0205228	−5.936	0.0006	***
dt_8	−0.121345	0.0308947	−3.928	0.0057	***
dt_9	−0.160462	0.0291936	−5.496	0.0009	***
dt_10	−0.210010	0.0245985	−8.538	<0.0001	***
dt_11	−0.257857	0.0217623	−11.85	<0.0001	***
dt_12	−0.263116	0.0212015	−12.41	<0.0001	***
					***
					***
Mean dependent var	2.010296		S.D. dependent var	0.170360	
Sum squared resid	0.127166		S.E. of regression	0.041177	
LSDV R-squared	0.953878		Within R-squared	0.800753	
Log-likelihood	181.8592		Akaike criterion	−321.7184	
Schwarz criterion	−267.8671		Hannan-Quinn	−299.9508	
rho	0.660048		Durbin-Watson	0.554298	

TABLE A2

REGRESSION RESULTS FOR PANEL DATA ANALYSIS

Table A2.1 -Model 1: Fixed-effects, using 96 observations
Included 8 cross-sectional units
Time-series length = 12 Dependent variable: LNGHGPC
Robust (HAC) standard errors
Joint test on named regressors -
Test statistic: F(2, 7) = 11.892 with p-value = P(F(2, 7) > 11.892) = 0.00560665
Robust test for differing group intercepts -
Null hypothesis: The groups have a common intercept
Test statistic: Welch F(7, 37.4) = 72.9159 with p-value = P(F(7, 37.4) > 72.9159) = 7.48724e-20

	Coefficient	Std. Error	Std. Error	t-ratio	p-value
const	−13.1975	5.31682	−2.482	0.0421	
LNGDP	0.570227	0.198119	2.878	0.0237	*
FFS_EL	−4.1834e-05	3.14421e-05	−1.331	0.2251	**
FFS_GAS	4.90812e-05	1.17744e-05	4.168	0.0042	*
FFS_OIL	5.47655e-08	7.97136e-06	0.006870	0.9947	
FFS_COAL	−1.9022e-05	5.26576e-05	−0.3612	0.7286	
dt_2	−0.0126447	0.0126289	−1.001	0.3500	
dt_3	−0.0175931	0.0150732	−1.167	0.2814	
dt_4	−0.0673803	0.0234567	−2.873	0.0239	***
dt_5	−0.108999	0.0347146	−3.140	0.0164	***
dt_6	−0.102739	0.0404546	−2.540	0.0387	***
dt_7	−0.119385	0.0352806	−3.384	0.0117	***
dt_8	−0.118744	0.0475993	−2.495	0.0413	***
dt_9	−0.169111	0.0505918	−3.343	0.0124	***
dt_10	−0.226034	0.0472674	−4.782	0.0020	***
dt_11	−0.268703	0.0407575	−6.593	0.0003	***
dt_12	−0.285244	0.0392772	−7.262	0.0002	***

Mean dependent var	2.010296		S.D. dependent var	0.170360	
Sum squared resid	0.123831		S.E. of regression	0.041471	
LSDV R-squared	0.955087		Within R-squared	0.805979	
Log-likelihood	183.1348		Akaike criterion	−318.2697	
Schwarz criterion	−256.7253		Hannan-Quinn	−293.3924	
rho	0.604772		Durbin-Watson	0.615808	

TABLE A2.2

REGRESSION RESULTS FOR PANEL DATA ANALYSIS

Table A2.2 - Model 2: Fixed-effects, using 96 observations
Included 8 cross-sectional units
Time-series length = 12
Dependent variable: LNGHGPC
Robust (HAC) standard errors
Joint test on named regressors -
Test statistic: F(5, 7) = 10.5049 with p-value = P(F(5, 7) > 10.5049) = 0.00374887
Robust test for differing group intercepts - Null hypothesis: The groups have a common intercept
Test statistic: Welch F(7, 37.1) = 70.619 with p-value = P(F(7, 37.1) > 70.619) = 1.73874e-19

	Coefficient	Std. Error	Std. Error	t-ratio	p-value
const	0.303571	6.51013	0.04663	0.9641	
LNGDP	0.0637710	0.242348	0.2631	0.8000	*
FFS_PSE	0.000143074	5.63578e-05	2.539	0.0387	**
FFS_CSE	−1.5460e-05	1.63741e-05	−0.9442	0.3765	*
FFS_GSSE	9.41301e-05	5.72169e-05	1.645	0.1439	
dt_2	−0.0258259	0.0322694	−0.8003	0.4261	
dt_3	−0.0370486	0.0332064	−1.116	0.2682	
dt_4	−0.110941	0.0328583	−3.376	0.0012	
dt_5	−0.165084	0.0331895	−4.974	<0.0001	***
dt_6	−0.149877	0.0335651	−4.465	<0.0001	***
dt_7	−0.168639	0.0346272	−4.870	<0.0001	***
dt_8	−0.154229	0.0348452	−4.426	<0.0001	***
dt_9	−0.212684	0.0360710	−5.896	<0.0001	***
dt_10	−0.269179	0.0368795	−7.299	<0.0001	***
dt_11	−0.340706	0.0344511	−9.890	<0.0001	***
dt_12	−0.358690	0.0376608	−9.524	<0.0001	***

Mean dependent var	0.826570		S.D. dependent var	2.359467	
Sum squared resid	0.290030		S.E. of regression	0.063032	
LSDV R-squared	0.999452		Within R-squared	0.731140	
LSDV F(22, 73)	6047.419		P-value(F)	4.3e-110	
Log-likelihood	142.2836		Akaike criterion	−238.5671	
Schwarz criterion	−179.5871		Hannan-Quinn	−214.7265	
rho	0.741867		Durbin-Watson	0.417413	

TABLE A3.3

REGRESSION RESULTS FOR PANEL DATA ANALYSIS

Table A2.3 - Model 3: Fixed-effects, using 96 observations
Included 8 cross-sectional units
Time-series length = 12
Dependent variable: LNGHGPC
Joint test on named regressors - Test statistic: F(4, 73) = 11.1429
with p-value = P(F(4, 73) > 11.1429) = 4.13626e-07
Test for differing group intercepts - Null hypothesis: The groups have a common intercept
Test statistic: F(7, 73) = 15575.2 with p-value = P(F(7, 73) > 15575.2) = 3.67185e-113
Wald joint test on time dummies - Null hypothesis: No time effects
Asymptotic test statistic: Chi-square(11) = 184.537 with p-value = 1.18502e-33

Country	TUR: Türkiye											
Support Mechanism	Total											
Support Mechanism	US Dollars (nominal) [in millions]											
Year	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021
Beneficiary or Sector	Fuel Type											
Total	End-use electricity	0	0	0	0	0	0	0	0	0	0	0	0
	Natural gas	1,304	1,448	1,317	1,304	26,283	63,652	46,244	90,804	64,912	62,715	50,13	69,801
	Petroleum	344,176	352,372	344,991	347,354	4039,412	3695,057	3631,762	4361,595	4178,007	2995,503	2289,994	3401,292
	Coal	652,632	728,137	725,709	744,321	600,66	645,822	868,35	967,496	487,849	463,232	489,171	595,558
	Total	998,113	1081,957	1072,016	1092,978	4666,354	4404,53	4546,357	5419,895	4730,768	3521,449	2829,294	4066,651
Beneficiary	Producer Support Estimate	End-use electricity	0	0	0	0	0	0	0	0	0	0	0	0
		Natural gas	0	0	0	0	25,19	63,207	45,909	90,53	64,858	62,66	50,08	69,766
		Petroleum	0	0	0	0	166,593	134,504	171,409	217,762	196,701	163,718	98,56	155,802
		Coal	303,623	286,217	258,553	298,055	287,863	347,484	416,005	590,882	235,533	256,345	263,805	324,925
		Total	303,623	286,217	258,553	298,055	479,647	545,196	633,323	899,174	497,093	482,724	412,444	550,492
	Consumer Support Estimate	End-use electricity	0	0	0	0	0	0	0	0	0	0	0	0
		Natural gas	0	0	0	0	0	0	0	0	0	0	0	0
		Petroleum	338,025	346,577	338,743	339,876	3865,593	3556,924	3457,483	4141,503	3981,045	2831,544	2191,199	3245,475
		Coal	296,259	389,742	413,761	391,789	260,584	268,97	425,08	353,606	249,877	204,465	173,358	208,984
		Total	634,284	736,319	752,505	731,665	4126,178	3825,894	3882,564	4495,108	4230,922	3036,01	2364,557	3454,459
	General Services Support Estimate	End-use electricity	0	0	0	0	0	0	0	0	0	0	0	0
		Natural gas	1,304	1,448	1,317	1,304	1,092	0,444	0,336	0,274	0,053	0,055	0,05	0,035
		Petroleum	6,151	5,795	6,247	7,477	7,225	3,628	2,869	2,33	0,261	0,24	0,235	0,015
		Coal	52,75	52,178	53,394	54,478	52,212	29,368	27,265	23,009	2,439	2,421	52,008	61,649
		Total	60,206	59,421	60,958	63,258	60,53	33,44	30,47	25,613	2,753	2,715	52,293	61,7
														0
Sector	Fossil-fuel Production	End-use electricity	0	0	0	0	0	0	0	0	0	0	0	0
		Natural gas	1,304	1,448	1.317	1.304	26.283	63.652	46.244	90.804	64.912	62.715	50.138	69.812
		Petroleum	6,151	5,795	6.247	7.477	173.818	138.132	174.279	220.092	196.962	163.958	98.711	155.705
		Coal	356,374	338,395	311.947	352.532	340.075	376.852	443.27	613.891	237.972	258.766	315.888	386.675
		Total	363,829	345,638	319.511	361.313	540.177	578.636	663.793	924.787	499.846	485.439	464.737	612.192
	Residential	End-use electricity	0	0	0	0	0	0	0	0	0	0	0	0
		Natural gas	0	0	0	0	0	0	0	0	0	0	0	0
		Petroleum	0	0	0	0	0	0	0	0	0	0	0	0
		Coal	296.259	389.742	413.761	391.789	260.584	268.97	425.08	353.606	249.877	204.465	173.358	208.984
		Total	296.259	389.742	413.761	391.789	260.584	268.97	425.08	353.606	249.877	204.465	173.358	208.984
	Electricity Generation	End-use electricity	0	0	0	0	0	0	0	0	0	0	0	0
		Natural gas	0	0	0	0	0	0	0	0	0	0	0	0
		Petroleum	0	0	0	0	79.945	74.596	75.838	75.365	68.564	4.993	0	0
		Coal	0	0	0	0	0	0	0	0	0	0	0	0
		Total	0	0	0	0	79.945	74.596	75.838	75.365	68.564	4.993	0	0
	Transportation	End-use electricity	0	0	0	0	0	0	0	0	0	0	0	0
		Natural gas	0	0	0	0	0	0	0	0	0	0	0	0
		Petroleum	0	0	0	0	1782.744	1609.805	1564.855	1371.606	1248.246	968.745	532.967	846.335
		Coal	0	0	0	0	0	0	0	0	0	0	0	0
		Total	0	0	0	0	1782.744	1609.805	1564.855	1371.606	1248.246	968.745	532.967	846.335
	Other	End-use electricity	0	0	0	0	0	0	0	0	0	0	0	0
		Natural gas	0	0	0	0	0	0	0	0	0	0	0	0
		Petroleum	338.025	346.577	338.743	339.876	2002.904	1872.523	1816.79	2694.532	2664.234	1857.807	1658.231	2399.14
		Coal	0	0	0	0	0	0	0	0	0	0	0	0
		Total	338.025	346.577	338.743	339.876	2002.904	1872.523	1816.79	2694.532	2664.234	1857.807	1658.231	2399.14

TABLE A3

Fossil Fuel Support in Turkiye (Total support in million USD)

Source: Data extracted on 18 Sep 2023 12:05 UTC (GMT) from OECD.Stat

Year	Total	Change compared to 1990 (%)	Energy	Industrial processes and product use	Agriculture	Waste
1990	219.5		139.5	22.9	46.1	11.1
1991	226.8	3.3	144.0	24.6	46.9	11.3
1992	233.1	6.2	150.3	24.3	47.0	11.5
1993	240.8	9.7	156.8	24.8	47.4	11.8
1994	234.4	6.8	153.3	24.1	44.9	12.0
1995	248.2	13.1	166.3	25.5	44.1	12.3
1996	267.6	21.9	184.0	26.2	44.8	12.7
1997	278.8	27.0	196.1	27.0	42.5	13.2
1998	280.3	27.7	195.8	27.3	43.7	13.5
1999	277.8	26.5	193.8	25.8	44.3	13.9
2000	298.9	36.2	216.0	26.2	42.3	14.3
2001	279.7	27.4	199.2	25.8	39.9	14.8
2002	285.6	30.1	206.0	26.8	37.6	15.2
2003	304.8	38.8	220.5	28.2	40.6	15.6
2004	314.4	43.2	226.3	30.8	41.3	16.1
2005	337.6	53.8	244.5	34.3	42.4	16.4
2006	358.0	63.1	260.5	36.8	43.9	16.8
2007	391.7	78.4	291.5	39.7	43.4	17.1
2008	388.5	77.0	288.3	41.7	41.3	17.2
2009	395.2	80.0	292.9	43.1	42.0	17.2
2010	398.8	81.7	287.9	49.1	44.4	17.4
2011	428.6	95.2	310.0	54.0	46.9	17.8
2012	448.2	104.2	321.6	56.3	52.7	17.6
2013	440.2	100.5	308.3	59.3	55.9	16.7
2014	459.5	109.3	326.7	60.1	56.2	16.5
2015	475.0	116.4	342.0	59.7	56.1	17.1
2016	501.1	128.3	361.7	63.8	58.9	16.7
2017	528.6	140.8	382.4	66.6	63.3	16.3
2018	523.1	138.3	373.4	67.7	65.3	16.6
2019	508.7	131.7	365.6	59.0	68.0	16.1
2020	524.0	138.7	366.6	68.0	73.2	16.3
2021	564.4	157.1	402.5	75.1	72.1	14.7
						***

TABLE A4

GHG emissions by sector, Turkiye, 1990 – 2021 (Mt CO2 equivalent)

Source: TurkStat, Greenhouse Gas Emissions Statistics, 1990 – 2021.

Note: Figures in table may not add up to totals due to rounding.

CHAPTER 4. FEMALE LABOR INCLUSION AND ENERGY POLICIES IN THE MEDITERRANEAN COUNTRIES: EVIDENCE FROM A MIXED METHODOLOGY APPROACH

AUTHORS : STELLA TSANI, CHRYSOULA CHITOU, KARINE MOUKADDEM AND VALENTINA DEDI

Medium shot of a smiling engineer holding a tablet
Credit : FreePik

The energy sector plays an important role in the production and employment landscape of the Mediterranean region. Policies related to the energy sector, like subsidies and local employment support, have direct socio-economic implications that are important for a timely and just energy transition in the region. This study investigates the links between energy policies and female employment in the Mediterranean region. Focus rests with energy subsidies and support to local employment in the energy sector. To achieve this objective, a three-step methodology is employed. This includes: i) systematic literature review which helps establish a knowledge base on the focus subject, ii) empirical assessment of the links between energy subsidies, at both production and consumption level, and female labor force participation, and iii) survey analysis of the energy sector in Greece. The review of the literature reveals a gap in the existing knowledge on the links between energy subsidies and female employment in the Mediterranean. The econometric assessment of the links between subsidies and female participation in the labor market provide quantitative insights. Case study analysis based on the survey results from the energy-related companies in Greece provides more nuanced findings and discussion inputs. Empirical results confirm the negative links between hydrocarbon subsidies and female labor force participation in the region. Survey results indicate the need for balanced gender-focused policies for the integration of local targets and priorities with the wider national and energy sector development policies. This policy paper emphasizes the need for policymakers not only to reevaluate existing policies, but more importantly, to develop policies with a gender-responsive dimension in all phases of design, implementation, monitoring, and evaluation of energy policies. Gender-inclusive energy policies, skills development initiatives, efforts to address information asymmetries, and collaboration between the relevant stakeholders, are crucial for fostering female empowerment and addressing gender disparities in the energy sector.

1. INTRODUCTION

Women are significantly underrepresented in the energy sector workforce, as indicated by regional and global data. The percentage of female sectoral employment is no more than 15%, which is well below the economy-wide average (IEA, 2022; Johnstone and Silva, 2020). The employment gap deteriorates in senior management positions, and it relates to lower earnings of women compared to men (IEA, 2023). Gender inequality reduces economic output and slows down innovation pace (Duflo, 2012; Hsieh et al., 2016). The presence of women in decision-making is also linked to more ambitious climate goals and policies (Strumskyte, et al., 2022). However, despite this crucial link, women remain underrepresented in energy decision-making positions (EIGE, 2021). Traditional energy sectors are associated with discriminatory barriers to women's entry and norms that hinder gender equality. Energy subsidies, particularly oil and gas subsidies, remain a widespread practice in the Mediterranean region despite their negative impact on the environment and intensified reforms since 2014 (Flochel, 2018; OME, 2022; Kjellingbro and Skotte, 2005). Fossil fuels subsidies disproportionately impact women, not only due to their environmental effects but also because of the structure of the energy sector. Thus, these subsidies may not only prove inefficient but could also exacerbate inequalities and prevent women from engaging with the energy sector. The transition to renewable energy sources is at the forefront of governments and the industry's agendas (OME, 2022). The renewable energy sector could be an opportunity to increase gender equity and female representation, with an estimated 25 million new jobs created worldwide (ILO, 2019). However, current occupational gaps in the renewable energy sector might persist, potentially limiting women's access to these jobs (IRENA and ILO, 2021; IEA, 2022).

Few studies quantitatively explore the links between energy policies and female employment in the Mediterranean region. Existing research concentrates on energy poverty or on discriminatory access to energy, with a primary focus on African countries and emerging Asian countries (e.g., Global Subsidies Initiative et al., 2019; Patnaik and Jha, 2020). However, an analysis specific to the Mediterranean context is crucial, as it can help define the obstacles to women's inclusion in the energy sector in the region. This, in turn, serves as an element for building an exhaustive and suitable energy transition strategy. Understanding the factors that sustain the gender employment gaps is important for developing comprehensive and holistic energy policies (Johnstone and Silva, 2020). Industry- and company-level dynamics are essential to elaborate actions that diminish barriers to women's entry and ensure their career advancement.

This study aims at exploring the links between explicit energy policies, like subsidies and local content, and female employment. The goals of the study are met with a mixed methodological approach which allows for a multi-faceted exploration of the link between explicit energy policies and female employment in the Mediterranean region. First, a systematic literature review is conducted to identify and assess the knowledge on the subject, with a specific focus on the Mediterranean region. Second, an empirical assessment is performed with the use of econometric analysis and the latest datasets on subsidies and labor force statistics in the Mediterranean. Last, a survey results analysis drawing from the energy sector in Greece is used. This analysis complements the regional empirical study by investigating the more granular aspects of market dynamics and mechanisms driving gender equality in the energy sector. Greece serves as an illustrative case study from the Mediterranean region, as it is in the middle of the income distribution in the region, with growth rates around 5% in 2022, lower than other North Mediterranean countries (OECD, 2021), but higher than other South Mediterranean countries (European Bank for Reconstruction and Development, 2022).
Investments are increasing in all parts of the Greek energy sector, including conventional and renewable energy sources. The Greek context is a good example of the means of untapping the local potential of the energy sector, which can yield relevant results for developing and developed countries in the Mediterranean. To the best of our knowledge, this is a first-time study to systematically examine the links between energy

subsidies, and female labor force participation in the Mediterranean region. By employing a mixed methodological approach including a systematic literature review, econometric analysis, and a targeted survey in Greece, this research provides a comprehensive understanding of the challenges and opportunities associated with gender inclusivity in the energy sector in the Mediterranean region. The study's findings contribute to evidence-based results-oriented policymaking, offering practical recommendations to address gender disparities and promote female socio-economic inclusion in the Mediterranean energy landscape.

The remainder of the paper is structured as follows: Section 2 presents the methods and data employed. Section 3 presents and discusses the literature review findings, the empirical and survey results, offering insights into the relationship between energy subsidies, female labor force participation, and local content policies. Lastly, Section 4 concludes the study, summarizing the key findings and presenting policy considerations for an inclusive energy transition in the Mediterranean region.

2. METHODS AND DATA

This study employs a mixed three-step methodology. This includes systematic literature review, empirical assessment of the links between energy subsidies and female employment, and survey results analysis. The review of the literature identifies the gap in the existing knowledge on the links between energy subsidies and female employment in the Mediterranean. Empirical results indicate the negative links between energy subsidies, particularly fossil fuel subsidies, and female labor force participation in the Mediterranean. Survey results from the case of Greece demonstrate the need for balanced gender-focused policies relevant to the energy sector. The following sections detail the complementary set of methodologies employed.

2.1. Systematic literature review

The literature review allows to establish meaningful connections between the accumulated knowledge and current policies, contributing to a deeper understanding of the links between energy subsidies, female employment, and broader socio-economic considerations. The research and literature review aim to address the following questions:

1. What is the impact of energy subsidies, specifically those associated with fossil fuel production or consumption, on female employment?
2. What methodologies are employed in existing studies to enhance our understanding of the relationship between energy subsidies and female employment?
3. What are the main findings of the existing studies on the relationship between energy subsidies and female employment?

A systematic literature review has been conducted in line with the required reporting items for systematic reviews (Rethlefsen et al., 2021). This methodological approach involves searching existing literature, employing text mining, conducting meta-analysis, and synthesizing evidence (Bhattarai et al., 2022)[129]. It enables to fully classify information that has been obtained and to identify any gaps, which can provide valuable information for future study directions (Koberg and Longoni, 2019; Chakraborty et al., 2021). Differentiating from non-systematic or expert reviews, a systematic literature review is preferred due to its transparency, comprehensiveness, and meticulous approach to literature selection. A systematic review follows a methodological and well-structured approach, in contrast to non-systematic and expert reviews, which do not have a clear process for choosing scientific contributions. Given the continuous influx of contributions and findings in scientific research, employing a systematic approach to literature selection, coupled with advanced technologies for searching and checking, ensures that any review effort includes relevant research while maintaining consistency with the subject under investigation.

The structured process of a systematic literature review begins with the selection of key terms. The first step in the literature review follows the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) Statement

128 This methodology is known for its effectiveness and is employed to develop an in-depth understanding of domain-specific knowledge, while simultaneously recognizing areas of convergence and divergence in the literature.

(Moher et al., 2010; Rethlefsen et al., 2021). This is keyword-based research specific to the study's objectives. The selected keywords, determined by the authors, are designed to address the questions, and aims of the research, including terms such as «female labor force participation», «energy subsidies», «Mediterranean», «North Africa», «Middle East», «MENA», «fossil fuel subsidies», «energy policies», and «female employment» (Table 1). The search covered Scopus and ScienceDirect databases, with ScienceDirect providing full articles and Scopus offering abstracts. Both databases, hosting Elsevier's scientific literature, were chosen for their reputable journals, comprehensive content, and high reliability. Scopus boasts a wider array of journals than databases such as PubMed and Web of Science. Additionally, Scopus provides a larger pool for citation analysis. The search encompassed published, peer-reviewed materials—journal articles, book chapters, conference abstracts—all in English, without limiting the publication year to ensure inclusivity of relevant research.

Figure 1 outlines the steps of the literature search and presents the results at each stage, indicating the number of papers remaining for review[130]. The primary goal of the first step is to collect a wide range of works for an extensive review. Search words in strings have been employed in titles, abstracts, or keywords. A summary of detailed results per keywords used is provided in Table 1. In the second step, entries were imported into Zotero[131], a free online reference management tool. After a duplicate check, 43 entries were removed. In the third step, abstracts from the remaining 59 papers were screened to determine their relevance to the present research objectives. This produced a sample of 16 entries for review. In the fourth step, full texts of the remaining entries were manually screened for relevance to the study's objectives, leaving a final list of 16 unique entries. These steps were implemented in November 2023.

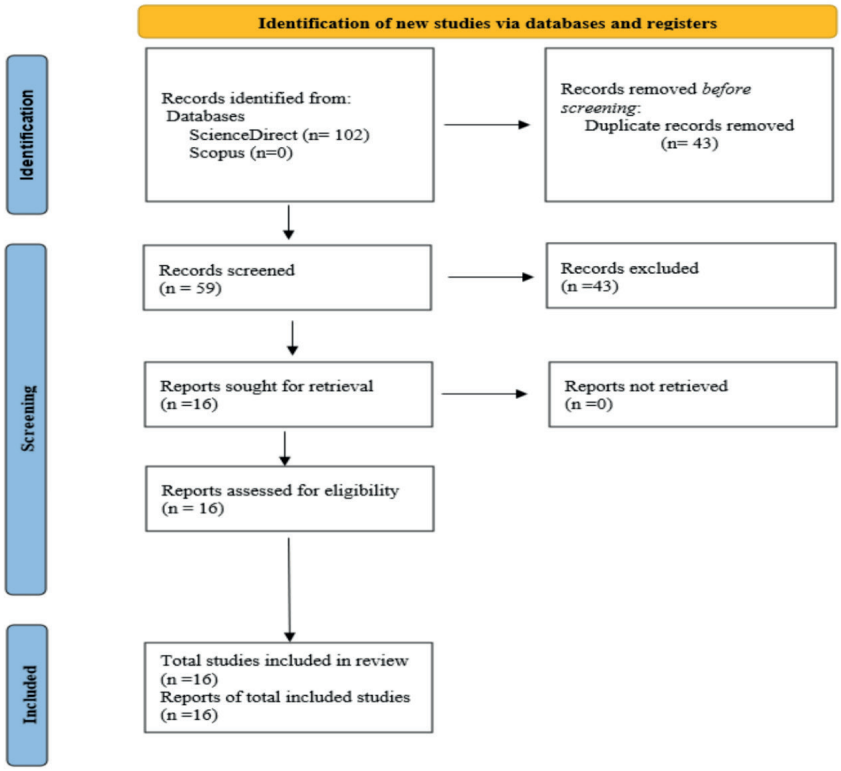

Figure 1. *Systematic literature review flow diagram*

129 For more information, visit: http://www.prisma-statement.org/

130 Available at: https://www.zotero.org/

Search words	Results	
	ScienceDirect	Scopus
«Female labour force participation» AND «energy subsidies»	5	0
«female labour force participation» AND «energy subsidies» AND «Mediterranean»	0	0
«female labour force participation» AND «energy subsidies» AND «North Africa»	2	0
«female labour force participation» AND «energy subsidies» AND «middle east»	2	0
«female labour force participation» AND «energy subsidies» AND «MENA»	1	0
«female labour force participation» AND «fossil fuel subsidies»	0	0
«female labour force participation» AND «fossil fuel subsidies» AND «middle east»	0	0
«female labour force participation» AND «fossil fuel subsidies» AND «North Africa»	0	0
«female labour force participation» AND «fossil fuel subsidies» AND «Mediterranean»	0	0
«female labour force participation» AND «fossil fuel subsidies» AND «MENA»	0	0
«female labour force participation» AND «energy policies»	20	0
«female labour force participation» AND «energy policies» AND «Mediterranean»	3	0
«female labour force participation» AND «energy policies» AND «North Africa»	2	0
«female labour force participation» AND «energy policies» AND «middle east»	4	0
«female labour force participation» AND «energy policies» AND «MENA»	1	0
«female employment» AND «energy subsidies»	6	0
«female employment» AND «energy subsidies» AND «Mediterranean»	0	0
«female employment» AND «energy subsidies» AND «North Africa»	2	0
«female employment» AND «energy subsidies» AND «middle east»	2	0
«female employment» AND «energy subsidies» AND «MENA»	1	0
«female employment» AND «fossil fuel subsidies»	1	0
«female employment» AND «fossil fuel subsidies» AND «Mediterranean»	0	0
«female employment» AND «fossil fuel subsidies» AND «North Africa»	0	0
«female employment» AND «fossil fuel subsidies» AND «middle east»	0	0
«female employment» AND «fossil fuel subsidies» AND «MENA»	0	0
«female employment» AND «energy policies»	35	0
«female employment» AND «energy policies» AND «Mediterranean»	3	0
«female employment» AND «energy policies» AND «north Africa»	5	0
«female employment» AND «energy policies» AND «middle east»	5	0
«female employment» AND «energy policies» AND «MENA»	2	0

TABLE 1
Literature review keywords and strings used and search results in ScienceDirect and Scopus

The creation of an Excel database to store the metadata of the examined scientific publications represents the first step in the meta-analysis conducted for this study. This database was built with the research aims in consideration, emphasizing the presentation of elements from the reviewed articles to answer the research questions that have been outlined.

The extracted data include the studies' geographical dimension, study methods, measurements of female employment, the types of energy subsidies (production/consumption, oil, etc.) that were taken into consideration, and the relationship between female employment and subsidies. The database can be found in the supplementary material to this paper.

For the empirical assessment of the links between energy subsidies and female employment, annual data for 18 Mediterranean countries (Albania, Algeria, Bosnia and Herzegovina, Croatia, Cyprus, Egypt, France, Greece, Israel, Italy, Lebanon, Libya, Morocco, Slovenia, Spain, Syria, Tunisia, and Türkiye) for the period 2010–2021 are employed. Country selection is determined by data availability and the target to include the largest sample of Mediterranean countries. The dataset includes figures on GDP per capita, female unemployment rate, and fertility rates (Table 2). Variable selection follows earlier works that examine female employment, allowing for methodological robustness and comparative analysis with existing studies in the field[132]. GDP per capita, using purchasing power parity, provides a measure of a country's economic development (Goldin (1994), Tam (2011)).

By including the log GDP per capita in the analysis, the broader economic environment within which female employment is situated is controlled-for. Additionally, female unemployment rates, as well fertility rates play significant roles in understanding the broader context of female employment and its interaction with economic and social factors, as explored in studies by Ahn and Mira (2002), Mishra and Smyth (2010), and Oshio (2019). A higher female unemployment rate may indicate challenges faced by women in accessing and retaining employment. Including fertility rates in the analysis allows the study to consider how family planning and demographic trends relate to female employment in the Mediterranean region. Energy subsidy data are obtained from the Fossil Fuel Subsidy Tracker[133] (2010-2021). Additionally, data on the female employment rate, fertility rate, GDP per capita and the unemployment rate are obtained from the World Development Indicators (WDI), World Banks' databank[134].

Variable	Definition	Time	Source
female_employment_rate	The proportion of a country's female population 15+ that is employed.	2010-2021	World Development Indicators (2022)
fossil_fuel_subsidies	Financial support provided to the fossil fuel industry. The total value is calculated in USD dollars. Fuel types that include the measure are the following: coal, end-use electricity, natural gas, and oil. Beneficiaries are consumers, general services, and producers. Support mechanisms include direct budgetary transfer, induced transfer, and tax expenditure[134].	2010–2021	Fossil Fuel Subsidy Tracker (n.d)
fertility_rate	The average number of births per woman	2010-2020	World Development Indicators (2022)
GDP_per_capita	Gross domestic product converted to international dollars using purchasing power parity rates	2010-2021	World Development Indicators (2022)
female_unemployment_rate	The share of the female labor force that is without work but available for and seeking employment.	2010-2021	World Development Indicators (2022)

TABLE 2
Variables, definitions, and sources

131 Based on both theoretical and empirical evidence, the inclusion of control variables in our analysis has been carefully considered. Statistical tests such as the Wald test have addressed concerns about including or excluding certain variables, such as unemployment rate and educational attainment. The results of these tests, as well as the existing literature on female employment supported our decision to retain or remove variables.

132 Available at: https://fossilfuelsubsidytracker.org/

133 Available at: https://data.worldbank.org/indicator

134 In our main analysis, we use the total, including all types, beneficiaries, and support mechanisms.

The main descriptive statistics are reported in Table 3. The average female employment rate among selected countries stands at 32.1%. In terms of fossil fuel subsidies, the average is 21.3%. Meanwhile, Table 4 presents the correlation matrix for both dependent and independent variables. Notably, there is a negative correlation of -0.330 between fossil fuel subsidies and the female employment rate. Likewise, the female unemployment rate exhibits a negative correlation with the female employment rate. Conversely, as the GDP per person increases, there is usually a higher rate of female employment.

Variable	Obs	Mean	Std. Dev.	Min	Std. Dev.
Female employment rate	216	32.1	13.347	10.11	57.41
Log fossil fuel subsidies	175	21.315	1.831	15.69	24.104
Log GDP per capita	204	9.968	.571	8.821	10.735
Female unemployment rate	216	15.999	6.918	3.926	31.38
Fertility rate	216	2.055	.677	1.19	3.441

TABLE 3
Descriptive statistics

Variables	(1)	(2)	(3)	(4)	(5)
Female employment rate	1.000				
Log fossil fuel subsidies	-0.330 (0.000)	1.000			
Log GDP per capita	0.764 (0.000)	0.035 (0.654)	1.000		
Female unemployment rate	-0.592 (0.000)	0.196 (0.009)	-0.388 (0.000)	1.000	
Fertility rate	-0.506 (0.000)	0.374 (0.000)	-0.417 (0.000)	0.053 (0.436)	1.000

TABLE 4
Matrix of correlations

The model employed to assess the links between **female employment rate and energy subsidies is given by equation 1 below.**

$$female\_employment\_rate_{i,t} = b_0 + b_1 \ log\_fossil\_ \ fuel\_ \ subsidies_{i,t} + \Sigma b_j \ x_{j,i,t} + e_{i,t} \quad (1)$$

where i is the country, t denotes the year from 2010 to 2021, $x_{j,i,t}$ represents the set of j explanatory variables of female employment, and ei,t is the error term. Pooled ordinary least squares (OLS) methods are used to estimate the coefficients, aligning with the notion of maintaining consistency across time and cross-sectional units. Pooled OLS approach is preferred as it also offers ease of interpretation by estimating coefficients for each explanatory variable, providing insights into the relationship between female employment and the factors under consideration. To dig deeper into the links between energy subsidies and female employment and to provide additional robustness to the empirical findings, subsidies are explored at aggregated levels and by source type, i.e., oil subsidies, natural gas subsidies, electricity subsidies, and coal subsidies at both production and consumption level.

2.3. Survey on female inclusion in the energy sector: The case of Greece

Additional work includes the completion of a survey of energy companies in Greece to gain insights on female employment and availability of skilled labor force. The goal of the survey was to gain an understanding of how women's participation and capabilities are perceived within the energy workforce across different companies. The qualitative insights from the survey act as a complement to the quantitative observations of the empirical investigation and aim to inform adjustments to policies and initiatives that promote diversity and equity, which in turn can lead to greater female inclusion. For this, an online questionnaire tailored to address pertinent issues related to the availability of talent pool with adequate technical skills and gender diversity has been developed. A total of 139 companies involved in various facets of the energy industry either directly (e.g., RES installation, oil, and gas) or indirectly (e.g., provision of legal services) have been reached-out to respond. The survey ran from November 21st, 2022, to February 22nd, 2023. The response rate was 36.7% (51 responses), with more than half of responding companies representing small-sized businesses with 0-49 employees. Notably, 86% of the total responses came from private companies, indicating a predominance of private sector activity. Most of the responses were collected from wind energy and oil and natural gas companies, the combination of which accounts for 51% of the responses received. Solar energy emerged as the third most responsive segment, representing 15.7% of participation. Construction, law, and trading contributed less than 3% of the total participation (for more details see the Appendix).

3. RESULTS AND DISCUSSION

3.1 Understanding the impact of energy subsidies: insights from systematic literature review

This section briefly discusses the results of the systematic literature review. Detailed results on the studies reviewed, methodologies, geographical coverage and main findings are provided in the supplementary material in the Appendix. In studying energy subsidies dynamics and consequences, studies to date focus mainly on questions related to energy consumption, the environment, employment, and economic outcomes and less to gender employment outcomes.

- **The impact of energy subsidies on economic development remains debatable**

Findings consistently confirm a negative impact of fossil fuels and their subsidies on the environment, mainly by inducing an increase in the consumption and production of polluting fuels. For instance, Albatayneh et al. (2022) showed that subsidies increase the amount of energy consumed during both winter and summer by comparing the average energy consumption of households receiving electrical subsidies to those paying full price in Jordan. The role of energy subsidies in economic development remains debatable in the literature to date. The primary reason behind subsidies is often to improve the economy by promoting manufacturing and more diversified industries, as well as to generate employment opportunities and to reduce inflation (Albatayneh et al., 2022). Yet, several studies find mixed effects with regards to the economic benefits of consumption subsidies. Karshenas et al. (2014) argued that these often induce distorted effects, benefiting

mostly the non-poor. Additionally, when it comes to domestic production and investment performances, subsidies can also be detrimental. Cabrales et al. (2017) find that subsidized fuel prices lead to increases in domestic demand that generate local shortages and a reliance on imported fuels, on top of a reduction in market value of domestic national oil companies.

- **Varied impact of fossil fuel subsidy removal on employment: Contextual discrepancies**

With regards to the links between energy subsidies and employment, some empirical works identify a correlation between fossil fuel subsidies removal and a drop in employment. Yet results differ in magnitude and significance (see for instance Jiang and Lin, 2014; Lin and Ouyang, 2014; Ouyang and Lin, 2014; Mundaca, 2017; Daneshzand et al., 2022). These discrepancies relate to the different contexts of the studies, the definition of fossil fuels used, the methodology utilized and the scope of the research (short vs long terms). Within the Chinese context, three papers have studied the impact of fossil fuel subsidy removal on employment and all three find a negative impact (Jiang and Lin, 2014; Lin and Ouyang, 2014; Ouyang and Lin, 2014). Lin and Ouyang (2014) use a computable general equilibrium model and look at consumption subsidies on coal, oil products, natural gas, and electricity. They find that removal of these subsidies decreases employment over the period 2006-2010 by about 3.5% yearly on average. Jiang and Lin (2014) also used an energy environment computable general equilibrium model but focus on fossil fuel subsidies to industries (especially heavy industry and transport) and on gasoline, diesel oil and natural gas consumption. They find that removing energy subsidies decreases employment by 2%. Similarly, Ouyang and Lin (2014) find that removal of fossil fuel subsidies decreases employment. However, by using a scenario analysis associated with cost-benefit analysis, Ouyang and Lin (2014) show that depending on the scale of the fossil-fuel subsidy reform, the adverse impact on employment differs. Their results indicated a 4% drop in employment if all subsidies were removed.

Some studies have focused on the impact of the timing and scale of reforms on employment in the wider MENA region. In the short run, the impacts of subsidy are found to be negative (Mundaca, 2017; Daneshzand et al., 2022). Daneshzand et al. (2022) found that in countries where energy is imported and low prices are practiced, removal of energy subsidies with no other reform negatively impacts energy supply, profit of companies, and employment. However, when looking at the longer run, countries that implement a reduction in subsidies to fossil fuels retail prices, experience higher GDP per capita growth, and higher levels of employment and labor force participation, especially among the young (Mundaca, 2017). Using three empirical strategies on MENA countries, namely cross-sectional, pooled cross-sectional and panel data, Mundaca (2017) finds that the strongest positive effects of energy price reform on the macro-economy is expected in countries with high initial energy subsidies. According to the author, this is mainly because energy subsidies have encouraged energy-intensive production in MENA countries, which also tends to be capital-intensive, and discourages employment. Therefore, on top of promoting entrepreneurial activity in the energy sector, subsidy removal can also increase allocative efficiency of production inputs (Mundaca, 2017).

Few studies seek to break down the effects of eliminating energy subsidies on the labor force. These papers usually find a differentiated effect felt by the most vulnerable communities (Acar and Yeldan, 2016; Shehabi, 2020). For example, in the Turkish case, Acar and Yeldan (2016) built a regionally differentiated applied general equilibrium model where high vs low-income regions as well as informal and formal labors are distinguished, spanning over 2015–2030. They estimate that if no policy changes occur, formal and informal labor employments in high- and low-income regions increase, whereas if subsidies on coal production are eliminated, the average unemployment rate would increase only in low-income regions by 0.2 percentage points. Similarly, using an economy-wide general equilibrium model with oligopolistic industrial structure, Shehabi (2020) finds that if oil subsidies are removed with no other reform, skilled and unskilled expatriates in Kuwait will benefit marginally, but the employment of unskilled domestic labor decreases. No studies have been identified to look at the causal links between subsidies and female employment.

- **Counteracting employment decline post-energy subsidy removal: Reinvestment in social welfare policies**

Research shows some consensus on the need to mitigate the adverse employment effects of energy subsidies' removal. First, it seems that optimal phase-out time of subsidies exists and that a gradual reform is needed to minimize the social welfare losses (Daneshzand et al., 2022). Second, policy implications from this strand of literature highlight the importance of reinvesting the money saved, or tax increases, into social welfare to compensate for the socio-economic consequences (Jiang and Lin, 2014; Mundaca, 2017; Shehabi, 2020; Daneshzand et al., 2022). Jiang and Lin (2014) find that if the savings from fossil fuel subsidies' removal are transferred to social welfare projects, employment would increase by 0.8% in China. This reallocation to the people and the economy could take the form of improving infrastructures and the healthcare system or targeting investments, and employment (Daneshzand et al., 2022). Similarly, Shehabi (2020) finds that, to avoid the contraction in the oil industry after the hydrocarbon subsidy removal in Kuwait, subsidies' removal needs to be accompanied by reforms that promote competition and mobility of nationals from the public to the private sector to increase employment in the country for all. Therefore, it seems that supporting policies could reverse the adverse impacts from energy price increase. One of the main explanations in the literature resides in the high returns of these long-term public investments that enhance countries' productive capacity (Mundaca, 2017).

- **The significance of policy interventions that also consider the gender-specific impacts of energy subsidy reforms**

Despite a significant bulk of works on the links between energy subsidies, energy consumption, economic and employment outcomes, there appears to be a notable gap in the scientific literature exploring the link between energy subsidies and female employment. The discussion on the relationship between subsidies and female employment appears inconclusive (Table 5). Despite the diversity in approaches and geographical contexts, none of the studies yield direct results regarding the impact of subsidies on female employment. Some studies, however, highlighted specific sectoral dynamics, such as the oil extraction sector in Tanzania being male-dominated and increasing women's vulnerability. A more detailed analysis of the previous studies is provided in the Appendix.

In their descriptive paper, Karshenas et al. (2014) suggest that to boost female employment in the MENA region, energy subsidies need to be replaced with family allowances and other social policies targeting women. Public policies should for instance focus on releasing additional funds for provisioning of child or family allowances to mothers, paid maternity leave and the provision of childcare centers at the workplace. These policy implications are derived from the need of Arab countries to tackle the lack of maternity leave insurance that restrict child-bearing women's employability and disincentivize women from entering and remaining in the labor force. The authors envision a progressive shift towards gender equality by fostering an environment that supports women's career continuity, as these policies would also help to gradually influence conservative family laws that suppress female labor supply and demand (Karshenas et al., 2014). Ovadia (2022) recommends that governments in resource-rich countries must pursue a holistic approach to gender equality including legislation, regulation, policy, education, and training, in view of maximizing the benefit from extractive industries and petro-development.

In the case of China, Ouyang and Lin (2014) show that if subsidies to fossil fuel consumption are replaced by renewable energy subsidies, employment could marginally increase. Similarly, Monasterolo and Raberto (2019) using an extended EIRIN Stock-Flow Consistent behavioral model with an energy sector and market show that a smooth and gradual phasing out of fossil fuels subsidies in high-income countries, with an increase in renewable energy subsidies, contributes to improving macroeconomic performance and fostering lower unemployment and a low-carbon transition. In the US case, Garrett-Peltier (2017) concludes that the expansion of clean energy creates three jobs for each job lost in the fossil fuel sector. A $1 million shift from support to the fossil fuel industry to renewable energies subsidies would create a net increase of 5 jobs.

When it comes to the relationship between renewable energy subsidies and female employment, a clear gap in the literature exists, especially in the Mediterranean region. Özkaynak (2008), in a scenario analysis for a Turkish city, shows that renewable energy subsidies can be a source of employment opportunities for women. Özkaynak (2008) identifies a best-case scenario for women in the city of Yalova in Türkiye, where female employment and support for renewable energies and their infrastructures seem to go hand in hand. This scenario is the "Yalova within social Europe", where national policies prioritize investments in public transport and aim to increase renewable energies in the total energy consumed by funding support and subsidies. Projects such as geothermal energy facilities would increase employment opportunities for women. However, Özkaynak (2008) points out the potential rise in female unemployment if the average growth of employment for women is smaller than the increase in the female labor force.

Reference	Country/ Regional Focus	Research Methodology	Relationship between subsidies and female employment
Acar and Yeldan (2016)	Türkiye	1. Regionally differentiated applied General Equilibrium (GE) model. 2. Alternative policy scenarios.	No direct result for female employment.
Albatayneh et al. (2022)	Jordan	Comparison between customers paying standard electricity tariffs and IDECO staff.	No direct result for female employment.
Daneshzand et al. (2022)	Iran	Simulation-based optimization model.	No direct result for female employment.
Karshenas et al. (2014)	MENA	1. Literature review. 2. Case study from Tunisia.	No direct result for female employment.
Monasterolo & Raberto (2019)	European Union	1. Extended EIRIN Stock-Flow Consistent behavioral model with energy sector. 2. Scenario analysis with policy simulation.	No direct result for female employment.
Özkaynak (2008)	Province of Yalova, Türkiye	1. Scenario approach. 2. Literature review and secondary data.	Female employment and renewable energy subsidies are compatible.
Shehabi (2020)	Kuwait	1. GE model with oligopolistic industrial structure for a country with low oil prices. 2. Scenario analysis with policy simulation.	No direct result for female employment.

TABLE 5

Selected studies on the impact of energy subsidies on female employment including evidence from some Mediterranean countries

3.2 Empirical results: Fossil fuel subsidies notably reduce the female employment rate

To motivate our empirical study, we visually assess the relationship between female employment and fossil fuel subsidies (Figure 2). The scatterplot includes data from the 18 Mediterranean countries sample from 2010 to 2021. Each point on the plot represents a specific country's annual data point, where the x-axis represents the level of fossil fuel subsidies, and the y-axis represents the corresponding female employment rate. The fitted line indicates a potentially negative relationship between the variables of interest.

Econometric results for different model specifications are summarized in Table 6. Regression results show that fossil fuel subsidies have a significantly negative effect on the female employment rate at a 1% significance level. This suggests that the expansion of fossil fuel subsidies significantly decreases female employment rate. This finding implies that opportunities or resources might be crowded out by the economic resources used to fossil fuel subsidies, possibly because of resource misallocation. Regarding the remaining control variables, the coefficient of the country's female unemployment rate is negative and statistically significant, indicating that a higher level of unemployment is associated with a lower female employment rate (at the 1% level of statistical significance). A high female unemployment rate indicates reduced job opportunities in the labor market, leading to a decline in female employment rates. The coefficient of GDP per capita appears to be positive, which states that a 1% increase in GDP per capita increases female employment rate. This outcome is in line with the idea that more opportunities for women to participate in the labor force are created by economic development and higher income levels. Furthermore, the fertility rate is positive and statistically significant, implying that an increase in the number of children born to a woman would lead to an increase in the female employment rate. Societal factors, such as improved work-life balance or policies that encourage working mothers, could be one explanation.

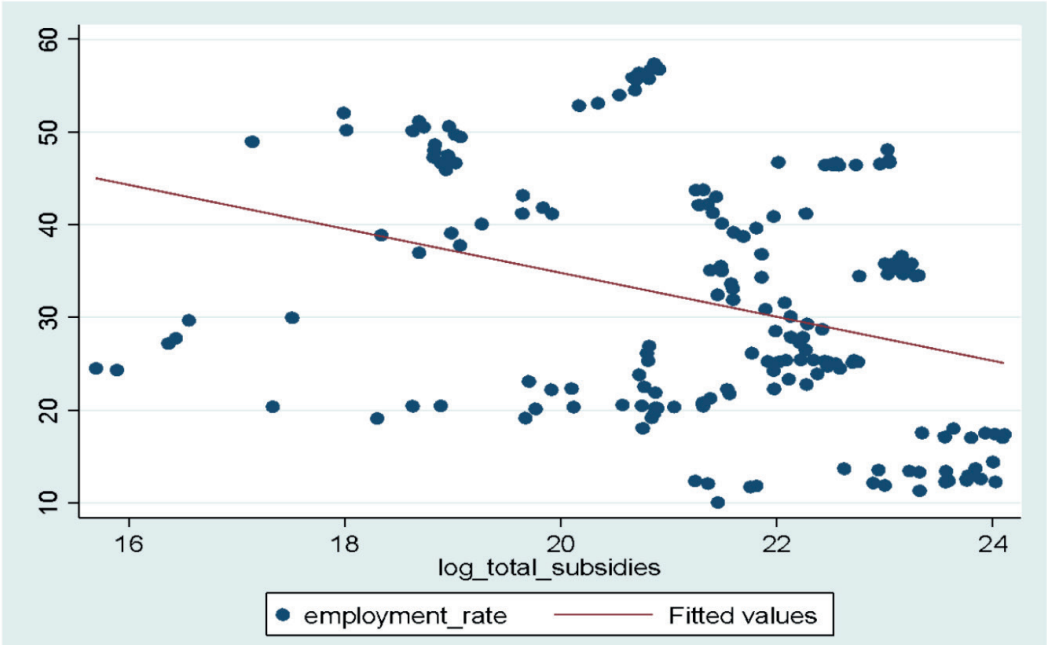

Figure 2. *Scatterplot of female employment rate and (total) fossil fuel subsidies in the Mediterranean countries*

VARIABLES	(1) female_employment_rate	(2) female_employment_rate	(3) female_employment_rate
log_fossil_fuel_subsidies	-2.372***	-2.537***	-2.843***
log_GDP_per_capita	(0.561)	(0.248) 18.90*** (0.807)	(0.196) 19.76*** (1.198)
female_unemployment_rate			-0.303***
fertility_rate			(0.0726) 3.807*** (0.858)
Constant	82.27*** (12.14)	-102.8*** (10.86)	-108.0*** (13.37)
Observations	175	170	170
P (F-stats)	0.0000	0.0000	0.0000
R-squared	0.109	0.806	0.867

TABLE 6

Pooled OLS results

*Notes: Robust standard errors in parentheses, ***, **, and * indicate statistical significance at the 1%, 5%, and 10% levels, respectively.*

Robustness tests

To control for the robustness of our findings, we explore the impact of different types of subsidies on the female employment rate (Table 7-Table 10). In Table 7, we investigate the robustness of our results by employing oil subsidies as the main independent variable, rather than (total) fossil fuel subsidies as in the previous analysis. This approach helps validate whether the observed effect on female employment is primarily driven by oil subsidies or if it holds true across various types of subsidies within the fossil fuel category. The results support our main findings, suggesting that oil subsidies have a negative significant impact on the female employment rate. The nature of the oil sector, which is often capital-intensive and male-dominated could be the economic rationale. The female unemployment rate and GDP per capita maintain their statistical significance, consistent with the results in Table 6.

VARIABLES	(1) female_employment_rate	(2) female_employment_rate	(3) female_employment_rate
log_oil_subsidies	-1.722***	-2.354***	-2.098***
log_GDP_per_capita	(0.588)	(0.381) 18.71*** (1.021)	(0.415) 17.29*** (1.535)
female_unemployment_rate			-0.484***
fertility_rate			(0.0764) 1.431 (1.245)
Constant	68.20*** (12.43)	-105.7*** (15.02)	-92.30*** (17.59)
Observations	161	156	156
P (F-stats)	0.0039	0.0000	0.0000
R-squared	0.069	0.696	0.761

TABLE 7

Pooled OLS results with oil subsidies

*Notes: Robust standard errors in parentheses, ***, **, and * indicate statistical significance at the 1%, 5%, and 10% levels, respectively.*

VARIABLES	(1) female_employment_rate	(2) female_employment_rate	(3) female_employment_rate
og_natural_gas_subsidies	-1.882***	-0.607**	-0.919***
log_GDP_per_capita	(0.466)	(0.250) 21.39*** (1.042)	(0.301) 17.96*** (1.635)
female_unemployment_rate			-0.487***
fertility_rate			(0.0856) 1.463 (0.988)
Constant	68.72*** (8.838)	-171.5*** (13.00)	-126.2*** (21.75)
Observations	132	132	132
P (F-stats)	0.0001	0.0000	0.0000
R-squared	0.098	0.747	0.811

TABLE 8

Pooled OLS results with natural gas subsidies

*Notes: Robust standard errors in parentheses, ***, **, and * indicate statistical significance at the 1%, 5%, and 10% levels, respectively.*

The results on natural gas subsidies and female employment rate are presented in Table 8. The effect of natural gas subsidies is negative and statistically significant, indicating a negative association with female employment rates. Again, the natural gas sector is characterized by factors that limit female participation, such as predominantly male-dominated production. The statistical significance of the female unemployment rate and GDP per capita is consistent with previous findings.

On the other hand, in Table 9, coal subsidies do not exhibit a statistically significant effect on the female employment rate in all model specifications. GDP per capita retains its positive and statistically significant impact. Broader economic factors play a more significant role in female employment rates than specific subsidies to the coal industry. However, the number of observations used for the analysis is small, which may result in a lack of statistical power to detect significant effects.

VARIABLES	(1) female_employment_rate	(2) female_employment_rate	(3) female_employment_rate
log_coal_subsidies	-2.639***	-1.452**	-1.322
log_GDP_per_capita	(0.684)	(0.696) 20.14*** (2.822)	(0.871) 17.03*** (3.902)
female_unemployment_rate			-0.191
fertility_rate			(0.122) -3.370 (2.610)
Constant	88.33*** (13.11)	-144.5*** (39.88)	-106.3* (57.44)
Observations	72	72	72
P (F-stats)	0.0003	0.0000	0.0000
R-squared	0.371	0.574	0.587

TABLE 9

Pooled OLS results with coal subsidies

*Notes: Robust standard errors in parentheses, ***, **, and * indicate statistical significance at the 1%, 5%, and 10% levels, respectively.*

Table 10 summarizes the estimation results on the links between electricity subsidies and female employment, revealing a negative and statistically significant effect on the female employment rate. This effect could be due to industry structure and its gender dynamics. Like previous findings, both the female unemployment rate and GDP per capita remain statistically significant.

VARIABLES	(1) female_employment_rate	(2) female_employment_rate	(3) female_employment_rate
log_electricity_subsidies	-3.271***	-2.008***	-1.664***
log_GDP_per_capita	(0.362)	(0.237) 14.51*** (0.853)	(0.181) 10.67*** (1.389)
female_unemployment_rate			-0.141**
fertility_rate			(0.0682) -4.524*** (1.036)
Constant	94.25*** (7.586)	-74.82*** (11.50)	-31.58* (17.73)
Observations	123	118	118
P (F-stats)	0.0000	0.0000	0.0000
R-squared	0.298	0.832	0.869

TABLE 10

Pooled OLS results with coal subsidies

*Notes: Robust standard errors in parentheses, ***, **, and * indicate statistical significance at the 1%, 5%, and 10% levels, respectively.*

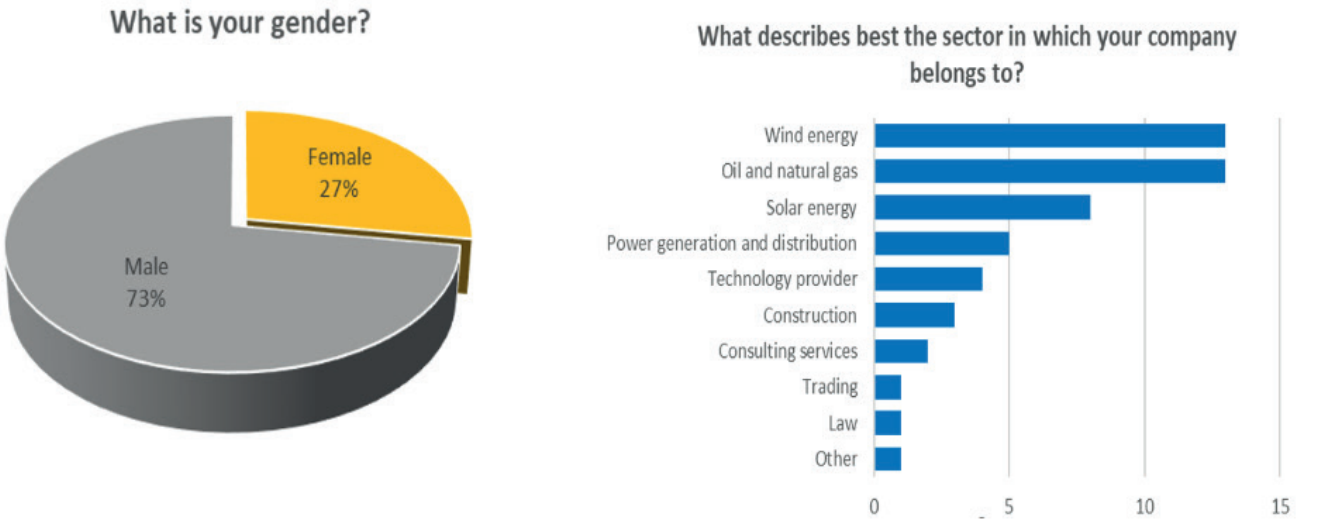

Figure 3. *Demographic Survey Results*

The econometric results under different model specifications and variables used, consistently identify a strong and adverse relationship between fossil fuel subsidies and female employment rates. The robustness tests further reinforce the main findings, as variations in the type of subsidies (oil, natural gas, and electricity) consistently show negative and statistically significant links with female employment rates.

3.3 Survey results

Results from the survey of Greek energy companies are summarized next. Two thirds of the respondents were male with a share of 72.5%, while female participation was limited to 27.5%. This disparity may raise concerns regarding the level of female involvement in the targeted sector. Additionally, it suggests a potential perception gap between men and women regarding female inclusion. Despite this, the survey garnered responses from a diverse range of companies, with approximately 40% operating in the oil and natural gas industry, and the wind sector accounting for 51%. Conversely, sectors such as construction, law, and trading had lower participation rates, each representing less than 3% of respondents (Figure 3).

When queried about the links between industry investments and job opportunities for women, about 29% of respondents expressed strong positivity, while more than half expressed positivity (see Figure 4). Around 80% of respondents expressed confidence in the skills and competence of female candidates, asserting that women are well-equipped to excel in any business environment within the sector (Figure 5). Respondents also indicated that their companies invest in building gender diverse teams and have set clear principles for equal treatment of employees regardless of gender.

This may better explain the survey outcome that women are well represented in higher management positions, according to 66% of total respondents (Figure 6). However, caution is advised in interpreting this finding, considering the higher male participation in the survey and the acknowledged disparity in how men and women perceive gender diversity issues.
About half of the survey participants said that women are underrepresented in their company (Figure 7). This pattern holds true across regions and is consistent with global findings that there is still room for progress to increase the number of women working in the energy sector. This might be attributed to the fact that not many women apply for job positions in the energy sector, as 45% of the respondents expressed (Figure 8).
The figures presented highlight the positive perception of women's competence, yet also reveal an opportunity for improvement in aligning industry investments with enhanced job opportunities for women. Continued efforts are needed to address systemic barriers and biases, fostering an inclusive sector where women are not only recognized for their capabilities but are actively encouraged and supported in advancing their works.

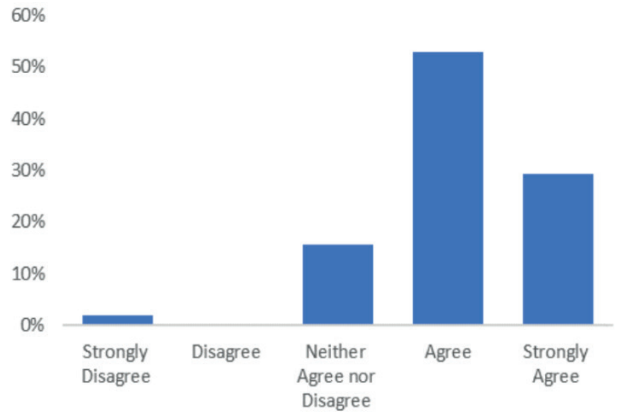

Figure 4. *Investments in the energy sector create employment opportunities for women in Greece*

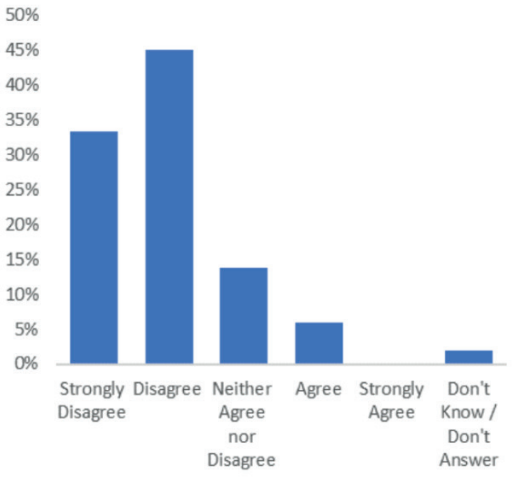

Figure 5. *The is lack of adequate skills and expertise among female candidates for employment in my company*

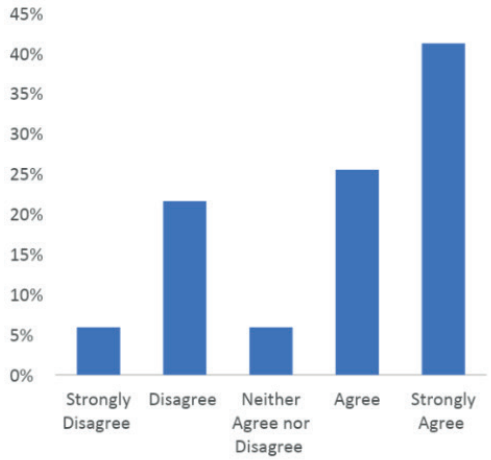

Figure 6. *Women are well represented in the higher management ranks in my company*

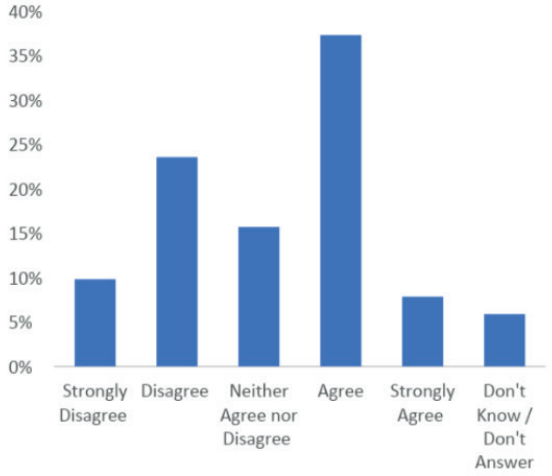

Figure 7. *Women account for less than half of the employees in my company*

4. Conclusions and policy considerations

The study has provided a comprehensive examination of female inclusion in the energy sector in the Mediterranean countries, with a focus on the role of energy subsidies, particularly fossil fuel subsidies. Our results suggest that energy subsidies harm female economic inclusion. Empirical results confirm a significant and adverse effect on female employment rate, indicating that hydrocarbon subsidies increase gender disparities in employment within the energy sector. Our survey findings also show that while respondents agreed that investment in all fields of the energy sector create opportunities for employment, less than one third of them were strongly positive on the impact of investments on women's employment. These insights underscore the importance of reevaluating regional energy policies with a dedicated focus on promoting gender inclusion.

Concrete actions are recommended to address these challenges. Governments in the Mediterranean region **are encouraged to gradually eliminate inefficient subsidies while reforming the rest in a way that does not hinder women's inclusion in the energy sector workforce.** Shifting to cleaner and more sustainable energy sources could have a positive impact for both the environment and the development of female labor market participation. Any subsidy reforms would need

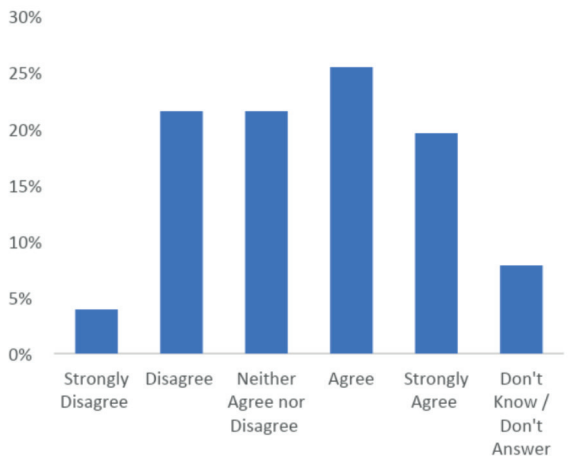

Figure 8. *Not many women apply for employment in my company*

to be designed carefully with **gender-responsive impact analysis** conducted to positively affect norms around women's work. Governments' expenditure in the Mediterranean on energy subsidies can be significant; they can even sometimes surpass investments in other important sectors, or, under limited budgetary resources, they may come at the cost of other priority social expenditures such as health and education. In Greece, the government dedicated EUR 9 billion from September 2021 to November 2022 to energy subsidies and other measures to help consumers pay utility bills, accounting for about 5% of the national GDP. This demonstrates a proactive effort to address energy affordability concerns, however, while these subsidies have played a vital role in supporting households, our study suggests that there is room for improvement in ensuring their effectiveness in promoting gender inclusion within the energy sector.

It is necessary to include **specific labor market requirements that enhance female inclusion in the energy sector,** as well as to **identify and remove discriminatory barriers from existing regulations and policies** (i.e., inefficient subsidies). As a policy example of relevance, Germany in order to increase female representativity in managerial positions in the private sector, introduced the Federal Act of 2015 which contained a gender quota of 30% for the supervisory boards in stock-listed and equally co-determined companies. Since 2022, energy companies are also obliged to appoint at least one woman to the executive boards consisting of more than three people. The German Federal Equality Act also requires federal authorities to draw up a new gender equality plan every four years. This reform includes measures that enhance the compatibility of jobs with care responsibilities. The current German equality plan has the objective of reaching gender equality at all management levels by 2025[136].

Governments could also decide to **directly support and help women-owned enterprises in the energy sector to scale up by providing mentoring and financing opportunities directed to their businesses.** According to a research report of GET.invest, in collaboration with ENERGIA, there is a lack of sustainable or scalable financing examples and opportunities for women in the sector[137]. **Redirecting a portion of financing from energy subsidies to policy accelerators that promote gender empowerment and removal of information asymmetries and skills training could be considered.** As per our findings in the survey, respondents expressed concerns regarding the availability of a qualified labor force in the local economy and the skills required by their companies. It is critical to ensure that women have the necessary skills and knowledge needed to succeed in the energy job market by supporting the creation of (green) skills training programs specifically designed for them. **Creating focused training programs** may include collaborations with academic institutions and the regional industrial community to facilitate female student to work transition. As another useful example, one can refer to engineering courses targeted towards women such as the "Girls in Energy" course provided by the North-East Scotland College, which allow young women to begin to build skills and knowledge to prepare them for the energy job market[138]. Another example is the "Future Female Leaders in Energy" course developed by the University of Cape Town in collaboration with the African Management Institute in view of equipping women, working in the energy sector in entry-level positions, with the skills to grow into management and leadership roles and to get promoted[139]. Subsidized training programs could therefore help break down horizontal segregation, and especially in fields in which men are traditionally overrepresented.

Gender concerns should be incorporated into the design and implementation of local employment policies and promoting inclusive practices at industry- and company-level. Public-private partnerships, mentorship programs, and family-friendly practices such as on-site childcare centers could further support women's inclusion in the labour market and in the energy sector in particular. Creating support systems for women in energy is essential to strengthen their inclusion. Forums and professional associations, such as the "CIGRE Women in Energy"[140] or the Sino-German subforum "Women Power in Energy Transition"[141] allow women to interact, develop their careers and increase their self-confidence and professional skills. Another example is from the Indo-German Energy Forum where a Women in Energy Roundtable and Networking Dinner is organized to provide mentoring opportunities for women and for them to participate in the design of inclusive energy policies[142].

Another recommendation emerging from the systematic literature review is to reinvest the savings from the removal of fossil fuel subsidies into social welfare programs. This could notably include directing funds towards family allowances or extending maternity leaves and providing more affordable childcare

136 https://www.bmwk.de/Redaktion/DE/Publikationen/Energie/publikation-g7-report-on-gender-equality-and-diversity-in-the-energy-sector.pdf?__blob=publicationFile&v=1

137 https://www.get-invest.eu/scaling-up-access-to-finance-for-women-energy-entrepreneurs/

138 https://www.nescol.ac.uk/courses/skills-for-work-national-5-girls-in-energy/

139 https://tea-lp.org/2023/05/31/future-female-leaders-in-energy-course-launches/

140 https://www.cigre.org/GB/community/women-in-energy

141 https://www.energypartnership.cn/home/events/women-power-in-energy-transition-subforum/

142 https://www.energyforum.in/home/2022/20220512-women-energize-women/

services. Providing maternity protection and inclusive leave policies could boost female economic participation both at the intensive and extensive margins. Cash and medical benefits during leave could be financed through social insurance or public funds, while minimizing employer's liability. Similarly, subsidized quality childcare services can be an important policy tool designed to enable women to participate in the labor market. Furthermore, **personal tax reforms could also incentivize sharing of work between spouses. Governments should also facilitate work attachment and reintegration. Governments could sponsor, or subsidize, return-to-work or career training programs that address motherhood or career break penalties and strengthen women's attachment to the labor market.**

Finally, the **implementation of mechanisms to measure energy subsidies and monitor the progress of female labor force participation in the energy sector could help towards the updated, challenges-responsive contemporary policymaking.** Governments should devote resources to strengthen female inclusion, by collecting gender statistics both for the formal and informal sectors, **integrating a gender perspective into all policies**, and ensuring monitoring and accountability. **Increasing data gathering on women** in the energy sector across the Mediterranean region and in South Mediterranean countries could also help understand the heterogeneity of barriers impeding female economic inclusion in the energy sector. Initiatives led by organizations like the Plan Bleu and its UNEP/MAP mandate can be an instigator of such data collection efforts. The Plan Bleu Observatory expertise can be very helpful in this endeavor, first, to build a common methodology for data gathering around the Mediterranean region allowing comparability of statistics both on energy subsidies and women's participation to the energy sector workforce across countries[143], but also to develop efficient tools to inform decision-makers and promote good practices such as the UNEP visualizing tool and data platform MapX. A similar tool for energy subsidies on fossil fuels and on green energy but also for female employment in the energy sector, would bridge the gaps in reporting and improve our understanding on the dynamics of the energy sector. It can also help increase the visibility of success stories and good practices for women's inclusion in the energy sector, through story-maps.

The development of the right strategy and policy framework for each country of the Mediterranean region will be a critical pre-condition for successfully addressing gender disparities in the energy sector. Collaboration between the different stakeholders of the energy sector—government, industry, academia, and civil society—is crucial in effectively fostering gender diversity within the sector. This paper is a first step to better understand female inclusion in the energy sector in the Mediterranean. Future research is required in this direction to support evidence-based policy making in the region. Future works could explore the role of various economic factors (e.g., childcare facilities), to provide a more comprehensive examination of the factors influencing women's labor force participation. Given the complexities of quantifying fossil fuel subsidies and their varied impacts on female employment, it is imperative for future studies to delve deeper into the distinctions between different mechanisms or beneficiaries of support. By examining the effects of energy policies on women's economic integration and measuring the benefits of positive subsidies and green financing for women in the energy workforce, future works can further support policymakers to develop inclusive policies for a sustainable transition.

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Declarations

The authors declare no known interests related to the submitted manuscript.

143 Very few data sources allow comparability of statistics in the region. They often differ on how energy subsidies data are measured and on how women employment statistics are gathered.

Appendix

Reference	Research Question	Methodology	Country of Focus and Data	Main Findings
Acar and Yeldan (2016)	What are the macroeconomic and environmental effects of Türkiye's existing coal subsidies? What are the environmental gains of abatement through the removal of these subsidies, and impacts on the regional and sectorial economic performances?	1. Regionally differentiated applied general equilibrium model where informal and formal labors are distinguished, spanning over 2015–2030. 2. Alternative policy scenarios to study the regional and sectorial performances of growth, employment, and other macroeconomic indicators.	Data on Türkiye: Updated 2002 Input–Output table published by TurkStat to 2010 using the national income data on macro-aggregates, ILO and TurkStat Household Labor Force Surveys data.	1. Elimination of coal subsidization, Türkiye can reduce its aggregate gaseous emissions by 5% without a significant loss in its GDP. 2. Under different scenarios, the consequences on the macro-economy differ but in all, total labor employment is expected to grow. However, unemployment seems to rise slightly for low income regions (by 0.2 percentage points) in the scenario where coal production subsidies are eliminated.
Albatayneh et al. (2022)	What are the consequences of subsidies on electricity consumption? How should the electrical subsidies be reorganized in the residential sector? Do fair tariffs for electricity pricing succeed in controlling demand and promoting sustainability?	Comparison between the customers paying standard electricity tariffs and IDECO members of staff.	Jordanian data from 260,000 regular customers paying standard electricity tariffs and from 1,000 energy-subsidized District Electricity Distribution Company members of staff over 2017 and 2018.	1. On average, normal homeowners used approximately 297 kWh/month, whereas customers whose electricity was subsidized consumed approximately 615 kWh/month. 2. The application of electricity tariffs (with no subsidies) provides a means of controlling the demand profile that is particularly effective.
Cabrales et al. (2017)	What are the impacts of employment policy and subsidized domestic fuel prices on national oil company's performance, including production, companies' market value and investments?	1. Optimal control model. 2. Four different scenario with a twenty-year projection: A base scenario where the company follows the optimal policy of an International Oil Company, a scenario with employment factor of 1.2, a scenario with a 20% discount on domestic fuel, and a scenario that combines employment factor of 1.2 and a 20% price subsidy.	Data on Colombian National Oil Companies, using mainly: Data of Ecopetrol, Colombian data for exploration investment and oil discovery during the period from 1978 to 2006, Ministry of Mines and Energy 2014 data.	1. Employment policies cause greater number of employees, unprofitable projects that may increase the production costs per barrel and the fixed costs of the company 2. Domestic fuel subsidies lead to increases in domestic demand. More fuel will need to be imported and market value is reduced of 34% with respect to baseline. 3. Combined scenario: recovery investments are absent and the market value will be reduced of 60% with respect to the baseline.

Daneshzand et al. (2022)	Do natural gas subsidies lead to overconsumption of energy and an increase in CO2 emissions? What are the overall benefits of subsidies compared to their costs? How to plan for subsidies phase-out and to select the optimal period over which to phase-out subsidies to minimize possible adverse impacts?	A simulation-based optimization model.	Case study of Iran from 1985 to 2017, using Energy balance sheet report (1990-2019) of the Ministry of Power of Iran	1. In countries where the energy is imported, reduction in consumption can negatively impact supply, profit of companies and employment. 2. Optimal subsidies removal period differ across consumption sectors: the industrial sector needs a longer phase-out period. 3. Reallocation of reserved funds saved from subsidy removal could be done through improving infrastructures, or the healthcare system, investments which leads to economic growth and higher employment.
Garrett-Peltier (2017)	What are the environmental and economic impacts of fiscal and regulatory policies regarding the energy sector in the US? Will the clean energy create more jobs than will be lost in fossil fuels with lower-carbon energy policies?	1. Input-Output Model using "synthetic" industries –clean energy industries that do not currently exist in Input-Output tables. 2. Existing literature and survey data to form vectors of demand. 3. Policy simulation – shifting $1 billion from Fossil fuel to Renewable Energies	71-industry "Summary" Input Output tables for 2013 from the U.S. BEA. Combined with survey data, expert interviews and financial data from energy industries or firms.	The expansion of clean energy creates three jobs for each job lost in the fossil fuel sector: A $1 million shift from support to the fossil fuel industry to renewable energies subsidies will create a net increase of 5 jobs. These employment effects are relevant for the short-to-medium term.
Jiang and Lin (2014)	How does the fossil fuel subsidy reform of the G-20, aiming to phase-out inefficient fossil fuel subsidies that encourage excessive consumption, impact emissions, energy efficiency and the macro-economy?	An Energy Environment Computable General Equilibrium model is used.	Data on China using the Energy Statistical Yearbook and China Urban Life and Price Yearbook 2009	Removal of subsidies decreases employment by 2.00%. However, if Supporting policies, which transfer the savings from subsidy removal to social welfare project are taken, employment increases by 0.78%.
Karshenas et al. (2014)	What are the issues to be addressed in a social dialog in the early stages of the democratization process after the Arab Revolution? How to establish a democratic and developmental political system? What social policy regime needs to emerge?	1. Literature review on social welfare and the rights of citizenship in the region to outline the evolution of the existing social welfare regimes over the past few decades. 2. Tunisia as a test case for crafting of social policy recommended.	- Secondary data: World Development Indicators, World Bank on the Arab countries of the Middle East and North Africa. - Comparative references to Iran and Türkiye and interviews combined with documentary data collected in Tunisia in March 2014.	1. Social policy can promote inclusion and is necessary for a well-functioning and dynamic economy. 2. Replace subsidies with child or family allowances to mothers, paid maternity leave and the provision of childcare centers at the workplace.

Kuralbayeva and Stefanski (2013)	What makes labor move from the (traded) manufacturing to the (non-traded) non-manufacturing sector? What are the consequences for productivity?	1. Panel of macro cross-country data and a cross-section of micro US county-level data 2. A small, open economy model with two sectors and with self-selection differences between resource-rich and resource-poor regions.	- Macro cross-country data on Labor shares from OECD and IPUMS - Micro US county data from BLS and Michaels (2011)	The share of women employed in the non-manufacturing sector, which is unproductive, in resource-rich regions is disproportionately greater: 83% of women employed in oil rich countries (vs 72% of men) and 78% of women in oil-poor countries (vs 71% for men). Women are less productive in both sectors compared to men, but have a comparative advantage in non- manufacturing.
Lin and Ouyang (2014)	What are the consequences on energy demand, the environment, GDP and employment of an energy price reform in China? How to render the macroeconomic impact acceptable?	1. Price-gap approach to measure fossil-fuel subsidies and the effects of subsidy removal in a systematic fashion during 2006– 2010. 2. Computable general equilibrium model.	Many data sources for China (2006 to 2010), from which: Nominal data from CEIC China Database (2006 to 2010), China Statistical Yearbook and the China Energy Statistical Yearbook.	Economic growth and employment are negatively affected as well as energy demand, carbon dioxide and sulfur dioxide emissions: Removal of subsidies decreases employment by 3.63 in 2006, 3.77 in 2007, 4.30 in 2008, 2.39 in 2009 and 3.37 in 2010.
Monasterolo and Raberto (2019)	What are the consequences of phasing out fossil fuel subsidies in high income countries, notably on the low-carbon transition? 1. To what extent could the phasing out of fossil fuel subsidies contribute to decarbonize the economy by influencing agents' investment behaviour? 2. Under which conditions could distributive effects of energy policies emerge in the economy?	1. Extended EIRIN Stock-Flow Consistent behavioral model with an energy sector and market. 2. Seven model scenarios that imply the introduction of three different sets of energy policies.	EIRIN is shaped on a high- income country of the EU, which signed the Paris Agreement, is committed to the EU2030 targets and has a high level of energy dependency.	1. A smooth phasing out of fossil fuels subsidies contributes to improve macroeconomic performance. 2. Renewable energy subsidies contribute to foster the low-carbon transition and lower unemployment. 3. Fossil fuel subsidies have higher distributive effects than green subsidies, but green subsidies have a green multiplier effect on the economy.
Mundaca (2017)	What is the empirical relationship between energy subsidies and economic growth? Does a reduction in subsidies move a country toward its optimal steady state potential for economic growth? What are the channels by which such changes in growth rates could take place?	1. Cross-section and pooled cross-section (with fixed effects) approaches analyze long-run effects. Robust OLS estimation method. 2. Pooled cross-section considers to account for business cycles. 3. Panel approach to study short- and medium-run effects. Combined with System General Method of Moments method	Cross-section covers all countries of the World Bank (1998 - 2012). For the panel, the data used is the World Bank region on an annual basis (1998–2012). Other main data sources: IMF World Economic Outlook and International Labor Organization.	A country that eliminates subsidies to fossil fuels will experience negative short-run impacts, but higher levels of employment, especially among the young in the long term: a 20 US$ cents increase in the diesel retail price for two consecutive periods is found to increase employment as a percentage of working population above 15 years old by 2.2%; and youth labor force participation by 0.86%.

Ouyang and Lin (2014)	Considering the life-cycle external costs, how should China reform fossil-fuel subsidies and reflect the resource cost and environmental cost in energy prices? What are the impacts of increasing renewable energy subsidies and phasing out fossil fuel subsidies on macro-economy and energy system in China?	1. Scenario analysis associated with cost-benefit analysis, with three scenarios: full removal of fossil fuel subsidies, 20% removal or 10% removal. 2. Computable general equilibrium model.	Three main data sources on China: National Development and Reform Commission (2010), CEIC China Database (2010), and European Environment Agency.	1. Scenario 1: If fossil fuel subsidies were eliminated, the negative impacts on employment is a decrease of 4.027%. Scenario 2: If fossil fuels are removed at the rate of 20%, employment decreases of 0.795%. Scenario 3: if subsidies to fossil fuel consumption were removed at the rate of 10%, employment decreases of 0.393%. 2. If subsidies for renewable energy were increased, employment would be increased by 0.006–0.040% in 2010.
Ovadia (2022)	How can we consider gender equity or female empowerment in local contents laws and regulations for the extractive industries?	Review of the literature and of existing survey.	Study on Tanzania gas industry. Secondary data, notably: 2014 ILFS survey Voluntary Service Overseas, the Vocational Education 2016 and Training Authority of Tanzania, etc.	1. Formal employment in oil extraction is traditionally male-dominated (over 80 percent male) and this sector has negative impacts affecting women's vulnerability. 2. The government must pursue a holistic approach to gender equality in legislation, regulation, policy, education and training in order to maximize the benefit from extractive industries and petro-development.
Özkaynak (2008)	How to improve small to medium-sized city planning and governance in a globalizing world?	1. Scenario approach to assess socioeconomic and environmental implications 2. Literature review and secondary data	Study on the Province of Yalova, Türkiye. Secondary Data from the State Institute for Statistics in Türkiye and the UNDP	1. In the "Yalova within social Europe" scenario, female employment and energy subsidies for renewable energy seem to go hand in hand. 2. In other scenarios, women would face high unemployment rates.
Parrot et al. (2022)	What are the impacts of five different food supply chains on society, economy, and environmental sustainability? How to improve benchmarking of Food Supply Chains in a sustainability framework, targeting of private funding investment, and policy support for sustainable development?	1. Value chain methodology for the economic sustainability. 2. Life cycle assessment for the analysis of environmental sustainability. 3. Scoring approach for social sustainability.	1. Data on five Food Supply Chains competing for mangoes in Burkina Faso. 2. Survey data collected in March and May 2017 on the fiscal year 2016. 3. Many secondary data sources, from which: the EU Delegation, the Urban Community of Banfora, etc.	1. The cost competitiveness of the dried mango export sector is allowed by heavy butane gas that create a lock-in effect in these oven technologies. 2. This Food Supply Chain employs mostly women (5% of the total workforce), who are employed with formal contracts. 3. The wages earned increase women's bargaining position.

Shehabi (2020)	What are the consequences of energy subsidy reform and economic diversification for oil exporters? What are the causes of a weak economic diversification in a MENA country? What are the policy recommendations to solve this issue?	1. An economy-wide, general equilibrium model with oligopolistic industrial structure for an oil dependent country. 2. Two scenarios simulated, both in a low oil price environment: - Energy subsidy reform alone - Energy subsidy reform accompanied by reforms that promote mobility of Kuwaiti nationals from the public to the private sector.	Data on Kuwait: The Kuwait Institute for Scientific Research Kuwait Central Statistical Bureau (2013, 2017), British Petroleum Company (2018), International Monetary Fund (2015) and EIA.	1. Energy subsidy reform: The overall employment level of expatriates increases marginally increasing the country's dependence on international labor mobility. 2. Energy subsidy reform accompanied by competition and labor reform: Despite contraction in the oil industry, mobility of Kuwaiti labor rises and both expatriate (skilled and unskilled) labor, and unskilled Kuwaiti labor increase.

TABLE A1

Systematic literature review results: Studies on the impact of energy subsidies on female employment

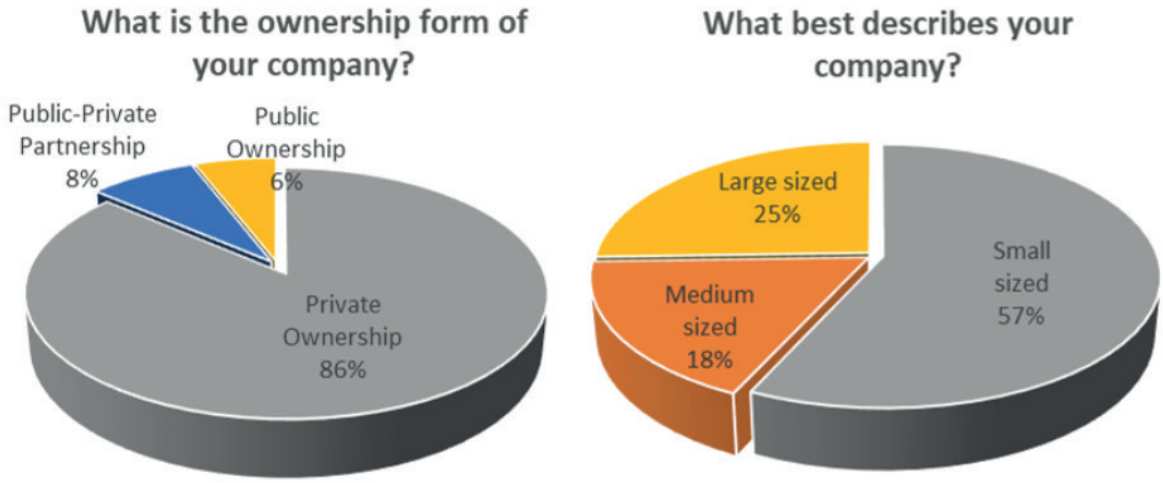

Figure A1. *Survey Results: General Company Information*

	Frequency	Percent
Wind energy	13	25.5
Oil and natural gas	13	25.5
Solar energy	8	15.7
Power generation and distribution	5	9.8
Technology provider	4	7.8
Consulting services	2	3.9
Construction	3	5.8
Law	1	2.0
Trading	1	2.0
Other (energy distribution - natural gas, biomethane, and hydrogen)	1	2.0
Total	**51**	**100.0**

TABLE A2

Frequency Analysis of Sector for Survey Respondents

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CHAPTER 5. FUELING ALGERIA'S FUTURE: MEASURING THE FOOTPRINT OF FOSSIL FUEL SUBSIDIES ON THE NATIONAL DUALITY OF "WATER STRESS-ENERGY CONSUMPTION"

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Low-angle shot of a factory with smoke and steam coming out of chimneys, captured at sunset
Credit : FreePik

In light of the environmental challenges and increasing energy demand in the southern Mediterranean countries, there is a pressing need to evaluate the impact of subsidies on both the environment and socio-economic conditions. This chapter seeks to provide insightful strategies by examining the influence of fossil fuel subsidies on the interplay between water stress and energy consumption in Algeria. Fossil fuel subsidies in Algeria were initially implemented by the government to foster a thriving middle-class society and shield vulnerable populations. Moreover, during the oil crisis, these subsidies proved instrumental in price management and volatility reduction. But over time, their scale and influence expanded. Through a comprehensive model, we highlight the significant implications of government fiscal policies, particularly subsidies on fossil fuel production, on water scarcity and local energy usage. Drawing from robust econometric analysis and empirical evidence, the chapter offers actionable policy recommendations. It advocates for a gradual reduction of fossil fuel subsidies, with a reallocation of resources towards the expansion of renewable energy sources like solar and wind power, which are plentiful in the region. Additionally,it proposes targeted support measures, including direct subsidies for renewable energy access and bolstered social safety nets, to safeguard vulnerable populations during the transition. Emphasizing the need for transparency, the chapter underscores the importance of regular public reporting and stakeholder engagement in the reform process. These recommendations hold relevance for all Mediterranean countries, as the examined situation is reflective of broader regional challenges and opportunities.

1. Introduction

Algeria's fossil fuel-driven political economy has historically navigated a delicate balance between socioeconomic stability and environmental sustainability (Fattouh & El-Katiri, 2012), nurturing the emergence of a thriving middle class and promoting state-driven economic development (Hertog, 2017). Despite challenges (Zeraoulia, 2020), including fluctuations in oil prices, the government has pursued public spending, through several five-year plans, subsidizing fuel and food as the main channels to redistribute wealth and boost economic development (Achy, 2013). However, these subsidies have placed a considerable strain on the government's budget, as domestic prices remained significantly lower than international benchmarks. Additionally, fossil fuel extraction activities have contributed to environmental degradation, especially in areas where underground water resources are being overexploited (Drouiche & Aoudj, 2015). While the interplay between water stress, fossil fuel subsidies, and energy consumption remains understudied in mainstream environmental literature, it is undeniable that these factors are intricately linked and warrant careful consideration in policy formulation. The proposed conceptual framework (Figure 1) illustrates the complex dynamics at play, highlighting the bidirectional causation between fossil fuel subsidies and the dual challenges of water scarcity and energy consumption. There are two key relationships that need to be taken into account.

- **Firstly, the water stress-fossil fuel subsidies relationship:** The relationship between water availability and government support for fossil fuels is multifaceted, often viewed through a social and economic lens. Water stress levels can influence public sentiment, potentially leading to calls for reduced fossil fuel production, which consumes significant quantities of fresh, potable water (Srinivas et al., 2018). This can place additional financial strain on the government if increased water usage necessitates higher operational costs. Conversely, increased financial support for fossil fuels may drive up water usage, exacerbating the strain on non-renewable water resources and necessitating the use of alternative water sources (Cohen et al., 2014). Moreover, extensive fossil fuel extraction, including oil, natural gas, and coal, poses a risk of water pollution in aquifers, threatening ecosystem stability and the well-being of local communities, particularly in arid regions like those found in Algeria.
- **Secondly, the energy consumption-fossil fuel subsidies relationship:** As energy consumption rises, there is a potential strain on the government's budget, leading to increased subsidies on fossil fuels to meet domestic demand. This effort involves maintaining prices below actual international levels, thus creating a disparity between real and domestic prices. Consequently, this situation might mislead the public, including citizens and industries, into perceiving energy as more affordable and readily available at lower prices. However, it is worth noting that fossil fuel subsidies also influence energy consumption levels. The continued subsidization of natural gas, oil, and coal could potentially stimulate energy consumption due to the increased affordability of energy for the public (Victor, 2009).

The established practices mentioned earlier must adapt to the current international economic landscape and consider the environmental degradation aspect (Solarin, 2022). By focusing on Algeria, this chapter aims to address the imperative of assessing the real impact of fossil fuel subsidies on environmental health and the increasing local energy demand. Specifically, our research employs an empirical approach to examine the two-way relationship between water stress, energy consumption, and fossil fuel subsidies, covering oil, natural gas, and coal. It also analyzes their effects on GDP and inflation. Moreover, the chapter explores the consequences of a one-standard deviation shock, assessing the impacts of increased subsidies on oil, natural gas, and coal on water stress levels and energy consumption. Importantly, this research represents a pioneering effort in utilizing a structural model, particularly SVAR, to simultaneously analyze the intentional policy of subsidizing the fossil fuel sector's impact on environmental degradation (water stress) and energy consumption, alongside various other macro variables.

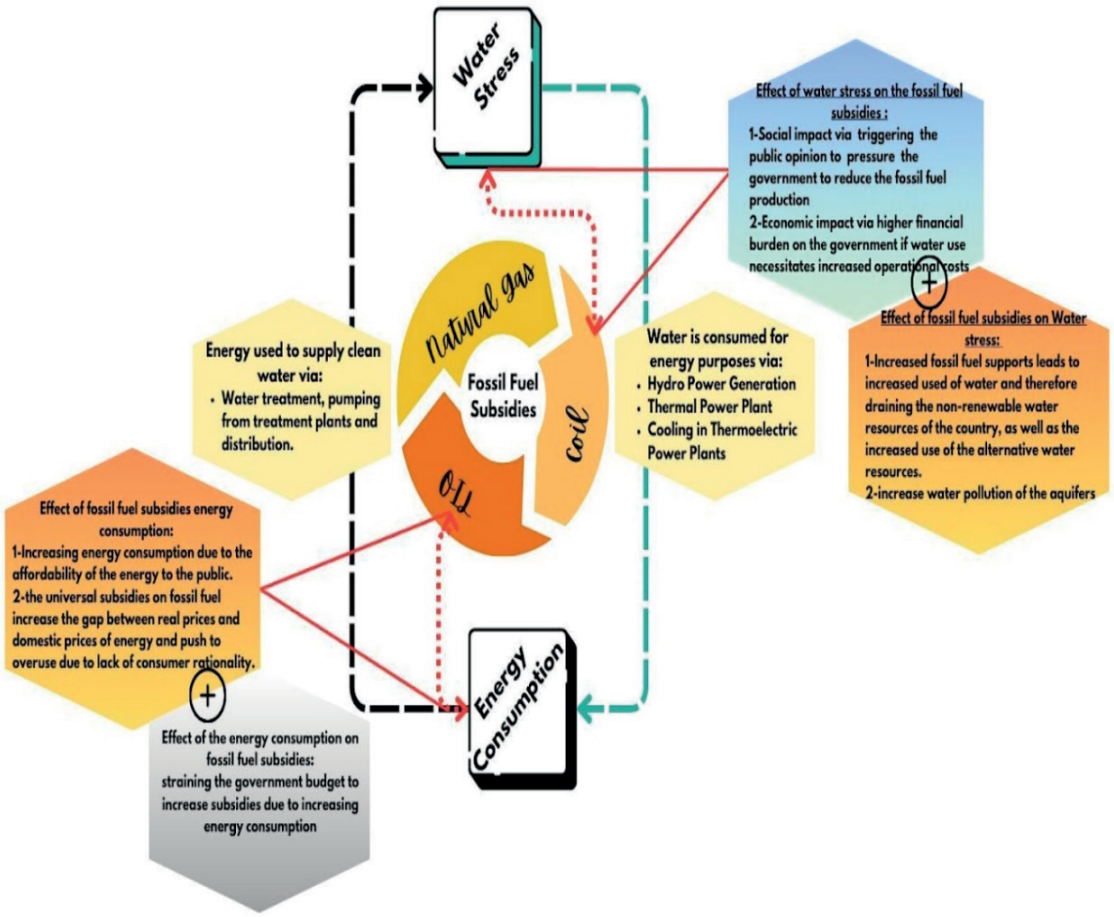

Figure 1. *Conceptualizing the interconnectedness between water-energy-fossil fuel*
Source : Own Production

2. Literature review on Detrimental Subsidies, Environmental Impact, and Sustainable Resource Management in Global Energy Policies

The increasing necessity to preserve the environment and take actions against global warming, has sparked intense debates among economists, environmental scientists, and policymakers worldwide regarding the issue of detrimental subsidies. The mainstream literature extensively investigates the mutual effect of the energy sector, fossil fuel, harmful subsidies, and the degradation of the environment (Espa & Rolland, 2015; Hadian & Madani, 2013; Martins et al., 2018; Merrill, 2015; Nair & Timms, 2020). Subsidies can be categorized into pre- and post-taxes support from governments. Pre-tax subsidies occur when consumers pay prices below the international price of energy products,


Coastal landscape of rocks and sea
Credit : FreePik

while post-tax subsidies involve the combination of pre-tax and tax subsidies. Tax subsidies occur when the tax imposed on these products is lower than that on other consumable products (Black et al., 2023).In their study, Zhou et al. (2016) utilized a general equilibrium model to examine the impact of fiscal policies in China on the water and energy sectors, revealing a spillover effect on both. They suggested that such policies could lead to improvements in the energy structure, reducing reliance on fossil fuels and promoting sustainable energy sources. Similarly, Haidan and Madani (2013) conducted an assessment of the current and projected global energy policies to determine their water footprint. Their findings indicated that the global water requirements for energy production are expected to surge by 37%–66% over the next two decades.

In Australia, Nair and Timms (2020) investigated the freshwater footprint of fossil fuel supply and electricity production, finding that coal production accounted for 85% of total freshwater withdrawal and consumption. They also observed high water stress levels in regions hosting energy plants.

Examining the energy-water-food nexus in Algeria, Drouich and Aouij (2015) emphasized the urgent need for integrated resource management across all three sectors. They highlighted the importance of adopting a holistic approach to natural resource management. Additionally, Kelly et al. (2019) argued that subsidizing fossil fuels diverts resources away from cleaner energy investments, hindering sustainable development efforts.

3.Data and methodology for analyzing the Interconnected Dynamics of Energy, Water, and Fossil Fuel Subsidies

The study aims to analyze the interconnectedness of fossil fuel subsidies, water stress, energy consumption, GDP, and inflation in Algeria, given the pressing issues of water stress, extensive fuel industry, and rising energy demand in the region (Belaïd & Zrelli, 2019; Drouiche & Aoudj, 2015; Lacheheb & Sirag, 2019; Merrill, 2015; Nair & Timms, 2020; Rahmane et al., 2021; Solarin, 2022; Zahraoui et al., 2021). To achieve this, the chapter employs a Structural Vector Auto-Regressive model, which is well-suited for examining causal relationships among variables, alongside impulse response functions to track the propagation of shocks over time. The analysis also incorporates long-term constraints using Blanchard and Quah long-run restrictions for robust policy implications. Data spanning from 2000Q1 to 2022Q4 is sourced from reputable international databases such as the World Bank, FRED, the International Energy Agency, and Statista, with variable descriptions provided in Table 1. Meanwhile, a technical description of our model is provided in Box 1.

Abbreviation	Variable	Description
FFS	Fossil Fuel Subsidies	Financial contributions by a government or agent that benefit recipients in the fossil fuel sector, including oil, gas, and electricity (Walsh & Boys, 2020).
WS	Water Stress Index	Assessment of a nation's renewable water supply's ability to meet all water needs for its population, including drinking and hygiene services (Gleick, 1996).
EC	Energy Consumption	Total energy use in a specific country over a specified period, encompassing electricity, transportation, heating, and cooking.
GDP	Economic Growth Rate	Annual mean rate of change of a country's Gross Domestic Product (GDP) at market prices over a specified period.
INF	Inflation Rate	Percentage increase in prices within a nation over a specified period of time.

TABLE 1
Variables description
Source: Authors' own.

Box 1

Modeling the Energy-Water-Fossil Fuel Subsidies Nexus

The vector of the variables is given as follows:

Xt=(FFS,WS,EC,GDP,INF)...(1)

We use Blanchard and Quah (1988) identification method, imposing restriction on the long run specification of the accumulated impulse response function, which can be represented as:

$$\varepsilon_t = \varepsilon^{FFS}, \varepsilon^{WS}, \varepsilon^{EC}, \varepsilon^{GDP}, \varepsilon^{INF} \ldots(2)$$

Where, FFS,WS,EC,GDP,INF are the impulse of fossil fuel subsidies including oil, natural gas and coil, water stress index, energy consumption, economic growth, and inflation, respectively. Applying Blanchard and Quah restriction to equation (1) we can specify the orthogonal matrix as :

FFS WS EC GDP INF =F11(L) F12(L) F13(L) F14(L) F15(L) F21(L) F22(L) F23(L) F24(L) F25(L) F31(L) F32(L) F33(L) F34(L) F35(L) F41(L) F42(L) F43(L) F44(L) F45(L) F51(L) F52(L) F53(L) F54(L) F55(L) FFS WS EC GDP INF ...(3)

Note that in equation (3) the arrangement of variables follows established literature, theories, and the researchers' assumptions. Consequently, we assume that the shocks related to fossil fuel subsidies (FFS) have a significant impact on other variables; however, the reverse is not posited. The reason behind such constraint is to isolate the effect of the redistributive wealth policy implemented by the Algerian government to make an informed analysis for decision-makers, to evaluate the effect of such fiscal policy on the other variables involved in the study with a special interest on the water stress-energy consumption duality. From equation (3) we have the long-term matrix F(L) denoted by:

$$F(L) = \sum_{j=0}^{\infty} F_j(L)$$

Using the restriction of the long term specification, equation (3) can be rewritten as follows (Blanchard & Quah, 1988):

FFS WS EC GDP INF =F11(L) 0 0 0 0 F21(L) F22(L) 0 0 0 F31(L) F32(L) F33(L) 0 0 F41(L) F42(L) F43(L) F44(L) 0 F51(L) F52(L) F53(L) F54(L) F55(L) FFS WS EC GDP INF ...(4)

In addition, we use the Granger Causality test, a statistical means used to determine if one time series can be considered as causing another, to analyze the nature of the relationship between pairs of our variables, we can therefore highlight the presence of a one way or a bi-directional causation between our variables.

While the VAR model offers a robust framework for analyzing interdependencies and forecasting the impacts of policy changes, it is crucial to recognize its limitations. Such models assume that the variables analyzed are static and predetermined, and their current values are influenced solely by their own historical values. However, these assumptions may introduce biases, particularly given the dynamic and interdependent nature of energy-water interplay. In fact, shifts in water stress levels and energy consumption patterns may simultaneously influence changes in fossil fuel subsidies, leading to simultaneity in the relationships. To address this issue, our analysis incorporates lagged variables into the VAR model, aiming to reduce endogeneity and capture the delayed effects of policy changes and environmental stressors on the energy-water nexus.

Additionally, the complexity of SVAR models, which require many parameters, can make the estimates less certain. This aspect is important as we are trying to explore how fossil fuel subsidies affect water stress and energy consumption in Algeria. Krolzig (2003) recognizes these issues and suggests a way to choose the best model to improve accuracy. Ludvigson (2017) emphasizes the need to ensure that the effects we see in the model align with real-world economic events. This is crucial to link changes in policies to actual outcomes in water and energy management in Algeria.
Furthermore, the adequacy of our sample is crucial to consider. While we examine a period characterized by notable shifts in global oil prices, changes in domestic energy subsidy policies, and fluctuating levels of water stress due to climatic factors, it may not fully encompass long-term trends. Recognizing this limitation, our analysis underscores the importance of continued research to refine our findings in response to evolving circumstances.

Figure (2) illustrates the detailed steps involved in the estimation process for the Structural Vector Autoregressive (SVAR) model.

Figure 2. *Estimation process and analysis flow*
Source : Own Production

4. Empirical results

We are focused on unravelling the intricate repercussions of FFS on the interplay between water-energy dynamics and various macroeconomic indicators. The findings of this investigation are presented in a specific sequence, succinctly summarized in Figure 03.

- First, the correlation matrix, detailed in Table 1 in the appendix, reveals several significant relationships between key variables. It reports a positive correlation of 0.36 between fossil fuel subsidies (FFS) and water stress, indicating that **as subsidies increase, water stress tends to rise.** In addition, the correlation between FFS and energy consumption is also positive at 0.31 and exhibits positive correlations with both GDP and inflation. Furthermore, there is a strong positive correlation between water stress and energy consumption, implying a **direct relationship between heightened water stress and increased energy usage.**
- Secondly, in econometrics, it is important for variables to be stable over time to get accurate results. We test for this and find that all our variables (FFS, WS, EC, and GDP) show patterns that change over time, so we need to make adjustments to make them stable[144]. However, inflation stays consistent and does not need adjustments (Table 02; Appendix).
- To understand how fossil fuel subsidies impact different aspects of the economy, we use a SVAR model. But before doing so, we employ a simpler model (VAR), where we figure out how far back we need to look at past data to predict future outcomes. This initial step involves determining appropriate "lag lengths"[145] (see Tables 3 and 4 in the appendix). Then, we add a series of constraints to help us interpret the results better. The «A» matrix shows us the immediate effects of changes, such as if a sudden rise in water stress makes fossil fuel subsidies drop right away (a negative coefficient in the second row) showing how sensitive subsidies are to environmental factors (Narayan, 2013). Meanwhile, the «B» matrix tells us about the longer-term effects of these changes, showing how they continue to influence things over time (Adesete & Bankole, 2020). This helps us see how different factors like subsidies, water stress, energy use, economic growth, and inflation all interact with each other. By looking at both matrices, we get a clearer picture of how everything works together (check Table 5 in the appendix for details).
- Following this analysis, we use Impulse Response Functions (IRFs) to understand how different factors in the system react to sudden changes. For instance, if there is a sudden increase in fossil fuel subsidies. IRFs can help us see how this change affects water stress, energy use, economic growth, and inflation over time.

4.1. The response to fuel fossil subsidies (FFS)

Figure 03 shows the path of the variables following an unexpected shock in FFS. In response to fossil fuel subsidies (FFS), several trends emerge. Firstly, an increase in FFS correlates with higher water stress levels over ten quarters, peaking at 0.75 (see Table 06 in the appendix). This

144 One of the main conditions in econometrics is stationarity in order to provide reliable results. Thus, to assess the stationarity properties of the variables under study, we have used the Augmented Dickey-Fuller (ADF) test which is commonly used in the literature. This test aims to determine whether a variable follows a unit root process, indicating its stationarity or non-stationarity (Paparoditis & Politis, 2018). The results indicate that all variables, including FFS, WS, EC, and GDP, exhibit a unit root and are integrated of first order. This suggests that in order to achieve stationarity, their initial differences must be calculated. Nevertheless, inflation remains constant at a certain level and does not necessitate the process of differencing.

145 Selecting an appropriate lag length is crucial for VAR and SVAR models as it determines how far back in time the model looks to capture the temporal dynamics and dependencies among variables. Choosing an inadequate lag length can result in omitted dynamics or unnecessary complexity, leading to biased parameter estimates and inefficient forecasts.

suggests **a potential trade-off between economic activities related to fossil fuel production and environmental impacts.** Additionally, there is a positive response of energy consumption (varies between 0.04 and 0.08) to FFS shock suggesting a **clear relation between the level of subsidies and local energy consumption patterns.** This positive impact is observed in the short-term economic growth, confirmed by the expansion of GDP following a shock in fossil fuel subsidies (FFS). This relationship aligns with economic theories where **greater availability and affordability of energy resources can stimulate economic activities and production.** Moreover, after a shock in fossil fuel subsidies, inflation rates rise to a level of 0.73. This increase suggests **that as fossil fuel subsidies rise, they tend to push up the overall price levels.**

4.2. The response to water stress shock

There is a complex interplay between water stress and economic dynamics. Figure 04 displays the response to a water stress shock, showcasing a notable increase in fossil fuel subsidies (FFS) peaking in the seventh quarter (refer to Table 07 in the appendix). This suggests that adjustments in subsidies are influenced by considerations of water stress. Initially, there is a negative response of energy consumption to the water stress shock, indicating a conservation effect in the short run. However, this trend shifts to a positive trajectory over time, emphasizing the importance of sustainable energy practices. Despite an initial decrease, GDP demonstrates resilience by rebounding positively through the sixth quarter, reaching 0.51. Additionally, inflation's response varies, initially declining before turning positive and peaking at 0.38 in the seventh quarter. These fluctuations signal emerging inflationary pressures in response to high water stress, highlighting the need for careful economic management.

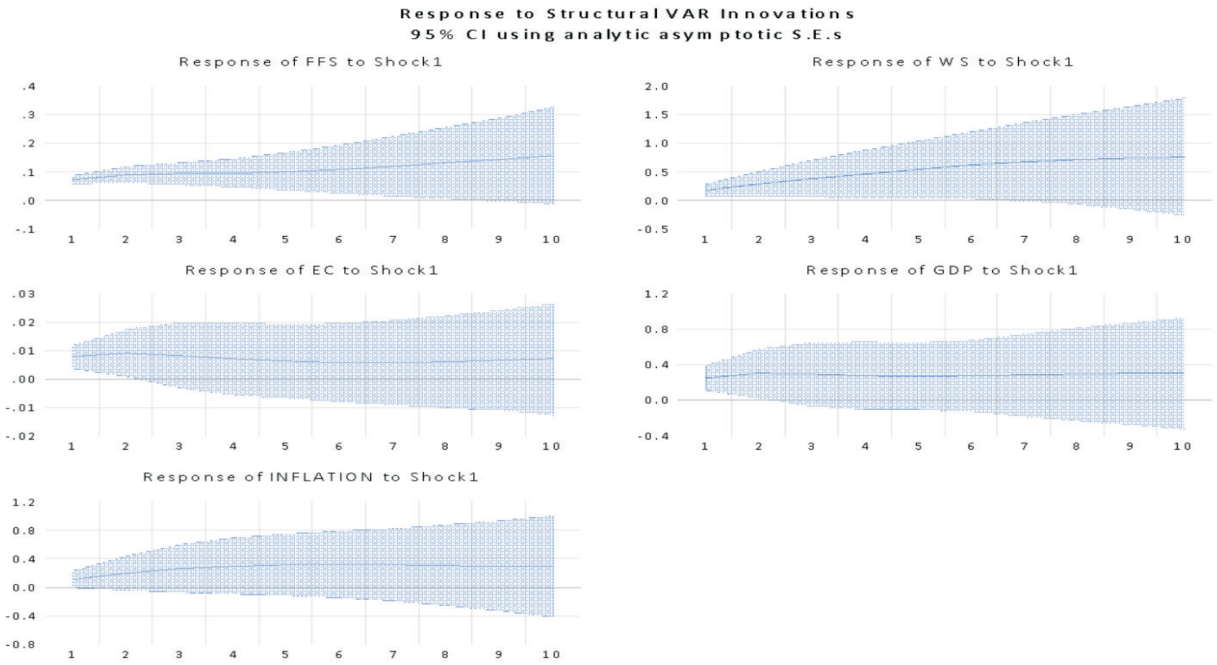

Figure 3. *FFS structural impulse responses*
Source: Authors calculations (e-views software outputs)

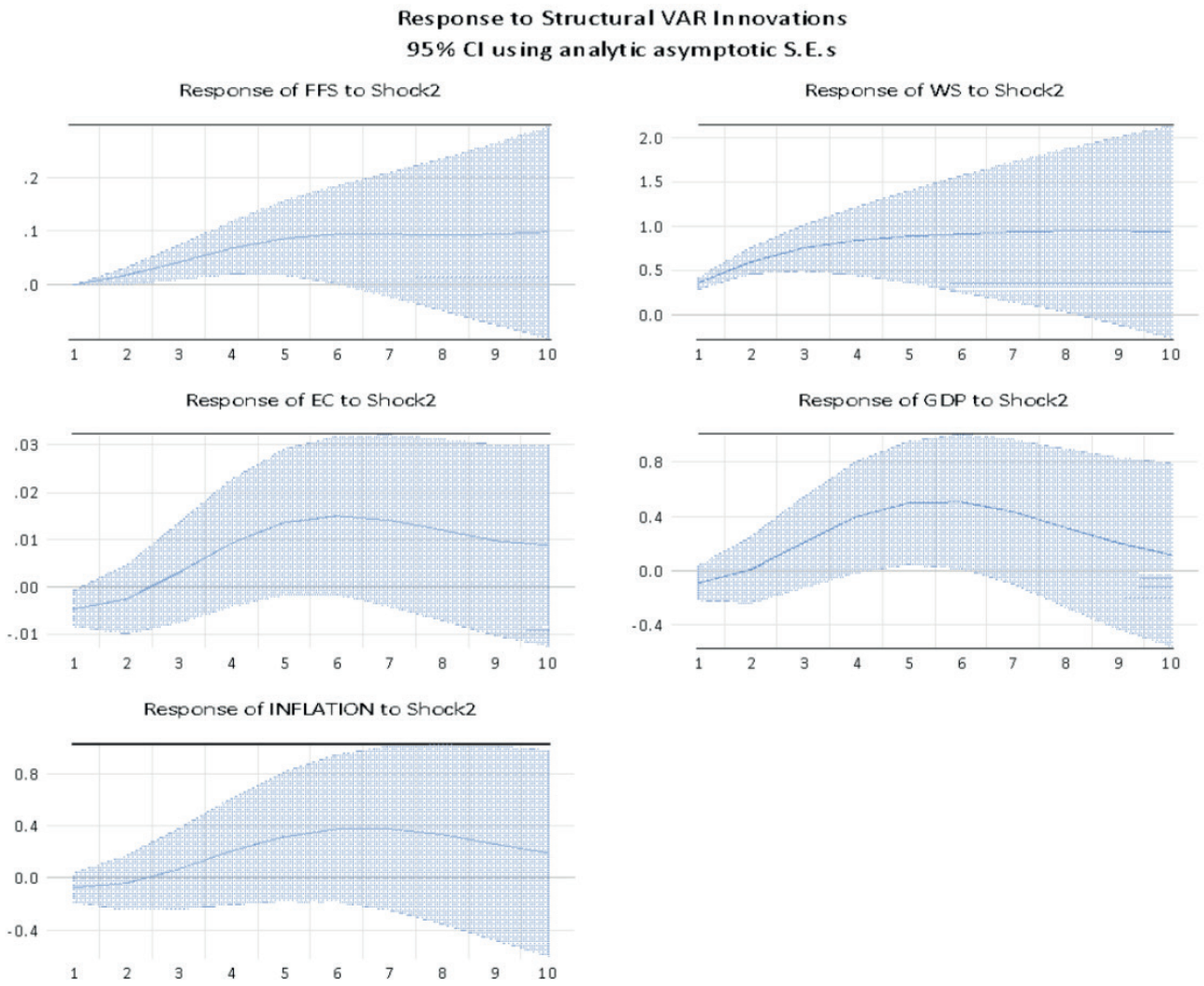

Figure 4. *Water stress response*
Source: Authors calculations (e-views software outputs)

4.3. The response to energy consumption

Increased energy consumption may cause inflation at first, but other factors or policies probably help reduce this impact over time. The impulse responses to an energy consumption (EC) shock in Algeria highlighted in figure 05, suggests a multifaceted relationship with various economic indicators under study. Initially, our analysis reveals a dynamic interaction between energy consumption and subsidy policies in Algeria. The results, shown in Table 08 in the appendix, indicate that fossil fuel subsidies (FFS) initially respond positively, peaking at 0.06 in the first two quarters. This suggests that an increase in energy consumption typically leads to higher fuel subsidies. However, subsidies decrease to -0.17 by the tenth quarter, reflecting a potential policy adjustment aimed at reducing these subsidies. Additionally, water stress showed a sustained positive response to EC shock suggesting a consistent and cascading effect of changes in energy consumption on water stress in Algeria. For example, fossil fuel-based energy production often requires significant water resources for extraction, processing, and cooling. (Nair

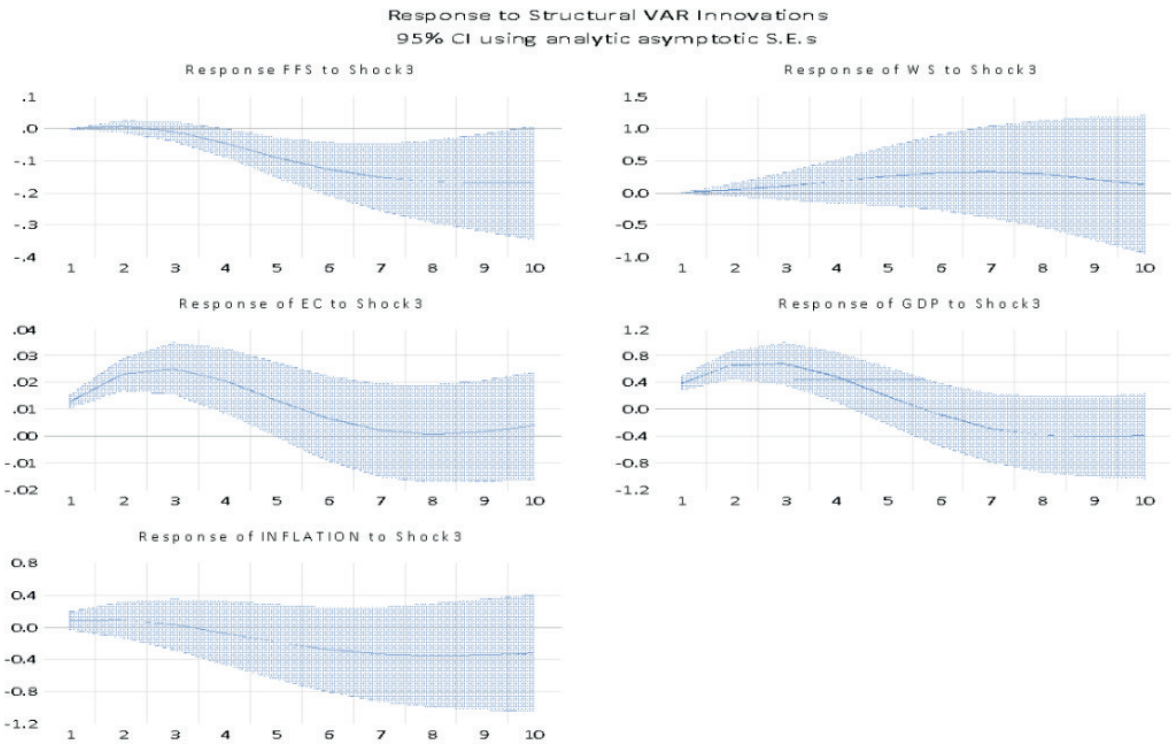

Figure 5. *Response to EC shock*
Source: Authors calculations (e-views software outputs)

& Timms, 2020). The positive response of GDP to energy use reaching the value 0.68 in the third quarter, indicates that an increase in energy consumption contributes to the economic activity positively. However, the subsequent negative drift starting from the sixth quarter implies a reversal impact with a notable decline to -0.36. This decline could be attributed to a combination of factors, including improvements in energy efficiency, technological advancements, and broader energy transition efforts. Alongside, due to high energy demand, inflation initially increases during the first three quarters. It then shifts to a negative trend continuing through to the tenth quarter. This pattern suggests that while increased energy consumption may initially drive inflationary pressures, subsequent factors or policy interventions likely mitigate these effects.

Finally, in order to complement the results, the granger causality test was conducted. By assessing the wald test[146] we can determine whether one variable can be said to Granger-cause another variable or not (Shukur & Mantalos, 2000). Results presented in (table 09; appendix) underscores several key findings for policymakers. Firstly, there's a bidirectional relationship between both water stress and FFS, as well as between energy consumption and FFS, indicating that changes in these environmental and economic factors influence each other. Additionally, there's mutual causality between water stress and Gross Domestic Product (GDP), suggesting that fluctuations in water stress levels can affect economic output and vice versa. However, no significant relationship was found between inflation and the other variables under study.

146 The Wald test (also called the Wald Chi-Squared Test) is a way to find out if explanatory variables in a model are significant.

Variable	Shock	Response	Significance
Water Stress	FFS Shock	Positive	Indicates environmental trade-offs
Energy Consumption	FFS Shock	Positive	Linked to subsidy level, promotes short-term economic growth
Inflation	FFS Shock	Positive	Expansion due to increased energy affordability
GDP	FFS Shock	Positive	Reflects inflationary pressures from higher subsidies
FFS	Water Stress Shock	Positive	Subsidy adjustments in response to water stress
Energy Consumption	Water Stress Shock	Mixed	Shows initial conservation effect, diminishing over time
GDP	Water Stress Shock	Mixed	Indicates economic resilience and recovery
Inflation	Water Stress Shock	Mixed	Inflationary pressures emerge with high water stress
FFS	EC Shock	Mixed	Initial increase followed by policy adjustment to reduce subsidies
Water Stress	EC Shock	Positive	Increased energy use impacts water resources
GDP	EC Shock	Mixed	Initial boost in economic activity, followed by decline
Inflation	EC Shock	Mixed	Initial inflationary pressures followed by mitigation

TABLE 2

Results summary

Souce : Author's production

These insights emphasize the importance of considering environmental factors such as water stress alongside economic indicators in policymaking to promote sustainable development and economic resilience.

In conclusion, the findings illustrate a range of effects on different economic variables, as outlined in Table 02.

The responses to fossil fuel subsidy (FFS) shocks demonstrate a complex environmental and economic interplay, where increased subsidies lead to greater energy consumption, boosting economic activities but also exacerbating water stress and inflation. Additionally, while the economy shows resilience to water stress, the resulting inflationary pressures require vigilant management. Conversely, reducing FFS could lead to several beneficial effects. Their decrease may result in reduced energy consumption as fossil fuels become costlier, which can alleviate water stress due to lower demand for water-intensive energy processes. Economically, while a reduction in FFS might initially slow-down economic growth due to higher energy costs impacting industrial activities and consumer spending, it could lead to healthier economic conditions over the long term. This shift could allow for reallocating funds from subsidies to more productive investments, supporting sustainable economic development and reducing dependency on fossil fuels. Moreover, the reduction of FFS is likely to mitigate the inflationary pressures seen when subsidies are high, as less government expenditure on subsidies can help stabilize national budgets and reduce inflation linked to the overconsumption of cheap energy.

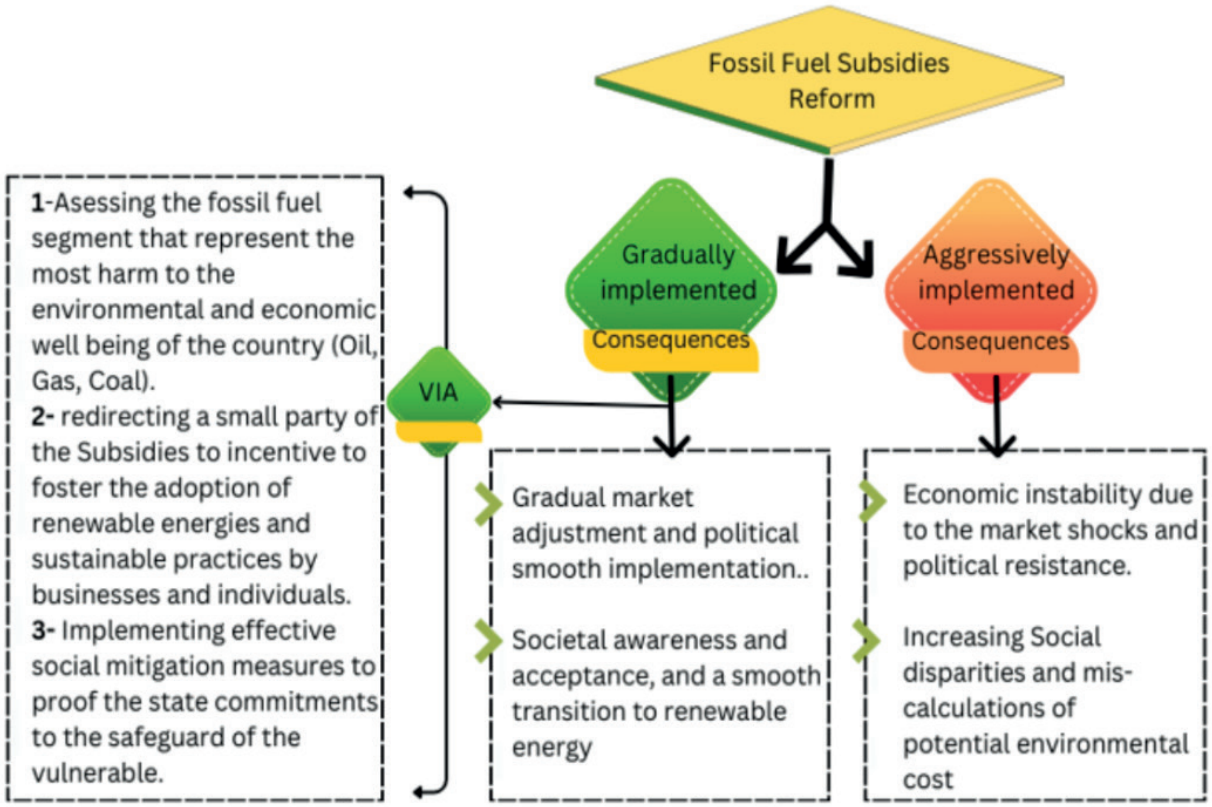

Figure 6. *Fossil fuel subsidies reform implementation*
Source: Author's production

5. Discussion and policy implications

As is the case with other countries faced with similar challenges, fossil fuel subsidies in Algeria were initially implemented by the government to foster a thriving middle-class society and shield vulnerable populations. Moreover, during the oil crisis, these subsidies proved instrumental in price management and volatility reduction. But over time, the scale and influence of fossil-fuel subsidies have expanded (Inchauste & Victor, 2017).

Consistent with what the existing literature states, we see how fossil fuel subsidies exert a notable influence on both energy consumption and water stress, posing detrimental effects. These subsidies, which lower the prices of fossil fuels like oil, coal, gas, and electricity, tend to encourage their excessive and inefficient use. Given that the energy sector is a major consumer of freshwater, employing water-intensive cooling systems and relying heavily on hydropower, heightened fossil fuel consumption exacerbates water stress. Moreover, increased consumption of fossil fuels contributes to elevated greenhouse gas emissions, exacerbating climate change and further impacting water resources negatively. These findings align with previous studies by Bélaïd & Youssef (2017) and Bouznit & Pablo-Romero (2016), which underscored the adverse environmental effects of non-renewable electricity consumption. Consequently, while defining energy subsidies precisely can be challenging, they typically encompass governmental measures aimed at reducing the energy costs borne by end consumers (Breton & Mirzapour, 2016).

In Figure (06) we illustrate a visual representation of suggested reforms, relevant not only for Algeria but for other Mediterranean countries as well, for a successful and smooth transition away from fossil fuel subsidies.

This figure illustrates two possible strategies for reforming fossil fuel subsidies: gradual and aggressive approaches. The gradual approach involves step-by-step measures like assessing harmful energy sectors, redirecting subsidies to promote renewable energy adoption, and implementing social measures to safeguard vulnerable populations. This method facilitates a smooth transition to renewables, with steady market and political adjustments and societal acceptance. On the other hand, aggressive reform may lead to economic shocks, political resistance, heightened social inequality, and underestimated environmental costs. This

highlights a potential trade-off between the speed of reform and its broader societal consequences. Overall :

- **Gradually reducing support for energy prices, while simultaneously implementing other forms of social welfare programs, could enhance public trust and flexibility towards such changes.** It is crucial for authorities to remain committed to adaptability and continue scheduled programs aimed at protecting the needy. In the Mediterranean region and beyond, lessons can be learned from successful acts of gradual energy price reform, coupled with robust social welfare support (Sobok, 2020). Spain has implemented various energy reforms aimed at sustainability while offering subsidies for vulnerable populations to afford renewable energy solutions, ensuring social protection amid economic change (Spain 2023 country report). Similarly, the Mexican government gradually reduced subsidies on gasoline and diesel, accompanied by increased social spending in healthcare and education to protect vulnerable populations from the effects of rising fuel prices. Additionally, Mexico introduced a carbon tax in 2014 to drive a shift towards cleaner energy use, indicating a combined approach between environmental and fiscal policy (Arlinghaus & Van Dender, 2017). Facing significant fiscal burdens due to extensive fuel subsidies, Indonesia initiated a reform process in 2015 by reducing subsidies and redirecting funds towards infrastructure development and direct cash transfers to the poorest households (Chelminski, 2018). This approach not only alleviated short-term economic shocks caused by higher fuel costs but also improved public transportation, benefiting the wider population. Mediterranean countries, more broadly, can draw from these experiences by integrating subsidy cuts with enhanced social welfare mechanisms. Implementing Spain's model, targeting subsidies for renewable energy, can make sustainable energy solutions more accessible while protecting vulnerable groups. Additionally, Mediterranean governments could implement direct cash transfers to compensate low-income families for increased energy costs, similar to Indonesia's strategy. Finally, to mitigate economic impacts and prepare the workforce for new opportunities in the green sector, they could subsidize access to renewable energy installation for vulnerable households, expand social welfare programs, and introduce job training. These examples demonstrate that with a carefully tailored strategy considering both international standards and specific national characteristics, countries can effectively balance economic reforms with the need to protect economically vulnerable groups (Van de Graaf & Blondeel, 2018).
- **Addressing fuel subsidies toward alternative sources is crucial to mitigate the environmental impact of FFS on water resources.** Promoting the adoption of renewable energy sources like solar and wind power is essential. These sources generate fewer greenhouse gas emissions and use less water compared to traditional fossil fuel power sources. One technology should not be considered inherently superior to another, rather, each technology must continuously strive to become more sustainable, so we can ensure a holistic approach to addressing environmental challenges and advancing towards a more resilient energy future. In Algeria, the Hassi Rmel solar power plant in 2011 serves as a prime example, highlighting the significance of investing in innovative and eco-friendly initiatives for a more sustainable energy landscape in Algeria (Haddad et al., 2017). Algeria has ambitious plans to install 15,000 megawatts (MW) of photovoltaic solar energy by 2035, along with 2,000 MW of concentrated thermodynamic solar energy by 2030 (IEF, 2021). Additionally, the country is part of the Desertec[147] Industrial Initiative, aiming to harness solar and wind power to supply 15 percent of Europe's electricity needs by 2050 (Anyu, 2017). This initiative not only capitalizes on the renewable energy potential of sun-rich and wind-abundant areas in North Africa but also fosters economic and energy cooperation between Europe and North African countries.

Overall, to ensure a successful transition to renewable energy, it is important to have

147 The Desertec Industrial Initiative is a collaborative project involving several countries and corporations, with the goal of harnessing the vast renewable energy resources of the Sahara Desert—specifically solar and wind power—to generate electricity. Algeria, due to its significant solar and wind potential, is a key participant in this initiative.

a multifaceted strategy that encompasses government initiatives and incentives for private investment. The Algerian government has started implementing initiatives to stimulate private sector investment in renewable energy, including grants for research and development, low-interest loans through collaborations with international financial institutions, and favorable feed-in tariffs to ensure higher returns on renewable energy production (Anyu, 2017). These measures aim to encourage private-sector development in renewable energy by addressing market imperfections, reducing transaction costs for investors, and promoting a level playing field for renewable technologies. Regulatory incentives, such as policies improving the business environment and market liberalization, can also support private investment in renewable energy. Fiscal incentives, such as easing the tax burden on investing companies or their employees and offering tax exemptions, can further stimulate investment. Market-based incentives, such as Tradable Green Certificates or Carbon credits, can encourage market actors to use or produce a share of electricity from renewable energy sources. Table (03) presents a strategic framework that details various approaches for fostering the adoption of renewable energy in Algeria.

However, the transition to renewable energy presents a delicate balancing act for policymakers, considering both the promise of environmental benefits and the risk of negative externalities such as; environmental damage from the extraction of raw materials needed for technology production, habitat disruption due to large-scale installations, and social challenges including job losses in traditional energy sectors. (Osman et al., 2024). Several successful renewable energy initiatives in the region and beyond offer valuable insights. Tunisia's Nawara Gas Field, while primarily a gas project, incorporates energy-efficient technologies to reduce environmental impact. Egypt's Benban Solar Park, one of the world's largest solar installations, exemplifies large-scale solar energy development with minimal water use. Jordan's Shams Ma'an Solar PV Plant is part of a national strategy to increase renewable energy contributions, utilizing the abundant solar resources of desert areas. Morocco's Tarfaya Wind Farm, one of Africa's largest wind farms, demonstrates the potential of wind energy in the region. These projects collectively showcase the diverse potential for renewable energy development in the Southern Mediterranean, offering models to reduce reliance on fossil fuels and promote environmental sustainability.

In addition, renewable energy can foster economic integration between Mediterranean countries through joint ventures, shared technology, and cross-border energy trade. This could lead to greater economic stability and open up new markets, enhancing the economic prospects of the region.

- **Implementing subsidy cuts shall be accompanied by measures to protect low-income households and vulnerable populations.** This gradual reduction in fossil fuel subsidies ensures fiscal responsibility while maintaining social equality (Rentschler & Bazilian, 2017). Effective subsidy reforms require careful planning, including sequenced policy measures and social protection mechanisms. Income-based subsidy programs, coupled with robust social safety nets, can shield vulnerable groups from the immediate impacts of subsidy reduction, facilitating a fair energy transition. For instance, Egypt's 'Takaful and Karama' programs, initiated alongside subsidy reforms in 2014, provide financial assistance to low-income families to offset the increased cost of living resulting from subsidy reductions (Breisinger et al., 2019). **Ensuring transparency and public participation** is critical to gaining broad support for these measures. This can be achieved through various means such as publishing detailed reports on subsidy usage and reductions, conducting public consultations, and involving community leaders in decision-making processes. These steps not only enhance the legitimacy of reforms but also address public concerns effectively. Several economies have successfully implemented such reforms, offering strategies that could be adapted by Mediterranean governments. Norway, for instance, has set a standard in transparency **by publishing annual environmental data and financial reports related to energy subsidies,** which has helped maintain public trust and support for environmental policies, New Zealand implemented extensive public consultation processes before making

Strategy Category	Detailed Strategies for Renewable Energy Adoption in Algeria
Government Investment	Develop infrastructure for solar and wind projects, particularly in high potential areas.
Financial Incentives	Provide tax breaks, subsidies, and feed-in tariffs for private sector renewable energy investments
Public-Private Partnerships	Implement PPPs to leverage private sector efficiency in large-scale renewable projects.
Research & Development	Allocate government grants for R&D and establish partnerships with academic institutions and private entities.
Capacity Building	Invest in training programs and technical education to build a skilled workforce in the renewable sector.
Regulatory Frameworks	Set clear energy production, consumption, and pricing guidelines, along with environmental standards for projects.
Energy Market Liberalization	Encourage competition by reducing state monopolies and welcoming private entities into the market.
International Partnerships	Form alliances with international organizations and countries to access additional funding, expertise, and technology.

TABLE 3

Strategic framework for renewable energy adoption in Algeria

Souce : Author's production

significant changes to its energy policies, which included reforms in subsidy structures. These consultations helped the government understand public sentiment and refine their approach to better meet the needs of the population (Energy Policy Review, 2023). Germany, during the 'Energiewende,' (Germany's energy transition program), engaged local leaders in discussions about renewable energy subsidies and reductions in fossil fuel subsidies, the program not only gained substantial public support but also facilitated smoother implementation at the community level (Vidican Auktor & Loewe, 2022). Indonesia in 2015 moved from a longstanding policy of substantial fuel subsidies to a more manageable system tied to international oil prices, which significantly reduced the fiscal burden of subsidies (ADB,2015). The Indonesian government improved transparency **by openly discussing the costs of subsidies in the national budget and engaging in a public dialogue through various media to explain the benefits of reform,** such as more available funds for infrastructure and social programs. Public acceptance was facilitated through targeted cash transfers to the poorest households, helping to cushion the effects of increased fuel prices.

- **Strengthening Regional Partnerships for Renewable Energy :** Collaborating with leaders in renewable energy technology, such as Spain and Italy, could accelerate the adoption of advanced renewable technologies across the region. Moreover, capacity-building programs with educational institutions throughout the region could help develop a skilled renewable energy workforce. These initiatives provide platforms for collaboration on energy projects, policy harmonization, and investment opportunities, crucial for developing robust renewable energy infrastructure. Additionally, engaging with international organizations like the International Renewable Energy Agency (IRENA) and the World Bank can provide technical and financial assistance, aiding Mediterreanean countries in maximizing the socioeconomic benefits of renewable energy adoption.
- **Collaborative regional strategies could harness shared opportunities while accounting for individual country contexts.** Unfortunately, the region faces increasing water scarcity exacerbated by energy consumption, driven in part by fossil fuel subsidies (El-Katiri & Fattouh, 2017) that distort the true value of energy, leading

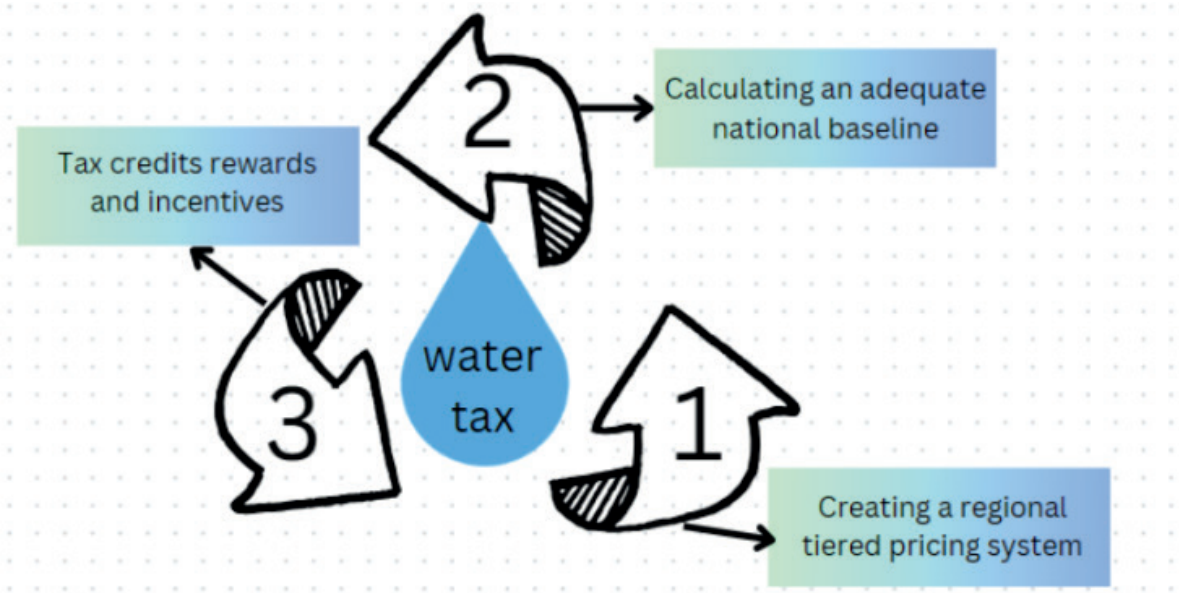

Figure 7. *Implementation of tiered pricing system in the southern Mediterranean region*
Source: Author's production

to overconsumption. To mitigate these effects, incentives for businesses to adopt water-efficient technologies, alongside taxation for excessive water use, could be instrumental (Mysiak & Gómez, 2015). For instance, the success of water-saving projects in Zaragosa, Spain, demonstrates the efficacy of tax incentives and educational campaigns in promoting water conservation (Vollaro et al., 2015). Tax credits for rainwater harvesting structures in the Netherlands further illustrate the potential of financial incentives. Figure 07 depicts the implementation of tiered pricing systems in the southern Mediterranean region, offering a customizable blueprint for policymakers.

These measures could be tailored to suit regional or national requirements, facilitating an adaptable framework. Tax incentives can be integrated into the Mediterranean Strategy for Sustainable Development (MSSD) to promote investments in water-saving technologies. By aligning tax policies with Integrated Water Resources Management (IWRM) principles, governments can incentivize sustainable water practices and foster long-term environmental sustainability. An integrated planning process considering the interplay between water and the energy sector is essential. Policymakers must evaluate the trade-offs between fossil fuel subsidies, water management, and energy consumption, redirecting funds to promote environmental and economic equilibrium.

6. Conclusion

This chapter has examined intricate relationships among fossil fuel subsidies, water stress, and energy consumption. The results highlight the significant impact of fossil fuel subsidies on both environmental and economic dimensions. The positive response of water stress to fossil fuel subsidy shocks underscores the urgent need for sustainable energy policies. Transitioning subsidies towards clean and renewable energies or targeting them exclusively for low-income citizens presents a strategic and forward-thinking policy approach that balances economic and social considerations. This aligns with global trends towards sustainable and eco-friendly energy sources, additionally, to address the inflationary pressures linked to higher fuel subsidies, a strategy could involve gradually reducing subsidies while investing in social safety nets to shield vulnerable populations from immediate price impacts.

The interaction between energy consumption, subsidies, and their effects on GDP and inflation calls for a balanced and informed policymaking approach. To guide policymakers and researchers in advancing the renewable energy agenda in the Mediterranean, several open-ended questions and suggestions for future research are proposed. These inquiries cover various aspects, including the role of renewable energy resources, social mitigation measures, private

sector engagement, international partnerships, public perception, economic opportunities and challenges, data-driven decision-making, lessons from other countries, and the promotion of a sustainability culture among citizens. Addressing these questions can offer valuable insights and strategies for Algeria's transition to a renewable energy-driven economy.

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Appendix

Correlation Probability	FSS	WS	EC	GPD	INFLATION
FSS	1.000000				
WS	0.364272 0.0101	1.000000			
EC	0.317011 0.0265	0.970793 0.0000	1.000000		
GPD	0.227715 0.1156	-0.473464 0.0006	-0.442899 0.0014	1.000000	
INFLATION	0.518181 0.0001	0.064438 0.6600	-0.023726 0.8714	0.453488 0.0011	1.000000

TABLE A1

Correlation matrix

Souce : data processing.

		At Level				
		FFS	WS	EC	GDP	INFLATION
With Constant	t-Statistic	-1.0223	-0.2811	-2.4517	-1.0858	-3.0643
	Prob.	***0.7358***	***0.9198***	***0.1349***	***0.7118***	***0.0363***
		n0	n0	n0	n0	**
With Constant & Trend	t-Statistic	-0.3484	-2.7164	-0.4025	-2.3789	-2.9910
	Prob.	***0.9862***	***0.2350***	***0.9840***	***0.3842***	***0.1455***
		n0	n0	n0	n0	n0
Without Constant & Trend	t-Statistic	0.6770	1.6666	-0.1490	-1.1073	-0.5114
	Prob.	***0.8579***	***0.9752***	***0.6259***	***0.2387***	***0.4897***
		n0	n0	n0	n0	n0
		At First Difference				
		d(FFS)	d(WS)	d(EC)	d(GDP)	d(INFLATION)
With Constant	t-Statistic	0.0026	-1.7992	-0.6418	-1.2705	-2.5687
	Prob.	***0.0031***	***0.0364***	***0.0494***	***0.0335***	***0.1066***
		n0	n0	n0	n0	n0
With Constant & Trend	t-Statistic	-0.8677	-1.7392	-2.4911	-1.3677	-2.6256
	Prob.	***0.0497***	***0.0178***	***0.0305***	***0.8548***	***0.2714***
		n0	n0	n0	n0	n0
Without Constant & Trend	t-Statistic	0.2483	-0.6703	-1.1745	-1.0323	-2.5457

TABLE A2

ADF stationarity test

Souce : data processing.

Lag	LogL	LR	FPE	AIC	SC	HQ
0	-295.9614	NA	0.443399	13.37606	13.57680	13.45090
1	87.73447	665.0729	5.33e-08	-2.565977	-1.361535	-2.116973
2	179.9366	139.3276*	2.81e-09*	-5.552737*	-3.344594*	-4.729564*
3	193.2629	17.17618	5.27e-09	-5.033908	-1.822064	-3.836565
4	222.6953	31.39448	5.44e-09	-5.230900	-1.015354	-3.659387

TABLE A3

Lag length criteria

Souce : data processing.

	FFS	WS	EC	INFLATION	GDP
LOG(FFS(-1))	1.050256 (0.21704) [4.83907]	-0.474101 (1.19842) [-0.39561]	-0.100585 (0.04813) [-2.08969]	0.266068 (1.31422) [0.20245]	-3.006119 (1.60891) [-1.86842]
LOG(FFS(-2))	0.008639 (0.24318) [0.03552]	0.455032 (1.34278) [0.33887]	0.113731 (0.05393) [2.10877]	-0.068987 (1.47253) [-0.04685]	3.584627 (1.80271) [1.98846]
WS(-1)	0.056564 (0.02387) [2.36953]	1.704804 (0.13181) [12.9336]	0.016447 (0.00529) [3.10658]	0.156071 (0.14455) [1.07971]	0.520191 (0.17696) [2.93957]
WS(-2)	-0.040422 (0.02275) [-1.77662]	-0.750382 (0.12563) [-5.97283]	-0.013457 (0.00505) [-2.66686]	-0.109021 (0.13777) [-0.79132]	-0.457795 (0.16866) [-2.71423]
EC(-1)	0.511588 (1.04802) [0.48815]	-4.494265 (5.78691) [-0.77663]	2.074423 (0.23243) [8.92495]	-10.76710 (6.34609) [-1.69665]	10.25508 (7.76907) [1.31999]
EC(-2)	-1.254483 (1.07533) [-1.16661]	6.322339 (5.93767) [1.06478]	-1.230353 (0.23849) [-5.15903]	8.337392 (6.51142) [1.28043]	-13.65605 (7.97147) [-1.71311]
INFLATION(-1)	0.020122 (0.01969) [1.02175]	0.087174 (0.10874) [0.80167]	0.001347 (0.00437) [0.30849]	1.600914 (0.11925) [13.4251]	0.144667 (0.14599) [0.99096]
INFLATION(-2)	-0.000695 (0.01937) [-0.03589]	0.004204 (0.10697) [0.03930]	0.000116 (0.00430) [0.02702]	-0.798304 (0.11731) [-6.80498]	-0.081902 (0.14362) [-0.57028]
GDP(-1)	-0.004124 (0.03422) [-0.12050]	0.216856 (0.18897) [1.14755]	-0.010863 (0.00759) [-1.43122]	0.269327 (0.20723) [1.29963]	1.334863 (0.25370) [5.26155]
GDP(-2)	-0.033123 (0.03079) [-1.07594]	-0.229311 (0.16999) [-1.34899]	0.002148 (0.00683) [0.31460]	-0.249003 (0.18641) [-1.33576]	-0.679869 (0.22821) [-2.97912]
C	-1.057035 (0.58489) [-1.80724]	1.986623 (3.22960) [0.61513]	-0.171877 (0.12972) [-1.32503]	-1.597470 (3.54167) [-0.45105]	-6.302768 (4.33582) [-1.45365]
R-squared	**0.973671**	**0.999256**	**0.997339**	**0.961888**	**0.948834**

TABLE A4

VAR estimation

Standard errors in ( ) & t-statistics in [ ]

Model: e = Phi*Fu where E[uu']=I F =				
C(1) C(2) C(3) C(4) C(5)	0 C(6) C(7) C(8) C(9)	0 0 C(10) C(11) C(12)	0 0 0 C(13) C(14)	0 0 0 0 C(15)
	Coefficient	**Std. Error**	**z-Statistic**	**Prob.**
C(1)	-4.127359	0.425705	-9.695348	0.0000
C(2)	14.66652	3.956532	3.706913	0.0002
C(3)	0.350678	0.090241	3.886020	0.0001
C(4)	-8.604902	0.938669	-9.167132	0.0000
C(5)	-4.914645	0.620063	-7.926041	0.0000
C(6)	25.06378	2.585143	9.695316	0.0000
C(7)	0.560958	0.059056	9.498720	0.0000
C(8)	-0.557200	0.300149	-1.856412	0.0634
C(9)	-0.794162	0.347583	-2.284814	0.0223
C(10)	0.081119	0.008367	9.695361	0.0000
C(11)	-1.217834	0.266474	-4.570174	0.0000
C(12)	-1.033580	0.320530	-3.224594	0.0013
C(13)	1.611162	0.166179	9.695358	0.0000
C(14)	1.371130	0.267161	5.132231	0.0000
C(15)	1.553904	0.160273	9.695358	0.0000
Log likelihood	155.8606			
Estimated S matrix				
0.041812	0.006823	0.034981	0.033375	-0.030187
0.290628	0.182526	-0.069013	-0.105224	-0.141992
-0.002715	0.008838	0.003548	0.012035	-0.002274
0.004943	0.201518	-0.079404	0.469801	-0.097532
0.180195	0.038281	0.017828	0.237902	0.306726
Estimated F matrix:				
-4.127359	0.000000	0.000000	0.000000	0.000000
14.66652	25.06378	0.000000	0.000000	0.000000
0.350678	0.560958	0.081119	0.000000	0.000000
-8.604902	-0.557200	-1.217834	1.611162	0.000000
-4.914645	-0.794162	-1.033580	1.371130	1.553904

TABLE A5

SVAR estimation

Structural VAR is just-identified

Period	LOG(FFS)	WS	EC	INFLATION	GDP
1	0.071018	0.165555	0.007620	0.245399	0.099978
	(0.00732)	(0.05459)	(0.00216)	(0.07250)	(0.06187)
2	0.088850	0.276253	0.008856	0.292816	0.188833
	(0.01445)	(0.11027)	(0.00424)	(0.13847)	(0.11990)
3	0.092228	0.369404	0.008064	0.285311	0.252236
	(0.02031)	(0.16640)	(0.00582)	(0.18407)	(0.17074)
4	0.094443	0.456429	0.006909	0.271491	0.289953
	(0.02593)	(0.21305)	(0.00643)	(0.19395)	(0.20108)
5	0.099379	0.537837	0.006019	0.265465	0.307475
	(0.03400)	(0.25618)	(0.00663)	(0.19191)	(0.21989)
6	0.107472	0.610231	0.005583	0.268524	0.311562
	(0.04378)	(0.30151)	(0.00701)	(0.20474)	(0.23853)
7	0.117968	0.669785	0.005574	0.277279	0.307965
	(0.05383)	(0.35040)	(0.00762)	(0.23281)	(0.26163)
8	0.129835	0.713873	0.005872	0.287209	0.300624
	(0.06389)	(0.40295)	(0.00827)	(0.26333)	(0.28951)
9	0.142162	0.741598	0.006323	0.294531	0.291788
	(0.07464)	(0.46121)	(0.00899)	(0.29092)	(0.32297)
10	0.154323	0.753697	0.006796	0.297166	0.282600
	(0.08700)	(0.52908)	(0.00993)	(0.31735)	(0.36368)

Structural VAR Innovations
Standard errors: Analytic standard deviations in parentheses

TABLE A6

FFS shocks innovations

Period	LOG(FFS)	WS	EC	INFLATION	GDP
1	0.000000	0.355483	-0.004574	-0.091464	-0.075983
	(0.00000)	(0.03667)	(0.00195)	(0.06728)	(0.06050)
2	0.016616	0.600128	-0.002750	0.004930	-0.041548
	(0.00788)	(0.07548)	(0.00376)	(0.12240)	(0.10858)
3	0.043584	0.750018	0.003022	0.202725	0.069053
	(0.01646)	(0.13223)	(0.00544)	(0.17048)	(0.15962)
4	0.069500	0.832911	0.009316	0.393166	0.203694
	(0.02533)	(0.19820)	(0.00683)	(0.20794)	(0.20974)
5	0.086853	0.878093	0.013625	0.502295	0.314990
	(0.03527)	(0.26667)	(0.00786)	(0.23319)	(0.25346)
6	0.094205	0.907169	0.015040	0.508103	0.374565
	(0.04664)	(0.33530)	(0.00862)	(0.25233)	(0.29015)
7	0.094696	0.930026	0.014042	0.431374	0.376547
	(0.05920)	(0.40387)	(0.00925)	(0.27296)	(0.32195)
8	0.093229	0.946169	0.011858	0.314314	0.332611
	(0.07254)	(0.47269)	(0.00983)	(0.29728)	(0.35111)
9	0.093956	0.949352	0.009765	0.199034	0.263067
	(0.08646)	(0.54220)	(0.01037)	(0.32265)	(0.37903)
10	0.098886	0.932851	0.008607	0.113454	0.188270
	(0.10111)	(0.61292)	(0.01092)	(0.34602)	(0.40663)

Structural VAR Innovations
Standard errors: Analytic standard deviations in² parentheses

TABLE A7

WS shocks innovations

Period	LOG(FFS)	WS	EC	INFLATION	GDP
1	0.000000 (0.00000)	0.000000 (0.00000)	0.013003 (0.00134)	0.390153 (0.05309)	0.074484 (0.05950)
2	0.006542 (0.00887)	0.032660 (0.04961)	0.022836 (0.00308)	0.664926 (0.10664)	0.084314 (0.11147)
3	-0.009932 (0.01598)	0.094546 (0.10981)	0.024990 (0.00486)	0.682367 (0.15642)	0.026822 (0.16156)
4	-0.046567 (0.02292)	0.174622 (0.17248)	0.020663 (0.00622)	0.487736 (0.19029)	-0.076728 (0.20338)
5	-0.089892 (0.03141)	0.252157 (0.23605)	0.013338 (0.00724)	0.196418 (0.21433)	-0.191686 (0.23848)
6	-0.127474 (0.04170)	0.304684 (0.30015)	0.006436 (0.00811)	-0.081709 (0.23823)	-0.285895 (0.27049)
7	-0.152844 (0.05314)	0.316657 (0.36373)	0.002060 (0.00884)	-0.280382 (0.26329)	-0.341335 (0.30023)
8	-0.165858 (0.06518)	0.284081 (0.42583)	0.000714 (0.00936)	-0.383702 (0.28555)	-0.357565 (0.32653)
9	-0.170551 (0.07778)	0.214065 (0.48720)	0.001704 (0.00973)	-0.412622 (0.30498)	-0.347760 (0.35009)
10	-0.172292 (0.09114)	0.120707 (0.55059)	0.003793 (0.01022)	-0.403777 (0.32628)	-0.330758 (0.37490)

Structural VAR Innovations
Standard errors: Analytic standard deviations in parentheses

TABLE A8

EC shocks innovations

Null Hypothesis:	Obs	F-Statisti	Prob
does not Granger Cause FFS FFS does not Granger Cause WS	47	0.76773 0.83781	0.4705 0.0398
EC does not Granger Cause FFS FFS does not Granger Cause EC	47	3.09727 1.47686	0.0156 0.0400
GDP does not Granger Cause FFS FFS does not Granger Cause GDP	47	2.32198 0.15385	0.1105 0.8579
INFLATION does not Granger Cause FFS FFS does not Granger Cause INFLATION	47	0.65827 1.61265	0.5230 0.2115
EC does not Granger Cause WS WS does not Granger Cause EC	47	1.29616 2.74682	0.2843 0.0757
GDP does not Granger Cause WS WS does not Granger Cause GDP	47	1.08134 4.81242	0.3484 0.0131
INFLATION does not Granger Cause WS WS does not Granger Cause INFLATION	47	2.31003 1.40134	0.1117 0.2575
GDP does not Granger Cause EC EC does not Granger Cause GDP	47	4.58517 2.47810	0.0158 0.0961
INFLATION does not Granger Cause EC EC does not Granger Cause INFLATION	47	0.32669 0.52483	0.7231 0.5955
INFLATION does not Granger Cause GDP GDP does not Granger Cause INFLATION	47	0.24437 0.04893	0.7843 0.9523

Structural VAR Innovations
Standard errors: Analytic standard deviations in parentheses

TABLE A9

EC shocks innovations

CHAPTER 6. WATER SUBSIDIES, DESALINATION, AND SUSTAINABLE RESOURCE MANAGEMENT: INSIGHTS FROM ALGERIA

AUTHORS : SAMIR B. MALIKI, MOURAD KERTOUS, MYRIAM BEN SAAD, RYM BEN SAAD, ABDELHADI BENGHALEM

Faucet with running water
Credit : Play Ground

Water desalination is an energy-intensive process, and its sustainability is influenced by energy subsidies and policies in Mediterranean countries. Energy subsidies can have both positive and negative effects on water desalination in the region, depending on how they are structured and their impact on the cost and accessibility of energy. This chapter seeks to shed light on Algeria's important efforts in water subsidy management in recent years, aiming to analyze the challenges and opportunities for simultaneously ensuring the long-term sustainability of water subsidies together with social equity, a dual objective that Algeria has been prioritizing. Despite limited analytical studies on the Algerian case, our methodology focuses on analyzing recent water resource regulations, the decision-making process regarding desalination plant construction, and the trends in domestic natural gas consumption amidst stagnant hydrocarbon industry investment. Utilizing descriptive analysis based on data from the World Bank, the International Atomic Energy Agency, and Algeria's domestic energy usage, we examine six scenarios related to Algeria's subsidy policy and water pricing. Our findings not only provide valuable insights for policymakers in navigating subsidy scenarios but also underscore the significance of Algeria's role as an energy-producing nation for supporting economic growth, particularly in the face of climate change challenges prevalent in the Mediterranean region. Our analysis suggests the importance of international collaboration and domestic policy reforms, such as strengthening water legislation, revising tariff structures to align with international standards and local incomes, and establishing institutional frameworks to address water wastage and pollution. Scenarios 3 and 4 present optimal decision-making opportunities with minimal socio-economic repercussions, highlighting the potential for balanced policy interventions.

1. Introduction

Water scarcity poses significant challenges for countries in the southern Mediterranean region, with water policy playing a critical role in mobilizing and managing water resources. Climatic aridity and issues related to climate change have made Algeria a highly vulnerable territory where water scarcity is more acute. Algeria's water stress index is low, with a water availability ratio of 411 m³/year/person, placing Algeria in a situation of chronic absolute water scarcity, as projected by the World Resources Institute for 2040. This pressure on water supply systems is the result of increased urbanization, population growth, economic development, and climate change.

In response to these challenges, Algeria has undertaken significant efforts to address water scarcity, including the installation of desalination plants and the expansion of surface water storage capacity (Benblidia & Thivet, 2010; Drouiche et al., 2012). Finally, a regional transfer program aimed at ensuring greater equity and reducing geographical disparities in access to water has been implemented.

It is worth noting that Algeria currently sources its water from three different sources: surface water (dams), groundwater, and desalination of seawater. Through this diversification of resources, the country aims to protect itself from climatic uncertainties, particularly recurring drought episodes. In the face of water scarcity, desalination appears to be an alternative when conventional resources (surface water, groundwater) become insufficient. This method involves removing salt from saline or brackish water to make it potable or suitable for irrigation and to meet the demand for drinking water. However, this solution may hurt the environment due to the composition of the effluents generated by this process, which can alter sea parameters and negatively affect underwater fauna and flora. The discharge generated by desalination plants typically takes the form of brine containing various salts and organic compounds. This brine is two to three times saltier (between 50 and 80 g/L) and hotter (between 32 C° to 42 C°) than the ambient seawater. As a result, the brine plumes display higher densities and potentially dive towards the surrounding seabed, impacting benthic fauna and flora (Chang, 2015; Ihsanullah et al., 2021).

The Algerian government has recently initiated an ambitious program to establish desalination plants to cope with water supply issues exacerbated by population growth[148]. Algeria's dedication to desalination is shown in its water plan, which involves establishing a specialized desalination agency. The «Water Emergency Plan 2021» was implemented to address the acute water crisis exacerbated by the scarcity of rainfall. This program has evolved from a political initiative to a tangible reality, particularly in the seawater desalination sector, aiming to cover 42% of the national potable water needs by the end of 2024. In 2023, emphasis was placed on accelerating this plan by launching five major desalination plants, increasing the national capacity to 300,000 m³ per day. These facilities, situated along the Algerian coast, represent a significant technological advancement, marking a notable self-reliance in controlling desalination processes.

Algeria aims to meet 60% of its potable water requirements through seawater desalination by 2030. Integral to this strategic initiative is enhancing the sustainability of containerized desalination plants. As part of its comprehensive approach, the Algerian Energy Company (AEC) intends to bolster the resilience of these facilities by promoting local production of critical components, such as filtration systems. This plan, detailed by AEC's Managing Director on December 19, 2023, underscores the commitment to technological self-reliance and industrial development. Concurrently, the AEC is progressing with the construction of five large-scale seawater desalination plants located in Oran, Boumerdès, El Tarf, Bejaïa, and Fouka 2, each with a capacity to produce 300,000 m³ of fresh water daily, cumulatively contributing 1.5 million m³ per day to the national supply. This endeavor reflects a significant step towards securing water resources and supporting sustainable development in Algeria.

Algeria's commitment to water policy is evident in its efforts to increase water supply to meet the needs of its growing population. At the same

148 Algeria has experienced strong population growth estimated at 45 million inhabitants in 2022, which could reach 50 million by 2050 (National Statistics Office 2022).

time, this means less focus is put on optimizing the use of existing resources, and addressing the inherent water scarcity. The present hydraulic model in Algeria is facing a critical decision point, marked by several challenges stemming from its dependence on established institutions and non-economic factors (Dinar et al., 2006). By shifting from a supply management approach that is focused on supply and difficult to implement, as described by Wutich et al. (2013), towards a demand-focused approach, akin to the «Second Order Focus» of the GDE model proposed by Turton et al. (2007), Algeria has the opportunity to address these limitations and enhance the effectiveness of its water policy.

Several studies have focused on establishing analytical frameworks for evaluating water governance. The OECD (2012) and Plan Bleu (2011) have performed significant research in this area. Our chapter will employ a case study approach that draws upon academic research and recent statistical data to examine the country's new public policy on desalination. By adopting such an approach, our research seeks to offer a projection scenario that identifies the potential beneficiaries of subsidies within the desalination industry.

The chapter is structured as follows. After this introduction, we examine Algerian seawater desalination policy literature. Algeria's energy and water subsidies will be addressed in the third section. Section 4 will discuss the sustainability of subsidies and water production, including water tariffs and daily supply scenarios. The paper concludes with policy implications.

2. Literature review on the Algerian context

There is a growing consensus among economists that worldwide investments in the water sector have been sidelined because of two related factors: the lack of legislation linked to water and the provision of subsidies to fossil fuels (Coady et al., 2017). The implications of fossil fuel subsidies on the optimal functioning of the market economy and the long-term sustainability of political and social systems have come under scrutiny in recent years. These subsidies effectively lower the costs associated with fossil fuels, thereby enhancing the profitability of investments in this sector. Consequently, investor behavior is influenced, as they find it challenging to accurately assess the risks and returns associated with investments in various energy sources. Such subsidies on the demand side lead to increased reliance on fossil fuels over other energy alternatives, thereby diminishing the competitive edge of renewable energy sources.

2.1. Challenges in Water Utilities and Desalination as a Viable Alternative

As documented by the scientific literature, water utilities in Algeria face challenges in providing consistent water services to their customers, largely due to inherent constraints, institutional complexities, and difficulties in recovering operational costs (Boukhari and de Miras, 2019). Such challenges are not unique to Algeria but are commonly encountered across different regions and countries, albeit with variations in their specific manifestations and severity. For example, to cope with service interruptions, households resort to other alternatives, activities like collecting and storing water in their own homes, drinking bottled and spring water, purchasing water from private suppliers (Boukhari et al., 2011; Maliki et al., 2009), and collecting rainwater (Guebaili et al., 2011). These costs can quickly add up to more than 10% of a family's income. (Amit and Sasidharan, 2019).
A cubic meter of water costs between AD60 and AD80 to produce, while the state only charges AD18 to sell to the consumer. This can be explained by Algeria's willingness to ensure affordability for consumers, particularly in subregions where water is scarce or where the population faces economic challenges. According to statistical projections, the impact of climate change will decrease rainfall in Algeria and North Africa by 20% by 2050, requiring the creation of an adequate plan as a preventative measure to avoid any catastrophes affecting the provision of drinking water to its people.
According to Hamiche (2018), desalination is becoming a viable alternative for Algeria's adaptation to climate change. Kherbache (2020) argues for a switch from supply-side to demand-side management of water resources, highlighting opportunities for policy improvement and emphasizing the importance of enhanced institutional coordination.

In recent years, we have seen more public water spending. The overall sums approved from 1999 to 2012 were US$43.642 billion (Kherbache & Oukaci, 2017) and reached US$50 billion in 2017. Nevertheless, due to substantial network losses (physical and commercial), drinking water yields are low, often less than 50% (Boukhari et al., 2011; Kertous, 2013).

Hamiche (2022) emphasized the importance of water desalination within Algeria's water management and sustainability policies. It must consider the trade-offs between these resources and any potential environmental effects of water sector adaptation measures. Drouiche et al. (2012) highlight Algeria's strategic focus on inter-basin water transfer projects, medium-sized dam development, and desalination as ways to improve water supply and management. According to Drouiche et al. (2022), desalination membrane technologies can support water-dependent sectors of Algeria's economy and contribute to the interaction of water, energy, and food resources when combined with renewable energy sources like solar power. These studies show that water desalination is critical to Algeria's sustainability plans. However, they also call for careful assessment of the implications for energy use and the environment.

2.2. Renewable Energy Integration to Overcome Challenges

Incorporating renewable energy sources into desalination operations and increasing irrigation efficiency can lower the world's demand for desalination and water costs (Caldera, 2023). Desalination systems must use renewable energy sources to overcome challenges like large capital expenditures and environmental effects (Panagopoulos, 2022). On the other side, Ahmadi and Rezaei (2020) emphasize once more how essential renewable energy technologies are to maintaining the viability of desalination facilities. Collectively, these results support the idea that incorporating renewable energy sources into desalinating water is a workable solution to the problem of water scarcity.

Figure 1 underscores the heterogeneity of water resource distribution in the MENA region, which is a critical factor in regional planning for sustainable water use and management. A cluster of countries, including Egypt, Tunisia, Oman, and Algeria, display moderate availability, hovering around the 500 cubic meter mark. It is noteworthy that the majority of the nations represented in this histogram have less than 1,000 cubic meters of renewable water per capita, which may suggest a prevalence of water scarcity issues in the region. The histogram reflects not only the physical quantities of renewable water but also hints at the socio-economic implications for the countries concerned.

In Algeria, desalination currently provides 17% of Algeria's water supply. In response to the challenges posed by climate change and a severe drought in 2021, the nation has set an ambitious target of increasing the contribution of desalination to 50% of its water supply by the year 2030. This proactive approach demonstrates Algeria's commitment to ensuring a more reliable and sustainable water source for its population in the face of evolving environmental and climate-related challenges. However, it is important to note that economic factors may present challenges to this endeavor. Statistical projections from international institutions indicate a decline in both Real GDP growth and Real GDP growth per capita from 2021 to 2024, potentially impacting the completion of investments in new seawater desalination plants.

3.Subsidies, energy and water management in Algeria

The Ministry of Water Resources (MRE) is the key actor in the Algerian water sector. It has the mandate to formulate and execute policies and strategies related to water resources and environmental protection, as stipulated by Decree no 16-89 of 2016. MRE oversees both the water and environment sectors. It has several public administrations and organizations under its authority (CEDARE 2014; Kettab 2001; The World Bank Report No.: 36270 – DZ 2007). The water sector in Algeria is composed of a few companies/utilities. The main agencies and their roles are shown in Figure 3 (Drouiche et al. 2012; Ministère des Ressources en Eau 2011). Following the establishment of the Ministry of Water Resources in 2000 and the enactment of new water legislation and related regulations, coupled with the rollout of a water policy

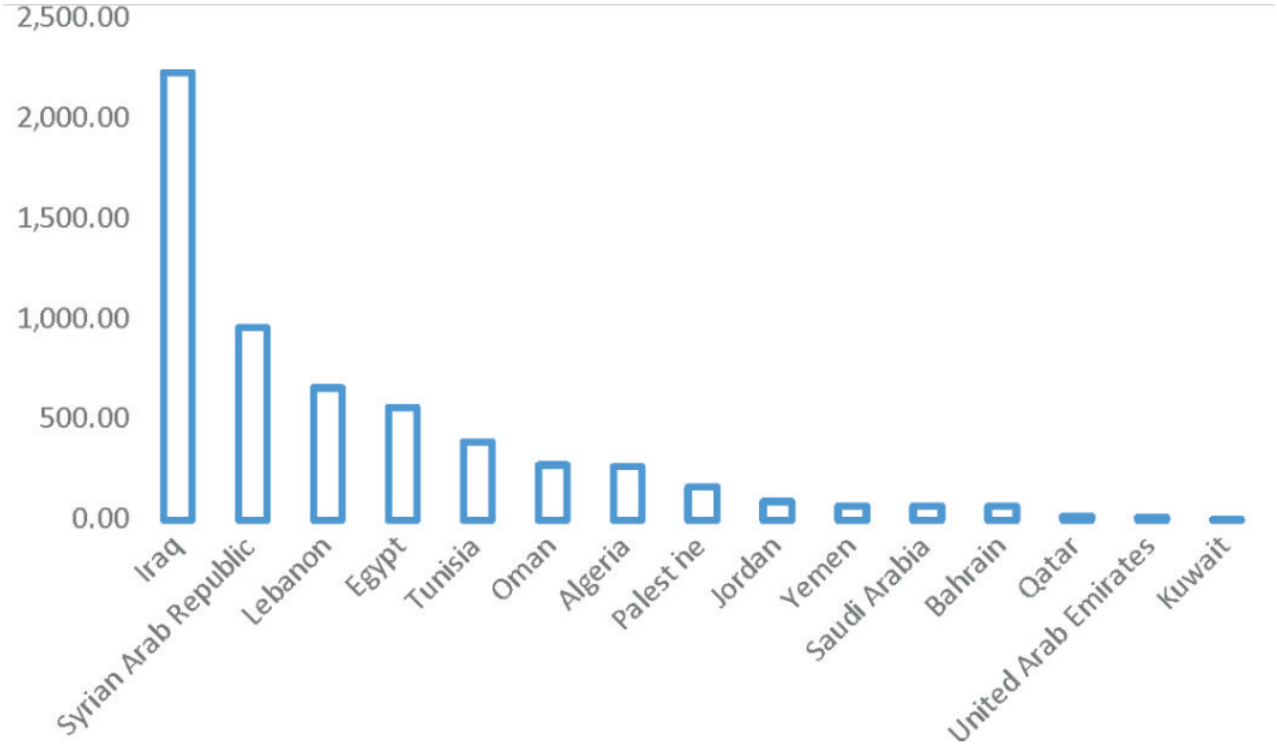

Figure 1. *Volume of renewable water per capita in the Middle East and North Africa region in 2020, by country (in cubic meters per inhabitant per year)*
Source: FAO (Aquastat), 2023

backed by substantial investment initiatives, we observed the emergence of four key national water entities collaborating closely: the Algerian Water Authority (ADE), the National Sanitation Office (ONA), the National Agency for Dams and Major Water Transfers (ANBT), and the National Irrigation and Drainage Office (ONID). The objective was to transition the water sector towards self-management, enhance service delivery through modernization, institute water regulation enforcement, and implement water pricing. The latest agency (AEC) was created to support desalination initiatives through the energy variable.

According to the 2035 renewable energy targets set by the Algerian government (ITA, 2021) 15 GW of power capacity will be produced at a rate of 1 GW per year. The government is working to attract foreign investment in power projects to meet these lofty goals considering the limited timeline and low renewable energy-derived electricity capacity (less than 1 GW in 2020).
Algeria has initiated an ambitious saltwater desalination program, and other projects are planned to equip most coastal municipalities with seawater treatment plants (Table 1).

The table underscores the pivotal role of energy in the desalination process across the 13 operational plants, while anticipating the completion of additional facilities currently under construction. Based on data provided by the Algerian Energy Company, we have calculated the average cost of the 13 plants to be around 0.62 USD per cubic meter. The availability of affordable energy has facilitated the continued implementation of this policy, which involves bridging the gap between high production costs and inadequately profitable water rates.

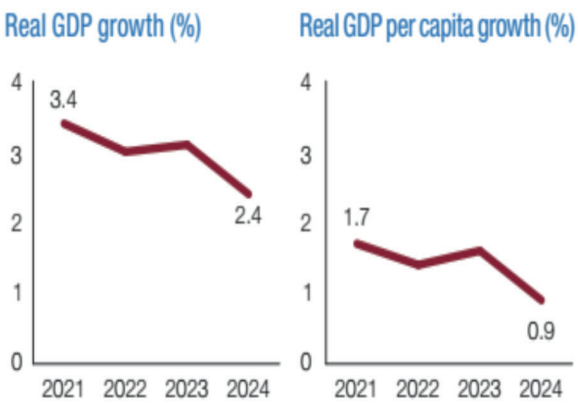

Figure 2. *Real GDP growth (%) and Real GDP per capita growth (%) for Algeria*
Source: African Economic Outlook, 2023

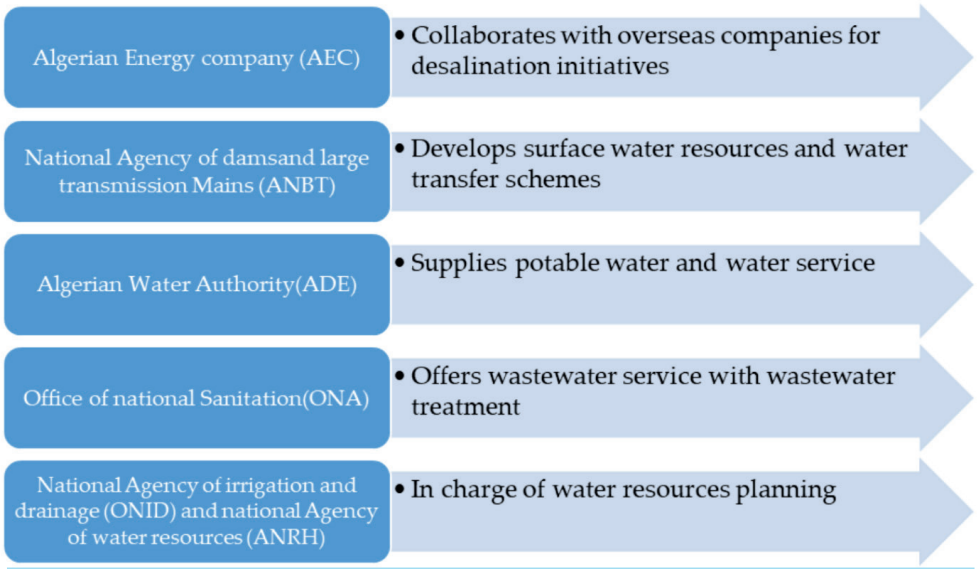

Figure 3. *Entities in the Water Sector and Their Responsibilities*

Seawater Plant	Production Capacity (10^3 m^3/d)	Project Partner	Energy Consumed kWh/m^3	Disposal Cost USD/m^3
	Plant in operation			
Ténes Chlef	500	Mena Spring Utility	-	0.5885
Souk Tlata Tlemcen	200	GS inima aqualia Spain	-	0.7725
Skikda	100	GEIDA Skikda SL (Abengoa 67% – Sacyr 33%)	3.56	0.7398
Mostaganem	200	GS INIMA&AQUALIA	⩽ 3.40	0.7257
Magtaa	500	Mensapring filiale Hyflux Singapour	3.2	0.5577
Arzew Oran	87	J.Burrow Ltd (Black & Vitch AF)	343 MWh	0.8500
Honaine Tlemcen	200	GEIDA Tlemcen S.L (BEFESA – SADYT)	4.42	0.8299
Fouka I Tipaza	120	SAU AWI SL (SNC Lavalin – Acciona Agua) Canada – Spain	⩽ 4	0.7505
El Marsa Alger	60	-	-	-
El-Hamma Alger	200	SUEZ water technologie solution Hamma holding USA	4	0.8521
Corso Boumerdès	80	-		
Cap Djinet I Boumerdès	100	GS Inima&Aqualia	3.7	0.7257
Beni-Saf Ain-Temouchent	200	Geida beni saf SL (Cobra) Spain	⩽ 4.15	0.6994
Bordj-el kiffen Alger	10	-	-	-

TABLE 1

Operational Seawater plants in Algeria

Source: Adapted from The Algerian Energy Company, December, 21, 2023

While upstream and downstream subsidies have been provided, they have inadvertently led to excessive water production and inequitable distribution of social benefits, disproportionately benefiting the wealthy even though the objective was to protect poorer populations. Moreover, despite ongoing efforts to develop desalination techniques for environmental preservation, this practice imposes a burden on the environment.

It is important here to remember the global context (see Figure 4) in 2021, the amount of financial support governments worldwide gave for fossil fuels, mainly in the form of subsidies, increased significantly, to reach a projected total of $697.2 billion. The significant rise in subsidies can be mainly attributed to petroleum, which got the most significant share of these funds, totalling nearly $302.7 billion in 2021.

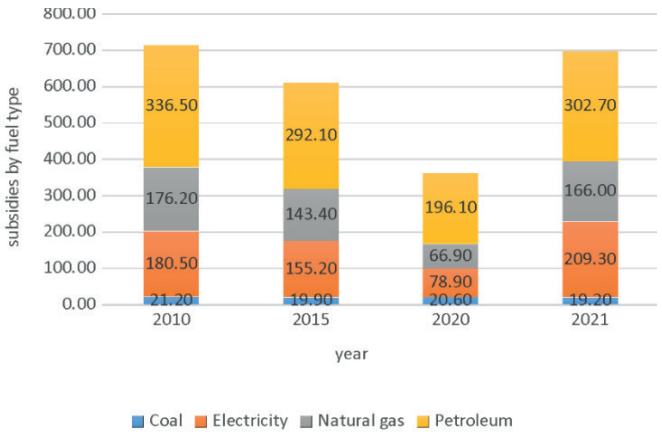

Figure 4. *Subsidies for fossil fuels worldwide from 2010 to 2021, by fuel type (in billion U.S. dollars) - Source: AOECD; IEA, 2023*

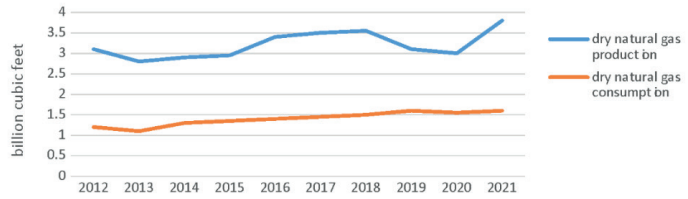

Figure 5. *Total dry annual natural gas production and consumption in Algeria, 2012-2021*
Source: International Energy Statistics Database (EIA), 2023

This can be attributed to increased energy consumption and government measures aimed at protecting consumers from rising energy prices. As for the Algerian government, it grants $15 billion per year in subsidies to the energy sector at all levels (subsidies for electricity, gas, fuel prices, seawater desalination, etc.). This represents approximately 4.2% of its GDP.

4. Different scenarios for sustainability and subsidies nexus

As shown previously in Figure 4, energy will decide this subsidy plan's length of time and sustainability. The 2012–2021 comparison of natural gas production and national consumption shows a convergence with increasing economic demand.

The blue line illustrates dry natural gas production increasing over the past decade. Starting at 3 billion cubic feet in 2012, it peaks about 2018 with minor modifications but stays beyond 3. Compared to production, the orange line demonstrates constant dry natural gas consumption. This line was just above 1 billion cubic feet in 2012 and increased marginally, below 2 billion (Figure 5). Despite ongoing efforts to diversify the Algerian economy, significant investments remain anticipated in the hydrocarbon industry. This strategic focus aims to ensure access to affordable energy, facilitating the production of desalinated water at competitive rates. This analysis indicates the necessity of subsidies to provide the population with drinking water and ensure water resource security across various sectors. In the subsequent table, we outline the benefits and drawbacks of water subsidies.

Regarding the water produced by desalination, the tariffs are as follows (Ministère des Ressources en Eaux, 2017; Drouiche, N. et al, 2011 and https://www.exchange-rates.org/fr/convertisseur/usd-dzd for the exchange rate):

Seawater reverse osmosis (SWRO) is DZD 50–60 (USD 1 = DZD 75 in 2017)
Multi-stage flash distillation (MSF) is DZD 60–70.

If we take the exchange rate of 2023 (USD 1 = DZD 134), the tariffs will move to:

Seawater reverse osmosis (SWRO) is DZD 90–100
Multi-stage flash distillation (MSF) is DZD 100–110.

Advantages of Water Subsidies in Algeria	Disadvantages of Water Subsidies in Algeria
• **Affordable Water Access:** Algerian water subsidies, which have some of the most accessible prices in the region, ensure that water remains readily accessible to the entire population, particularly those with modest financial resources. • **Promotion of Agricultural Development:** Government subsidies in the agricultural sector, including for irrigation, provide financial assistance to promote the growth and modernization of agriculture. This is crucial for ensuring the country's food security and promoting rural development. • **Improving water quality:** Desalination technology can produce high-quality drinking water, which is particularly important in regions where existing water supplies may be contaminated or saline. • **Reduced dependence on rainfall:** Seawater desalination can reduce dependence on rainfall and on freshwater sources that are dependent on climate change, as has been the case in Algeria in recent decades. • **Promoting sustainability in water management:** subsidies can be used to encourage the adoption of more sustainable practices and technologies, such as using renewable energy to power desalination plants or implementing measures to reduce polluting discharges into the ocean.	• **High Cost of Water Management resulting in increased Budgetary Pressures:** Although consumer costs are low, the cost of providing water is considerable. The price of one cubic meter of water in dams is around $0.50, and additional distribution charges range from $0.25 to $0.30. This disparity requires substantial government funding and subsidies, which may stress the national budget. • **Inefficiency and Lack of Targeted Support:** The extensive subsidy system indiscriminately helps all income brackets, regardless of necessity, potentially increasing inequality and failing to target the most disadvantaged segments of society adequately. • **Dependency on Government Investment:** The government's investment plays a crucial role in ensuring water resources' long-term sustainability and safety. Due to the reduction in subsidies and the increasing costs, there is a growing requirement for private investment to maintain the water supply. • **Continued reliance on non-renewable resources:** The country will keep on an unsustainable development path and contributing to worsening environmental problems. • **Impact on marine ecosystems:** The desalination process can have an impact on marine ecosystems by releasing concentrated brine and chemicals used in water treatment into the ocean. These discharges can disrupt the local ecological balance and threaten marine biodiversity.

TABLE 2

Listing advantages and disadvantages of water subsidies in Algeria

Source: Developed by the authors using various press reports

In this situation, the proportion of subsidies will increase and the economic indicator will take priority. At that point, policymakers face the challenge of evaluating and targeting the subsidy program more effectively, particularly toward genuinely disadvantaged households (Maliki S. et al., 2009).

4.1. Towards a uniform, progressive national water pricing system

To better inform policymakers, Kertous et al. (2022) highlight various water pricing strategies in Algeria to gauge their effects on consumer welfare. Using their methodology (see Box 1), we update their analysis to encompass multiple scenarios. Specifically :

- The first two scenarios involve increasing the average price of water (the ratio between the bill amount and the quantity consumed) for each household (by 10% and 20% respectively), followed by measuring the impact on household welfare variation using the equivalent and compensatory variation method after estimating the households' demand function. Two approaches were adopted: the individual estimation approach and the average profile approach.
- The third scenario, on the other hand,

involves increasing the tariff of the second block to 28.45 DZD (the average cost of producing one cubic meter of conventional water). Similarly, the fourth scenario involves increasing the tariffs of the first two tiers to 28.45 DZD.

- The fifth scenario involves a simulation with water produced through seawater desalination. The results show a 155% increase in household bills, equivalent to a welfare loss of 1153 DZD.
- The final scenario assesses the discomfort caused by reduced household consumption (a decrease of 1 hour of water supply) for various reasons related to an aggressive tariff. This reduction in supply time results in a welfare decrease of 140 DZD, equivalent to 18.81% (Table 3).

Our findings support the implementation of a uniform, progressive national water pricing system instead of having regional variations (actually the prices of the first brackets are different from 5 zones with 6.30 DZD, for 6.10 DZD and 5.80 DZD). We observe that while supply limitations are not ideal, they can positively modulate water demand. Key results indicate that a 10% and 20% price increase results in welfare losses of 144 DZD and 284 DZD, respectively. The most favorable outcome is observed in Scenario 3, with a minimal loss of 52 DZD, highlighting significant economic impacts. These findings suggest that changes in water pricing policies could significantly affect consumer welfare, equivalent to about 2.4% of a household's monthly income. Additionally, limiting supply hours has a similar impact to a 10% price increase. However, adjusting the second tariff block to 28.45 DZD/m³ minimizes welfare loss to 52 DZD.

The **optimal and practical scenario concerns adopting a policy that aligns the second tariff block with production costs, balancing social equity and sustainable water management.** This approach would help the Algerian water authority achieve environmental and social goals and gradually encourage the population to contribute to the real cost of water production, provided that targeting the poor population will be more effective.

Changing water pricing policies would significantly decrease consumer welfare. Oil was the most heavily subsidized resource as of 2020, receiving subsidies from the Algerian government of 5.8 billion dollars. Following closely after with roughly 1.4 billion and 1.2 billion dollars each, respectively, were electricity and gas (Statista, 2023).

Box 1

Methodology

A sample of 172 households was randomly selected from the Algerian national water supplier's survey conducted in 2016 in the City of Bejaia in the north of Algeria with more than 7740 observations. Data were collected through telephone interviews, covering household io-demographic characteristics, housing attributes and water consumption variables.

We use a Marshallian water demand function that can be expressed as the following equation:

$$\ln Q_{it} = \beta_0 + \beta_1 \ln P_{it} + \beta_2 \ln R_{it} + \sum \beta_s \ln Z_{it} + \sum \beta_f F_{it}$$

LnQ, LnP, LnR, LnZ and F represent, respectively, household demand for water, average water price paid by consumer, household income, a set of explanatory socio-economic and weather variables and a dummy variable used to design the king of billing (flat or real). The obtained estimation results are utilized to conduct scenario-based analysis regarding the potential impact of the aforementioned policy option on consumers' welfare.

For more details, see: Kertous, M., Zaied, Y. B., Omri, A., & Kossai, M. (2022). Achieving sustainable development goals from a water perspective: clean water pricing policy reform and consumers' welfare in Algeria. Environmental Economics and Policy Studies, 1-18.

Scenario	Description of change in well-being using the Average Profile and Individual Utility Function	Mean	Min	Max	Av. Profile
1	Increase average price: 10%	144	27	539	127
	The total sum of the invoice	19,35%	3,62%	72,44%	17,07%
2	Increase average price: 20%	284	53	1057	250
	The total sum of the invoice	38,17%	7,12%	142,07%	33,60%
3	Increase the second tariff block to 28.45 AD/m³ (First OPTIMAL Scenario)	52	0	368	738
	The total sum of the invoice	6,96%	0,000%	49,46%	99,19%
4	Increase the first and the second tariff blocks to 28.45 DZD/m³ (Second OPTIMAL Scenario)	733	40	1785	1349
	The total sum of the invoice	98,52%	5,37%	239,92%	181,31%
5	Water produced through seawater desalination (83 DZD/m³	1153,67	62,06	4974,71	1152,65
	The total sum of the invoice	155,06%	58,34%	668,64%	154,92%
6	Reduction of water supply time by 1h	140	23	361	134
	The total sum of the invoice	18,81%	3,90%	48,52%	18,01%

TABLE 3

Different scenarios for water management and subsidies in Algeria (welfare loss per capita, in Algerian Dinar)

Source: Kertous et al., 2022 and updated by use

5. Conclusion and policy implications

The use of desalination as an unconventional source of fresh water presents itself as an essential recourse; however, its application entails both positive and negative impacts. Consequently, there is a pressing need to enhance its efficiency. To this end, a multitude of studies have been undertaken, seeking to comprehensively grasp the diverse economic, environmental, and societal ramifications. Biologists, ecologists, economists, and other experts have proposed measures to mitigate the negative effects of this essential technique, which remains vital for many countries facing a shortage of potable water. The goal is to maximize the efficiency of desalination while preserving ecological integrity and social well-being.

The challenge of balancing rising demand with diminishing supply highlights the issue of managing scarcity. The widening gap between escalating demand and available resources necessitates a shift towards sustainable development. Consequently, water utilities are prompted to explore and adopt strategies to address these evolving demands while aligning with sustainability goals.

Our analysis highlights the gains that can be achieved from reconsidering the approach to subsidies. Shifting towards targeted subsidies could offer advantages for all stakeholders, serving as a potential model for other Mediterranean countries aiming to integrate renewable energies effectively. International collaboration on mitigation efforts is crucial based on our data analysis.

Our analysis suggests that involving the population in bearing part of the water production costs could yield positive outcomes. This approach aims to reduce dependency on subsidies, reform subsidy policies to target those in need more effectively, and promote rationalized water production and consumption, indirectly leading to more efficient energy use. Transparent communication about water

scarcity and the development of national water strategies can foster understanding and support among communities. Successful examples from countries like Brazil and South Africa demonstrate how strategic communication coupled with policy reforms can effectively manage water consumption during periods of scarcity (De Waal, D. et al., 2023).

In conclusion, we recommend several practical measures to be prioritized, relevant for all Mediterranean countries:

- **Strengthening Water Law:** Enhance Water Law (in the Algerian example, Law No. 05-12 of 2005) would allow to address issues of water wastage, pollution, and natural resource protection. This entails establishing an institutional framework dedicated to implementing and enforcing these regulations effectively.
- **Reassessing Urbanization Policies:** Review existing urbanization policies to mitigate surface water loss caused by urban expansion. By optimizing land use, we can preserve valuable surface water resources essential for irrigation and ecosystem health.
- **Tariff Revision:** Revise tariff schedules to align with international standards and accommodate income levels, including the minimum wage and low-income brackets. This ensures fair pricing while maintaining affordability for all citizens.
- **Implementing Solidarity Water Tariffs:** Introduce a solidarity water tariff scheme providing 10 cubic meters per quarter free of charge to each citizen, meeting WHO standards for essential water needs. Additionally, establish a social tariff offering 25 cubic meters per quarter at a nominal price, promoting equitable access to water resources.
- **Public Awareness Campaigns:** Launch extensive public awareness campaigns to promote water conservation practices among citizens. By fostering a culture of responsible water usage, we can collectively mitigate water scarcity issues.
- **International Collaboration:** Collaborate with international institutions such as Plan Bleu, UNEP, and the International Solar Alliance to leverage their expertise and diverse perspectives. Engaging with these organizations can provide valuable insights and guidance for effective water management strategies tailored to local needs and global best practices.

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CHAPTER 7. "THE ANTAGONISTIC EFFECTS OF TOURISM INDUSTRY STRATEGIES ON LAND USE MANAGEMENT: A COMPARATIVE ANALYSIS OF TOULON AND KUŞADASI"

AUTHORS : ELOISE LEGUERINEL, MYRIAM BENSAAD AND VINCENT MONIER

Mass tourism overcrowded beach Mediterranean
Credit : Adobe Stock

This chapter aims to examine the impact of two distinct tourism policies, employing both geographical and economic lenses and proposing quantitative and qualitative methodologies. By retrospectively examining the evolution of tourism in these regions, this chapter aims to illustrate how differing approaches to tourism management can yield varying environmental outcomes, beyond mere changes in land use. Our analysis reveals contrasting outcomes between Toulon and Kuşadası. Toulon's coastline shows stability, attributed to long-standing urbanization, while Kuşadası exhibits greater divergence, influenced by rapid development since the 1980s. Climate change impacts are projected to emerge earlier in Kuşadası than in Toulon. Additionally, we raise questions about the potential role of specific tourism subsidies in influencing these outcomes, underscoring the need for a more nuanced classification of financial support to the tourism sector. In Toulon, grants support specific purposes like limiting tourism's environmental impact and promoting sustainable practices. Conversely, in Kuşadası, economic growth seems to be the main objective. Caution is warranted in drawing conclusions about the relationship between subsidies and tourism development due to limited and incomparable data. Future studies could establish a clearer link between subsidy types and land management trends through longitudinal studies and interdisciplinary collaboration among researchers.

1. Introduction

The urgency of the climate crisis is increasingly apparent, with its impacts already being felt worldwide. Regardless of the achievement of the objectives of the Paris Agreement, and efforts to significantly reduce GHG emissions, the transition to a low-carbon economy will represent one of the most significant socio-economic transformations in human history, with significant implications for global tourism that cannot be underestimated (Gössling and Hall, 2021). Tourism, recognised as a sector that is highly sensitive to the impact of climate change (Dogru et al., 2019; Scott et al., 2012, Scott et al., 2016), faces unprecedented challenges as the climate crisis escalates. While climate forecasts and studies have advanced in many sectors, they remain rudimentary in tourism (Gössling et al., 2012; Damm et al, 2019; Scott & Lemieux, 2010). The interplay between climate change and tourism has long been acknowledged (Wall et al 1986; Wall 1992, 1998; Wall & Badke 1994, Elsasser & Burki, 2002), but recent research underscores the indispensable role of both the sector and governmental policies in combating climate change and fostering sustainable tourism.

Evidence suggests that the climate crisis is already reshaping the tourism sector, particularly at regional and coastal levels, with profound impacts on cultural and environmental assets and territorial structures (Tallandier, 2019, Monier et al, 2023). Other studies have also revealed the continued growth of tourism emissions in the Mediterranean basin (MedECC, 2020). Tourism is responsible for 8% of global warming due to CO2 emissions and other long-lived greenhouse gases (methane, nitrous oxide, hydrofluorocarbons, chlorofluorocarbons, sulphur hexafluoride, nitrogen trifluoride). Aviation is the largest tourism sub-sector in terms of emissions growth. Between 1960 and 2018, the sector increased by a factor of 6.8, reaching an estimated total of 1,034 Mt of CO2 (Lee et al., 2021).

Tourism, a vital sector for Mediterranean countries, holds immense economic significance but also poses environmental risks, especially along coastlines. Balancing tourism development with environmental preservation amid climate change poses critical questions for stakeholders. Addressing these challenges requires the formulation and implementation of sustainable tourism policies. Our chapter aims to shed light on the consequences of tourism policies along the Mediterranean coast and underscore the urgent need for sustainable approaches in the face of climate change. Additionally, we seek to provide guidance to tourism stakeholders in enhancing their current and future development strategies. Our contribution to the literature encompasses two key aspects: firstly, a comparative spatial analysis of tourism development in Toulon (France) and Kuşadası (Türkiye) using GIS software, based on Corine Land Cover data. Secondly, the development of transition matrices for each territory to facilitate a prospective study of land cover changes, considering climate change predictions by the IPCC. Furthermore, we raise questions about the potential role of specific tourism subsidies in influencing tourism development, underscoring the need for a more nuanced classification of support to the tourism sector.

This work is structured as follows. Section 2 provides a comparative and diachronic spatial analysis of TPM (Toulon Provence Méditerranée) and Kuşadası. Section 3 presents a prospective study based on the transition matrix, and its results (Section 4). Section 5 provides reflections on the impact of tourism support (subsidies/grants) and economic policies recommendations, while Section 6 concludes.

2. Comparative and prospective spatial analysis methods: TPM vs Kuşadası

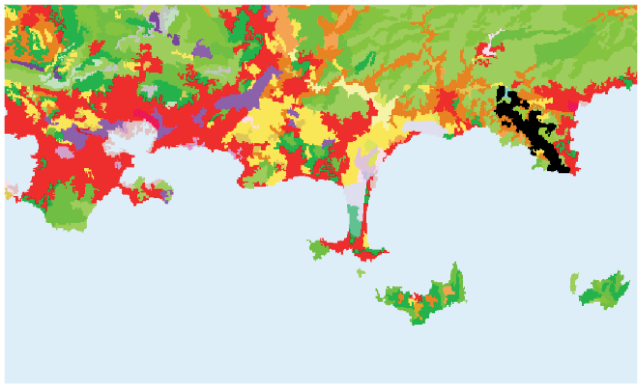
2.1. A general framework of Toulon and Kuşadası

2.1.1. Influence of landscape amenities on the local economy.

The two study cities considered are Toulon and Kuşadası.

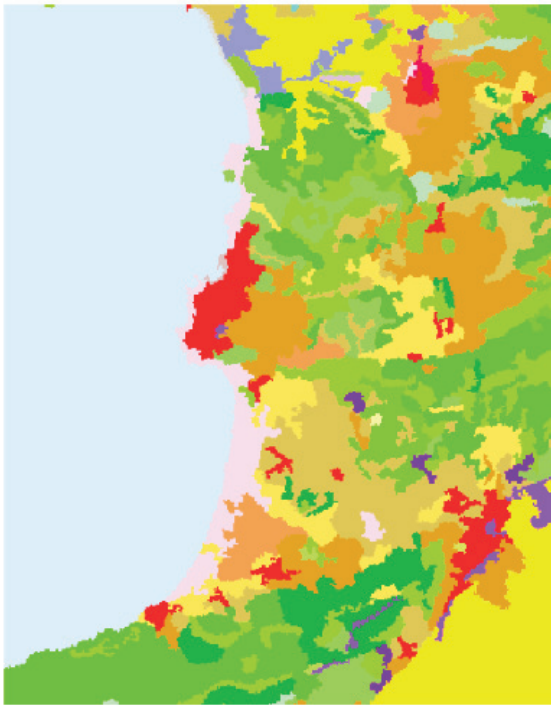
Toulon, located on the eastern French Mediterranean coast, situated within the Var department, stands as France's foremost tourist destination after Paris. Renowned for

its picturesque natural landscape featuring a dual harbor and the establishment of a National Natural Park in 1963, Toulon holds historical significance as France's primary military port and ranks third in the country for cruise ports. Following the NOTRe[149] law of 2018, Toulon transformed into a metropolis with a population of 450,441 residents (INSEE[150], 2023) residing across 12 municipalities, covering a total area of 365 km². Annually, the metropolis attracts over 8 million tourists, accounting for 66 million overnight stays (Var Tourisme, 2023). Initial observations of land use reveal a densely populated urban area typical of the Mediterranean coastline, interspersed with natural spaces contributing to its exceptional charm.



Map 1. *Land use of Toulon in 2018. Source: Corine Land Cover, 2018, extraction by the authors, 2023.*

Meanwhile, the Kuşadası district, situated on the Turkish coast, has experienced significant tourist and urban growth since the 1980s. Today, it ranks as the 5th most popular tourist destination in Türkiye, propelled by its bustling cruise port (the 3rd largest in the country) and its proximity to UNESCO World Heritage sites like Ephesus. During the peak tourist season, the city hosts up to 2 million visitors, despite having a permanent population of only 135,000 residents—significantly less than the 180,000 residents in the municipality of Toulon. An initial observation of land use reveals a distinct pattern dominated by hotel complexes (depicted in pale purple on the map below) extending into the urban areas and beyond.



Map 2. *Land use of Kuşadası, 2018 Source: Corine Land Cover, 2018, extraction by the authors, 2023.*

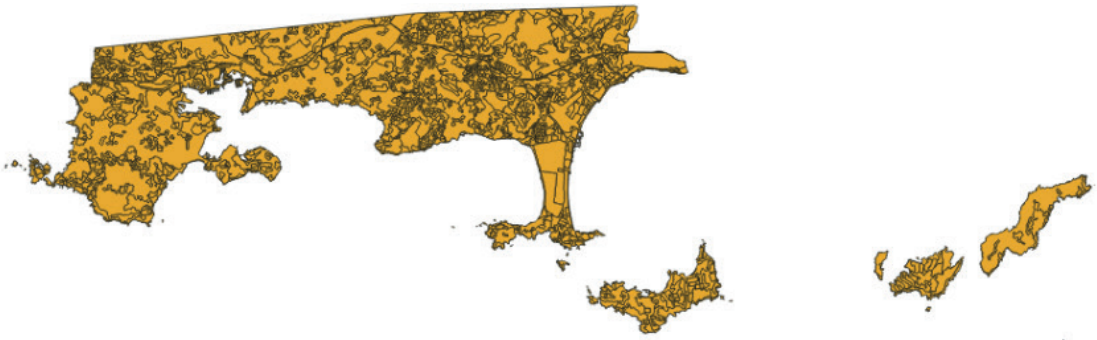
Here we examine two coastal communities driven by tourism as their primary economic driver. Both communities feature a cruise port, iconic tourist attractions (including several UNESCO sites), numerous beaches, and distinctive natural environments (such as the double tombolo of the Giens Peninsula). Consequently, these areas experience significant fluctuations in population during tourist seasons, necessitating robust urban and transportation infrastructure to accommodate the needs of the tourism sector. Additionally, sizable resident populations are concentrated along the coastline, characterized by substantial urban development.

2.1.2. Definition of study areas: a 5km coastal strip to maximise the effects of tourism.

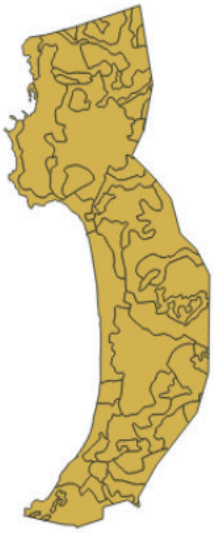
As explained in section 3.1, we used the GIS software QGIS to 'divide' the areas of Toulon and Kuşadası along a distance of 5km from their respective coastlines, in order to focus on the areas with the most tourist infrastructures (cruise ports, yachting harbours...) but also with

149 Nouvelle Organisation Territoriale de la République i.e. New Territorial Organisation of the Republic (translation from the authors)
150 Institut National de la Statistiques et des Etudes Economiques i.e. french national census bureau.)

numerous landscape amenities (hiking trails, Natura 2000 sites, natural parks on land and at sea), all of which contribute to the attractiveness of these two areas. The following two maps show the areas considered in the following sections of this paper.



Map 3. *5 Km strip coastline of Toulon area*
Source: CLC, 2018, extraction by the authors, 2023
Scale 1/200 000



Map 4. *5 Km strip coastline of Kuşadası*
Source: Source: CLC, 2018, extraction by the authors, 2023
Scale 1/200 000

3. Transition matrix: a tool for a spatial and perspectivist analysis of land use evolution

3.1. Databases and software

The land use data comes from the open Corine Land Cover (CLC) database created by the Copernicus Institute (EU) using qn orthophotography approach. (appendix B-1) This database has two advantages: firstly, it covers the whole of Europe, plus Türkiye, and secondly, it enables changes in land use to be recorded between each update.

However, depending on the country and the referencing method, the geolocated data available is sometimes incomplete, as we have seen for the TPM area. We therefore chose to use the OCSOL database, (appendix B-2) which is based on the Corine Land Cover nomenclature but uses SPOT satellite data. The main difference lies in the precision of the land areas considered: whereas CLC has a precision of 25ha, OCSOL has a precision of 5ha. As a result, land artificialisation is better considered, by referencing all roads for example. Note that OCSOL, like CLC, offers a change table enabling the evolution of land use between 1988 and 2019 to be tracked.

To obtain the data for our two 5 km strips of coastline, we used the freeware QGIS to 'slice' and reduce the CLC and OCSL databases to the two study areas. It should be noted here that the slicing function modifies the surface area of the polygons considered to adapt it to the 'stencil' we have determined: for example, if a supposed surface area of 25ha straddles the fixed boundary, it will be sliced and only the area inside the determined border will be considered. Once these operations have been carried out, it's easy to extract the data into a spreadsheet.

Finally, the addition and multiplication operations

on the transition matrices were carried out using the free online software matrix calculator[151].

3.2. Building transition matrices

The groupings used are essentially based on level 2 of the CLC nomenclature[152], with Urbanised Spaces (US) including urbanised areas, industrial and commercial zones, and communications networks. It should be noted that the latter are much better considered in the TPM region. Cultivated land includes arable land and permanent crops, as well as greenhouse crops for TPM.

Category	Symbol	CLC codes
Urban Area	UA	111 + 112 + 113
Recreational area	RA	114
Cultivated land	CL	221 +222
Meadows	M	223
Heterogeneous agricultural areas	HAA	224
Forests	F	331
herbaceous vegetation associations	HVA	332
Open spaces with little or no vegetation	SNV	333
wetlands	WL	441 + 442
Coastal lagoons	COL	521

TABLE 1
Transition Matrices : groupings and nomenclatures used

Using the latest data extracted, i.e. 2012 and 2018 for Kuşadası and 2014 and 2019 for TPM, we looked for the most appropriate tool for modelling changes in land use. It would have been illusory to treat the evolution of each variable separately, as they are all potentially interdependent. For example, the increase in recreational areas may well come from agricultural land, meadows, forests, etc. We therefore need to consider each study area as a closed system with no loss or gain of surface area, for which we have the initial and final states, and where we can closely monitor all the changes in land use.

We chose to use Markov chains for our analysis. A Markov chain is a mathematical model that describes a sequence of random events where the outcome of each event depends only on the outcome of the previous event. The process is described in more technical terms in Box 1.

Coastal View
Credit : Play Ground

151 https://matrixcalc.org

152 Level 2 of the CORINE Land Cover (CLC) nomenclature is a part of a hierarchical classification system used to categorize land cover across Europe. This system is structured into three levels, with each level providing a more detailed breakdown of land cover types. Level 2 specifically consists of 15 categories that offer a more detailed classification than Level 1, which includes broader categories such as artificial surfaces, agricultural areas, forests and semi-natural areas, wetlands, and water bodies.

Box 1

Technical explanation of the application of the Markov chain to changes in land use in Toulon and Kuşadası

A Markov chain is a random process (Xn) n2N whose transitions are given by a stochastic matrix P (X n, X n+1). These processes verify the Markov property, i.e. observed from a (stopping) time T, (X T +n) n2N depends only on X T and is once again a Markov chain. This is the case here assuming that the land use transformation process is homogeneous, i.e. invariant over time.
We have therefore constructed a different transition matrix for each study area, reflecting local changes, called K for the Kuşadası coastal strip and T for the TPM coastal strip. These are stochastic matrices of order 10, with the sum of the coefficients in each row equal to 1.
We also order the values in hectares of the categories in the same order to obtain two-line vectors showing land use in 2018 for Kuşadası and 2019 for TPM[153]. These are respectively:

(UA RA CL HAA F HVA SNV WL COL)
V_{2018} = (1616 2206 3280 0 5880 8352 3904 0 0 0) for Kuşadası
U_{2019} = (38664 946 2156 1484 772 6767 1616 414 873 160) for TPM

a) Without taking climate change into account.

It is then easy to model the future changes in each area if the current trend, which is essentially the result of human activity and economic and political development choices, were to continue unchanged. The vectors deduced by multiplication with the various powers of K and T will also be indexed according to their corresponding year, i.e., for the most representative periods:

$V_{2036} = V_{2018} \times K^3$; $V_{2054} = V_{2018} \times U^6$; $V_{2102} = V_{2018} \times U^{14}$
$U_{2034} = U_{2019} \times T^3$; $U_{2054} = U_{2019} \times T^7$; $U_{2104} = U_{2019} \times T^{17}$

b) Taking climate change into account.

In addition to the direct effects of human activity, the projection of the current trend can be considered to incorporate the effects of climate change observed in recent years in the Mediterranean region. This corresponds to a temperature increase of less than 1.5°C since the beginning of the last century, which is the IPCC's most favourable scenario for future global warming. However, if we want to propose a model that considers a possible warming by the end of the century of 1.5°C, 2.5°C or worse, more than 4°C, then we need to modify the two transition matrices K and T, respectively for Kuşadası and Toulon.
The result is:

$K_{1,5°} = K + GK_{1,5°}$ $K_{2.5°} = K + GK_{2,5°}$ $K_{>4°} = K + GK_{>4°}$
$T_{1,5°} = T$ ++ $GT_{1,5°}$ $T_{2.5°} = T + GT_{2,5°}$ $T_{>4°} = T + GT_{>4°}$
where $GK_{1,5°}$, $GK_{2,5°}$, $GK_{>4°}$, $GT_{2,5°}$, $GT_{2,5°}$, $GT_{>4°}$ are square matrices of order 10 such that the sum of each of their rows is zero, so that the matrices obtained remain matrices of transitions.

In the light of the available literature on climate change in the Mediterranean area (IPPC, 2022; MedECC, 2020) and the urbanisation rates of Toulon and Kuşadası, we have chosen to act essentially on the categories of cultivated land, mixed agriculture and forests, which will tend to shrink or even disappear. Moreover, the increase in the risk of fire and the rise in the aridity coefficient - higher in

153 For greater clarity, the vectors representing the initial states are indexed according to their reference years, 2018 and 2019.

Toulon than in Kuşadası - (Berdugo et al, 2020) suggest an increase in the herbaceous vegetation area and open space with no or little vegetation categories. In addition, given the databases used, it proved tricky to model the land-sea interface, and beaches in particular, even though these could disappear and thus have a profound effect on seaside activities (Dal, Baysan, 2010; Khodkar, 2019). The full matrices can be found in Appendix C.

	UA	RA	CL	M	HAA	F	HVA	SMV	WL	COL
UA	2974,000	0,01960942	0	0	0	0	0	0	0	0
RA	0	1	0	0	0	0	0	0	0	0
CL	0,045	0,007	0,928281	0	0	0	0,01	0,01	0	0
M	0	0	0	1	0	0	0	0	0	0
HAA	0,013	0,00909274	0	0,000	0	0	0,01	0	0	0
F	0,001152	0	0	0	0,000	0,9788475	0,01	0,01	0	0
HVA	0	0	0	0	0	0,000	0,987703	0,01	0	0
SMV	0	0	0	0	0	0	0	1	0	0
WL	0	0	0	0	0	0	0	0	0	0
COL	0	0	0	0	0	0	0	0	0	0

TABLE 2

Transition matrix K2,5°C

Source: Authors elaboration, 2023

This means that every six years, cultivated land and forest both change by 1% into HVA and 1% into SNV. Shrub vegetation is also likely to change into SNV. In the absence of local climate data, we have therefore chosen to attenuate the effects of climate change on land use, but even so, the results presented in the following section are rich in lessons.

4. Interpretation of the results and findings

4.1. Contrasting outcomes

Our findings provide valuable information for tourism planners and decision makers seeking to build a sustainable sector. While all the data presented in this section are expressed in ha, we have chosen a logarithmic scale for Toulon to make it easier to visualise the results, given the total surface area analysed (over 50,000 ha for Toulon ; 25,000 ha for Kuşadası).

The comparative analysis shows contrasting outcomes. On the one hand, concerning the Toulon coastline, the state of the different categories analysed previously show stability, while Kuşadası exhibits a greater divergence. It should first be pointed out that Toulon's stability is essentially due to the long-standing urbanisation of the 5 km coastal strip, whereas Kuşadası only began to develop in the 1980s, when the Tourism Act (1982) came into force. This seems to have had a direct and rapid impact in terms of land use[154].

In Toulon, long-standing urbanization practices

154 The fall in urbanised area observed between 2000 and 2006 in Kuşadası should not be taken into account, as it is a result of incorrect categorisation in the CLC database, which placed almost 1,000 ha of touristic lands in UA.

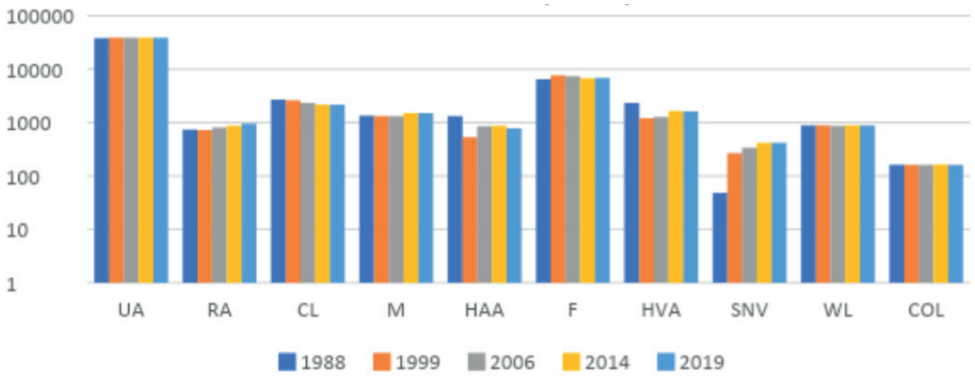


Fig 1. *Evolution of land use in TPM between 1988 and 2019 (in Ha)*

have contributed to the stability of land use categories along the coastal strip. This stability indicates effective management and planning, ensuring the preservation of natural areas amidst urban development. Additionally, the establishment of the Port-Cros National Marine and Land Natural Park in the 1970s showcases a proactive approach to environmental conservation, promoting sustainable tourism practices and enhancing the area's attractiveness to visitors.

For Kuşadası, despite the challenges posed by rapid tourist and urban development, there are positive aspects as well. The growth in tourism infrastructure and facilities boosted the local economy, creating employment opportunities and supporting livelihoods for residents. Moreover, the influx of tourists brought economic benefits to the community, contributing to the overall vibrancy and diversity of the destination. However, to ensure long-term sustainability, there is a need to balance development with environmental conservation efforts and implement measures to mitigate the negative impacts on natural and cultivated spaces.

The divergence in territorial developments between the two cases studied can be largely attributed to the impacts of differing tourism strategies. It appears that the territorialization of public policies, particularly in France, has facilitated better land management and the preservation of environmental assets, albeit with limited impact on natural terrestrial environments. Conversely, a more centralized policy approach has yielded significant financial gains although it may have overlooked the degradation of local environmental quality.

In our analysis, we have chosen three pivotal dates: 2034, aligned with the goals of the Paris Agreement to limit temperature rise to 1.5°C; 2072, to underscore the potential effects of sustainable development policies; and 2100, offering a long-term perspective. For each of these dates, we have considered various scenarios based on those outlined by the Intergovernmental Panel on Climate Change (IPCC, 2022), which offers five scenarios reflecting different levels of future climate disruption. Our methodology, inspired by Nigel (2011), employs a matrix architecture to define the efforts needed globally to achieve concentration profiles corresponding to each scenario.

Fig 2. *Evolution of land use in Kusadasi between 1990 and 2018 (in Ha)*

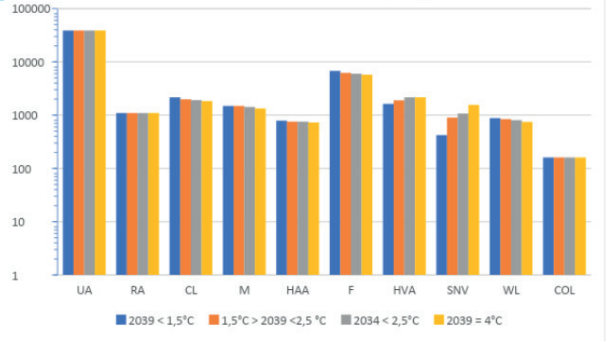


Fig 3. *Land use in TPM in 2034 (in ha)*

Types	Adaptation challenge/Mitigation challenge	Scenario	Simulated scenario for TPM and Kuşadası	
			Yes	No
SSP1	Low/Low	Very ambitious scenario to meet the 1.5°C target of the Paris Agreement	X	
SSP2	Medium/Medium	Sustainable development scenario	X	
SSP3	High/High	Intermediate scenario	X	
SSP4	High/Low	Scenario of regional rivalries		X
SSP5	Low/High	Development based on fossil fuels	X	

TABLE 3
Challenges and Scenarios

4.2. Effects of tourism support and climate change impacts on land use.

In Toulon, climate change will be felt most acutely at the end of the next century. It should be noted that only by complying with the SSP1 will it be possible to limit the degradation of natural areas.
Therefore, it is imperative to continue enhancing these areas. Significant efforts have been made to reduce greenhouse gas emissions, exemplified by the €20 million investment in electrifying cruise ship docks, resulting in an 80% reduction. The «Contrat de Baie» (TPM, 2022a), a multi-year planning document with €80 million allocated for its first phase, is a commendable initiative aiming to balance economic development with environmental conservation. Additionally, the annual report on sustainable development provides valuable insights into identifying and safeguarding key sites, such as the «Presqu'Île de Giens», designated as a «Grand Site de France», despite suffering environmental degradation due to its popularity (TPM, 2022b).

Furthermore, nearly 10% of the TPM coastal strip is managed by the Conservatoire du Littoral, highlighting efforts to preserve coastal landscapes. The Toulon arsenal, occupying 276 ha of waterfront, plays a role in limiting coastal urbanization, while the interests of the French Navy contribute to landscape preservation. For instance, Map 5 illustrates parcels in the municipality of Saint-Mandrier classified as unbuildable defense zones (in violet), underscoring the commitment to environmental protection and compliance with defense zoning regulations (Monier, 2012).

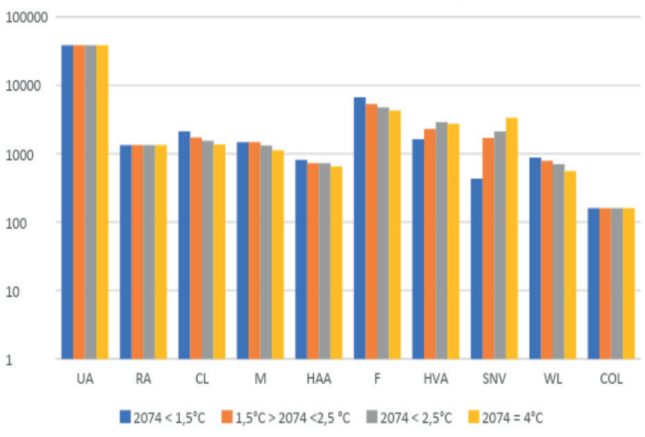


Fig 4. *Land use in TPM in 2074 (in Ha)*

In Kuşadası, the forthcoming scenario will play a pivotal role in safeguarding the area's environmental assets. The municipality shares

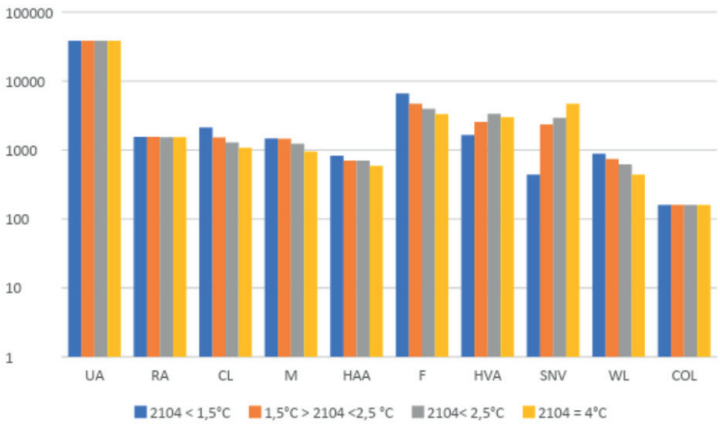


Fig 5. *Land use in Toulon 2104 (in ha)*

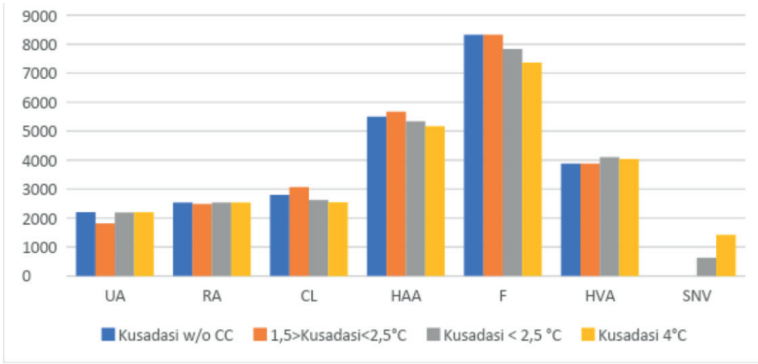
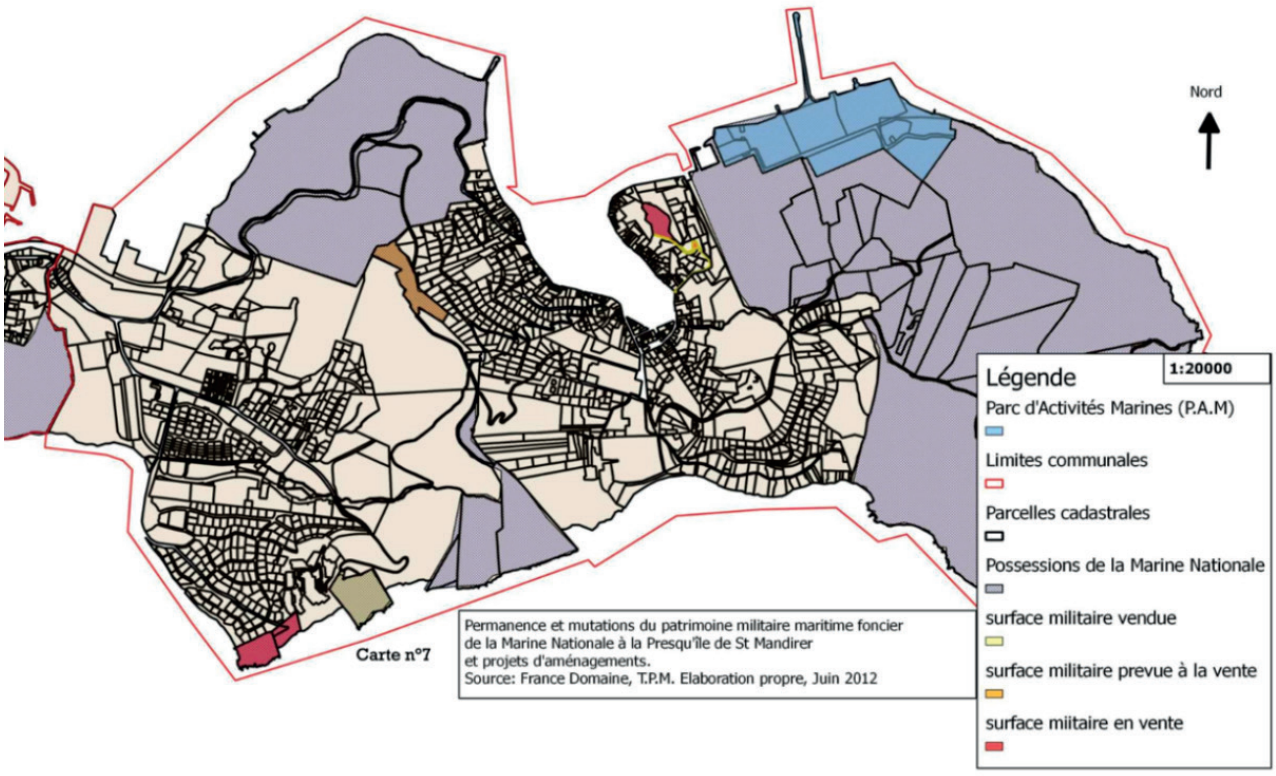


Fig 6. *Land use in Kusadasi in 2036 (in ha)*



Map 5. *French Navy occupation in Saint-Mandrier area*
Source : Source: Monier, 2012

ranking 5th in Türkiye. This generates an annual revenue of €200 million through mooring fees paid by the 1,000 visiting boats annually. However, given that a 2,500-passenger boat emits as much nitrogen dioxide in one day at the quayside as 12,000 cars (France Nature Environnement, 2019), there is a need to diversify local tourism offerings beyond sea-based activities.

To underscore the impact of tourism on land use, we have considered a deliberately false hypothesis of no climate change for Kuşadası (indicated in blue on the graphs above). This projection clearly reveals that the pursuit of tourism and urban development initiated since the enactment of the 1982 Tourism Act will lead to a scenario where tourist areas will surpass urban areas as early as 2036. According to Khodkar (2019), if the municipality of Kuşadası follows an SSP-3 scenario, some beaches may disappear entirely, while others could experience a 70% reduction in capacity as soon as 2050. Despite its natural heritage, such as thermal springs and regional natural parks, which the municipality is striving to promote and develop, the town of Kuşadası is poised to endure significant challenges due to climate change. As depicted in the graphs above, a policy that disregards the depletion of this natural capital would align with an SSP 5 scenario, jeopardizing the attractiveness of the destination. Unlike Toulon, where effects are projected to emerge by the century's end, the Kuşadası region appears more susceptible to climate change impacts, expected to manifest as early as 2036.

5. Reflections on the impact of tourism support and economic policies recommendations

The influence of the type of tourism support

The disparity described above, despite numerous similarities between the two cities, underscores a possible correlation between the impact of tourism support (grants and subsidies) and land use. Our focus needs to revolve around examining the potential disparities in outcomes, both economic and environmental, resulting from various forms of support to the tourism sector, particularly grants and subsidies. We would like to discern whether different types of support mechanisms yield distinct effects on the tourism industry's performance and environmental impact. By categorizing these forms of assistance, we can better understand their implications, enabling policymakers and stakeholders to make informed decisions regarding the allocation of resources and the formulation of sustainable tourism policies. This reflective process underscores the importance of strategic resource allocation and the need for nuanced approaches to support tourism development while mitigating adverse environmental effects.

As seen in Box 2, Plan Bleu (2023) already underscored how subsidies within the tourism sector can either support environmentally harmful practices or contribute to sustainable tourism development. In the former case, these subsidies often promote mass tourism and unsustainable activities, which can have detrimental effects on both the environment and the economy.

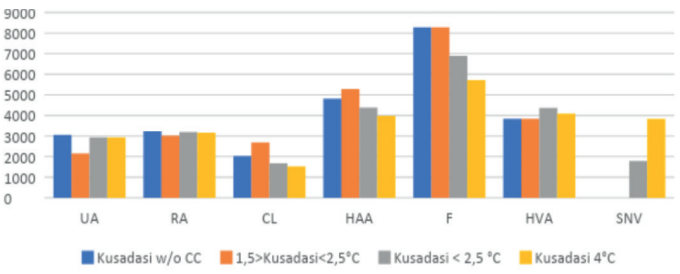


Fig 7. *Land use in Kusadasi in 2072 (in ha)*

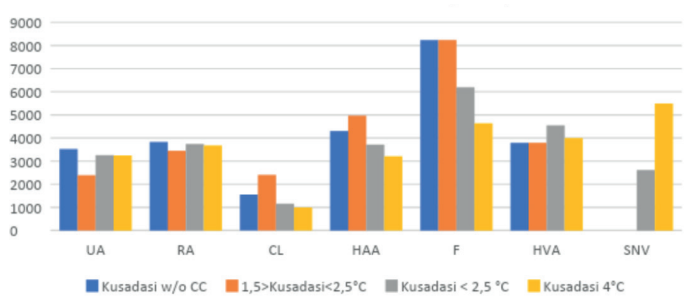


Fig 8. *Land use in Kusadasi in 2102 (in ha)*

Box 2

EHS in Tourism

Harmful subsidies in tourism come in two main forms: specific and indirect. Specific subsidies are tailored to tourism products, while indirect subsidies affect goods and services used by both tourists and locals, especially during peak tourism seasons. These subsidies, particularly prevalent in the aviation and maritime sectors, encourage increased visitor numbers and activities that adversely impact the environment.

For instance, exemptions from taxes on kerosene, a policy established in the Chicago Convention of 1945, significantly lower air travel costs, making it more accessible to travellers. However, air travel is a major contributor to greenhouse gas emissions, despite receiving substantial public subsidies. Similarly, tax exemptions for maritime navigation activities, such as pleasure boating and jet-skiing, further contribute to environmental degradation.

Indirect but specific harmful subsidies, such as inadequate tourist taxes, also exacerbate environmental degradation. These taxes, typically paid by tourists per night spent in a municipality, often fail to reflect the true environmental costs associated with tourism activities.
Additionally, direct subsidies and tax reductions aimed at promoting tourism infrastructure development can have adverse environmental consequences, particularly in coastal areas. Reduced VAT rates on tourism-related goods and services further incentivize consumption and attendance, particularly in the hospitality sector.

The economic and social impacts of environmentally damaging subsidies are multifaceted. While subsidies to air transport primarily benefit higher-income individuals, they may exacerbate environmental degradation and adversely affect local communities' livelihoods and quality of life. In regions heavily reliant on tourism, the influx of visitors often strains local resources, such as water, and leads to anti-tourist sentiments among residents. Furthermore, environmental degradation diminishes the attractiveness of tourist destinations, ultimately undermining the sustainability of the tourism industry itself.

Type of Subsidies	Economic and Social Consequences	Promoted Practices	Environmental Pressures
- Aid for Financing of Infrastructure - Non internalizing Tourist Tax - Tax Exemptions or Reductions (Transport, Housing, Yachting) - Water Sub-Tariffs	- Unequal targeting - Challenges to the livelihoods of local people (access to water) - Questioning the sustainability of the tourism sector	- Coastal development and tourism infrastructure - Fuel consumption - Consumption of tourism goods and services	- Air and water pollution - Degradation of biodiversity (coastal and marine) - Over-consumption of resources (water, fossil fuels)

TABLE 4

Summary of EHS in Tourism sector

Source: Plan Bleu (2023), "Technical report: Exploratory study on environmentally harmful subsidies in the Mediterranean".

Some data on tourism support provided in both regions is illustrated in Appendix E. Though the provided information is far from exhaustive, especially in the case of Kuşadası, it is evident that there is significant investment and support allocated to various aspects of tourism development in both the TPM area and Kuşadası district. Overall, we may note that :

Toulon

- In the TPM area, there are grants available for specific purposes such as limiting the environmental impact of tourism activities, enhancing natural sites, supporting out-of-season tourism, and providing financial assistance to tourist accommodation providers and SMEs in the tourism sector. **This support aims to promote sustainable tourism practices, biodiversity conservation, all the while contributing to the overall economic development of the region.** This might explain why Toulon exhibits greater stability when looking into land management trends.
- For instance, funding is provided for events like the GALATHEA Festival and educational initiatives like «La Rade m'a dit.» These programs aim to enrich the tourism experience, educate about the region, and **raise awareness about marine environmental concerns** (TPM, 2023). In this regard, several initiatives funded by these subsidies have **direct ecological benefits**, such as the conservation of marine life and habitats, and educational programs aimed at raising environmental awareness among tourists and locals. Such subsidies are detailed by the Métropole Toulon Provence Méditerranée for 2022, encompassing various tourism-related subsidies (TPM, 2022).
- Moreover, the Office de Tourisme Provence Méditerranée (OTP) is responsible for managing tourism in the Toulon metropolitan area. The OTP's budget for 2024 amounts to €8.3 million (OTP, 2024), incorporating diverse subsidies dedicated **to enhancing tourism within the region.** For example, the OTP invests in marketing and advertising campaigns to **promote the region's tourism products, including its unique cultural heritage and natural attractions.** The OTP also supports initiatives that **promote sustainable tourism practices, such as eco-friendly accommodations, environmentally responsible transportation, and responsible wildlife viewing.**
- Furthermore, specific local grants, such as the €80 million for the Contrat de Baie in the TPM area and the Opération Grand Site-Giens structuring project, indirectly support tourism development by **addressing environmental issues, improving infrastructure, and enhancing the overall tourism experience.**

Kuşadası

- As for the Kuşadası district, there is a focus on promoting tourism through various initiatives aimed at attracting tourists, enhancing alternative tourism experiences, and supporting local farmers. Additionally, there are efforts to strengthen international **partnerships to further develop sustainable tourism in the region.** While some of these initiatives may contribute to environmental sustainability, **the overarching focus appears to be on fostering economic growth and generating tourism revenue.** Perhaps this could yield greater economic results, however this might also explain why our projections show the Kuşadası region to be susceptible to climate change impacts earlier than in Toulon.
- The country's evolution towards market-oriented policies in the 1980s and 1990s has influenced the current approach to tourism development. The policy and regulatory framework concerning tourism subsidies in Kuşadası, and Türkiye more broadly, appears to prioritize liberal economic strategies. The Turkish government has implemented various policies and regulations to promote tourism, including the **Tourism Encouragement Framework Decree and the Tourism Encouragement Law in 1882** (Göymen, 1995). These policies aim to create a favorable business **environment for tourism investments.** However, there are areas for improvement in the existing regulatory

frameworks, particularly concerning environmental impact assessments and the management of tourism-related waste. In these regards, the local policies on tourism subsidies need to be reviewed to ensure that they are **aligned with the goals of sustainable tourism and environmental protection**, and that they take into account the **specific needs and concerns of the local community** (Tanrisevdi et al., 2021).

- The government introduced incentives in order to achieve a significant increase in tourism investment, such as :

1. allocation of public land to investors on a long-term basis for tourism projects,
2. soft loans provided by the Turkish Tourism Bank,
3. exemptions from various taxes including customs and export taxes,
4. preferential tariff rates for electricity, water and gas consumption,
5. priority for communication needs, i.e. telex, telephone, fax, etc.,
6. allowance of foreign personnel employment up to 20% of total workforce, and investment allowance, and
7. Special incentive premium for foreign investors (TYD, 1992; Özen & Kuru, 1998).

- Indeed, in Kuşadası, subsidies have for years been primarily targeted towards **expanding the tourism sector.** This has entailed significant investments in cruise port infrastructure and the promotion of large-scale resorts and hotels. The Tourism Development Fund, established in 1962, provides grants and loans for the construction of hotels and motels in tourist areas (Nohutçu, 2002). The United States Agency for International Development (US. AID) played a major role in this development by providing grants and loans for the construction of roads, hotels and motels in tourist areas (Nohutçu, 2002). Tourism was subsequently identified as a «sector of special importance for development,» leading to various financial incentives including grants and allowances (TYD, 1992).
- Therefore, between 1985 and 1992, US$ 422 million worth of grant resources were provided to investors under the cash incentives program that constituted an investment volume of TL 5.5 trillion (TYD, 1992).
- A recent example is the US$30 incentive per traveler for cruise operators with vessels carrying 750 passengers or more until December 31, 2023, to boost visitor numbers and offset the impact of security concerns. In addition, the financial package provided by the International Finance Corporation (IFC) to Ege Ports in 2004, which includes an $18 million loan to finance the construction of a new passenger terminal facility and improve existing piers at Kuşadası cruise ship port (IFC, 2004), aims to enhance the port's efficiency and transform it into a world-class cruise ship destination, thereby **driving economic activity and employment opportunities in the area**. This cruise ship subsidy and tourism encouragement policies may be cost-effective in the short term, as they aim to boost visitor numbers and stimulate economic growth. However, their long-term sustainability and environmental impact also need to be factored-in. The surge in tourism and associated infrastructure development may result in observed **changes in land use**, potentially leading to environmental degradation and biodiversity loss.
- According to the tourism strategy for Türkiye in 2023, the Turkish government has provided financial support to hotel owners to upgrade their facilities and services and subsidies for leisure activities, such as water sports and cultural events, which contribute to **the diversification of tourist experiences and increase the overall appeal of Kuşadası as a tourist destination** (T. R. Ministry of Culture and Tourism, 2007). For example, Kuşadası seeks to increase tourism to twelve months by integrating thermal resources with health tourism (Tanrisevdi et al., 2021).

Overall, in France, initiatives like local climate plans in Toulon showcase promising efforts that integrate mitigation and adaptation strategies. Conversely, Türkiye's predominantly national approach highlights the need for more localized climate plans, akin to the «Future lies in Tourism» program, which empowers local actors to contribute to sustainable tourism development. Coastal cities, particularly susceptible to environmental changes due to tourism activity, must enhance their resilience through innovative urban planning approaches. Moreover, reorienting tourism priorities towards

positive impacts, such as social tourism and youth education, aligns with concepts like «socializing tourism» advocated by scholars like Higgins-Desbiolles (2020). This intention is also present in the Turkish Tourism Strategy and would benefit from being deployed in Kuşadası.

6. Conclusion : The need for a multifaceted approach

The tentative conclusions drawn regarding the relationship between subsidies and tourism development must be approached with caution due to the inherent limitations stemming from the lack of comprehensive and comparable data on financial support to tourism in both regions. Without a detailed understanding of such subsidies over the years, our ability to make definitive assessments is restricted. To ensure robust analyses, future research endeavors should prioritize the acquisition of comprehensive data sets that capture the full spectrum of financial support allocated to tourism activities. This data should encompass both direct subsidies and indirect forms of support, such as tax incentives or infrastructure investments. Moreover, efforts to collect data should extend beyond mere financial figures to include qualitative assessments of the intended objectives and outcomes of various subsidy programs.

Establishing a clearer link between the type of tourism support and its impact on land management trends necessitates a multifaceted research approach. First and foremost, comprehensive data collection efforts should be undertaken to gather detailed information on the specific characteristics of subsidy programs, including their objectives, target beneficiaries, funding mechanisms, and geographical scope. Longitudinal studies tracking changes in land management practices over time in response to different forms of tourism support are crucial for understanding the causal relationships between subsidies and land use dynamics. Qualitative research methods, such as interviews, focus groups, and stakeholder surveys, can provide valuable insights into the perceptions, attitudes, and behaviors of key actors involved in tourism development and land management. Additionally, interdisciplinary collaboration among researchers from diverse fields, including environmental science, economics, sociology, and public policy, is essential for generating holistic understandings of the complex interactions between tourism subsidies and land management practices.

Differentiating between Environmentally Harmful and Environmentally Friendly Tourism Support is paramount for fostering sustainable tourism development in the Mediterranean region. To achieve this goal, the development of a joint Mediterranean methodology requires careful consideration of several key factors. Firstly, clear and transparent criteria should be established to categorize tourism support based on its environmental impact, taking into account factors such as resource consumption, pollution generation, and biodiversity conservation. These criteria should be informed by scientific evidence and stakeholder input to ensure their relevance and applicability across diverse contexts. Secondly, comprehensive assessments of subsidy programs should be conducted to evaluate their alignment with sustainability objectives and identify opportunities for improvement. This entails analyzing the direct and indirect environmental effects of subsidies, as well as their social and economic implications. Standardized reporting mechanisms should be implemented to facilitate the monitoring and evaluation of subsidy programs over time, enabling policymakers to track progress towards sustainability goals and identify areas requiring intervention. Furthermore, knowledge sharing and collaboration among Mediterranean countries are essential for fostering mutual learning and exchange of best practices in sustainable tourism governance and policy implementation. By leveraging the collective expertise and resources of regional stakeholders, a joint Mediterranean methodology can pave the way for more effective and coordinated efforts to promote environmentally sustainable tourism across the region.

Appendixes

Appendixe B: CLC and OCSOL nomenclature

Appendix C : Transition matrices of Kuşadası area

1. Transition matrices of Kuşadası area

Kusadasi 2012_2018										
	UA	RA	CL	M	HAA	F	HVA	SNV	WL	COL
UA	0,980	0,020	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,000
RA	0,000	1,000	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,000
CL	0,045	0,007	0,948	0,000	0,000	0,000	0,000	0,000	0,000	0,000
M	0,000	0,000	0,000	1,000	0,000	0,000	0,000	0,000	0,000	0,000
HAA	0,013	0,009	0,000	0,000	0,978	0,000	0,000	0,000	0,000	0,000
F	0,001	0,000	0,000	0,000	0,000	0,999	0,000	0,000	0,000	0,000
HVA	0,002	0,000	0,000	0,000	0,000	0,000	0,998	0,000	0,000	0,000
SNV	0,000	0,000	0,000	0,000	0,000	0,000	0,000	1,000	0,000	0,000
WL	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,000	1,000	0,000
COL	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,000	1,000
Kusadasi 2012_2018 and GIEC <1,5° SSP1										
	UA	RA	CL	M	HAA	F	HVA	SNV	WL	COL
UA	0,990	0,010	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,000
RA	0,000	1,000	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,000
CL	0,015	0,007	0,978	0,000	0,000	0,000	0,000	0,000	0,000	0,000
M	0,000	0,000	0,000	1,000	0,000	0,000	0,000	0,000	0,000	0,000
HAA	0,003	0,009	0,000	0,000	0,988	0,000	0,000	0,000	0,000	0,000
F	0,001	0,000	0,000	0,000	0,000	0,999	0,000	0,000	0,000	0,000
HVA	0,002	0,000	0,000	0,000	0,000	0,000	0,998	0,000	0,000	0,000
SNV	0,000	0,000	0,000	0,000	0,000	0,000	0,000	1,000	0,000	0,000
WL	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,000	1,000	0,000
COL	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,000	1,000

K 2,5°C										
	UA	RA	CL	M	HAA	F	HVA	SNV	WL	COL
UA	2974,000	0,01960942	0	0	0	0	0	0	0	0
RA	0	1	0	0	0	0	0	0	0	0
CL	0,045	0,007	0,928281	0	0	0	0,01	0,01	0	0
M	0	0	0	1	0	0	0	0	0	0
HAA	0,013	0,00909274	0	0,000	0,9676052	0	0	0,01	0	0
F	0,001152	0	0	0	0,000	0,9788475	0,01	0,01	0	0
HVA	0	0	0	0	0	0,000	0,987703	0,01	0	0
SNV	0	0	0	0	0	0	0	1	0	0
WL	0	0	0	0	0	0	0	0	0	0
COL	0	0	0	0	0	0	0	0	0	0

	K >4°C									
	UA	RA	CL	M	HAA	F	HVA	SNV	WL	COL
UA	0,980	0,020	0	0	0	0	0	0	0	0
RA	0	1	0	0	0	0	0	0	0	0
CL	0,045	0,007	0,918	0	0	0	0,01	0,02	0	0
M	0	0	0	1	0	0	0	0	0	0
HAA	0,013	0,009	0	0	0,958	0	0	0,02	0	0
F	0,001	0	0	0	0	0,959	0,015	0,025	0	0
HVA	0,002	0	0	0	0	0	0,973	0,025	0	0
SNV	0	0	0	0	0	0	0	1	0	0
WL	0	0	0	0	0	0	0	0	1	0
COL	0	0	0	0	0	0	0	0	0	0

2. Transition matrices of TPM area

	TPM 2014_2019									
	T									
	UA	RA	CL	M	HAA	F	HVA	SNV	WL	COL
UA	0,99905	0,00077	0,00009	0,00000	0,00004	0,00002	0,00000	0,00004	0,00000	0,00000
RA	0,00039	0,99960	0,00000	0,00000	0,00000	0,00000	0,00000	0,00001	0,00000	0,00000
CL	0,00083	0,00017	0,99537	0,00313	0,00050	0,00000	0,00000	0,00000	0,00000	0,00000
M	0,00084	0,00140	0,00246	0,99479	0,00048	0,00002	0,00000	0,00000	0,00000	0,00000
HAA	0,00000	0,00000	0,00001	0,00000	0,99999	0,00000	0,00000	0,00000	0,00000	0,00000
F	0,00059	0,00048	0,00000	0,00000	0,00000	0,99849	0,00038	0,00000	0,00005	0,00000
HVA	0,00004	0,00039	0,00021	0,00000	0,00000	0,00000	0,99936	0,00000	0,00000	0,00000
SNV	0,00000	0,00000	0,00000	0,00000	0,00000	0,00000	0,00000	1,00000	0,00000	0,00000
WL	0,00000	0,00000	0,00000	0,00000	0,00000	0,00000	0,00000	0,00000	1,00000	0,00000
COL	0,00000	0,00000	0,00000	0,00000	0,00000	0,00000	0,00000	0,00000	0,00000	1,00000
	$T_{1,5°}$									
	UA	RA	CL	M	HAA	F	HVA	SNV	WL	COL
UA	0,99905	0,00077	0,00009	0,00000	0,00004	0,00002	0,00000	0,00004	0,00000	0,00000
RA	0,00039	0,99960	0,00000	0,00000	0,00000	0,00000	0,00000	0,00001	0,00000	0,00000
CL	0,00083	0,00017	0,97537	0,00313	0,00050	0,00000	0,01000	0,01000	0,00000	0,00000
M	0,00084	0,00140	0,00246	0,99479	0,00048	0,00002	0,00000	0,00000	0,00000	0,00000
HAA	0,00000	0,00000	0,00001	0,00000	0,98999	0,00000	0,00000	0,01000	0,00000	0,00000
F	0,00059	0,00048	0,00000	0,00000	0,00000	0,97854	0,01038	0,01000	0,00000	0,00000
HVA	0,00004	0,00039	0,00021	0,00000	0,00000	0,00000	0,98936	0,01000	0,00000	0,00000
SNV	0,00000	0,00000	0,00000	0,00000	0,00000	0,00000	0,00000	1,00000	0,00000	0,00000
WL	0,00000	0,00000	0,00000	0,00000	0,00000	0,00000	0,00000	0,01000	0,99000	0,00000
COL	0,00000	0,00000	0,00000	0,00000	0,00000	0,00000	0,00000	0,00000	0,00000	1,00000

$T_{2,5°}$										
	UA	RA	CL	M	HAA	F	HVA	SNV	WL	COL
UA	0,999045	0,000768	0,000095	0,000000	0,000039	0,000016	0,000000	0,000037	0,000000	0,000000
RA	0,000386	0,999601	0,000000	0,000000	0,000000	0,000000	0,000000	0,000013	0,000000	0,000000
CL	0,000832	0,000166	0,965372	0,003132	0,000497	0,000000	0,015000	0,015000	0,000000	0,000000
M	0,000842	0,001403	0,002456	0,984793	0,000481	0,000024	0,010000	0,000000	0,000000	0,000000
HAA	0,000002	0,000000	0,000010	0,000000	0,989988	0,000000	0,000000	0,010000	0,000000	0,000000
F	0,000592	0,000479	0,000000	0,000004	0,000000	0,968544	0,015381	0,015000	0,000000	0,000000
HVA	0,000045	0,000388	0,000212	0,000000	0,000000	0,000000	0,989355	0,010000	0,000000	0,000000
SNV	0,000000	0,000000	0,000000	0,000000	0,000000	0,000000	0,000000	1,000000	0,000000	0,000000
WL	0,000000	0,000000	0,000000	0,000000	0,000000	0,000000	0,010000	0,010000	0,980000	0,000000
COL	0,000000	0,000000	0,000000	0,000000	0,000000	0,000000	0,000000	0,000000	0,000000	1,000000

$T_{>4°}$										
	UA	RA	CL	M	HAA	F	HVA	SNV	WL	COL
UA	0,999045	0,000768	0,000095	0,000000	0,000039	0,000016	0,000000	0,000037	0,000000	0,000000
RA	0,000386	0,999601	0,000000	0,000000	0,000000	0,000000	0,000000	0,000013	0,000000	0,000000
CL	0,000832	0,000166	0,955372	0,003132	0,000497	0,000000	0,020000	0,020000	0,000000	0,000000
M	0,000842	0,001403	0,002456	0,969793	0,000481	0,000024	0,015000	0,010000	0,000000	0,000000
HAA	0,000002	0,000000	0,000010	0,000000	0,979988	0,000000	0,010000	0,010000	0,000000	0,000000
F	0,000592	0,000479	0,000000	0,000004	0,000000	0,958924	0,015000	0,025000	0,000000	0,000000
HVA	0,000045	0,000388	0,000212	0,000000	0,000000	0,000000	0,974355	0,025000	0,000000	0,000000
SNV	0,000000	0,000000	0,000000	0,000000	0,000000	0,000000	0,000000	1,000000	0,000000	0,000000
WL	0,000000	0,000000	0,000000	0,000000	0,000000	0,000000	0,020000	0,020000	0,960000	0,000000
COL	0,000000	0,000000	0,000000	0,000000	0,000000	0,000000	0,000000	0,000000	0,000000	1,000000

Appendix D- Results of TM

1. Results for Kuşadası

K w/o CC												
	UA	RA	CL	M	HAA	F	HVA	SNV	WL	COL	Totral area	Matrix power
2018	1616	2206	3280	0	5880	8352	3904	0	0	0	25237	
2024	1824	2314	3109	0	5751	8344	3896	0	0	0	25237	
2030	2018	2424	2948	0	5624	8335	3888	0	0	0	25238	^2
2036	2200	2536	2794	0	5500	8327	3881	0	0	0	25237	^3
2042	2369	2649	2649	0	5379	8319	3873	0	0	0	25238	^4
2048	2527	2763	2511	0	5261	8310	3865	0	0	0	25237	^5
2054	2674	2879	2381	0	5145	8302	3857	0	0	0	25238	^6
2060	2810	2995	2257	0	5032	8293	3850	0	0	0	25237	^7
2066	2937	3112	2140	0	4921	8285	3842	0	0	0	25237	^8
2072	3055	3230	2028	0	4813	8277	3834	0	0	0	25237	^9
2078	3163	3349	1923	0	4707	8269	3826	0	0	0	25237	^10
2084	3264	3468	1823	0	4603	8260	3819	0	0	0	25237	^11
2090	3356	3588	1728	0	4502	8252	3811	0	0	0	25237	^12
2096	3441	3707	1638	0	4403	8244	3804	0	0	0	25237	^13
2102	3519	3827	1553	0	4306	8236	3796	0	0	0	25237	^14

$K_{1,5°}$												
	UA	RA	CL	M	HAA	F	HVA	SNV	WL	COL	total area	matrix power
2018	1616	2206	3280	0	5880	8352	3904	0	0	0	25237	
2024	1683	2298	3207	0	5809	8344	3896	0	0	0	25237	
2030	1748	2390	3137	0	5740	8335	3888	0	0	0	25238	^2
2036	1811	2481	3068	0	5671	8327	3880	0	0	0	25238	^3
2042	1871	2571	3001	0	5603	8318	3873	0	0	0	25237	^4
2048	1931	2661	2935	0	5535	8310	3865	0	0	0	25237	^5
2054	1988	2751	2870	0	5469	8302	3857	0	0	0	25237	^6
2060	2043	2840	2807	0	5403	8294	3850	0	0	0	25237	^7
2066	2097	2929	2745	0	5339	8285	3842	0	0	0	25237	^8
2072	2150	3017	2685	0	5274	8277	3834	0	0	0	25237	^9
2078	2200	3105	2626	0	5211	8269	3826	0	0	0	25237	^10
2084	2249	3192	2568	0	5149	8260	3819	0	0	0	25237	^11
2090	2297	3279	2511	0	5087	8252	3811	0	0	0	25237	^12
2096	2342	3365	2456	0	5026	8244	3804	0	0	0	25237	^13
2102	2387	3451	2402	0	4965	8236	3796	0	0	0	25237	^14

K2.5°		UA	RA	CL	M	HAA	F	HVA	SNV	WL	COL	total area	matrix power
	1990	1141	359	3995	0	8390	7333	3972	0	47	0	25237	
	2000	2278	925	3870	0	7282	7217	3665	0	0	0	25238	
	2006	1233	2146	2621	0	7052	8863	3282	41	0	0	25237	
	2012	1404	2095	3446	0	5998	8587	3707	0	0	0	25238	
Kusadasi	2018	1616	2206	3280	0	5881	8352	3904	0	0	0	25237	
	2024	1824	2314	3044	0	5692	8177	3972	214	0	0	25237	^1
	2030	2014	2423	2825	0	5510	8005	4037	423	0	0	25237	^2
	2036	2189	2533	2621	0	5333	7837	4097	627	0	0	25237	^3
	2042	2349	2643	2433	0	5163	7672	4151	826	0	0	25237	^4
	2048	2494	2753	2257	0	4998	7511	4204	1020	0	0	25237	^5
	2054	2627	2864	2095	0	4838	7353	4250	1210	0	0	25237	^6
	2060	2760	2994	1945	0	4681	7198	4314	1345	0	0	25237	^7
	2066	2842	3084	1806	0	4529	7046	4333	1597	0	0	25237	^8
	2072	2933	3194	1676	0	4382	6897	4368	1787	0	0	25237	^9
	2078	3015	3313	1556	0	4240	6751	4415	1947	0	0	25237	^10
	2084	3099	3423	1444	0	4103	6608	4452	2108	0	0	25237	^11
	2090	3169	3537	1341	0	3970	6468	4472	2280	0	0	25237	^12
	2096	3228	3647	1245	0	3842	6331	4498	2446	0	0	25237	^13
	2102	3257	3745	1156	0	3718	6197	4550	2614	0	0	25237	^14

$K_{>4}$												
	UA	RA	CL	M	HAA	F	HVA	SNV	WL	COL	total area	matrix power
2018	1616	2206	3280	0	5881	8352	3904	0	0	0	25238	
2024	1829	2313	3012	0	5632	8008	3955	489	0	0	25238	
2030	2022	2420	2766	0	5393	7678	3998	961	0	0	25238	^2
2036	2197	2527	2540	0	5164	7363	4031	1416	0	0	25238	^3
2042	2355	2634	2332	0	4945	7060	4057	1855	0	0	25238	^4
2048	2497	2740	2142	0	4735	6769	4076	2279	0	0	25238	^5
2054	2625	2846	1966	0	4535	6491	4087	2688	0	0	25238	^6
2060	2739	2952	1806	0	4343	6223	4093	3082	0	0	25238	^7
2066	2841	3057	1658	0	4159	5967	4093	3463	0	0	25238	^8
2072	2932	3162	1522	0	3982	5722	4087	3831	0	0	25238	^9
2078	3012	3266	1398	0	3813	5486	4077	4186	0	0	25238	^10
2084	3083	3367	1284	0	3652	5261	4061	4530	0	0	25238	^11
2090	3144	3471	1179	0	3497	5044	4042	4861	0	0	25238	^12
2096	3197	3572	1083	0	3349	4836	4019	5182	0	0	25238	^13
2102	3243	3672	994	0	3207	4637	3993	5492	0	0	25238	^14

2. Results for Toulon Area

T w/O CC												
	EU	ZR	TC	Pr	Am	Fo	V	E	ZH	L	total area	matrix power
1988	37928	727	2670	1330	1312	6463	2329	48	883	161	53852	
1999	38579	724	2596	1325	529	7609	1192	265	873	160	53852	
2006	38574	802	2324	1317	843	7366	1263	336	867	160	53852	
2014	38721	857	2142	1502	866	6662	1641	415	884	162	53852	
2019	38664	946	2156	1484	772	6767	1616	414	873	160	53852	
2024	38635	982	2154	1483	775	6757	1618	415	873	160	53852	
2029	38605	1017	2151	1482	779	6748	1619	417	874	160	53852	^2
2034	38576	1053	2149	1481	782	6738	1621	418	874	160	53852	^3
2039	38547	1088	2147	1480	785	6729	1622	420	874	160	53852	^4
2044	38517	1124	2144	1479	788	6719	1624	421	875	160	53851	^5
2049	38488	1159	2142	1478	792	6710	1625	423	875	160	53852	^6
2054	38460	1195	2138	1477	795	6701	1627	424	875	160	53852	^7
2059	38431	1230	2136	1476	798	6692	1628	426	875	160	53852	^8
2064	38402	1265	2133	1475	801	6683	1630	427	876	160	53852	^9
2069	38373	1301	2131	1474	805	6673	1631	429	876	160	53853	^10
2074	38344	1336	2128	1473	808	6664	1632	431	876	160	53852	^11
2079	38315	1371	2126	1472	811	6655	1634	432	877	160	53853	^12
2084	38285	1407	2124	1471	815	6645	1635	434	877	160	53853	^13
2089	38257	1442	2121	1470	818	6636	1637	435	877	160	53853	^14
2094	38227	1477	2119	1469	821	6627	1638	437	878	160	53853	^15
2099	38197	1511	2120	1469	824	6615	1640	437	879	160	53852	^16
2104	38170	1547	2114	1466	828	6608	1641	440	878	160	53852	^17

$T_{1,5°}$

	EU	ZR	TC	Pr	Am	Fo	V	E	ZH	L	total area	matrix power
1988	37928	727	2670	1330	1312	6463	2329	48	883	161	53852	
1999	38579	724	2596	1325	529	7609	1192	265	873	160	53852	
2006	38574	802	2324	1317	843	7366	1263	336	867	160	53852	
2014	38721	857	2142	1502	866	6662	1641	415	884	162	53852	
2019	38664	946	2156	1484	772	6767	1616	414	873	160	53852	
2024	38635	982	2111	1483	768	6622	1691	537	864	160	53853	
2029	38605	1017	2066	1482	763	6481	1763	659	856	160	53852	^2
2034	38576	1053	2023	1481	759	6342	1832	780	847	160	53853	^3
2039	38546	1088	1981	1479	754	6207	1898	900	839	160	53852	^4
2044	38516	1123	1940	1478	750	6075	1962	1018	830	160	53852	^5
2049	38486	1158	1900	1476	746	5945	2024	1135	822	160	53852	^6
2054	38457	1194	1861	1475	741	5818	2083	1251	813	160	53853	^7
2059	38427	1229	1822	1473	737	5694	2140	1365	806	160	53853	^8
2064	38397	1264	1785	1471	733	5572	2194	1479	797	160	53852	^9
2069	38367	1298	1749	1469	729	5453	2247	1591	790	160	53853	^10
2074	38336	1333	1714	1467	724	5337	2297	1702	782	160	53852	^11
2079	38306	1368	1679	1465	720	5223	2345	1812	774	160	53852	^12
2084	38276	1403	1646	1462	716	5112	2391	1921	766	160	53853	^13
2089	38246	1437	1613	1460	712	5003	2435	2029	758	160	53853	^14
2094	38216	1471	1581	1457	708	4896	2477	2135	751	160	53852	^15
2099	38185	1506	1550	1454	704	4791	2518	2241	743	160	53852	^16
2104	38155	1540	1519	1452	700	4689	2556	2345	736	160	53852	^17

$T_{2.5°}$

	EU	ZR	TC	Pr	Am	Fo	V	E	ZH	L	total area	atrix pow
1988	37928	727	2670	1330	1312	6463	2329	48	883	161	53852	
1999	38579	724	2596	1325	529	7609	1192	265	873	160	53852	
2006	38574	802	2324	1317	843	7366	1263	336	867	160	53852	
2014	38721	857	2142	1502	866	6662	1641	415	884	162	53852	
2019	38664	946	2156	1484	772	6767	1616	414	873	160	53852	
2024	38635	982	2089	1468	768	6555	1759	582	855	160	53853	
2029	38605	1017	2024	1453	763	6349	1896	747	838	160	53852	^2
2034	38575	1053	1962	1437	759	6150	2026	909	822	160	53853	^3
2039	38545	1088	1902	1421	754	5957	2151	1068	806	160	53852	^4
2044	38515	1123	1843	1405	750	5771	2271	1225	789	160	53852	^5
2049	38485	1158	1787	1390	745	5590	2385	1378	774	160	53852	^6
2054	38455	1193	1733	1374	741	5415	2494	1529	758	160	53852	^7
2059	38425	1228	1680	1359	737	5245	2598	1678	743	160	53853	^8
2064	38394	1263	1630	1344	732	5081	2697	1824	728	160	53853	^9
2069	38364	1297	1581	1328	728	4921	2792	1968	713	160	53852	^10
2074	38333	1332	1534	1313	724	4767	2882	2109	699	160	53853	^11
2079	38302	1366	1488	1298	719	4618	2968	2248	685	160	53852	^12
2084	38271	1401	1444	1283	715	4473	3049	2385	671	160	53852	^13
2089	38240	1435	1401	1268	711	4333	3127	2519	658	160	53852	^14
2094	38209	1469	1360	1253	706	4197	3201	2652	645	160	53852	^15
2099	38178	1503	1321	1238	702	4066	3270	2782	632	160	53852	^16

$T_{>4°}$

	EU	ZR	TC	Pr	Am	Fo	V	E	ZH	L	total area	matrix power
1988	37928	727	2670	1330	1312	6463	2329	48	883	161	53852	
1999	38579	724	2596	1325	529	7609	1192	265	873	160	53852	
2006	38574	802	2324	1317	843	7366	1263	336	867	160	53852	
2014	38721	857	2142	1502	866	6662	1641	415	884	162	53852	
2019	38664	946	2156	1484	772	6767	1616	414	873	160	53852	
2024	38635	982	2067	1446	760	6490	1767	708	838	160	53853	
2029	38605	1017	1983	1409	748	6224	1906	996	805	160	53853	^2
2034	38575	1052	1902	1373	736	5969	2035	1278	772	160	53852	^3
2039	38545	1087	1824	1337	725	5724	2154	1554	742	160	53852	^4
2044	38515	1122	1750	1302	713	5490	2263	1825	712	160	53852	^5
2049	38484	1157	1680	1269	702	5265	2363	2089	683	160	53852	^6
2054	38454	1192	1612	1236	691	5049	2455	2348	656	160	53853	^7
2059	38423	1226	1547	1203	680	4843	2538	2602	630	160	53852	^8
2064	38392	1260	1485	1172	669	4644	2614	2851	605	160	53852	^9
2069	38361	1294	1426	1141	659	4454	2683	3094	580	160	53852	^10
2074	38330	1328	1369	1111	648	4272	2745	3332	557	160	53852	^11
2079	38298	1362	1315	1082	638	4097	2800	3565	535	160	53852	^12
2084	38267	1396	1263	1053	628	3929	2849	3793	514	160	53852	^13
2089	38235	1429	1214	1025	618	3769	2893	4016	493	160	53852	^14
2094	38204	1463	1167	998	608	3614	2931	4234	473	160	53852	^15
2099	38172	1496	1121	972	599	3466	2964	4448	454	160	53852	^16
2104	38140	1529	1078	946	589	3325	2992	4658	436	160	53853	^17

a) For Kuşadası area

	UA	RA	CL	HAA	F	HVA	SNV
Kusadasi w/o CC	2200	2536	2794	5500	8327	3881	0
1,5>Kusadasi<2,5°C	1811	2481	3068	5671	8327	3880	0
Kusadasi <2,5 °C	2189	2533	2621	5333	7837	4097	627
Kusadasi 4°C	2197	2527	2540	5164	7363	4031	1416

Kusadasi 2072

	UA	RA	CL	HAA	F	HVA	SNV
Kusadasi w/o CC	3055	3230	2028	4813	8277	3834	0
1,5>Kusadasi<2,5°C	2150	3017	2685	5274	8277	3834	0
Kusadasi <2,5 °C	2933	3194	1676	4382	6897	4368	1787
Kusadasi 4°C	2932	3162	1522	3982	5722	4087	3831

Kusadasi 2102

	UA	RA	CL	HAA	F	HVA	SNV
Kusadasi w/o CC	3519	3827	1553	4306	8236	3796	0
1,5>Kusadasi<2,5°C	2387	3451	2402	4965	8236	3796	0
Kusadasi <2,5 °C	3257	3745	1156	3718	6197	4550	2614
Kusadasi 4°C	3243	3672	994	3207	4637	3993	5492

Evol OCSOL Kusadasi 90-18

	UA	RA	CL	HAA	F	HVA	SNV
1990	1141	359	3995	8390	7333	3972	0
2000	2278	925	3870	7282	7217	3665	0
2006	1233	2146	2621	7052	8863	3282	41
2012	1404	2095	3446	5998	8587	3707	0
2018	1616	2206	3280	5881	8352	3904	0

b) For Toulon area

	UA	RA	CL	M	HAA	F	HVA	SNV	WL	COL
2039 < 1,5°C	38547	1088	2147	1480	785	6729	1622	420	874	160
1,5°C > 2039 <2,5 °C	38546	1088	1981	1479	754	6207	1898	900	839	160
2034 <2,5°C	38545	1088	1902	1421	754	5957	2151	1068	806	160
2039 =4°C	38545	1087	1824	1337	725	5724	2154	1554	742	160

	UA	RA	CL	M	HAA	F	HVA	SNV	WL	COL
2074 < 1,5°C	38344	1336	2128	1473	808	6664	1632	431	876	160
1,5°C > 2074 <2,5 °C	38336	1333	1714	1467	724	5337	2297	1702	782	160
2074 <2,5°C	38333	1332	1534	1313	724	4767	2882	2109	699	160
2074 =4°C	38330	1328	1369	1111	648	4272	2745	3332	557	160

	UA	RA	CL	M	HAA	F	HVA	SNV	WL	COL
2104 < 1,5°C	38170	1547	2114	1466	828	6608	1641	440	878	160
1,5°C > 2104 <2,5 °C	38155	1540	1519	1452	700	4689	2556	2345	736	160
2104< 2,5°C	38147	1537	1282	1224	698	3939	3337	2910	619	160
2104 =4°C	38140	1529	1078	946	589	3325	2992	4658	436	160

Evol OCSOL TPM 88-19

	UA	RA	CL	M	HAA	F	HVA	SNV	WL	COL
1988	37928	727	2670	1330	1312	6463	2329	48	883	161
1999	38579	724	2596	1325	529	7609	1192	265	873	160
2006	38574	802	2324	1317	843	7366	1263	336	867	160
2014	38721	857	2142	1502	866	6662	1641	415	884	162
2019	38664	946	2156	1484	772	6767	1616	414	873	160

Appendix E - Support to Tourism (direct and indirect), selected examples

Subsidy	Beneficiary	Maximum Funding (€) and Funding Method
Limiting the impact of moorings and guaranteeing the sustainable development of nautical activities and tourism	Public organizations	Up to 80% of the study's total cost Capital expenditure: Up to 40% (max €200K)
Strengthening the resilience of the region and its ecological functions, by ensuring their restoration while reducing sources of pressure	Public organizations and associations	Up to 80% of the eligible amount Grant awarded may not exceed a maximum of 80% of the eligible amount
Revealing biodiversity as a source and driver of sustainable, innovative economic development to inject dynamism into all the region's regions	Companies, local authorities, and/or associations	Up to 80% of the eligible amount EU funding rules, particularly the de minimis regulation no. 1407/2013 of 18 December 2013
Adoption by the region of the «Trait de Côtes» scheme, which will also make it possible to rethink the level of service and quality of the seaside tourism offering	EPIC (community of municipalities, agglomerations, metropolises)	Part 1: 50% of the total cost of the project, up to a maximum of €200,000. Part 2: - 30% of the total value of the project, up to a maximum of €3 million for the works -50% of the total cost of the project, up to a maximum of €200,000 for engineering. Part 3: 50% of the total cost of the project, up to a maximum of €200,000 for both works and engineering. EU funding rules, particularly the de minimis regulation no. 1407/2013 of 18 December 2013
Enhancing natural sites	Managers of major tourist sites and «alternative» sites	Strands 1 and 2: -40% maximum of eligible capital expenditure, up to a maximum of €200,000. Strand 3: Maximum 60% of eligible capital expenditure. Maximum €80,000 per project.
Helping to develop out-of-season business tourism	The organisers of the event	Provisional figures for overnight stays and net exhibition area, declared by the promoter (after verification by CR). Overnight stays counted = overnight stays by participants (not exhibitors) exclusively between the 1st day and the last day of the event.
Support for tourist accommodation	All VSEs and SMEs, SCIs or property companies, traditional independent hotels, open-air hotels, holiday villages and centres, and youth hostels	Investment of up to €100,000 at a rate of 60%, supplemented by a Sustainable Development bonus (between €5,000 and €10,000) awarded on presentation of proof of obtaining or renewing an environmental label.
Investour, to grow and consolidate your equity capital	VSEs hiring seasonal workers. SMEs in the tourism sector	Equity loans, between €50,000 and a maximum of €350,000, subject to the de minimis rule.

TABLE E1

Regional Grant available for tourism development in TPM Area

Source : Author's compilation

Subsidy	Target Audience	Funding planned over 5 years (2020-2024)
Promoting tourism in Kuşadası	General public	11,603,825 TL (353,394 €)
Increasing Kuşadası's share of Turkish tourism	Tourists	14,642,923 TL (445,950 €)
Ensuring the development of alternative tourism such as spa tourism	Tourists	42,986,980 TL (1,309,168 €)
Encouraging the development of organic farming	Turkish farmers + Tourists	22,544,608 TL (686,596 €)
Strengthening the twinning with the town of Sinaia (Romania) through sustainable tourism	Municipality of Kuşadası	125,447 (ERDF over 11 months)

TABLE E2

Direct tourism subsidies in Kuşadası district
Source : Author's compilation

Objective	Number of projects/actions	Amount (€)
Reduce bacteriological, chemical, nitrate and pesticide pollution and waste in natural environments	100 projects, 27 project owners	67,300,000
Ensuring sustainable and balanced management of water resources, to better adapt to the effects of climate change	31 projects, 14 project owners	11,400,000
Sustainable management of watercourses and wetlands, in conjunction with risk prevention	52 projects, 8 project owners	5,400,000
Sustainable management of the land-sea interface and the marine environment	37 projects, 14 project owners	4,400,000
Reinforce the integration of «WATER» issues in urban planning documents	4 projects, 4 owners	20,000
TOTAL	**224 projects, 67 project owners**	**88,520,000**

TABLE E3

Specific (local) grant indirectly supporting tourism development in TPM area : Contrat de Baie
Source : Author's compilation

Actions	Amounts (total of actions carried out or planned) € (in euros)
Creating a sustainable mobility plan in line with the metropolitan Urban development plan	6,524,547
Creating gateways to Tombolos and Ayguade-Salins	885,000
Define a landscape policy to upgrade the Grand Site's entrances and roads	65,000
Design and implement an overall information master plan for the Grand Site	Unknown
Enhancing the Hyères salt marsh sites	10,722,000
Define the principles of access, development and management of the Grand Site's beaches	7,800,000 (€780k/y)
Promoting and upgrading the Grand Site's tourism offering	Unknown
Implement a plan to promote the Grand Site's points of interest	25,000
Restoring the public continuity of major walking routes: Coastal footpath	1,390,836
Implement an ecological continuity management plan	1,328,000
Upgrading heritage public spaces in the village of Giens	1,290,812
Upgrading the heritage public spaces of La Tour Fondue	5,269,396

TABLE E4

Specific (local) grant indirectly supporting tourism development in TPM area : Examples of actions undertaken as part of the Opération Grand Site-Giens structuring project (2019-2029)
Source : Author's compilation

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CHAPTER 8. TAX INCENTIVES AND ENERGY TRANSITION FROM A LEGAL POINT OF VIEW: ANALYSIS OF BEST PRACTICES ADAPTED TO THE DECARBONISATION OF THE MEDITERRANEAN REGION

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A wind farm
Credit : FreePik

This chapter aims to answer the question of how to effectively and efficiently use the best mix of fiscal policies to speed up the energy transition process in the Mediterranean Region by considering the existing international legal framework and EU legislation. To do this, a particular attention has been given to the decarbonisation of the electricity supply industry (hereinafter ESI) because electricity is the main energy used for not only industrial production but also for the heating and transportation sectors[155]*. While assessing best policies and fiscal instruments for the Mediterranean region, we focus on effectiveness and efficiency of the incentives provided. Mediterranean countries exhibit diverse legal systems, necessitating tailored fiscal approaches based on socio-political and geo-political factors. The question of which fiscal policies would be the best should be answered by considering the motives, the expected results and country in question. Meanwhile, fiscal incentives should be directed towards the «right renewables», prioritizing support for sources that offer the greatest environmental and societal benefits and/or that have the least impact on local ecosystems and communities (for instance, offshore wind farms require careful consideration of marine protected areas). Overall, to expedite Renewable Energy (RE) deployment, the preference for Feed-in Tariff (FIT) schemes is recommended, emphasising efficient price control and administrative simplicity. Acknowledging the political feasibility of schemes, the adoption of diversified, market-based incentives is also essential, recognizing variations between countries. Introduction of effective carbon taxes is encouraged, with coverage tailored to the majority of greenhouse gas emissions in each country. To mitigate resistance to new taxes, their combination with incentive mechanisms is proposed, along with an exploration of ancillary benefits beyond primary objectives. Even though one of the focus points in this chapter has been the European Union (EU) Legal Framework on State Aid because it is mandatory for Member States to comply with the EU State Aid Rules, the incentive schemes supported for renewable energy generation in this chapter are suitable and applicable in all Mediterranean countries.*

155 David M. Newbery, 'Towards a green energy economy? The EU Energy Union's transition to a low-carbon zero subsidy electricity system – Lessons from the UK's Electricity Market Reform' Applied EnergyEnergy Policy Research Group (EPRG), University of Cambridge, Sidgwick Ave., Cambridge CB3 9DE, UK , 1321.

1. Problem & Statement of Research: introducing the complex interplay between EU state aid law and environmental aid

National parliaments, having fought hard for their authority over taxation throughout history, are cautious when considering delegating this power to the EU[156]. As a result, there are not many tax provisions in the Treaty on the Functioning of the European Union (hereinafter TFEU), and the adoption of measures regarding harmonisation of tax matters requires unanimity in the European Council[157].

The traditional theoretical policies preferred by countries differ when it comes to supporting the Renewable Energy (hereinafter RE) industry. Some countries have adopted policy maximising market-mechanisms. Meanwhile, others are associated with some degree of state dirigisme[158], a term that refers to the willingness of the state to control certain economic activities[159]. Depending on the context, each approach may have its merits. When the targets and numerical limits brought by the Commission's recent proposals regarding RE are taken into account, it is seen that these include elements of state dirigisme as well[160]. On the other hand, in the context of globalization and liberalization, which entail the international movement of capital and the removal of associated barriers, as well as cooperation in tax matters among OECD countries, some degree of openness should also be expected[161].

Estimates point to the fact that the EU can achieve its climate neutrality goal by 2050 if it is possible for Member States to supply at least 30% of the electricity from offshore wind energy[162]. At the same time regarding the installation and sustainable operation of offshore wind turbines, it is essential to consider the Convention for the Protection of the Marine Environment and the Coastal Region of the Mediterranean (hereinafter the Barcelona Convention). Moreover, while trying to achieve carbon neutrality, it is essential to refrain from conventional energy generation methods when they pose soil and water contamination threats under particular circumstances.

1.1. Understanding EU State Aid Law

Article 107 of the TFEU establishes a general rule prohibiting Member States from providing any form of state aid unless it is exceptionally justified. State aid is only considered an issue when it meets four specific requirements outlined in this provision: there must be a transfer of state resources, an advantage for the undertaking, selectivity, and a potential distortion of competition and impact on trade between Member States[163].

The state aid control mechanism, based on Articles 107 and 108 of the TFEU, requires Member States to rely on certain rules in the event that they are to provide financial benefits to economic actors[164]. The Court of Justice of the European Union (CJEU) interprets key concepts like advantage, selectivity, and discrimination within state aid law[165]. In this sense, subsidies and incentive mechanisms to be introduced in the EU countries should be created based on the EU State Aid Rules.

The 2022 Guidelines on State aid for climate, environmental protection, and energy, which

156 R.S.R.F. Mathijsen and P. Dyrberg, Mathijsen's Guide to European Union Law (Sweet& Maxwell, Thomson Reuters,11th edn, 2013) 461

157 ibid.

158 Green, Richard and Adonis Yatchew, 'Support Schemes For Renewable Energy: An Economic Analysis' Economics Of Energy & Environmental Policy, Vol. 1, No. 2, 2012, 84

159 Dictionary Cambridge: Dirigisme < https://dictionary.cambridge.org/dictionary/english/dirigisme >
Oxford Reference: Dirigisme < https://www.oxfordreference.com/display/10.1093/oi/authority.20110810104751557?rskey=8IOPhZ&result=10> accessed 1 January 2024.

160 European Parliament: Briefing requested by the ECON Committee: State Aid: EU's response to the US Inflation Act (IRA), 11. < https://www.europarl.europa.eu/RegData/etudes/IDAN/2023/740087/IPOL_IDA(2023)740087_EN.pdf> accessed 5 January 2024.

161 R.S.R.F. Mathijsen and P. Dyrberg, Mathijsen's Guide to European Union Law (Sweet& Maxwell, Thomson Reuters,11th edn, 2013) 461

162 R Josep Lloret, Paul Wawrzynkowski, Carlos Dominguez-Carrió, Rafael Sardá, Climent Molins, Josep Maria Gili, Ana Sabatés, Josep Vila-Subirós, Laura Garcia, Jordi Solé, Elisa Berdalet, Antonio Turiel, Alberto Olivares, Floating offshore wind farms in Mediterranean marine protected areas: a cautionary tale, ICES Journal of Marine Science, 2023;, fsad131, https://doi.org/10.1093/icesjms/fsad131

163 Leigh Hancher, Tom Ottervanger, Piet Jan Slot, EU Stade Aids (Sweet & Maxwell-Thomson Reuters,4th edn, 2012)813.

164 Isabelle Richelle, Wolfgang Schon, Edoardo Traversa, 'State Aid Law and Business Taxation' (Springer, Berlin& Heidelberg, 2016) 4

165 Ibid.

were published based on a Communication from the Commission[166], outline that compatible aid should not only stimulate economic activity but also incentivize actions aligned with the objectives of the Green Deal without adversely affecting competition and trade[167].

Early EU State aid policy and rules focus on the idea of controlling the amount of subsidies to be granted by public authorities[168]. This is still the case; however, it is seen that in addition to this general idea of prohibition of state aid, the Commission has focused on positive integration of state aid rules as well. Alongside the general principle of prohibiting state aid, the Commission now emphasizes the potential for state aids to serve as instruments for advancing the EU's Climate Change Policy and Sustainability goals. Certain categories of aids or those generating positive externalities may be justified under the EU Commission's practices and the CJEU case law. Therefore, when evaluating best practices for EU countries, adherence to the EU State Aid Rules is crucial. Essentially, any incentives provided by EU Member State authorities must comply with these rules.

According to the Commission notice, fiscal incentives undergo specific tests to determine their status as state aid. These tests involve assessing whether the aid entails favorable tax treatment, the cost of state resources, selectivity, and its impact on competition and trade between Member States[169]. Additionally, Case C-156/98 Germany v. Commission (2000) established that advantages granted by regional or public bodies, or through their resources, also fall under the definition of state aid[170]. It is essential to understand that not all countries in the Mediterranean are obliged to comply with the same state aid rules at the same level. As its very name signifies, the EU State Aid rules are binding for Member States in theory. As regards to candidate countries, each case should be evaluated based on the country's accession level, ongoing negotiations, and approvals.

The EU State Aid Mechanism involves positive and negative integration; positive integration is about giving tax incentives, and negative integration is related with their prohibition. Initially, the EU's perspective was centered around prohibition, but over time, the Commission has established criteria for permissible state aid to facilitate the positive integration process[171]. Since positive integration is a term brought 'from the above', the Commission is regarded as supranational entrepreneur of treaty provisions regarding this matter[172]. In this sense, it is essential to check the Commission's practices while evaluating positive integration of state aid rules or incentives that are promoted by the Commission when it comes to energy transition.

At the EU level, the existing energy taxation rules, based on the Energy Taxation Directive, have not changed since 2003. As part of the EU's Green Deal Package, these rules should have been revised in 2021. From time to time, such revision attempts may fail, or achieving feasible results may take longer than expected due to procedural issues. In other words, traditionally unanimity/ special legislative procedure may be important legal barriers for such revisions. Yet, the recent approaches focus on the idea that by virtue of the TFEU, the EU taxation should be in conformity with the EU's climate objectives; therefore, ordinary legislative procedure by qualified majority voting would be sufficient to adopt proposals rather than unanimity[173].

According to Article 107(3) (c) TFEU, some aids facilitating the development of certain economic

166 Communication from the Commission – Guidelines on State aid for climate, environmental protection and energy 2022 (OJ C 80, 18.2.2022, pp. 1–89)

167 EUR Lex: Summaries of EU Legislation < https://eur-lex.europa.eu/EN/legal-content/summary/2022-guidelines-on-state-aid-for-climate-environmental-protection-and-energy.html> accessed 4 October 2023.

168 Nicola Saccardo, Tsax Implications of Brexit, (Bloomsburry Professional, 1st edn, 2021) 145.

169 Ben J. M. Terra, Peter J. Wattel, European Tax Law (Fifth Edition,Kluwer Law International, 2008)203.

170 İbid,204.

171 Michael Blauberger, 'From Negative to Positive Integration. European State Aid Control through Soft and Hard Law'EUSA Eleventh Biennial International Conference, 23-25 April 2009

172 Ibid, 3.

173 European Commission: Energy Taxation < https://energy.ec.europa.eu/topics/markets-and-consumers/energy-taxation_en> accessed 7 January2024.

activities may be exempted from the general prohibition of state aid[174]. This type of aid, as it is directed to certain sectors, is classified as sectoral aid, and there is no one single legislative instrument covering general sectoral aid rules[175].

1.2. Environmental Aid: Understanding the Legal Framework and Implications

The legal basis of the EC-driven environmental taxes stems from the Polluter Pays Principle (PPP)[176]. Similarly, the EU's current environmental policy is centred around the PPP which is codified under Article 191(2) of the TFEU[177]. The legal framework governing environmental aids is established through CJEU Case Law.

In the Case T-176/01, Ferriere Nord/ Commission, it is seen that environmental aids (aids aimed at environmental protection) are evaluated by virtue of Articles 6[178] and 87 EC and by considering the Community Guidelines adopted by the Commission for assessing such aids[179]. These correspond to Articles 11 and 107 of the TFEU respectively. Moreover, in this case it was stated that the main rules regarding environmental protection and state aid are regulated under the Community Guidelines on State Aid for Environmental Protection[180]. These guidelines do not apply for the state aids granted for nuclear energy even though nuclear power reactors do not produce any greenhouse gas emissions[181]. Also, there are no provisions regarding state aid control in the Euratom Treaty which is a lex specialis[182] [183]. As per Article 192 Euratom Treaty, Member States are obliged to ensure the fulfilment of the treaty measures and refrain from the measures that could jeopardise the achievements in achieving the objectives[184]. The Global Financial Crisis prompted a reevaluation of the EU's approach to state aid, particularly concerning environmental aids. In 2005, the Commission introduced the State Aid Action Plan (SAAP), aiming to refine the economic approach to state aid. Subsequently, in 2008, the General Block Exemption Regulation (GBER) was enacted to decentralize state aid control[185]. Although certain environmental aids fall under the scope of the GBER, their application differs from that of the guideline[186]. The GBER is part of the State Aid Action Plan (hereinafter SAAP) and includes rules governing subjects related to horizontal and regional aid[187]. The SAAP includes four pillars which shape union's current policy: 'Less and Better Targeted Aid' and 'The refined economic approach', 'more effective procedures' and 'shared responsibility between the EU and Member States'[188].

According to Article 101(3) of the TFEU, if conditions are present, Member States are authorised to provide funds without pre-approval or authorisation of the EU Commission[189]. Some environmental aids, such as aid to district heating, waste management, remediation of contaminated sites, relocation of undertakings and tradable emission permit schemes or any forms of operating aid, are excluded from the GBER[190].

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174 Leigh Hancher, Tom Ottervanger, Pıet Jan Slot, EU Stade Aids (Sweet & Maxwell-Thomson Reuters,4th edn, 2012)831.

175 Ibid.

176 Ben J. M. Terra, Peter J. Wattel, European Tax Law (Fifth Edition,Kluwer Law International, 2008)427.

177 The Polluter Pays Principle: Inconsistent application across EU environmental policies and actions, Special Report, 12/2021, the European Court of Auditors <https://op.europa.eu/webpub/eca/special-reports/polluter-pays-principle-12-2021/en/#:~:text=The%20Polluter%20Pays%20Principle%20is,costs%20it%20imposes%20on%20society.> accessed on 21 November 2023.

178 Article 6 (ex Article 3c) Environmental protection requirements must be integrated into the definition and implemen¬ tation of the Community policies and activities referred to in Article 3, in particular with a view to promoting sustainable development'. Consolidated Version of the Treaty Establishing the European Community > < https://eur-lex.europa.eu/legal-content/EN/TXT/?uri=CELEX%3A12002E%2FTXT> accessed 12 January 2024.

179 Case T-176/01, Ferriere Nord/ Commission, Judgement of 18 November 2004, ECR II-3931, 134.
Rene Barents, Directory of EC Case Law on State Aids (Kluwer International, Aalpen aan den Rijn, 2008),221.

180 COMMUNITY GUIDELINES ON STATE AID FOR ENVIRONMENTAL PROTECTION (2008/C 82/01)

181 EIA: Nuclear explained < https://www.eia.gov/energyexplained/nuclear/nuclear-power-and-the-environment.php> accessed 9 January 2024.

182 The principle in legal interpretation that when there are multiple laws or legal provisions that could potentially apply to a situation, the more specific or specialized law takes precedence over the more general one.

183 Leigh Hancher, Tom Ottervanger, Pıet Jan Slot, EU Stade Aids (Sweet & Maxwell-Thomson Reuters,4th edn, 2012)730.

184 Ibid,732.

185 Ibid,3.

186 Ibid,801.

187 Kelyn Bacon, European Community Law of State Aid (2009, Oxford University Press Inc, New York)5.

188 Leigh Hancher, Tom Ottervanger, Pıet Jan Slot, EU Stade Aids (Sweet & Maxwell-Thomson Reuters,4th edn, 2012)7.

189 EUR-Lex: General Block Exemption Regulation < https://eur-lex.europa.eu/EN/legal-content/summary/general-block-exemption-regulation.html> accessed 20 September 2023.

190 Leigh Hancher, Tom Ottervanger, Pıet Jan Slot, EU Stade Aids (Sweet & Maxwell-Thomson Reuters,4th edn, 2012)805.

The State Aid Concept in the EU is seen as a 'living instrument' bringing the Commission's existing policies into existence[191]. In conjunction with this, the GBER has been amended in the light of the EU Green Deal and the new Commission Guidelines[192]. These amendments have enabled Member States to introduce new aids in environmental protection, renewable energy, decarbonization projects, and investments in renewable hydrogen, among others[193]. Together with these amendments, Member States are allowed to regulate energy prices, including the prices of electricity, gas and heat produced from natural gas[194]. It is important to highlight that there is no legal constraint in the EU Legislation for the introduction of Pigouvian taxes or rates for environmental purposes.

2. Research Methodology

In the EU, there is a general rule against state aid, but exceptions and positive integration policies allow for tax incentives. Understanding EU laws, policies, case precedents, and best practices is crucial, especially concerning renewables. To address this, we have used comparative legal research methods to detect the best practices and procedures and suggest the most suitable subsidy implications and fiscal policies for the Mediterranean Countries, considering their socio-economic and geographical similarities and differences.

Our central research question is: **What policy tools and taxation schemes are most suitable for Mediterranean countries to expedite the energy transition and mitigate climate change ?** To delve into this inquiry, the chapter focuses on the decarbonization of the electricity sector, given its direct association with industrial energy consumption, transportation, and heating. Various countries, both developed and emerging, are analyzed for their fiscal methods aimed at achieving climate change targets. Furthermore, changes in policy frameworks, such as the transition from Premium FiTs to standard FiTs, are explored to understand their impact on investor behavior and energy consumers.

3. Research Results

3.1. From the EU State Aid Law Perspective

The EU Green Deal includes key principles for the energy transition, and it is seen that the Commission has adopted several proposals to facilitate taxation policies for reducing GHG emissions[195]. "**The Green Deal Industrial Plan for the Net-Zero Age** (the **Net Zero Plan**) adopted by the European Commission on 23 June 2023, is an important instrument aiming at making the Europe the World's first climate-neutral continent by 2050.

Broadly speaking, **RE Support policies can be classified into three main groups: regulatory policies, fiscal incentives and public financing[196].** In the regulatory policies, electricity companies or consumers tend to pay for renewable power; Feed-in tariff (FIT) schemes, Renewable Portfolio Standards (RPS) Schemes and Tradable Green Certificate (TGC) Schemes are among the most very well-known regulatory policies[197].

The TGC scheme is market-based, and it enables the supplier to buy certificates irrespective of its electricity purchases[198]. Fiscal incentives, Subsidies and tax reductions are among the second group of policies[199]. For the success of the schemes or programmes introduced, it is mostly necessary to support them with second group of policies.

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191 Juan Jorge Piernas López, 'The Evolving Nature of the Notion of Aid under EU Law' European State Aid Law Quarterly , Vol. 15, No. 3 (2016), 400.

192 Such as : the new Regional Aid Guidelines, the Climate, Energy and Environmental State aid Guidelines, the Risk Finance Guidelines, the Research, Development and Innovation Framework and the Broadband Guidelines. EC : State aid: Commission amends General Block Exemption rules to further facilitate and speed up green and digital transition < https://ec.europa.eu/commission/presscorner/detail/en/ip_23_1523> accessed 12 January 2024.

193 EC : State aid: Commission amends General Block Exemption rules to further facilitate and speed up green and digital transition < https://ec.europa.eu/commission/presscorner/detail/en/ip_23_1523> accessed 12 January 2024.

194 State aid: Commission amends General Block Exemption rules to further facilitate and speed up green and digital transition < https://ec.europa.eu/commission/presscorner/detail/en/ip_23_1523> accessed 12 January 2024.

195 European Commission: A Clean Energy Transition < https://commission.europa.eu/strategy-and-policy/priorities-2019-2024/european-green-deal/energy-and-green-deal_en#:~:text=The%20European%20Green%20Deal%20focuses,and%20digitalised%20EU%20energy%20market> accessed 30 December 2023.

196 Green, Richard and Adonis Yatchew, 'Support Schemes For Renewable Energy: An Economic Analysis' Economics Of Energy & Environmental Policy, Vol. 1, No. 2, 2012, 85.

197 Ibid.

198 Ibid.

199 Ibid.

The Community Guidelines on state aid for environmental protection, the GBER and the TFEU cover the main rules regarding environmental aids in the EU[200]. According to the guidelines, it is clear that the Commission exercises its discretion power under the Article 107/3(c) of the TFEU in the event that the environmental state aid in question is compatible with the EU's internal market[201].

The question of when environmental measures could be regarded as state aid under Article 107(1) of TFEU should be answered carefully. According to the existing practice, should the aid in question fulfil the four criteria indicated under this provision, then, it should be treated as state aid. In practice, it is not always easy to detect whether all criteria are fulfilled or not[202].

Considering the CJEU Case Law, the control over sources is among the important point while deciding whether the aid in question constitutes state aid. For instance, even though there is a public/private body established by national laws, the measure can be considered as state aid If the sources are under the control of state[203]. Another important point is that if the fund to support renewable energy companies is financed by relying on compulsory contributions imposed upon electricity consumers, then the transfer of state resources criterion is fulfilled. (For example, the MEP introduced by the Netherlands to back Dutch renewable energy producers and producers of combined heat and power (CHP) was not inconformity with the State Aid Rules, and the Commission decided that this measure was state aid because it was being financed by the compulsory contribution made by all electricity consumers, and thus it was favouring Dutch Energy Producers)[204].
When it comes to environmental aids, it is important to highlight that social[205], economic[206], environmental and health objectives[207], on their own, are not sufficient to escape from the application of Article 87 EC. Moreover, even though the grounds of the protection of the environment and road safety are legitimate, these are not effective reasons taken into account within Article 87(1) EC.

In the Case T-210/02[208], it is highlighted that neither the reasons for nor objectives of the aid, on its own, can be sufficient to remove the aid from the scope of the article[209]. Fiscal nature, social or economic aims related with the protection of environment or of human safety cannot be a sole excuse to refrain from the Article 87(1) EC[210]. Justification for an aid can be possible under Article 87(3) EC in the event that the measure is compatible with the common market[211]. Within this concept, the classification of the aid measures under Article 87 EC is not made by considering national laws, rather this classification is made in a community context[212].

3.2. The EU Emission Trading Scheme (ETS)

All Member States, Iceland, Norway and Liechtenstein are included in the EU's ETS

200 Leigh Hancher, Tom Ottervanger, Pıet Jan Slot, EU Stade Aids (Sweet & Maxwell-Thomson Reuters,4th edn, 2012)801.

201 Ibid,804.

202 Ibid,813.

203 Case C-206/06 Essent Netwerk Noord v Aluminium Delfzijl (2008) ECR I-05497, para 70.
Leigh Hancher, Tom Ottervanger, Pıet Jan Slot, EU Stade Aids (Sweet & Maxwell-Thomson Reuters,4th edn, 2012)813.

204 State Aid N 707/2002, The Netherlands MEP (Stimulating renewable energy) (2003) O.J. C148/11
State Aid N 708/2002, The Netherlands MEP (Stimulating combined heat and power production (CHP)) (2003), O.J. C148/11.
Leigh Hancher, Tom Ottervanger, Pıet Jan Slot, EU Stade Aids (Sweet & Maxwell-Thomson Reuters,4th edn, 2012)814.

205 Case C-172/03, Wolfgang Heiser, Judgement of 3 March 2005, ECR I-143, 46.
Rene Barents, Directory of EC Case Law on State Aids (Kluwer International, Aalpen aan den Rijn, 2008),43.
Case C-56/93, Belgium/ Commission, Judgement of 29 February 1996, ECR-I723, 79.
Case C-24/94 France/ Commission (Kimberly Clark), Judgement of 26 September 1996, ECR-I-4551,21.
Rene Barents, Directory of EC Case Law on State Aids (Kluwer International, Aalpen aan den Rijn, 2008),42.

206 Joined cases 6/69 and 11/69, Commission/France, Judgement of 11 December 1969, ECR 523, 20-21
Rene Barents, Directory of EC Case Law on State Aids (Kluwer International, Aalpen aan den Rijn, 2008),41

207 Case T-109/01, Fleuren Compost/ Commission, Judgement of 14 January 2004, ECR II-127, 54.
Rene Barents, Directory of EC Case Law on State Aids (Kluwer International, Aalpen aan den Rijn, 2008),43.

208 Case T-210/02, British Aggregates Association/ Commission, Judgement of 13 September 2006, ECR II-2789, 106.
Rene Barents, Directory of EC Case Law on State Aids (Kluwer International, Aalpen aan den Rijn, 2008),41.

209 Rene Barents, Directory of EC Case Law on State Aids (Kluwer International, Aalpen aan den Rijn, 2008),41

210 Ibid.

211 Case T-67/94, Landbroke Racing/ Comission, Judgement of 27 January 1998, ECR II-1, 52.
Rene Barents, Directory of EC Case Law on State Aids (Kl uwer International, Aalpen aan den Rijn, 2008),41

212 Case T-459/93, Siemens/ Commission, Judgement of 8 June 1995, ECR II-1675, 76.
Rene Barents, Directory of EC Case Law on State Aids (Kluwer International, Aalpen aan den Rijn, 2008),41

working based on the 'cap and trade' principle[213]. While the ETS has achieved notable procedural and practical success, its effectiveness in redirecting energy investments is limited due to relatively low prices and incomplete coverage of greenhouse gas (GHG) emissions[214]. To enhance the energy transition process, it is essential to complement the ETS with effective carbon taxes. The link between carbon taxes and the GHG emissions are worth mentioning. In fact, carbon taxation can be the issue for different types of GHGs (e.g.carbon dioxide, methane, nitrous oxide and fluorinated gases)[215]. Therefore, it is possible to see different types of carbon taxes from one country to another. This also means that not all GHGs are covered by the carbon taxes introduced, and it is essential to design carbon taxes covering the vast majority of the GHGs.

3.3. Case Studies

For **environmental protection purposes, certain state aid measures may be declared compatible with the common market** as indicated under the Community Guidelines on State Aid for Environmental Protection (OJ 1994 C 72, p.3)[216].

Previous guidelines did not include specific provisions and therefore, an environmental aid was assessed directly based on Article 107/3(c) of the TFEU[217]. The Commission has developed the balancing test to assess whether an aid is compatible with the internal market or not; this test has been applied to environmental aids thanks to the guidelines[218]. While applying this test, the commission considers the SAAP focusing on the economic effects of aid[219]. This test requires that the positive effects of the environmental aid must outweigh the negative effects on the market[220].

Subsidies and taxation represent distinct concepts: subsidies entail fiscal support, while taxation involves financial burdens[221]. However, the CJEU case law indicates that state aid can be granted as a part of taxation as well. Case 30/59 (Gezamenlijke Steenkolenmijnen), judgment of 23 February 1961, ECR 1961, p. 1 (19). Therefore, while making suggestions as to the most suitable fiscal applications for the Mediterranean countries, it is important to consider the CJEU Case Law and country specific taxation rules as well. Even though some countries in the region are not part of the EU, similar perspectives on the prohibition of state aid mechanisms may apply.

For projects aiming to enhance economic productivity while also bolstering environmental protection through the adoption of new or upgraded equipment, the environmental aspect of the investment may only be considered partially valid if it is evident that the same economic outcomes could have been achieved using less costly and more environmentally harmful equipment[222].

Our research shows that :

- **Tax incentives and subsidies are of particular importance for RE investments. In Denmark,** market share of renewables showed a significant increase from 5 percent to 30 percent in Denmark between 1995 and 2010. It is seen that during this process, Denmark, of which primary RE generation is onshore wind power, supported the RE generation thanks to various subsidies and tax incentives. Offshore wind tribunes were promoted thanks to tender schemes[223].
- **FIT schemes are more successful than the other schemes. Nonetheless, it's crucial**

213 European Commission: What is the EU ETS < https://climate.ec.europa.eu/eu-action/eu-emissions-trading-system-eu-ets/what-eu-ets_en> accessed 30 December 2023.

214 Green, Richard and Adonis Yatchew, 'Support Schemes For Renewable Energy: An Economic Analysis' Economics Of Energy & Environmental Policy, Vol. 1, No. 2, 2012, 84.

215 Tax Foundation: Carbon Taxes in Europe < https://taxfoundation.org/data/all/eu/carbon-taxes-in-europe-2023/> accessed 30 December 2023.

216 Case C-143/99, Adria- Wien Pipeline and Wietersdorfer & Peggasuer Zementwerke, Judgement of 8 November 2001, ECR I-8365, 31.
Rene Barents, Directory of EC Case Law on State Aids (Kluwer International, Aalpen aan den Rijn, 2008),222.

217 Leigh Hancher, Tom Ottervanger, Piet Jan Slot, EU Stade Aids (Sweet & Maxwell-Thomson Reuters,4th edn, 2012)804.

218 Ibid,810.

219 Ibid,811.

220 Ibid,812.

220 Ibid,812.

221 Isabelle Richelle, Wolfgang Schon, Edoardo Traversa, 'State Aid Law and Business Taxation' (Springer, Berlin& Heidelberg, 2016) 4

222 Case t-176/01, Ferriere Nord/Commission, Judgement of 18 November 2004, ECR II-3931, 151.
Rene Barents, Directory of EC Case Law on State Aids (Kluwer International, Aalpen aan den Rijn, 2008),222.

223 Green, Richard and Adonis Yatchew, 'Support Schemes For Renewable Energy: An Economic Analysis' Economics Of Energy & Environmental Policy, Vol. 1, No. 2, 2012, 90.

to bolster FIT schemes with additional supportive measures. In Germany, after the introduction of FIT programme in early 1990s, the share of Renewables increased from 4 percent onwards to 6 percent onwards. Additionally, there was a shift in grid access responsibility, transitioning from utilities to grid operators. This shift streamlined operations for companies, facilitating market entry for new players, as utilities were previously resistant to expansion efforts[224]. Together with the FIT programme, the actual cost of RE was taken into account while FIT remuneration rates were being calculated. As a result, the share of renewables reached 16 per cent by 2010[225].

- **Because FIT schemes are simple, they enable small companies to operate easily[226]. For example, in Spain,** the renewable energy share in electricity generation, primarily hydropower, rose to over 15 percent by 2005. Between 2005 and 2010, it surged to 33 percent due to an aggressive renewable energy plan that allowed generators to boost their income by participating in the wholesale market[227]. The Spanish authorities managed increasing generation costs by controlling the trade deficit in the market. Ratepayers were shielded from the tariff deficit, as it was recovered through future rates[228]. Reductions in tariffs were implemented by the legislator to regulate the market, providing predictability for those entering the renewable energy market.
- **Feed-in Tariffs are successful applications in practice. The UK's** FiTs serve as a notable example for two key reasons. Firstly, the UK has set stricter emission objectives compared to the EU, driving a stronger commitment to renewable energy (RE) adoption[229]. Secondly, the UK has prioritized lowering the cost of finance as a cornerstone of its energy transition policy, facilitating the transition to renewables[230]. Initially, the UK implemented Premium Feed-in Tariffs (FiTs), which later transitioned to a system closer to standard FiTs[231]. However, challenges emerged in the 1990s due to the non-fossil fuel obligation mandating electricity retailers to purchase RE for new capacities[232]. Despite numerous tenders, many winning bids failed due to difficulties in obtaining planning permissions, leading to an array of abandoned schemes. In this sense, many tenders were organised, and even the winning bids failed because developers could not receive planning permissions[233]. Also, due to over-optimistic bids, many developers abandoned their schemes. (Among the 302 winning wind schemes, only 75 of them were built)[234]. The UK's initial policy relied heavily on financing renewables solely through the electricity industry and companies, passing costs on to customers[235]. In 2002, the Renewables Obligation Scheme was brought[236]. However, this complex Tradable Green Certificate (TGC) scheme fell short of achieving the UK's targets[237]. In response, a FiT regime for small RE generators was implemented in 2010. Additionally, the contract for difference scheme, which pays generators the difference between an agreed support price and a reference market price, was planned to further support renewable energy development[238].

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224 Green, Richard and Adonis Yatchew, 'Support Schemes For Renewable Energy: An Economic Analysis' Economics Of Energy & Environmental Policy, Vol. 1, No. 2, 2012, 91.

225 Ibid.

226 Ibid.

227 Ibid.

228 Ibid.

229 David M. Newbery, 'Towards a green energy economy? The EU Energy Union's transition to a low-carbon zero subsidy electricity system – Lessons from the UK's Electricity Market Reform' Applied EnergyEnergy Policy Research Group (EPRG), University of Cambridge, Sidgwick Ave., Cambridge CB3 9DE, UK , 1321.

230 Ibid, 1322.

231 Ibid, 1321.

232 Green, Richard and Adonis Yatchew, 'Support Schemes For Renewable Energy: An Economic Analysis' Economics Of Energy & Environmental Policy, Vol. 1, No. 2, 2012, 91.

233 Ibid, 92.

234 Ibid, 92.

235 Ibid, 84.

236 Ibid, 92.

237 Ibid, 95.

238 Ibid, 92.

- **Overall assessment of the FIT: Various support mechanisms exist for financing renewable energy,** aligning with objectives outlined in the Paris Agreement to reduce the carbon intensity of economic activity. Decarbonizing the Energy Sector Infrastructure (ESI) is essential, supported by the EU's Energy Union Packages advocating for renewable integration into the market[239]. Long-term fiscal and energy policies are crucial to supporting energy transition in line with Climate Change Targets. **Aggressive Feed-in Tariff (FIT) programs swiftly boost renewable energy (RE) shares and presence.** However, in the long term, it is essential to monitor potential rate increases[240]. Between 1990 and 2010, there is an overall significant increase in market shares of Renewables in Denmark, Germany and Spain[241]. These countries applied evolving and aggressive FIT programmes during this process while the UK and the State of Texas preferred TGC and RPS programmes respectively. While the UK and Texas saw more modest gains in market shares during this period[242], FIT programs proved to be more efficient overall. **In the quota-based scheme,** key parameters are controlled by the government. RE Provider bears some risks, including, but not limited to output price risk, demand risk, cost risk, political risks and regulatory risks[243]. FIT and quota regimes differ in terms of risk management; while the FIT regime mitigates price and demand risks, such risks are mitigated in quota regimes only if long-term contracts are provided[244]. Statistics clearly indicate that energy transition related investments are increasing if required subsidies or tax incentives are provided. It is also known that incentivising the use of renewable sources is not enough on its own. Also, it is necessary to disincentivise environmentally hazardous energy generation methods. To do this, subsidies and incentives for the environmentally hazardous activities should be limited or completely removed. Also, by considering the Pigouvian approach, effective carbon taxes should be introduced for the carbon intensive industries[245].

3.4. The Barcelona Convention: a key framework to devising effective and sustainable decarbonization strategies for the Mediterranean

Fiscal incentives should be directed towards the «right renewables», prioritizing support for sources that offer the greatest environmental and societal benefits (and/or that have the least impact on local ecosystems and communities).

In the EU, national governments have the authority to choose their energy sources and decide on subsidies and taxation for renewable energy (RE). The only exception to this rule is the binding national targets, which are set at the EU level[246]. When considering the most effective fiscal incentives to promote the decarbonization of electricity in the Mediterranean Region as a whole, including non-EU countries, it is important to take into account the EU State Aid Mechanism as well as the Barcelona Convention and its protocols. Specifically :

- The Barcelona Convention and its protocols offer a comprehensive framework on pollution, green economy, sustainable energy and sustainable consumption and production[247]. The contracting parties to the Barcelona Convention are as follows: Albania, Algeria, Bosnia and Herzegovina, Croatia, Cyprus, Egypt, France, Greece, Israel, Italy,

239 David M. Newbery, 'Towards a green energy economy? The EU Energy Union's transition to a low-carbon zero subsidy electricity system – Lessons from the UK's Electricity Market Reform' Applied EnergyEnergy Policy Research Group (EPRG), University of Cambridge, Sidgwick Ave., Cambridge CB3 9DE, UK , 1321.

240 Green, Richard and Adonis Yatchew, 'Support Schemes For Renewable Energy: An Economic Analysis' Economics Of Energy & Environmental Policy, Vol. 1, No. 2, 2012, 91.

241 Ibid, 90.

242 Ibid, 90.

243 Ibid, 89.

244 Ibid, 89.

245 Zubeyde Senturk Ulucak and Ali Gokhan Yucel, 'Can renewable energy be used as an effective tool in the decarbonization of the Mediterranean region: fresh evidence under cross-sectional dependence' Environmental Science and Pollution Research (2021) 28:52082–52092 https://doi.org/10.1007/s11356-021-14350-2 , p. 52089

246 M. Villar Ezcurra: State Aid Law and Business Taxation (Springer, Vol:6, Berlin Heidelberg 2016) 198

247 IIDS: SDG Knowledge Hub < https://sdg.iisd.org/commentary/guest-articles/spring-boarding-from-ocean-conservation-to-sustainable-development-the-barcelona-convention/> accessed 6 October 2023.

Lebanon, Libya, Malta, Monaco, Montenegro, Morocco, Slovenia, Spain, Syrian Arab Republic, Tunisia, Türkiye, and the European Union[248].

- Given that the European Union is a party to the convention, this chapter has primarily focused on existing EU legislation, especially state aid rules, when designing fiscal incentives and new policy tools to accelerate the energy transition process in the Mediterranean. It is worth noting that state aid rules may also apply to some candidate countries based on their accession level and policies.
- According to Article 2 of the Barcelona Convention, the term 'pollution' covers substances or energy introduced by man into the marine environment. Also, installation and operation of offshore wind farms requires careful consideration of marine protected areas. Understanding the implications of offshore wind farm installations on marine protected areas is integral to devising effective and sustainable decarbonization strategies for the Mediterranean. With approximately 70% of the world's surface covered by water, offshore solar and wind farms are likely to become increasingly important projects in the coming years. However, currently, there is limited scientific data on how the construction and operation of offshore wind farms (OWFs) specifically impact the Mediterranean Region[249]. Some studies suggest that lessons learned from Northern Europe can guide us in identifying the most suitable locations for OWFs in the Mediterranean. Additionally, we can look at the effects of existing OWFs operating in Northern European Seas as a reference to predict potential outcomes in the Mediterranean[250]. For example, researchers at the University of Southampton conducted studies examining the underwater impacts of offshore wind farms (OWFs) on the marine environment. They focused on OWFs in Denmark and Sweden, where scientists observed minimal negative impacts on the marine environment[251]. Presently, OWFs are strategically installed near electricity grids and in areas where water depths do not exceed 15 meters, mainly due to technical considerations[252]. The seabed space allocated for wind turbines, approximately 5 meters in diameter, and the wide spacing between turbines generally do not adversely affect seabed habitats, provided that construction processes adhere to established standards[253].

Wind farm field
Credit : FreePik

248 UNEP: Contracting Parties < https://www.unep.org/unepmap/who-we-are/contracting-parties> accessed 18 March 2024.

249 Laura Bray, Sofia Reizopoulou, Evangelos Voukouvalas, Takvor Soukissian,Carme Alomar, Maite Vázquez-Luis, Salud Deudero, Martin J. Attrill andJason M. Hall-Spence, 'Expected Effects of Offshore Wind Farms on Mediterranean Marine Life' Journal ofMarine Science and Engineering, MDPI,2.

250 Ibid,3.

251 Certified Final Report Volume I, Byrne Ó Cléirigh Ltd, Ecological Consultancy Services Ltd (EcoServe) School of Ocean and Earth Sciences, University of Southampton 'Assessment of Impact of Offshore Wind Energy Structures on the Marine Environment'i.

252 Ibid.

253 Ibid.

Potential Effects	Related International Legal Framework
Some scholars argue that OWFs could cause serious risks to the **seabed and diversity in the Mediterranean**[254]. However, as of today, there is a **lack of scientific data** regarding how the OWFs and their construction could affect the Mediterranean Region[255]. Furthermore, as is indicated by the EU, **there is a general lack of data regarding parties' monitoring and reporting**, even though these are obligations listed under the Barcelona Convention[256]. • **OWFs:** **-Effects on Resident and Migrating birds:** It is known that wind farms may affect resident and migrating birds hazardously. Yet, it is not easy to monitor this situation for the OWFs. For seabirds, studies in the North show that the seabird population is adversely affected by OWFs[257]. **-Effects on Marine Mammals:** The lack of data is considered as a major problem by researchers while assessing this. Some potential hotspots for the OWFs, such as the Gulf of Lion, might be home to many kinds of resident marine mammals which are to be affected hazardously by the OWFs. Additionally, existing OWFs in Scotland have been observed to negatively impact dolphin populations[258]. **- Effects on Fish Communities:** Electromagnetic fields occurring in the OWFs may adversely affect the fish population[259]. **-Effects on Benthic Communities and the Mediterranean Planktonic Communities** can be the case depending on farm projects[260].	The legal framework regarding offshore wind and solar farms varies from one country to another. For example, whether offshore wind farms (OWFs) are permitted in Marine Protected Areas (MPAs) depends on the specific regulations of each country[261]. All parties to the Barcelona Convention and related protocols are among the 193 United Nation Member States that unanimously adopted the SDGs[262] [263]. Though the SDGs are not legally binding, national frameworks are expected to be in conformity with these goals[264]. • The Portoroz Ministrerial Declaration, an important outcome of the COP23,highlights the COP23 Agenda and parties' commitments to the decarbonisation goals and protection of the coastal and marine areas[265]. • As is indicated in the foreword of the Barcelona Convention, the convention covers Rio Conference's key concepts including 'the sustainable development, the precautionary principle, integrated coastal management, the use of best available techniques and best environmental practices and the promotion of environmentally sound technology. • On the other hand, t**he Paris Climate Change Agreement** is a legally binding international treaty signed by all parties to the Barcelona Convention[266]. According to this agreement, parties to the convention are expected to comply with the nationally determined contributions (NDCs), reduce their greenhouse gas emissions and report their emissions as well as their efforts to reduce them on a regular basis. (Article 4 of the Paris Agreement). While Article 2/ 1(b) of the Paris Agreement refers to low greenhouse gas emissions development, Article 2/1(c) points to the fact that finance flows are expected be in conformity with 'a pathway towards low greenhouse gas emissions and climate-resilient development.'. This obligation may be interpreted in a way that **fiscal incentives and mechanisms to be designed by the parties should comply with the aims of the convention and support transition process.** Even though the Paris Agreement relies on equity and the principle of common responsibilities as a general rule, there is a clear reference to the different national circumstances (Article 2/3). In parallel with this, it is seen that some of the obligations, such as nationally determined contributions, are expected to be in line with the country classification which is as follows: developed countries, developing countries and the least developed counties and small island developing states.(Article 4 paragraphs 4 &6).

254 Josep Lloret, Antonio Turiel, Jordi Solé, Elisa Berdalet, Ana Sabatés, Alberto Olivares, Josep-Maria Gili, Josep Vila-Subirós, Rafael Sardá, 'Unravelling the ecological impacts of large-scale offshore wind farms in the Mediterranean Sea' Science of The Total Environment,Vol.824,2022,1.

255 Laura Bray, Sofia Reizopoulou, Evangelos Voukouvalas, Takvor Soukissian,Carme Alomar, Maite Vázquez-Luis, Salud Deudero, Martin J. Attrill andJason M. Hall-Spence, 'Expected Effects of Offshore Wind Farms on Mediterranean Marine Life' Journal ofMarine Science and Engineering, MDPI,2.

256 IISD Bulletin: Summary Report 5-8 December 2023, 23rd Meeting of the Contracting Parties to the Barcelona Convention (COP 23), < https://enb.iisd.org/barcelona-convention-cop23-summary> accessed 6 April 2024.

257 Laura Bray, Sofia Reizopoulou, Evangelos Voukouvalas, Takvor Soukissian,Carme Alomar, Maite Vázquez-Luis, Salud Deudero, Martin J. Attrill andJason M. Hall-Spence, 'Expected Effects of Offshore Wind Farms on Mediterranean Marine Life' Journal ofMarine Science and Engineering, MDPI,3.

258 Ibid,6.

259 Ibid,8.

260 Ibid,9-10.

261 For instance, according to the general rule in France, OWFs are not built in MPAs. However, it is seen that the legal framework includes some exeptions as well. Josep Lloret, Paul Wawrzynkowski, Carlos Dominguez-Carrió, Rafael Sardá, Climent Molins, Josep Maria Gili, Ana Sabatés, Josep Vila-Subirós, Laura Garcia, Jordi Solé, Elisa Berdalet, Antonio Turiel, Alberto Olivares, Floating offshore wind farms in Mediterranean marine protected areas: a cautionary tale, ICES Journal of Marine Science, 2023;, fsad131, 2

262 United Nations: Member States, < https://www.un.org/en/about-us/member-states> accessed 22 March 2024.

263 Article 21(1) of the Treaty on European Union refers to 'respect for the principles of the United Nations Charter'. . The EU also has observer status in the UN General Assembly. The European Commission: EC Library Guides, <https://ec-europa-eu.libguides.com/EU-and-UN> accessed 22 March 2024.

264 UN Sustainable Development Goals: Agenda, < https://www.un.org/sustainabledevelopment/development-agenda-retired/#:~:text=While%20the%20SDGs%20are%20not,achievement%20of%20the%2017%20Goals.> accessed 22 March 2024.

265 IISD Bulletin: Summary Report 5-8 December 2023, 23rd Meeting of the Contracting Parties to the Barcelona Convention (COP 23), < https://enb.iisd.org/barcelona-convention-cop23-summary> accessed 6 April 2024.

266 UN Paris Climate Change Agreement,, < https://www.un.org/sustainabledevelopment/blog/2016/04/parisagreementsingatures/> accessed 22 March 2024.

Potential Effects	Related International Legal Framework
• **OSFs:** Floating PV farms have the potential to reduce the amount of heat reaching the water by blocking the sea surface[266]. Scientists are exploring whether this characteristic of floating farms could be utilized to mitigate the rising water temperatures in the Mediterranean Sea, which pose a significant threat to marine ecology. It is of paramount importance to assess the large-scale FPV farms and their affects on dissolved oxygen levels and number of planktones[267]. Due to lack of data, monitoring approaches should be developed especially for the large-scale FPV farms and OWFs. In this way, the precautionary principle can be successfully implemented. Offshore farms can be preferred for many reasons; especially valuable lands can be used for many other purposes when water areas are used to meet the area requirements for these farms[268]. The initial studies examining the impacts of offshore solar installations on the marine ecosystem were conducted in the Netherlands. While significant differences were observed between the marine life underneath the solar farms and reference sites, scientists cautioned against making generalizations due to insufficient data. Moreover, offshore solar structures are known to impact marine life, particularly due to biofouling. This raises questions about specific operational farms, such as whether floating structures could lead to the enrichment of organic material. This is because floating PV farms have the potential to reduce heat reaching the water and block the sea surface[269].	By considering protocols and legal obligations listed under the **Barcelona Convention**, it can be argued that installation and operation of the offshore wind and solar farms require careful consideration of marine protected areas (MPAs). • **Article 2 of the Barcelona Convention** defines what pollution means in the context of the convention. According to this, the term pollution refers to 'the introduction by man, directly or indirectly, of substances or energy into the marine environment, including estuaries, which results, or is likely to result, in such deleterious effects as harm to living resources and marine life, hazards to human health, hindrance to marine activities, including fishing and other legitimate uses of the sea, impairment of quality for use of seawater and reduction of amenities.' In this sense, the term pollution can be interpreted widely as it covers not only direct or indirect introduction of substances but also of energy into the marine environment. • When the **Barcelona Convention** and its protocols are considered, it is seen that offshore installations are regulated specifically under the Protocol for the Protection of the Mediterranean Sea against Pollution Resulting from Exploration and Exploitation of the Continental Shelf and the Seabed and its Subsoil (hereinafter Barcelona Offshore Protocol) adopted on 14 Actober 1994. By virtue of **Article 1 (f) of this protocol**, installation refers to 'any fixed or floating structure, and any integral part thereof, that is engaged in activities, including, in particular: (ı)Fixed or mobile offshore drilling units; (ıı)Fixed or floating production units including dynamically-positioned units;...' **Article 15(3) of this protocol** necessitates a certificate of safety and finess for the production platforms, mobile drilling units, offshore storage facilities,loading systems and such other installations. As per Article 20(1) of this protocol, removal of such installations require careful consideration of existing guidelines. For instance: IMO's Guidelines for the removal of offshore installations and Standards can be an important guideline in this sense. • **As per Article 2(f) of the Protocol on Integrated Coastal Zone Management in the Mediterranean,** integrated coastal zone management refers to 'the sustainable management and use of coastal zones, taking into account at the same time fragility of coastal ecosystems and landscapes, the diversity of activities and uses, their interactions, the maritime orientation of certain activities and uses and their impact on both the marine and land parts.' • **Article 2 of the Protocol concerning Specially Protected Areas and Biological Diversity in the Mediterranean** highlights the geographical coverage of the protocol. According to this, the protocol covers the seabed, its subsoil, the waters, the terrestrial coastal areas an so on. The following provisions includes general obligations under the protocol, requiring parties to take the necessary measures to protect, preserve and manage specifically protected areas and threatened or endangered species of flora and fauna. (Article 3/1 (a) & (b)).

TABLE 1

Potential Effects of Wide-Scale Offshore Wind Farms (OWFs) or Offshore Solar Farms (OSFs)

267 Brigitte Vlaswinkel, Pauline Roos and Mei Nelissen, 'Environmental Observations at the First Offshore Solar Farm in the North Sea'Sustainability 2023, 15, 6533. https://doi.org/10.3390/su15086533

268 Ibid.

269 Ibid.

270 Ibid.

4. Policy implications and recommendations

There are different methods of supporting renewable energy industries. **The question of which fiscal policies would be the best should be answered by considering the motives[271], the expected results and country in question as well.**

Member states are required to factor in the incentive effect and proportionality when designing their incentive mechanisms. The incentive effect refers to conducting counterfactual analyses to assess the situation with and without aid. It should be evident that the investment or action generating positive externalities would not have occurred without the aid. Therefore, the authority providing the aid is expected to gather the necessary evidence to demonstrate this[272]. Proportionality only exists once the same environmental result would not have been achieved with less aid[273].

Achieving a green economy involves reducing greenhouse gas emissions, particularly through decarbonizing industrial renewable energy (RE) usage. Various policy instruments exist for supporting energy transition, some more effective than others.

4.1. Best and Worst Practices

In the realm of **Best Practices**, we recommend :

- **Adopting a Pigouvian Approach[274]:** it is necessary to disincentivise environmentally hazardous energy generation methods. Effective carbon taxes should be introduced for the carbon intensive industries. While some countries tend to adopt existing policies applied by their neighbours, others may come up with new policies[275], or they may choose to apply a mix of different policies to speed up their energy transition process. Some countries may easily introduce and apply environmental taxes, e.g. Finland, Sweden, Norway, Denmark introduced carbon tax in the early 1990s[276].
- **FIT Schemes:** According to the European Commission, the feed-in tariff schemes are mostly the most efficient and effective support schemes for promoting and supporting renewable electricity[277]. This can be true in many contexts. However, depending on the results aimed at, other schemes can be preferred as well. Not all FIT programmes are efficient or successful. Some State based RPS Programs in the USA and national FIT programs in Europe limit inter jurisdictional gains from carbon trade[278]. Also, tariffs that do not encourage production cause inefficiencies[279]. Deployment of generation points away from the loads would increase inefficiencies as well. In addition to these, FIT Schemes increase rapid deployments and reduce risks from the renewable generator; on the other hand, they could increase the financial burden on tax/rate payers. Residential electricity prices in selected countries increased dramatically[280].

In the realm of **Worst Practices**, we recommend avoiding :

- **Complex aid or incentive mechanisms:** Such mechanisms prevent SMEs or small potential RE Generators from entering the market. It is already known that SMEs may not have sufficient know-how base for reducing their

271 Green, Richard and Adonis Yatchew, 'Support Schemes For Renewable Energy: An Economic Analysis' Economics Of Energy & Environmental Policy, Vol. 1, No. 2, 2012, 84

272 Leigh Hancher, Tom Ottervanger, Piet Jan Slot, EU Stade Aids (Sweet & Maxwell-Thomson Reuters,4th edn, 2012)811.

273 Ibid,812.

274 Refers to a concept in economics that suggests imposing taxes or levies on activities that cause negative externalities, like pollution, to discourage them. It aims to make those responsible for the negative effects pay for them.

275 Green, Richard and Adonis Yatchew, 'Support Schemes For Renewable Energy: An Economic Analysis' Economics Of Energy & Environmental Policy, Vol. 1, No. 2, 2012, 84

276 Ibid,84.

277 Ibid,95.

278 Ibid,86.

279 Ibid,86.

280 Ibid,96.

tax burden[281]. A facilitating framework is essential for supporting SMEs.

- **Complex Carbon Trading Mechanisms:** Elaborate carbon trading policies benefit big companies by creating barriers to entry. Simpler rules would be more advantageous for small and medium-sized enterprises (SMEs)[282].
- **Subsidies provided for hazardous energy generation methods:** Subsidies or fiscal incentives for hazardous energy generation methods as well as conventional energy generation methods should be limited.

4.2. Recommendations tailored to Mediterranean Countries

The Mediterranean Region comprises diverse countries with varying legal systems, particularly concerning taxation and energy laws. Different countries adopt different fiscal approaches to support renewable electricity generation based on their socio-political and geo-political contexts. In the EU, state aid rules, guidelines, and case law play a crucial role in shaping support mechanisms for all member states. Priority should be given to fiscal perspectives that can expedite the energy transition while addressing climate change concerns.

- **In general, for rapid RE deployment and investments, FIT Schemes should be preferred:** These schemes can be efficient if FIT prices are effectively controlled and administrative complexity is reduced, considering the costs to consumers or taxpayers. However, in TGC and RPS schemes, producers bear the risk, and energy prices may remain moderate. In this sense, if the rate or quantity targets are essential for the country in question, then such schemes can be preferred over FIT Schemes[283]. The political feasibility of schemes varies between countries; for example, RPS programs in the USA[284] directly burden the electricity industry, while higher taxes are preferred in the EU. Hence, aggressive FIT schemes, standard taxes, subsidies or quotas can be seen everywhere. Economists believe that diversified approaches with market-based incentives would support RE investments[285].
- **Effective carbon taxes should be introduced:** It can be argued that no scheme, on its own, would be sufficient to achieve the best outcomes for RE transition goals. In this sense, one of the best solutions and crucial points is pricing negative externalities thanks to carbon taxes[286]. Taxes on carbon emissions indirectly support renewable energy. However, the carbon taxes introduced should be effective. For instance, the carbon tax in Liechtenstein is applied to more than 81% Of the GHG emissions in the country[287].
- **Introducing new taxes can cause resistance. To prevent this, incentive mechanisms should be brought together with the introduction of new taxes as well.** Furthermore, ancillary Benefits of the schemes should not be ignored.
- **RECs (Renewable Energy Communities) should be supported in the Mediterranean.** Evidence shows that those involved in domestic scale RE generation tend to reduce their energy demand and become more energy conscious[288].
- **Incentives should provide short- and long-term benefits at the same time.** Those preferring RE should be better off than those buying conventional methods or preferring fossil fuels. The Cost of producing RE from solar and wind power is still an important barrier for many people and SMEs especially when such costs are compared with the conventional methods[289]. Therefore, supporting research and development (R&D) is crucial. Germany, for instance, has pursued a policy that incentivizes R&D activities, particularly for the installation and

281 R.S.R.F. Mathijsen and P. Dyrberg, Mathijsen's Guide to European Union Law (Sweet& Maxwell, Thomson Reuters,11th edn, 2013) 461

282 Green, Richard and Adonis Yatchew, 'Support Schemes For Renewable Energy: An Economic Analysis' Economics Of Energy & Environmental Policy, Vol. 1, No. 2, 2012, 85

283 Ibid, 96.

284 Ibid, 87.

285 Ibid, 89.

286 Ibid, 95.

287 Tax Foundation: Carbon Taxes in Europe < https://taxfoundation.org/data/all/eu/carbon-taxes-in-europe-2023/> accessed 30 December 2023.

288 Green, Richard and Adonis Yatchew, 'Support Schemes For Renewable Energy: An Economic Analysis' Economics Of Energy & Environmental Policy, Vol. 1, No. 2, 2012, 86

289 ibid, 89.

setup of wind and solar power generation facilities[290]. Incentives are mostly given for innovation and reduction of costs[291].

- **Energy Security:** Energy security is essential for achieving energy independence and fostering circular economies. This is particularly crucial for countries heavily reliant on fossil fuels. Renewable energy offers a solution by reducing dependency on fossil fuels, thereby enhancing energy security[292]. For instance, following the unprecedented natural gas reductions due to the war in Ukraine, the Council Regulation 2022/2577 of December 2022, laying down a framework to accelerate the deployment of renewable energy, has been adopted in the EU based on Article 122(1) of the TFEU[293].
- **Strategic environmental assessment should be made before granting fiscal incentives for the Offshore Farms:** While OWFs can be an element for a just energy transition, the Mediterranean Region is home to numerous endemic and protected animals. Due to the lack of scientific evidence on the potential effects of OWFs in the region, we must draw insights from examples elsewhere. Assessments in Northern countries have shown that OWFs (their infrastructure and/or operation) can harm migrating or resident birds, marine mammals, fish communities, and benthic communities. All Mediterranean countries must adhere to rules protecting the region, emphasizing the precautionary principle. This principle dictates that unless it's scientifically proven that large-scale OWFs and OSFs in a Mediterranean hotspot pose no harm to the environment, installation should not proceed. This aligns with the strict application of principles derived from the Sustainable Development Goals (SDGs).

The negative impacts of OWFs can be mitigated through proper site selection, operational plans, foundation designs, and artificial reefs. Measures to address issues like turbine noise and electromagnetic radiation are essential[294]. Potential OWF hotspots in the Mediterranean include the Gulf of Lion, the North Adriatic Sea, the Gulfs of Hammamet and Gabès, the Gulf of Sidra, and the Nile Delta[295]. Depending on the project site and circumstances, floating wind turbines may offer an effective solution to limit adverse effects[296].

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290 ibid, 84.

291 ibid, 93.

292 ibid, 88.

293 Council Regulation (EU) 2022/2577 of 22 December 2022 laying down a framework to accelerate the deployment of renewable energy

294 Certified Final Report Volume I, Byrne Ó Cléirigh Ltd, Ecological Consultancy Services Ltd (EcoServe) School of Ocean and Earth Sciences, University of Southampton 'Assessment of Impact of Offshore Wind Energy Structures on the Marine Environment'i.

295 Laura Bray, Sofia Reizopoulou, Evangelos Voukouvalas, Takvor Soukissian,Carme Alomar, Maite Vázquez-Luis, Salud Deudero, Martin J. Attrill andJason M. Hall-Spence, 'Expected Effects of Offshore Wind Farms on Mediterranean Marine Life' Journal ofMarine Science and Engineering, MDPI,2.

296 Ibid,11.

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CHAPTER 9. CONCLUSIONS : EMBRACING SUSTAINABLE SEAS BY REIMAGINING ECONOMIC SUPPORT

AUTHORS : ROBIN DEGRON AND CONSTANTIN TSAKAS


Credit : Play Ground

1. Key conclusions on EHS

As highlighted by Damania et al (2023)[297], the world today is confronted by two great imbalances that are worsened by the scale and design of EHS. They are :

- **The Rapid Decline in Natural Capital:** Essential resources – air, land, and oceans – are being degraded at an alarming rate due to unsustainable practices and a lack of incentive to protect them.
- **Soaring Public Debt:** The latter is at a historic high, particularly in developing nations, limiting investment in crucial areas. This coincides with a surplus of private savings in wealthy countries struggling to find profitable investments.

The Mediterranean concentrates these issues, but also adds its own unique challenges.

- **The North-South Divide:** A stark economic disparity still exists between shores. This divide limits opportunities in the south, fueling social unrest.
- **A Water-Scarce Region:** Water scarcity is a growing threat due to increasing demand, population growth, and climate change. Unequal access to this vital resource exacerbates existing inequalities, potentially leading to social tensions and competition.
- **Fractured Politics:** Political instability and ongoing conflicts in some parts of the Mediterranean create uncertainty and hinder regional cooperation on economic and environmental challenges.
- **A Tangled Web:** These imbalances are not isolated threads; they intertwine and exacerbate each other. Environmental degradation can limit economic growth, making it harder to service public debt.

297 Damania, Richard, Esteban Balseca, Charlotte de Fontaubert, Joshua Gill, Kichan Kim, Jun Rentschler, Jason Russ, and Esha Zaveri. 2023. Detox Development: Repurposing Environmentally Harmful Subsidies. Washington, DC: World Bank. doi: 10.1596/978-1-4648-1916-2.

Political instability discourages investment, hindering development projects that could address water scarcity or promote renewable energy.

Meanwhile, despite the documented harms associated with EHS and efforts towards shifting towards green(er) tools, they still persist worldwide (and in the Mediterranean). Several key factors contribute to this phenomenon:

- **Limited Information:** The environmental consequences of subsidies, particularly those impacting marine ecosystems, emerge gradually over extended periods. For instance, the detrimental effects of capacity-enhancing fishing subsidies on fish stocks may not be readily apparent for years. This delayed visibility hinders public awareness and mobilization against such policies.
- **Diffuse Costs and Fragmented Governance:** The environmental damage caused by subsidies, including in the Mediterranean, affects all countries. However, the benefits accrue to specific industries or regions within individual countries. This disparity hinders the formation of regional coalitions for reform, further complicated by the complex political landscape of the Mediterranean.
- **Economic Inertia and Livelihood Dependence:** Subsidies in the Mediterranean often prop up traditional practices that may be inefficient but deeply ingrained in local economies. For example, water-intensive subsidies in drought-prone regions create a false sense of security and hinder investments in water-saving technologies. Populations become reliant on these subsidies, creating resistance to change.
- **Powerful Interest Groups:** Lobbying efforts by industries benefiting from subsidies can have significant political influence. These groups can effectively stall or block reform efforts, even when the long-term economic and environmental consequences are evident.

Taking this into account, where do we go from there ? This report has provided a comprehensive analysis of Environmentally Harmful Subsidies (EHS) in the Mediterranean, highlighting their impacts on the environment, economy, and society. Through each chapter the report covered various sectors and/or aspects, including fisheries, energy, water, tourism and inclusion and offered valuable insights into the need for comprehensive and coordinated policies to address EHS in the region.

As seen throughout the report, the findings emphasize the importance of establishing legally binding commitments, prioritizing transparency and data availability, fostering inclusive stakeholder engagement, implementing a gradual transition with compensation measures, and promoting cross-border cooperation. Specifically:

- **the adoption of a Euro-Mediterranean EHS Phase-Out and Reform Framework (EHS-MedFRAME)** is recommended to aid in identifying compensation measures and ensuring a harmonized approach to environmental sustainability in the region. The economic indicators of such a framework (such as government expenditure, employment in green sectors, GDP impact) would facilitate the assessment of the financial implications of EHS reform and help evaluate the broader economic consequences of the subsidy phase-out. Meanwhile, environmental indicators (greenhouse gas emissions, resource use efficiency, waste reduction, adoption of eco-friendly technologies etc) would help monitor EHS phase-out, as they directly align with the goal of fostering ecological sustainability. Social indicators (ex. income distribution and gender/generational equity, health impacts, social services and infrastructure, access to green technologies) would assess the impact of EHS reform on societies and ensure that benefits reach all socioeconomic groups.
- Policy suggestions related to implementing such a framework include **establishing a common regional definition and criteria for identifying EHS,** emphasizing the need for coordination among Mediterranean countries. Secondly, it is important to **integrate EHS reform into existing regional sustainability frameworks like the Barcelona Convention and the Mediterranean Strategy for Sustainable Development (MSSD),** leveraging international institutions for support. Thirdly, there is a necessity of enhancing national monitoring and reporting mechanisms for EHS reform. Lastly, gradual reform approaches with compensation

measures to mitigate public resistance are key, they should be accompanied by awareness-raising campaigns to garner support for reform initiatives.

A comprehensive analysis across different sectors reveals how EHS are counterproductive, whether from an environmental, economic or social standpoint.

- in the fisheries sector, the use of capacity-enhancing subsidies and ineffective fisheries management plans lead to unsustainable practices and overexploitation of marine resources. Recommendations include implementing responsible fishing practices in line with international guidelines, emphasizing the Ecosystem Approach to Fisheries (EAF) and the Complex Adaptive Systems (CASs) approach. **Focus should be shifted from harmful subsidies to those incentivizing conservation,** complemented by participatory adaptive governance. Supporting Local Communities is also key, which can be achieved by **enhancing support mechanisms for artisanal, small-scale fishing (SSF) communities,** recognizing their vital role in coastal cultures and food security. Addressing the rights and inclusion of fisherwomen in fisheries policies, aligning with UN Sustainable Development Goals for gender equality, is also suggested. **Improving Data Availability and Transparency is another key issue,** one which requires investment in modernizing fisheries monitoring programs, including satellite-based surveillance systems and technology for traceability and transparency in the seafood supply chain. Meanwhile, **incentivizing responsible fishing practices is needed**, through supporting the designation and management of marine protected areas (MPAs) to conserve critical habitats and vulnerable fish stocks.
- the energy sector is another area where EHS have significant negative impacts. Fossil fuel subsidies in Mediterranean countries contribute to increased greenhouse gas emissions, undermining efforts to mitigate climate change. Eliminating FFS, especially for coal, petroleum, and natural gas, can reduce GHG emissions, enhance energy efficiency, and promote renewable energy adoption. **Key steps include announcing realistic timelines to phase out fossil fuel extraction and combustion, conducting comprehensive assessments of pre-reform subsidies, and implementing supportive policies and communication strategies.** Reforming taxation systems to remove tax breaks for fossil fuels and implementing compensatory measures for vulnerable groups affected by FFS removal are crucial. International collaboration can facilitate energy transition processes, particularly in overcoming financial and political barriers. The experiences of Morocco and Egypt in reforming fossil fuel subsidies provide valuable insights and inspiration for neighboring countries, demonstrating the feasibility of subsidy reform and the importance of compensatory measures to mitigate adverse effects on vulnerable populations.
- the report also highlighted how shifting to cleaner and more sustainable energy sources could have a positive impact on the development of **women's inclusion in the labor market.** The findings underscore the need for reevaluating energy policies to prioritize gender inclusion. Recommendations include **gradually eliminating inefficient subsidies while ensuring reforms do not hinder women's participation in the energy workforce.** Governments are urged to incorporate gender-responsive impact analyses into subsidy reforms and implement specific measures to enhance female inclusion. Examples such as Germany's gender quota legislation and support for women-owned enterprises provide policy frameworks for promoting gender diversity in the energy sector. Investing in skills training programs tailored for women, creating family-friendly workplaces, and fostering mentorship programs are essential steps. **Redirecting savings from subsidy removal towards social welfare programs, such as family allowances and childcare services, can further support female economic participation.** Governments should also implement mechanisms to monitor female labor force participation in the energy sector and collect gender-disaggregated data to inform policymaking. Collaboration between

stakeholders—government, industry, academia, and civil society—is crucial for effective policy implementation.

- **the report provided insightful strategies by examining the influence of fossil fuel subsidies on the interplay between water stress and energy consumption.** Proposed reforms outline two possible strategies: **gradual and aggressive approaches.** The gradual approach involves phased measures to redirect subsidies towards renewable energy adoption while safeguarding vulnerable populations through social measures. Conversely, aggressive reforms may lead to economic shocks and social inequality. Examples from Spain, Mexico, and Indonesia highlight successful implementations of gradual subsidy reduction coupled with social welfare support. Transitioning towards renewable energy sources like solar and wind power is crucial to mitigate environmental impacts and promote sustainability. One technology should not be considered inherently superior to another, rather, each technology must continuously strive to become more sustainable, so we can ensure a holistic approach to addressing environmental challenges and advancing towards a more resilient energy future. Algeria's ambitious plans for solar energy expansion exemplify this shift towards eco-friendly initiatives. Additionally, successful renewable energy projects in the region, such as Tunisia's Nawara Gas Field and Egypt's Benban Solar Park, offer valuable insights for sustainable development. **To ensure a successful transition, policymakers must implement a multifaceted strategy that includes government initiatives, financial incentives, public-private partnerships, research and development, capacity building, regulatory frameworks, energy market liberalization, and international partnerships.** However, this transition requires careful consideration of potential negative externalities and social challenges, such as job losses in traditional energy sectors. **Transparency and public participation are crucial for gaining broad support for reforms,** as demonstrated by examples from Norway, New Zealand, Germany, and Indonesia. Strengthening regional partnerships and collaborating with leaders in renewable energy technology can accelerate adoption and maximize socioeconomic benefits.
- on water subsidies, **the report's findings underscore the importance of implementing a uniform, progressive national water pricing system, standardizing tariffs across regions to mitigate disparities and promote efficient water use.** While supply constraints may not be ideal, they can effectively modulate water demand. Even modest price increases of 10% and 20% result in significant welfare losses, emphasizing the sensitivity of consumers to changes in water pricing. **Aligning the second tariff block with production costs (charging people a price for water that matches how much it costs to produce and deliver it) represents a practical approach to minimize welfare loss while ensuring sustainable water management.** By gradually transitioning towards cost-reflective tariffs, water authorities can encourage responsible water consumption while safeguarding the interests of vulnerable populations. Recommendations, applicable to all Mediterranean countries, include enhancing institutional frameworks dedicated to implementing and enforcing water regulations to address issues of wastage, pollution, and resource protection effectively.
- in the tourism sector, the report highlighted how **differing approaches to tourism management can yield varying environmental outcomes.** Questions were raised about the potential role of specific tourism subsidies in influencing resilience to climate change, underscoring the need for a more nuanced classification of financial support to the tourism sector. Future studies are needed to establish a clearer link between subsidy types and land management trends.
- regarding fiscal incentives, the report stressed how **effective carbon taxes could be introduced for carbon-intensive industries.** Some countries may easily introduce and apply environmental taxes, in the same manner that Finland, Sweden, Norway and Denmark introduced carbon tax in the early 1990s. Furthermore, **feed-in tariff schemes seem to be the most efficient and effective support schemes for promoting and supporting renewable electricity.** In general,

for rapid RE deployment and investments, FIT Schemes can be efficient mechanisms when FIT prices are controlled effectively, and administrative costs and complexity are reduced. On the other side of the spectrum, **complex aid or incentive mechanisms should be avoided, as such mechanisms prevent SMEs or small potential RE Generators to enter the market**. On Offshore Wind Farms (OWFs), before granting fiscal incentives, **thorough assessments should be conducted to mitigate potential negative impacts on marine ecosystems and biodiversity.** This aligns with the precautionary principle and sustainable development goals.

2. Moving forward with reform : Green Instruments, CSR and the role of the MSSD

As Fernand Braudel, the renowned French historian, once said «The Mediterranean is not a landscape, but a thousand landscapes. It is not a sea, but a succession of seas", all constantly changing. This quote highlights the dynamic nature of the region and the need for addressing imbalances through a multi-pronged approach. Fostering regional cooperation is key. By acknowledging the complex web of challenges and working together, the countries of the Mediterranean can move towards a more sustainable and equitable future. Moving forward, the following axes need to be considered :

- **Replacing EHS with «Green Instruments»:** Our analysis has shed light on the detrimental impacts of EHS. It is now imperative to phase them out and replace them with «green economic instruments» that are more cost-efficient and that also contribute to environmental sustainability. Correctly utilized economic tools can incentivize sustainable practices and innovation, driving the transition. While this transition may pose challenges for some countries in the region, it is a necessary step towards a more sustainable future. Reforming these economic tools to align with environmental objectives is also essential for unlocking financial resources and redirecting investments towards sustainable development. These instruments can take many forms, including taxes, (virtuous) subsidies, grants, and regulatory measures, among others. The primary objective of green instruments is to internalize the environmental costs of economic activities and promote sustainable practices. Replacing harmful subsidies with green instruments in the Mediterranean is essential for several key reasons. Firstly, EHS distort market signals, leading to overconsumption and overproduction of environmentally harmful goods and services, something that was clearly seen in the case of the fisheries sector. By removing these subsidies, using a framework such as the one suggested above, prices will reflect the true cost of these goods and services, encouraging consumers and producers to shift towards more sustainable alternatives. Secondly, EHS often benefit larger corporations, rather than the most vulnerable members of society. By redirecting these subsidies towards green instruments, governments can promote social equity and support those most in need. Thirdly, green instruments can stimulate innovation and job creation in green industries, contributing to sustainable economic growth, which is much needed in the region.

The Mediterranean is an excellent "playground" to replace harmful subsidies with green instruments. For instance, in the fisheries sector, governments can replace capacity-enhancing subsidies that contribute to overfishing with green instruments that promote sustainable fisheries management. This can include providing subsidies for the adoption of sustainable fishing practices, such as using selective fishing gear and reducing bycatch, as well as investing in fisheries research and monitoring. Similarly, in the agriculture sector, governments can replace harmful subsidies that promote the use of chemical fertilizers and pesticides with green instruments that encourage sustainable farming practices. Moreover, governments can also introduce carbon pricing mechanisms to promote the transition to a low-carbon economy.

The transition from harmful subsidies to green economic instruments is a complex process that requires careful planning,

stakeholder engagement, and political will. Continuing its effort to suggest more adequate tools and policies that support and fund sustainable development, Plan Bleu will explore the theme of "Green Economic Instruments" in a follow-up "Call for Policy Papers" and Edited Volume, tackling the above-mentioned issues. The aim would be to continue providing policymakers with evidence-based recommendations for designing and implementing effective policies that support the transition towards a green economy in the Mediterranean region.

- **The Need to Strengthen Corporate Social Responsibility :** Governments are not the only ones who can take action. Another clear path that emerges to address the Mediterranean challenges is by strengthening corporate social responsibility (CSR) among businesses operating in the region. CSR refers to the voluntary actions taken by companies to promote social, environmental, and economic sustainability, beyond their legal obligations. Strengthening CSR in the Mediterranean can help address challenges by promoting sustainable business practices that benefit both the environment and society. To strengthen CSR in the region, governments, businesses, and civil society organizations need to work together to create an enabling environment that promotes sustainable business practices. This can include developing CSR standards and guidelines, providing incentives for CSR initiatives, and encouraging transparency and accountability in corporate reporting. Plan Bleu is thus also planning to explore the theme of CSR in future Calls for Policy Papers, with a focus on identifying best practices and policy options for promoting CSR in the Mediterranean region. This could include, for example, examining the role of government regulations, voluntary initiatives, and multi-stakeholder partnerships in promoting CSR.

- **Capitalizing on the MSSD and proposing a Green Taxonomy :** To successfully implement reform, a prerequisite is promoting intersectoral cooperation among government agencies, industries, and civil society, crucial for effective policy implementation and enforcement. Furthermore, enforcing legal obligations and regulations to support the transition to sustainable practices is also key. This includes setting clear targets, standards, and penalties for non-compliance to ensure accountability and drive progress towards environmental sustainability. In addition to the benefits of aligning with the Mediterranean Strategy for Sustainable Development (MSSD) and the protocols of the Barcelona Convention, something which has been highlighted throughout the report, a pressing need to establish a «Green Taxonomy» specific to the Mediterranean also emerges, akin to the one implemented by the European Union. This taxonomy would provide a standardized framework for classifying environmentally sustainable economic activities, guiding investments towards initiatives that contribute to the region's ecological integrity and socio-economic development. UNEP/MAP, as a leading authority in environmental conservation in the Mediterranean, can spearhead the development of this Green Taxonomy. By convening stakeholders from governments, businesses, and civil society, UNEP/MAP can facilitate the design of criteria and standards that reflect the unique environmental challenges and opportunities of the Mediterranean region. This taxonomy would not only help channel investments towards green projects but also promote transparency and accountability in the financing of sustainable development initiatives.

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