MEDITERRANEAN ACTION PLAN (MAP)
REGIONAL MARINE POLLUTION EMERGENCY RESPONSE CENTRE FOR THE MEDITERRANEAN SEA (REMPEC)

Regional Expert Meeting on the Possible Designation of the Mediterranean, as a whole, as a Nitrogen Oxides Emission Control Area (Med NO_X ECA), pursuant to MARPOL Annex VI

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Agenda Item 6: Examining the Possibility of Designating the Mediterranean Sea, as a whole, as NOx ECA under MARPOL Annex VI

"Towards a Mediterranean NECA: Contextual Foundations and Sectoral Implications for Fisheries and Tourism"

REMPEC
Malta, 2025

Note by the Secretariat

This study is an independent publication prepared by UNEP/MAP Plan Bleu/RAC, together with a team of consultants, prepared in consultation with REMPEC. The final document will be presented and discussed during the Plan Bleu/RAC workshop to be held in Marseille, France, on 5 November 2025.

Background

1 The document is an independent publication by UNEP/MAP Plan Bleu/RAC, developed in alignment with the comprehensive Technical and Feasibility Study initiated by REMPEC. The document provides a survey-based analysis of the indirect sectoral repercussions of the potential Mediterranean Nitrogen Oxides Emission Control Area (Med NOx ECA) on highly sensitive socio-economic sectors like fisheries and tourism, addressing a knowledge gap concerning impacts beyond direct shipping.

2 Structure of Document: The analysis includes two policy-oriented technical papers:

◦ Paper 1 focuses on an expert survey regarding NOx controls and their implications for the fisheries sector.

◦ Paper 2 examines the potential impacts of the NOx ECA implementation on tourism in the Mediterranean region

3 The Papers are presented in the **Appendix** to the present document.

Action requested by the Meeting

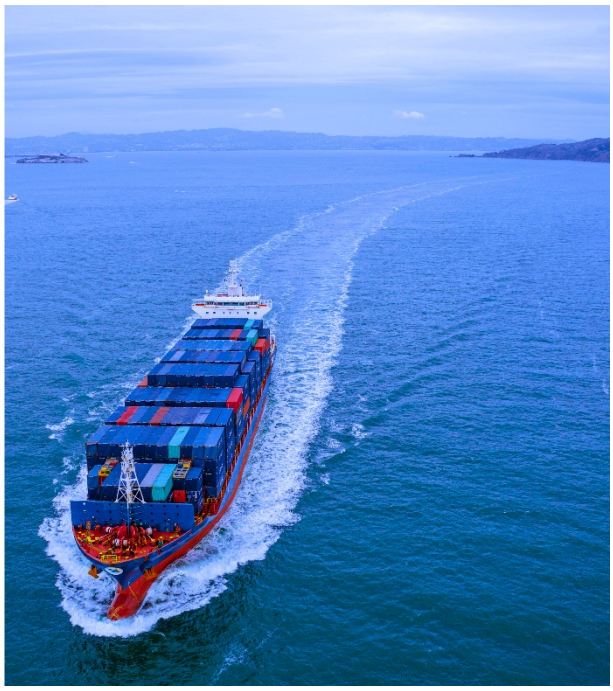
4 **The Meeting is invited to take note** of the information provided in the present document.

Appendix

"Towards a Mediterranean NECA: Contextual Foundations and Sectoral Implications for Fisheries and Tourism".

- Introduction
- Paper 1. Expert Survey on NOx Controls in Mediterranean Marine Settings
- Paper 2. Potential Impacts of the implementation of the NOx Emission Control Area on Tourism in the Mediterranean region

Towards a Mediterranean NECA: Contextual Foundations and Sectoral Implications for Fisheries and Tourism[1]



[1] This report was peer-reviewed by Constantin Tsakas, Léo Le Scour (Plan Bleu) and Robin Degron (Plan Bleu). Additional comments were provided by Ivan Sammut (REMPEC), Antoine Lafitte (Plan Bleu) and Chloé Martin (Plan Bleu) whose time and contributions are gratefully acknowledged. Please cite as : Plan Bleu. Towards a Mediterranean NECA: Contextual Foundations and Sectoral Implications for Fisheries and Tourism. November 2025.

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Foreword

The Mediterranean Sea stands at a crossroads. As one of the world's busiest maritime regions, it is both a driver of economic activity and a hotspot of environmental vulnerability. Shipping-related emissions are a major contributor to air pollution and nitrogen deposition, with cascading impacts on ecosystems, public health, and coastal economies. In recent years, the Contracting Parties to the Barcelona Convention, under the auspices of UNEP/MAP, have taken decisive steps to address this challenge—notably through the designation of the entire Mediterranean as a Sulphur Oxides Emission Control Area (SECA). Building on this landmark achievement, governments are now considering going further by designating the region as a Nitrogen Oxides Emission Control Area (NOx ECA) under MARPOL Annex VI—an ambitious step toward reconciling economic dynamism with environmental responsibility.

In support of this intergovernmental process, UNEP/MAP, through REMPEC, has initiated a comprehensive Technical and Feasibility Study. Meanwhile, Plan Bleu, as one of UNEP/MAP's Regional Activity Centres, has developed a complementary, survey-based, body of work focusing on the sectoral repercussions of a Mediterranean NOx ECA. By drawing on literature review, expert consultation, and engagement with stakeholders across the region, this work brings forward perspectives that may otherwise remain underrepresented—particularly those of local communities, fisheries, and tourism operators.

This publication responds to an important knowledge gap. While existing studies have largely concentrated on the direct impacts for shipping, the ripple effects on highly sensitive and strategic sectors such as fisheries and tourism remain insufficiently understood. Yet, these sectors are both deeply dependent on the health of marine and coastal ecosystems and vulnerable to the economic adjustments triggered by regulatory change. Drawing on literature review, data analysis, and extensive engagement with stakeholders, the two policy-oriented technical papers presented here provide fresh insights into the complex interplay between environmental ambition and socio-economic resilience.

For fisheries, the findings highlight strong support by stakeholders for NOx controls but stress the need for fair cost-sharing and context-sensitive policies to safeguard competitiveness while advancing environmental goals. For ***tourism****, stakeholders see clear opportunities to position the Mediterranean as a sustainable destination, provided that financial support and collaborative governance mitigate implementation challenges. Together, these analyses underscore a critical message: the effectiveness and acceptability of a Mediterranean NOx ECA will depend not only on the design of regulatory measures but also on the foresight and inclusiveness of accompanying policies. Financial support, phased deployment, training, and partnership mechanisms will be essential to align environmental objectives with economic viability and social fairness.*

By shedding light on the opportunities and challenges ahead, this study aims to guide collective ambition toward a Mediterranean that is not only cleaner and healthier, but also a global model of resilience and sustainability, a vision to which Plan Bleu will continue contributing through its expertise and long-term engagement.

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

Introduction

Authors: Constantin Tsakas (Plan Bleu), Léo Le Scour (Plan Bleu), Samson Bellières (Plan Bleu)

Understanding the context

The Mediterranean Sea is today confronted with severe environmental pressures that threaten both its ecological balance and the well-being of the millions who live along its shores. As highlighted by Sébastien Barles, Deputy Mayor for Ecological Transition of the City of Marseille, "half of Marseille's air pollution comes from ships" (France 3 Régions / Franceinfo, 2023). This assertion is corroborated by data from the regional air quality observatory Atmosud, which attributes 54% of nitrogen oxide (NOx) emissions to the maritime sector, compared with 30% for road transport, 8% for industry, and 3% for the residential sector (Atmosud, 2022). Indeed, among the most pressing challenges is atmospheric pollution from maritime transport, which has already been recognized as a major source of sulphur oxides (SOx) and particulate matter, and more recently, nitrogen oxides. While significant progress has been achieved with the adoption of the Mediterranean Sea Emission Control Area for Sulphur Oxides (Med SOx ECA), entering into force in May 2025, the issue of NOx emissions remains largely unaddressed.

Nitrogen oxides not only contribute to poor air quality and associated health risks in densely populated coastal areas, but also accelerate ocean acidification and eutrophication, threatening fragile marine ecosystems and key economic sectors such as fisheries and tourism. Furthermore, NOx emissions have climate-warming effects and may exacerbate regional weather variability, compounding existing vulnerabilities in a region already under pressure from climate change. Given the density of maritime traffic, the high coastal population, and the strategic economic role of the Mediterranean, the external costs of NOx emissions are particularly acute compared to other regions.

Analyses by the European Environment Agency (EEA, 2024) confirm that NOx and fine particulate matter concentrations are higher in proximity to ports - within a radius of one to ten kilometres - as observed in the case of the Port of Marseille. Several coastal areas and ports in the Mediterranean currently exceed, or are at imminent risk of exceeding, the annual limit value of 20 µg/m³ of nitrogen dioxide (NO_2) set for 2030 (EEA, 2024). At such concentrations, NO_2 - primarily generated by the combustion of marine fuels in ship engines - is associated with well-documented adverse effects on human health (particularly on the respiratory and cardiovascular systems) as well as on ecosystems. This phenomenon, characteristic of areas with high maritime density, is also observed along numerous international shipping corridors, with impacts extending far beyond coastal zones. Reducing the exposure of coastal populations, maritime workers, and marine ecosystems to these pollutants is therefore both a public health imperative and an environmental preservation priority.

Nitrogen Oxides: Multi-Impact Pollutants

Nitrogen oxides, commonly referred to as NOx and comprising primarily nitric oxide (NO) and nitrogen dioxide (NO_2), are odorous gases whose toxicity increases significantly with atmospheric concentration. Produced mainly by the combustion of fossil fuels—particularly in the transport and heating sectors—these pollutants expose a majority of the global population to nitrogen dioxide levels exceeding the air quality guidelines set by the World Health Organization (WHO) (Le Grand Continent, 2023). Exposure to such elevated concentrations has deleterious effects on the respiratory system, owing to the ability of NOx to react with atmospheric moisture, ammonia, and other compounds to form fine particulate matter. Due to their small size, these particles can penetrate deep into the respiratory tract, causing significant harm both in the short term and during prolonged exposure. In particular, a recent study published in the *British Medical Journal* demonstrated a link between short-term exposure to nitrogen dioxide and increased risks of cardiovascular and respiratory mortality (BMJ, 2021). Chronic exposure, for its part, is associated with heightened risks of respiratory infections, the development of asthma, and greater vulnerability to chronic pulmonary diseases, with older adults and children being particularly affected (Ministère de la Transition Écologique, 2024).

Beyond their health impacts, NOx are major atmospheric pollutants. When reacting with water vapour in the air, nitrogen dioxide contributes to the formation of nitric acid, which is deposited on soils and bodies of water in the form of acid rain. This phenomenon leads to the acidification of soils and aquatic environments, depleting the nutrients necessary for vegetation and reducing agricultural yields. Moreover, acid rain accelerates the corrosion of metals used in construction, thereby weakening infrastructure (Ministère de la Transition Écologique, 2024).

Additionally, NOx - and notably nitrous oxide (N_2O) - contribute indirectly to climate change. In the presence of volatile organic compounds and under the influence of solar radiation, they promote the formation of tropospheric ozone, a potent greenhouse gas that contributes to anthropogenic global warming (EEA, 2020).

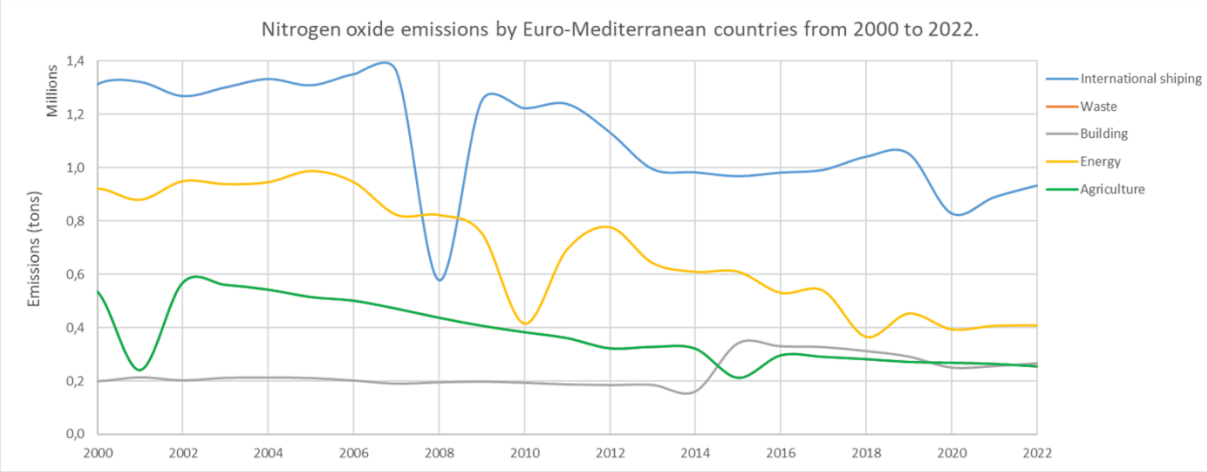
Maritime Transport and Atmospheric Pollution: The Rise of Nitrogen Oxide Emissions

With over 100 million tonnes of NOx emissions recorded globally in 2015, the need to reduce these atmospheric pollutants in response to public health and environmental challenges is becoming increasingly urgent (International Energy Agency, 2017). The transport sector is the primary source of emissions, accounting for more than 57 million tonnes in 2015—around 53% of total global NOx emissions. While road transport is the main contributor inland, the relative share of each mode of transport changes significantly near coastlines. In France, for example, maritime transport accounts for only 3% of national NOx emissions, but this share rises to 21% in the Provence-Alpes-Côte d'Azur region and exceeds 50% in Marseille, home to France's largest Mediterranean port (CITEPA, 2023; Atmosud, 2023). Similarly, in the Baltic Sea, 2016 measurements revealed that maritime traffic emitted as much NOx as the combined national emissions of Sweden and Finland (Centre d'Études Stratégiques de la Marine, 2016). Given Europe's geographical characteristics and its heavy reliance on maritime transport for trade, the sector accounted for nearly 24% of NOx emissions within the European Union in 2018 (EMSA, 2021).

Maritime NOx emissions have increased sharply in Europe in recent years. Between 2015 and 2023, these emissions rose by around 10% across the European Union, with even greater increases in certain regions, such as the Atlantic and the Arctic, where emissions grew by 33% and 32% respectively. Overall, the share of maritime transport in transport-related NOx emissions has continued to rise, reaching nearly 39% in 2022 (EMSA, 2025).

As seen in Figure 1, in the Mediterranean countries of the European Union (EU), international shipping has historically been the principal sector responsible for nitrogen oxide (NOx) emissions. This is followed by the energy sector, and then agriculture and buildings, which are tied in third position. This hierarchy reflects the heavy maritime activity along EU Mediterranean coasts and the centrality of ports like Barcelona, Marseille, and Piraeus in global and regional trade flows. The dominance of international shipping in NOx emissions underlines the strategic importance of regulating maritime transport emissions for achieving regional air quality objectives.

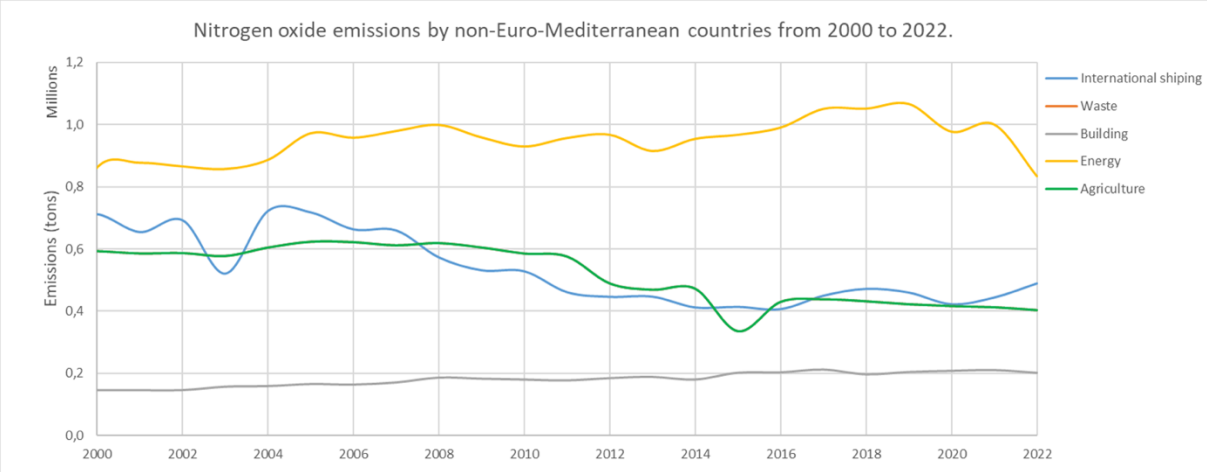
Figure 1. Nitrogen oxide emissions by Euro-Mediterranean countries from 2000 to 2022, by sector



Source: Hoesly et al. (2024) - Community Emissions Data System (CEDS), Population based on various sources (2024) - with major processing by Plan Bleu Observatory (Samson Bellieres)

However, the picture shifts markedly in non-EU Mediterranean countries (Figure 2), where the energy sector becomes the primary source of NOx emissions, with international shipping a distant second and agriculture in third place. This divergence is significant and illustrates how energy production, often based on fossil fuels in these countries, remains a critical area for emission reductions. It also signals the need for differentiated policy responses within the Mediterranean, aligned with the specific emission profiles and capacities of each subregion.

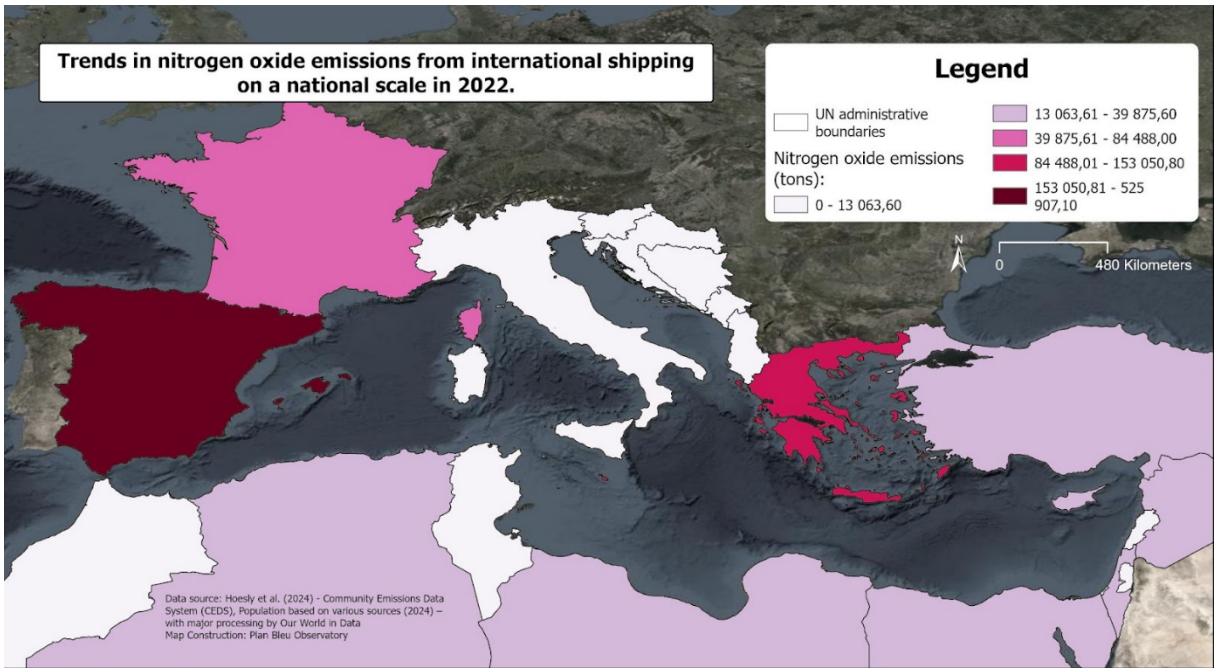
Figure 2. Nitrogen oxide emissions by non-Euro-Mediterranean countries from 2000 to 2022, by sector



Source: Hoesly et al. (2024) - Community Emissions Data System (CEDS), Population based on various sources (2024) - with major processing by Plan Bleu Observatory (Samson Bellieres)

The significant and growing contribution of maritime transport to NOx emissions underscores the urgency of adopting effective measures to limit the impacts of these pollutants on public health and the environment. Despite the uneven contribution to emissions by countries in the region (Figure 3), the transboundary nature of these atmospheric gases - dispersing widely beyond their source - means that mitigation strategies must be coordinated internationally to ensure substantial and lasting reductions in emissions.

Figure 3. Trends in *nitrogen oxide emissions from international shipping on a national scale in 2022*



Source: Hoesly et al. (2024) - Community Emissions Data System (CEDS), Population based on various sources (2024) - with major processing by Our World in Data; Map Construction: Plan Bleu Observatory (Samson Bellieres)

Regulatory Framework and Overview of Existing Emission Control Areas

As awareness of the adverse environmental and health effects of maritime emissions has grown, many states have collaborated through the International Maritime Organization (IMO) to establish *Emission Control Areas* (ECAs). These areas are subject to stricter standards than general international maritime law, aiming to reduce emissions of sulphur oxides (SOx), nitrogen oxides (NOx), and particulate matter (PM).

The *International Convention for the Prevention of Pollution from Ships* (MARPOL), adopted in 1973 under the IMO, is the key regulatory instrument for preventing pollution from maritime sources. It applies to nearly the entire global merchant fleet and has significantly contributed to reducing pollution from international maritime transport (IMO-a). Annex VI, adopted in 1997, sets out the "Regulations for the Prevention of Air Pollution from Ships", including provisions on ECAs.

Certain standards apply globally, such as the 2020 *global sulphur cap*, which limits the sulphur content of marine fuels to 0.5%. Other, more stringent rules apply specifically within ECAs:

- **Sulphur**: a maximum sulphur content of 0.1% in marine fuels within *Sulphur Emission Control Areas* (SECAs) (IMO-b).
- **Nitrogen oxides**: a requirement for ships to be equipped with engines compliant with Tier III standards under Annex VI, or fitted with *Selective Catalytic Reduction* (SCR) systems, *Exhaust Gas Recirculation* (EGR) systems, or alternative fuels such as liquefied natural gas (LNG) to meet prescribed limits (IMO-c). This requirement applies to marine diesel engines with a power output above 130 kW, except for vessels used exclusively for emergencies or operating solely in their flag state's waters.

Not all areas combine restrictions on SOx and NOx. Three categories are distinguished:

- **SECAs**: areas applying only sulphur content limits in fuels.
- **NECAs** (*Nitrogen Emission Control Areas*): areas applying only NOx emission limits.
- **ECAs**: areas applying both SOx and NOx restrictions simultaneously.

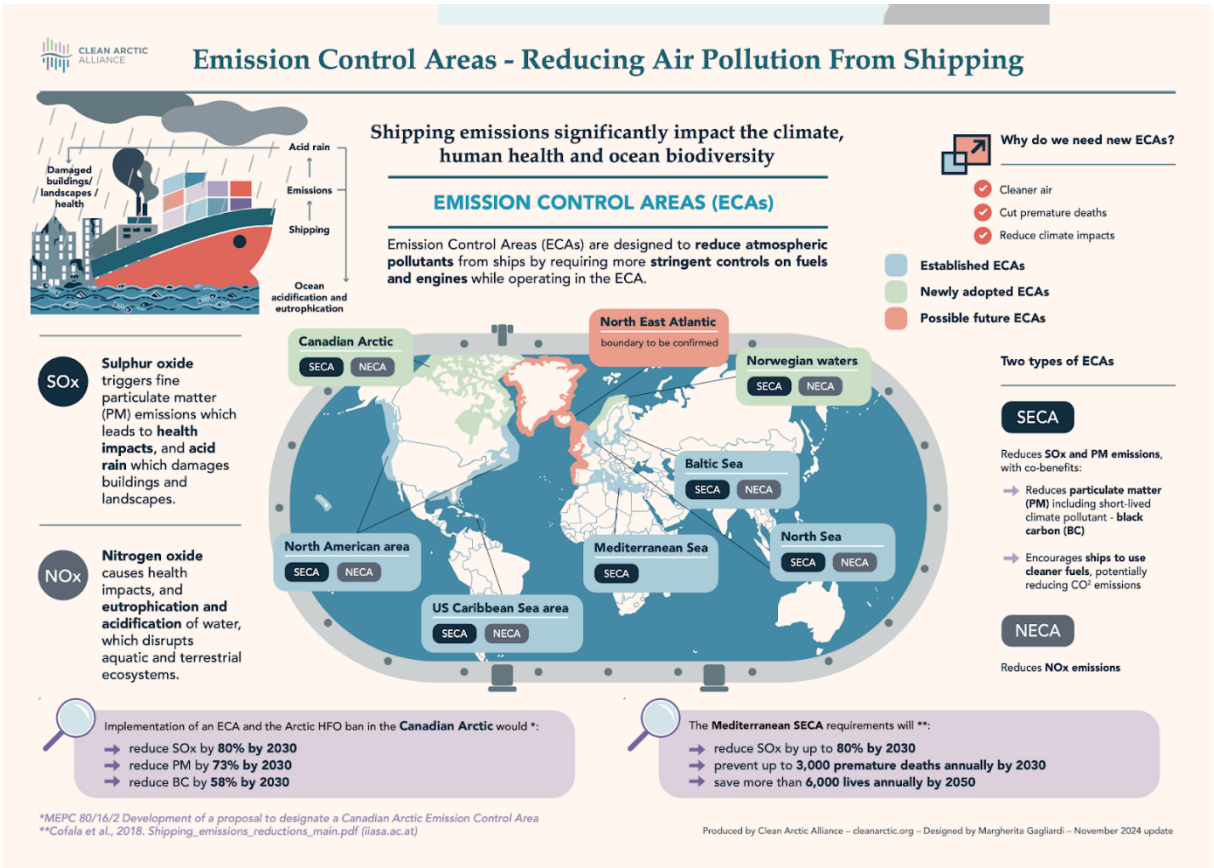
At present, there are four ECAs that include both sulphur and NOx restrictions (IMO-d). The **Baltic Sea** SECA, adopted in September 1997 and implemented on 19 May 2006, was the first such zone, covering the entire Baltic Sea, including the Gulfs of Bothnia and Finland. Following its success, a second SECA was adopted in the **North Sea** in July 2005 and entered into force on 22 November 2007, later expanding to the Irish Sea in January 2020. These European achievements paved the way for two further ECAs, covering both sulphur and NOx: the **North American** ECA - extending 200 nautical miles from the U.S. and Canadian coasts, including the eight main Hawaiian Islands and French territories in the area (USEPA, 2010) - and the **U.S. Caribbean Sea** ECA, covering the coasts of Puerto Rico and the U.S. Virgin Islands up to 50 nautical miles offshore (USEPA, 2011). Adopted in 2010 and 2011 respectively, these zones became fully operational on 1 January 2016. The Baltic and North Sea SECAs followed suit one year later, introducing NOx restrictions effective from 1 January 2021.

The effectiveness of these measures has inspired several national initiatives, leading to the creation of *Domestic Emission Control Areas* (DECAs). Since 2015, China has applied these restrictions to all inland waters, ports, and coastal areas (Ministry of Transport of the PRC, 2018), while South Korea has introduced them in its five main port areas (Korean Register, 2020). Norway adopted similar measures in 2019 for its fjords, excluding those already subject to stricter heritage protections. In 2020, Australia and Iceland implemented comparable regulations. Since 2021, Turkiye has enforced SECA-equivalent sulphur restrictions, while prohibiting the use of Exhaust Gas Cleaning Systems (EGCS) (Maritime Optima, n.d.). In parallel, the European Union has set a 0.10% maximum sulphur limit for marine fuels used in all its ports, aligning with SECA standards.

In summary, the current global landscape comprises:

- **4 ECAs**: North America, U.S. Caribbean Sea, Baltic Sea, North Sea.
- **8 SECAs**: China, South Korea, Norwegian fjords, Australia, Iceland, Turkiye, EU ports, and certain designated zones.

Several new ECA proposals are currently under consideration. The U.S. government has proposed designating the Great Lakes as an ECA (USEPA, 2012). In September 2024, the 82nd session of the IMO's Marine Environment Protection Committee (MEPC) adopted a resolution establishing ECAs in Canadian Arctic waters and the Norwegian Sea, to take effect on 1 March 2026 (IMO, 2024a). In April 2025, at the 83rd MEPC session, a proposal to designate the Northeast Atlantic - covering the Faroe Islands, France, Greenland, Iceland, Ireland, Portugal, Spain, and the United Kingdom - as an ECA was approved, with final adoption expected in autumn 2025 (Ministère de la Transition Écologique, 2025). Furthermore, on 10 June 2022, the 78th MEPC session endorsed the creation of a SECA covering the entire Mediterranean Sea, entering into force on 1 May 2025 (IMO, 2022). Finally, the Contracting Parties to the Barcelona Convention have initiated discussions on a potential designation of the Mediterranean Sea as a NECA, within the framework of the "Med NOx ECA" proposal (PAM-REMPEC, 2023).



Despite pressure from a coalition of NGOs established in 2016 to promote this measure (Safety4Sea, 2019), no formal agreement has yet been reached.

Ecological and Health Impacts of Emission Control Areas

International support for the establishment of *Sulphur Emission Control Areas* (SECAs) can be largely explained by consistent empirical evidence demonstrating their effectiveness in reducing sulphur emissions. Evaluations conducted by U.S. and U.K. authorities confirm the significant impact of sulphur restrictions following the introduction of *Emission Control Areas* (ECAs). U.S. experts have even referred to "substantial reductions in sulphur oxide and fine particulate matter emissions from international maritime transport" (IMO, 2023).

By contrast, results regarding nitrogen oxides (NOx) are less conclusive. Data collected in the United States do not reveal any measurable reduction in NOx emissions (IMO, 2023), while the United Kingdom has observed only a slower decline (UK Informative Inventory Report, 2023). Several factors account for this situation. First, as previously noted, the strictest NOx restrictions apply only to new vessels or those having replaced their engines, thus limiting their scope to a fraction of the global fleet. The gradual renewal of the fleet toward Tier III-compliant ships—which are subject to the most stringent limits—has therefore been particularly slow. Second, some vessels employ operational strategies that circumvent the intent of the regulations. For instance, Tier III ships have been observed to operate at low speeds within ECAs so that *Auxiliary Control Devices* (ACDs) disable *Selective Catalytic Reduction* (SCR) systems when engine load falls below 25%, in order to preserve the engine. Under such conditions, NOx reductions are not achieved. Finally, U.S. authorities highlight the difficulty of isolating the share of NOx emissions attributable specifically to maritime transport as opposed to other emission sources (IMO, 2023).

Another concern lies in the fact that sulphur emission standards apply only to marine diesel engines with an output above 130 kW. Consequently, a significant share of the fleet operating in these areas escapes regulation, despite the potential for substantial contribution to total emissions. The International Maritime Organization has indicated plans to address this gap (EMSA, 2025).

Despite these limitations, U.K. authorities report a 48% reduction in NOx emissions from the domestic maritime transport sector between 1990 and 2021, although this decline cannot be attributed entirely to the establishment of ECAs. They also note that Tier III standards can reduce NOx emissions from new vessels operating in these zones by

approximately 75% (UK Government, 2023). These findings are corroborated by the European Maritime Safety Agency, which reports that between 2015 and 2023, NOx emissions fell by 17% in the North Sea, 7% in the Black Sea, and 6% in the Baltic Sea, while cautioning that such changes may also reflect exogenous factors such as the COVID-19 pandemic or geopolitical tensions (EMSA, 2025).

Forward-looking studies further confirm the relevance of such measures. The ECAMED study (INERIS, 2019), commissioned by France in the framework of a proposed Mediterranean ECA, estimates monetised health benefits at between €8.1 and €14 billion per year for all coastal states, with approximately 1,730 premature deaths avoided annually. It emphasises that these benefits would be felt not only in coastal areas but also inland. Regarding NOx, the implementation of a *Nitrogen Emission Control Area* (NECA) could reduce emissions by 38% when 50% of the fleet is Tier III-compliant, and by 77% when compliance reaches 100%, compared to 2015 levels.

The *International Council on Clean Transportation* (ICCT) further estimates that the strictest regulations could ultimately reduce SOx emissions by 82%, PM2,5 by 64%, and NOx by up to 71%, depending on the pace of fleet renewal (ICCT, 2024). Nitrogen deposition on coastal ecosystems could decline by 30-40%, while NOx reductions would also curb secondary fine particulate formation. The study concludes that SECA and NECA strategies should be deployed jointly to maximise health benefits. Cost-benefit analysis confirms that public health gains from combined implementation would be at least three times greater than the costs involved.

Adaptation Measures and Technological Solutions for NECA Compliance

To enable maritime transport operators—and the economic sectors that depend on them—to successfully navigate the transition brought about by the creation of a NECA, a coherent set of technical, organisational, and regulatory measures must be considered.

Beyond the option of installing a new engine compliant with Annex VI of the MARPOL Convention, several approaches can achieve the required emission limits. These include the use of low-sulphur fuels (distillates, desulphurised heavy fuel oil, hybrid blends), liquefied natural gas (LNG), or alternative fuels such as methanol or hydrogen. However, these alternatives often require engine conversions, with costs varying according to the fuel type, and remain sensitive to energy market fluctuations as well as public support or taxation policies (Wang, 2021).

From a technical perspective, two primary NOx reduction technologies are currently deployed: *Exhaust Gas Recirculation* (EGR) and *Selective Catalytic Reduction* (SCR). EGR works by recirculating approximately 30% of exhaust gases to lower internal combustion temperatures, thereby reducing NOx formation through decreased oxygen content in the intake air (Alfa Laval, 2020). SCR, by contrast, operates post-combustion: a nitrogen-based reagent, typically ammonia or urea, is injected into exhaust gases to chemically convert NOx into molecular nitrogen and harmless water vapour (Science Direct). Economically, analyses show that SCR is better suited and more cost-effective for four-stroke engines, while EGR is more advantageous for two-stroke engines (Danish Ministry of the Environment, 2012).

Complementary measures include the partial use of renewable energy to power vessels - for instance, through onboard photovoltaic systems or modernised wind-assisted propulsion technologies - which can contribute to achieving IMO targets (Green Voyage 2050). Port infrastructure also plays a critical role: providing *shore power* solutions based on low-emission and economically viable energy sources can reduce emissions from ships at berth, thus limiting the use of fossil fuels during port calls (M. Rogosic et al., 2025).

Economic Outlook for the Establishment of a Mediterranean NECA

The creation of a NECA directly affects multiple economic segments, with the maritime sector most immediately impacted. Operators of vessels active within a NECA - whether for freight or passenger transport - face compliance costs comprising initial capital expenditure (CAPEX) for the purchase and installation of Tier III-compliant NOx abatement technologies, and recurring operational expenditure (OPEX) related to energy consumption and the reagents required for these systems. Technical literature provides indicative estimates: the unit surcharges for Tier III engines (or retrofit costs per kW for SCR/EGR) can be substantial, leading to significant increases in both fixed and variable costs for shipowners, depending on vessel category and compliance pathway chosen (Danish Ministry of the Environment, 2012). Detailed studies on CAPEX/OPEX breakdowns and cost allocation methodologies confirm that these expenses vary considerably according to ship size, time spent within the NECA, and the technical strategy adopted (ICCT, 2019). In theory, higher maritime transport costs could pass through to final prices, GDP, and local employment.

Modal shift is another potential outcome: if maritime transport costs rise sufficiently, some goods or passengers could switch to road, rail, or air transport. However, the substantial economies of scale in maritime shipping - particularly for freight - and the structure of supply chains make this scenario unlikely in the short term for most established trade

routes. Empirical and prospective assessments (including those for the Med SOx ECA) indicate that for land-based modes to become competitive across Mediterranean routes, maritime freight costs would need to increase dramatically - by factors ranging from 1.6 to over 30 in some estimates - making a wholesale modal shift improbable except for certain short-distance, niche traffic (IMO, 2022).

Another possible response by shipowners is to alter trade routes to bypass ports subject to restrictions, or to favour calls at states that have not ratified MARPOL Annex VI (Algeria, Bosnia and Herzegovina, Egypt, Lebanon, Libya). This strategy could generate unequal competitive conditions among ports and alter regional transshipment dynamics. However, recent surveys and studies on the implementation of maritime environmental policies - including impact assessments of European instruments such as the EU ETS applied to ports (European Commission, 2025) - have found no robust evidence of large-scale, systemic transshipment relocation to neighbouring non-regulated ports. In other words, the macroeconomic risk of significant maritime traffic relocation following the establishment of a Mediterranean NECA appears limited, although localised competitive effects between ports remain possible and should be assessed on a case-by-case basis.

Beyond the maritime sector, a NECA generates positive health externalities with potential indirect economic benefits. Reducing NOx emissions - and, secondarily, fine particulate matter (PM2,5) - leads to public health gains through reduced premature mortality, hospitalisations, and respiratory and cardiovascular diseases, which translate into healthcare cost savings and productivity gains by preserving the workforce. Peer-reviewed research and expert reports consistently show that monetised health benefits outweigh implementation costs: cost-benefit analyses for the Mediterranean (INERIS, 2019) estimate annual health benefits in the order of €8-14 billion, with implementation costs significantly lower, yielding favourable benefit-cost ratios (≥3 in conservative scenarios). More broadly, international literature on maritime transport air pollution reduction consistently concludes that health and environmental benefits exceed costs in most assessed scenarios (M. Sofiev et al., 2018; S. Wang et al., 2024).

From a public policy perspective, these findings highlight the need for a long-term approach. The actual effectiveness of a NECA will largely depend on the pace of fleet renewal - whether through incentives for acquiring Tier III-compliant vessels or retrofitting -, the choice of technological solutions (SCR, EGR, or alternative fuels), the degree of enforcement and compliance monitoring, and the scope of accompanying measures (targeted subsidies, innovative financing mechanisms, support to ports to maintain competitiveness). Investment decisions by shipowners and routing behaviours should therefore be modelled under multiple prospective scenarios to anticipate the spatial and sectoral distribution of costs and benefits.

Plan Bleu's ongoing efforts and knowledge contribution

Against this backdrop, UNEP/MAP, through REMPEC, has initiated the preparation of a comprehensive Technical and Feasibility Study to assess the implications of designating the Mediterranean as a Nitrogen Oxides Emission Control Area (Med NOx ECA) under MARPOL Annex VI. This process aims to provide Contracting Parties to the Barcelona Convention with the necessary evidence and guidance to support informed decision-making at both national and regional levels. Plan Bleu, as a Regional Activity Centre of UNEP/MAP, is also strongly engaged in these efforts. Building on its established expertise in assessing the economic impacts of maritime emissions—most notably its 2022 study on SOx emissions in the Mediterranean—Plan Bleu contributes as a member of the MAP NOx ECA Technical Committee of Experts (NECA TCE) but also through its dedicated 2024-2025 Work Program.

Right now, knowledge remains limited for certain key sectors of the Mediterranean economy and does not fully capture the heterogeneity of impacts across activities. While direct effects on maritime transport are relatively well documented, indirect repercussions on specific industries such as fisheries and tourism remain insufficiently explored and sometimes rest on untested assumptions. Yet these two sectors - highly dependent on the quality of the marine and coastal environment - could both benefit from environmental improvements and face economic adjustments resulting from changes in costs or maritime flows. Therefore, as part of its Work Program, Plan Bleu has produced two policy-oriented technical papers that form the backbone of the present study "Towards a Mediterranean NECA: Contextual Foundations and Sectoral Implications for Fisheries and Tourism" which complements the REMPEC study. This complementary output is intended to enrich the intergovernmental process with survey-based insights and foster dialogue among policymakers, stakeholders, and experts.

Capitalizing on qualitative work and interviews with local stakeholders, our work is presented in two complementary papers.

Paper 1 – Expert Survey on NOx Controls in Mediterranean Marine Settings

The first analysis focuses on the fisheries sector, a key pillar of regional coastal economies. While the environmental objectives of a Mediterranean NECA primarily target the reduction of pollutant emissions from maritime transport, the

interactions between such a measure and fishing activities remain underexplored in the scientific literature, despite the fact that fisheries depend directly on the health of marine ecosystems and the quality of the coastal environment. This research addresses this gap through a methodology combining literature review, analysis of secondary data, interviews with representatives of fishing communities, environmental experts, and port authorities, as well as a comparative assessment of three NECA implementation scenarios. The first scenario envisages a rapid and stringent application of standards, offering potentially maximal environmental impact but also imposing substantial economic constraints on the sector. The second scenario involves a gradual implementation, allowing more time for technological and financial adaptation but delivering delayed environmental benefits. The third scenario integrates targeted support measures - financial assistance, facilitated access to alternative fuels, and training programmes - aimed at balancing environmental performance with economic viability.

The results of this analysis indicate that, across all scenarios, NOx emission reductions would likely contribute to improved air quality, reduced nitrogen deposition, and the preservation of marine habitats, which could, in turn, enhance fisheries productivity over the long term. However, economic impacts vary significantly depending on the pace and scope of implementation. The targeted-support scenario appears the most balanced, limiting risks to fishery profitability while ensuring meaningful ecological gains.

Paper 2 – Potential Impacts of the Implementation of the NOx Emission Control Area on Tourism in the Mediterranean Region

The second analysis focuses on a particularly prominent activity in the region: tourism. Given that maritime transport, as previously established, is a significant contributor to atmospheric emissions, the establishment of a Nitrogen Oxides Emission Control Area (NECA) could serve as a strategic lever to position the Mediterranean Sea as a sustainable tourism destination. However, such a transition entails technical, economic, and organisational adjustments for all stakeholders involved.

This research examines the potential implications of creating a Mediterranean NECA for the tourism sector, drawing on a mixed-methods approach that combines documentary analysis, semi-structured interviews, and surveys conducted with a diverse panel of stakeholders, including tourism operators, maritime sector representatives, local communities, and non-governmental organisations. This approach makes it possible to integrate quantitative data on emissions and tourism flows with qualitative insights on the perceived opportunities and constraints of the measure.

The findings reveal a broad convergence of opinions on the anticipated environmental and health benefits, notably the improvement of air quality and coastal living conditions, as well as an enhancement of the region's ecological image. These positive effects could bolster tourism appeal, particularly among a growing segment of travellers attentive to sustainability. Nevertheless, concerns remain regarding compliance costs - especially for small operators and the cruise industry - as well as potential job losses in certain traditional sectors. In conclusion, the study underscores that the success of a Mediterranean NECA will hinge on the implementation of appropriate accompanying measures: financial incentives, public-private partnerships, phased deployment, and training schemes to support professional retraining. Such levers appear essential to balance environmental objectives with economic viability and social justice, while maximising the positive spillovers for regional tourism.

In conclusion, the study highlights that the effectiveness of a Mediterranean NECA for the fisheries sector will largely depend on the choice of implementation scenario and on policymakers' ability to integrate suitable support measures. The adoption of a concerted and differentiated approach appears essential to maximise environmental benefits while safeguarding the socio-economic sustainability of fishing communities.

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1 Paper 1. Expert Survey on NOx Controls in Mediterranean Marine Settings

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Executive Summary

This report presents the findings of a targeted expert survey assessing perceptions, expectations, and policy preferences related to the potential implementation of a Nitrogen Oxides (NOx) Emission Control Area (ECA) in the Mediterranean. The survey gathered insights from 31 experts representing academia, government, industry, NGOs, and international institutions active in maritime, fisheries, tourism, and environmental governance across multiple Mediterranean countries. The objective was to provide evidence-based guidance on the economic, environmental, and governance implications of NOx controls, grounded in both quantitative and qualitative analysis.

Key findings

Readiness and perceived benefits

Expert views on readiness were mixed, with a significant share indicating that current policy frameworks, economic conditions, and stakeholder relationships only partially support NOx control implementation. While most respondents believe the environmental and health benefits of NOx reduction outweigh the costs, concerns remain about fragmented regulations, uneven stakeholder engagement, and cost burdens on specific sectors.

Equity and cost distribution

Maritime transport operators were overwhelmingly identified as the sector most likely to bear the highest compliance costs, followed by small-scale fishers and local communities. In contrast, the primary beneficiaries were seen as coastal residents and the wider public through improved air quality and reduced health risks, with tourism also perceived as a major winner. This points to an asymmetry between those incurring costs and those receiving benefits, underlining the importance of equitable policy design.

Policy preferences

Respondents were presented with a range of policy tools reflecting both price-based (tax incentives, subsidies) and quantity-based (emission trading systems, performance standards) approaches. Environmental performance standards linked to financial rewards or penalties emerged as the most preferred instrument, valued for their combination of clear environmental targets and economic incentives. Tax incentives for cleaner technologies and emission trading systems also received substantial support, while subsidies and flexible compliance mechanisms were less favoured.

Feasibility considerations

Qualitative responses revealed a nuanced picture: while international regulatory frameworks (e.g. MARPOL Annex VI) provide a foundation, regional implementation faces challenges including ageing fleets, high capital costs, fragmented national policies, and uneven political will. Successful deployment of NOx controls will require harmonised regulations, targeted financial mechanisms, and sustained stakeholder engagement to balance environmental certainty with economic feasibility.

Recommendations

Based on the findings, the report recommends:

1. Developing a harmonised Mediterranean-wide regulatory framework aligned with international standards to reduce policy fragmentation.

2. Targeting financial incentives, such as tax credits and low-interest loans, at sectors facing the highest compliance costs, particularly maritime transport operators and small-scale fishers.
3. Combining performance standards with economic incentives to encourage over-compliance and stimulate innovation in low-NOx technologies.
4. Strengthening stakeholder engagement platforms to address equity concerns and build long-term buy-in.
5. Supporting capacity-building measures, especially for smaller operators, to ensure a just transition and avoid disproportionate impacts on vulnerable sectors.

This survey-based analysis offers a detailed, stakeholder-informed foundation for designing effective, equitable, and feasible NOx control policies in the Mediterranean. The insights can guide policymakers, regional bodies, and industry actors in advancing environmental objectives while managing economic and social impacts.

Résumé exécutif

Ce rapport présente les résultats d'une enquête ciblée auprès d'experts visant à évaluer les perceptions, attentes et préférences en matière de politiques liées à la mise en œuvre potentielle d'une zone de contrôle des émissions d'oxydes d'azote (NOx ECA) en Méditerranée. L'enquête a recueilli les avis de 31 experts issus du monde académique, des administrations publiques, de l'industrie, des ONG et d'institutions internationales, actifs dans les domaines du maritime, des pêches, du tourisme et de la gouvernance environnementale dans plusieurs pays méditerranéens. L'objectif était de fournir des orientations fondées sur des données probantes concernant les implications économiques, environnementales et de gouvernance des mesures de contrôle des NOx, en s'appuyant sur une analyse à la fois quantitative et qualitative.

Points Clés

Préparation et bénéfices perçus

Les avis des experts sur le degré de préparation sont partagés, une proportion importante estimant que les cadres politiques actuels, les conditions économiques et les relations entre parties prenantes ne permettent qu'en partie de soutenir la mise en œuvre de contrôles des NOx. La majorité des répondants considèrent toutefois que les bénéfices environnementaux et sanitaires de la réduction des NOx l'emportent sur les coûts, même si des inquiétudes persistent concernant la fragmentation réglementaire, l'inégale mobilisation des acteurs et la charge financière supportée par certains secteurs.

Équité et répartition des coûts

Les opérateurs du transport maritime ont été massivement identifiés comme le secteur le plus susceptible de supporter les coûts de conformité les plus élevés, suivis par les pêcheurs artisanaux et les communautés locales. À l'inverse, les principaux bénéficiaires seraient les habitants des zones côtières et la population dans son ensemble, grâce à une amélioration de la qualité de l'air et une réduction des risques sanitaires, le tourisme étant également perçu comme un grand gagnant. Cela révèle une asymétrie entre ceux qui supportent les coûts et ceux qui bénéficient des retombées, soulignant l'importance d'une conception équitable des politiques.

Préférences en matière de politiques

Les répondants ont été invités à se prononcer sur un éventail d'outils politiques reflétant à la fois des approches fondées sur les prix (incitations fiscales, subventions) et sur les quantités (systèmes d'échange de quotas d'émission, normes de performance). Les normes de performance environnementale assorties de récompenses ou de pénalités financières se sont imposées comme l'instrument le plus plébiscité, grâce à leur combinaison de cibles environnementales claires et d'incitations économiques. Les incitations fiscales pour les technologies plus propres et les systèmes d'échange d'émissions ont également reçu un soutien important, tandis que les subventions et les mécanismes de conformité flexibles ont été moins appréciés.

Considérations de faisabilité

Les réponses qualitatives dessinent un tableau nuancé : si les cadres réglementaires internationaux (par ex. MARPOL Annexe VI) offrent une base solide, la mise en œuvre régionale fait face à des défis tels que le

vieillissement des flottes, le coût élevé des investissements, la fragmentation des politiques nationales et une volonté politique inégale. Une mise en œuvre réussie des contrôles des NOx nécessitera des réglementations harmonisées, des mécanismes financiers ciblés et un engagement durable des parties prenantes, afin de concilier certitude environnementale et faisabilité économique.

Recommandations

Sur la base des résultats, le rapport recommande :

- De développer un cadre réglementaire méditerranéen harmonisé, aligné sur les normes internationales, afin de réduire la fragmentation des politiques ;
- De cibler les incitations financières, telles que des crédits d'impôt et des prêts à faible taux d'intérêt, sur les secteurs les plus exposés aux coûts de conformité, en particulier les opérateurs du transport maritime et les pêcheurs artisanaux ;
- De combiner des normes de performance avec des incitations économiques pour encourager le sur-respect et stimuler l'innovation dans les technologies à faibles émissions de NOx ;
- De renforcer les plateformes de dialogue entre parties prenantes afin de répondre aux enjeux d'équité et de favoriser une adhésion durable ;
- De soutenir des mesures de renforcement des capacités, notamment pour les petits opérateurs, afin d'assurer une transition juste et d'éviter des impacts disproportionnés sur les secteurs vulnérables.

Cette analyse fondée sur une enquête auprès d'experts offre une base détaillée et éclairée par les parties prenantes pour la conception de politiques de contrôle des NOx efficaces, équitables et réalistes en Méditerranée. Ces enseignements peuvent guider les décideurs politiques, les instances régionales et les acteurs économiques dans la poursuite des objectifs environnementaux tout en gérant les impacts économiques et sociaux.

1.1 INTRODUCTION

The Mediterranean Sea is one of the busiest maritime regions in the world, hosting a diverse range of shipping activities, including international cargo transport, passenger ferries, cruise vessels, fishing fleets, and recreational boating. This high intensity of maritime traffic is accompanied by significant air pollutant emissions, particularly nitrogen oxides (NOx), which contribute to environmental degradation and pose risks to human health. NOx emissions from ships are associated with the formation of ground-level ozone and fine particulate matter, which can impair respiratory health, exacerbate cardiovascular disease, and negatively affect ecosystems through nitrogen deposition and acidification.

Against this backdrop, Mediterranean coastal states, in cooperation with the International Maritime Organization (IMO), are considering the establishment of a **Mediterranean NOx Emission Control Area (ECA)**. This regulatory measure would require vessels operating in the region to meet **Tier III NOx emission standards** under Annex VI of the MARPOL Convention, significantly reducing NOx emissions from new ships and major engine modifications. The proposed ECA would represent a major step toward aligning Mediterranean air quality standards with other Emission Control Areas already in force in the North American, Baltic, and North Sea regions.

In parallel with technical and economic modelling exercises, it is essential to understand the perspectives of those most directly involved in, and affected by, such a regulatory change. This report draws on an expert survey designed to capture stakeholder views across multiple sectors, geographies, and professional backgrounds. The survey focused on perceived impacts, distribution of costs and benefits, sectoral readiness, policy tools, and enabling conditions for effective NOx control implementation.

By gathering and analysing these perspectives, this report aims to complement quantitative modelling with qualitative insights, ensuring that decision-making processes are informed by the expertise and practical knowledge of stakeholders in fisheries, tourism, shipping, environmental management, policy, and research. The survey is not only a diagnostic tool to assess perceptions but also a bridge between technical feasibility studies and stakeholder engagement, highlighting potential areas of consensus, contention, and opportunity in the pathway toward a Mediterranean NOx ECA.

1.2 METHODOLOGY

This study applied a sequential mixed-methods approach to assess stakeholder perceptions, sectoral impacts, and preferred policy instruments for implementing NOx emission controls in the Mediterranean. The analysis progressed in a logical sequence, beginning with levels of support for NOx controls, moving through preparedness assessments, examining cost and benefit perceptions and equity concerns, evaluating policy tool preferences, and concluding with governance readiness and enabling conditions.

The survey consisted of 18 structured questions designed to capture expert views on the potential impacts, benefits, and challenges of implementing stricter NOx emission controls in the Mediterranean maritime sector. The questions combined numerical rating scales, typically ranging from one to ten with percentage-based interpretations, multiple-choice formats, and open-ended prompts for qualitative commentary. This design allowed respondents to provide both quantifiable assessments and detailed professional perspectives.

Topics addressed included anticipated cost implications for maritime transport, fisheries, and other sectors; expected environmental and socio-economic benefits; the perceived distribution of costs and benefits across stakeholder groups; preferred policy tools for easing compliance; levels of sectoral readiness; and the wider policy and economic context influencing feasibility.

A total of 31 experts participated in the survey. Of these, fifteen were from academia and research with expertise on either MPA or fisheries management, five from the private sector and consultancy, two from international institutions, and two from NGOs and advocacy groups. Additionally, two participants were from the shipping industry, while the remainder were spread across government agencies, industry associations, and other sectors. This broad mix was intended to ensure the survey reflected both operational and strategic perspectives, capturing views from those directly affected by regulatory changes as well as those involved in policy development and oversight. The distribution was designed to include more perspectives from actors linked to fisheries, in line with the paper's focus. As for shipping stakeholders, they represented a relatively small share of the total sample. Therefore, the conclusions on compliance costs should be interpreted with this sample distribution in mind. While the survey highlights broad recognition of the environmental and health benefits of a Mediterranean NOx ECA, its findings on cost distribution mainly reflect the consulted sample and should be viewed as indicative rather than fully representative of all stakeholder perspectives.

Participants were predominantly based in Mediterranean states or active within the region's maritime policy sphere, including Italy, Spain, Greece, Portugal, Tunisia, Algeria, Croatia, Turkiye, Morocco, and Malta. Several respondents also reported working across multiple Mediterranean jurisdictions, reflecting the interconnected nature of shipping routes, fisheries management, and environmental governance in the region. This concentration of regional expertise aligns with the geographic scope of the proposed NOx Emission Control Area (ECA) and underscores the relevance of the insights gathered.

The responses were evaluated using a mixed-methods approach. Quantitative results from the rating scales and multiple-choice questions were aggregated and examined for patterns, average values, and sectoral differences. These were analysed descriptively, with percentages calculated to reveal dominant positions and sectoral patterns.

Qualitative answers were coded into thematic categories, enabling the identification of recurring issues, innovative proposals, and sector-specific concerns. This thematic analysis followed a structured coding process to capture the reasoning behind quantitative answers, providing context and depth to numerical findings. The integration of these narratives highlighted underlying drivers, such as perceived feasibility, political will, sectoral capacity, and market conditions.

Interpretation of stakeholder preferences for policy tools was informed by environmental economics theory, particularly the prices versus quantities framework and the concept of internalising externalities. This lens was used to distinguish between price-based instruments, such as Pigouvian taxes and tax incentives, and quantity-based instruments, such as cap-and-trade and performance standards, which has direct implications for cost certainty, environmental certainty, and behavioural incentives.

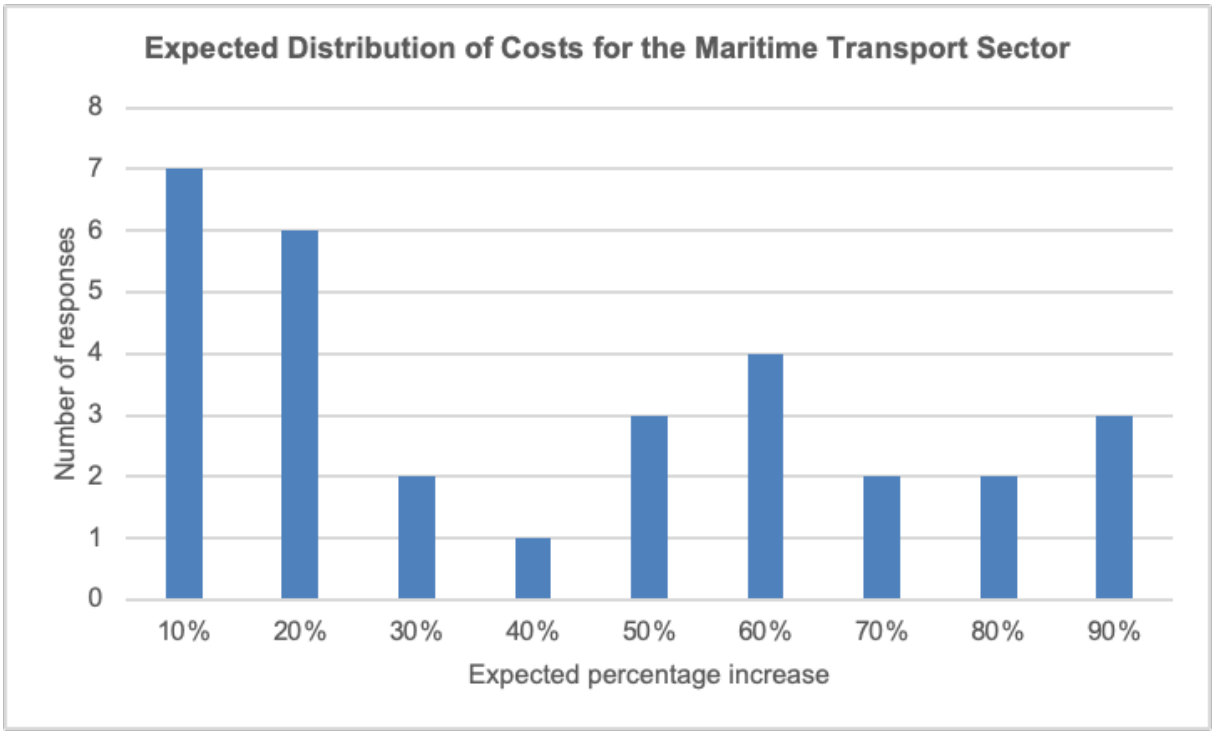
By combining statistical trend analysis with qualitative coding, the methodology ensured that findings reflect both the breadth of stakeholder positions and the depth of professional judgement from actors familiar with the complexities of maritime environmental regulation in the Mediterranean context. This sequential structure allowed each stage of the analysis to build on the last, resulting in a cumulative understanding of stakeholder attitudes and the conditions under which NOx control measures could be effectively implemented.

1.3 KEY FINDINGS

1.3.1 Economic Impacts and Cost Distribution

The distribution of expert expectations regarding the potential increase in maritime transport costs from NOx control implementation shows a pronounced clustering at the lower end of the scale. Nearly half of respondents anticipate cost increases of 20% or less, suggesting that many stakeholders foresee only modest economic impacts. However, there is also a notable tail toward higher cost estimates, with a smaller but significant group projecting increases of 60% or more. This divergence highlights a considerable degree of uncertainty and heterogeneity in perceived impacts, which may reflect differences in operational contexts, fleet characteristics, or the assumed timeline for compliance. The presence of high-impact estimates (up to 90%) indicates that while the median expectation is moderate, some experts foresee substantial cost burdens for parts of the sector, underlining the importance of targeted policy tools to manage uneven economic effects across stakeholders. Figure 4 below presents a graph showcasing the distribution of expected price increases for the Maritime Transport sector:

Figure 4. Distribution of Costs of NOx controls for the Maritime Transport Sector



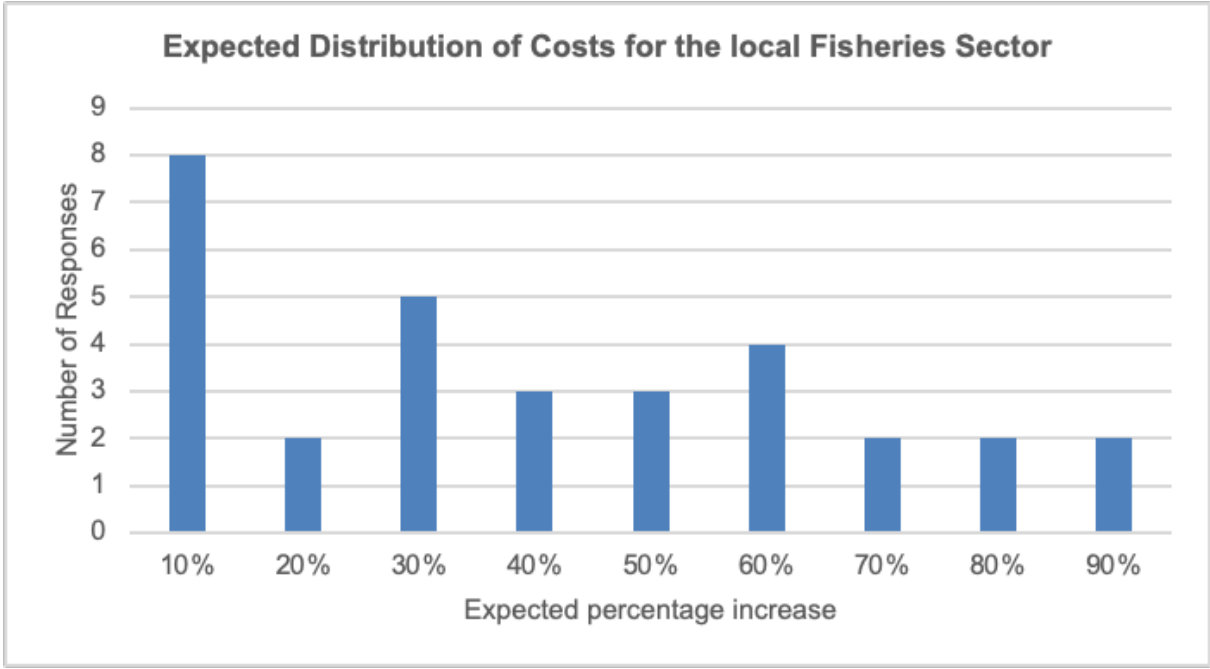
The survey results indicate that the perceived economic impacts of NOx emission controls on the Mediterranean fisheries sector are substantial but not uniformly distributed across stakeholders. When considering all respondents, cost expectations span the full range from minimal (<10%) to very high (>90%) increases, with the largest share clustered at the low end. Around one-quarter of respondents foresee increases of 10%, while others anticipate a variety of moderate to high impacts, producing a median estimated cost increase of approximately 30%. This distribution suggests that while some stakeholders believe compliance costs will be relatively modest, perhaps due to expectations of targeted subsidies, exemptions, or gradual adoption. Others anticipate more significant operational and capital investment needs.

However, filtering the results to include only those respondents with self-declared expertise in fisheries management produces a different picture. This subgroup's responses are more evenly spread across the moderate-impact brackets, with roughly half estimating cost increases in the range of 30% to 60%. Minimal cost expectations (<20%) are less common among these experts, and while high-cost projections (≥70%) are present, they remain less frequent than in the broader stakeholder sample. The median expected cost increase for this expert group is approximately 40%, notably higher than the general fisheries sample.

This difference in outlook may be explained by technical familiarity with the operational realities of Mediterranean fishing fleets, many of which operate with ageing vessels, limited capital reserves, and diverse gear types. Experts may

also be more aware of the challenges associated with retrofitting engines for Tier III compliance, adapting to alternative fuels, or integrating selective catalytic reduction systems within spatial and safety constraints. At the same time, their lower propensity to predict extreme cost increases could indicate confidence that phased implementation schedules, targeted financial assistance, or exemptions for small-scale operators will limit the most severe burdens. Overall, these findings underscore the heterogeneity of perceptions within the fisheries sector and the importance of distinguishing between general stakeholder opinion and domain-specific expertise when designing policy. While the broader stakeholder community sees a mix of low- and high-cost possibilities, fisheries experts tend to converge around moderate yet significant increases, highlighting the need for tailored compliance pathways and support mechanisms to ensure sectoral resilience. Figure 5 below presents a graph showcasing the distribution of expected price increases.

Figure 5. Expected Distribution of Costs from NOx Controls to the fisheries sector



The pattern of responses for maritime transport costs under a Mediterranean NOx Emission Control Area (ECA) reveals a generally optimistic outlook tempered by a significant minority of high-impact expectations. Nearly half of stakeholders foresee cost increases of 20% or less, indicating a perception that compliance measures, such as adoption of Tier III engines, selective catalytic reduction (SCR), or exhaust gas recirculation (EGR) can be implemented without dramatic disruption. However, the presence of estimates as high as 90% reflects concerns over specific fleet segments, operational profiles, or port dependencies that may face disproportionately higher retrofit or fuel-switching costs. This heterogeneity is consistent with the highly diverse operational landscape of Mediterranean shipping, where fleet age, size, propulsion technology, and trade patterns vary widely (Plan Bleu, 2019; UNCTAD, 2017a).

The Mediterranean maritime transport sector is both strategically significant and structurally complex. Hosting three major chokepoints (the Strait of Gibraltar, the Suez Canal, and the Bosporus) the region handles a mix of long-haul transit, extra-Mediterranean trade (40–50% of port calls), and a growing proportion of intra-Mediterranean short sea shipping (Plan Bleu, 2019; Arvis et al., 2019). Fleet registries are concentrated in a few high-capacity states, with Malta, Greece, and Cyprus among the world's largest registries (UNCTAD, 2017a), and the sector encompasses oil tankers, bulk carriers, container ships, and an expanding cruise segment. Such diversity implies that NOx control costs will not be evenly felt—large, modern fleets engaged in deep-sea trades may absorb compliance with relative ease, while smaller, older short-sea operators could face proportionally higher investment burdens.

The fisheries sector exhibits a similarly uneven cost perception profile but with a more pessimistic central tendency. Across all respondents, the median expected increase is about 30%, with cost projections ranging from minimal (<10%) to extreme (>90%). Notably, one-quarter of respondents foresee a 10% increase, suggesting confidence in manageable compliance pathways, while others anticipate significant impacts. When filtered to fisheries management experts, however, the median rises to approximately 40%, and the distribution shifts toward moderate-to-high brackets (30–60%). This pattern suggests that sector insiders are more attuned to the operational and financial realities of Mediterranean fishing fleets, many of which operate with ageing vessels, constrained capital reserves, and gear

configurations that complicate retrofitting for Tier III standards (STECF, 2021). The relative absence of extreme (>70%) projections among experts may reflect expectations of phased implementation, targeted subsidies, or exemptions for small-scale operators.

From a distributional perspective, both sectors appear sensitive to NOx control cost increases, but in different ways. For maritime transport, the lower median expectation masks a long tail of high-impact concerns, implying that while most operators might experience marginal increases, a subset (likely smaller or niche market players) could face disproportionately higher burdens. For fisheries, the higher median among experts points to a more uniform concern over moderate cost impacts, suggesting a sector more consistently exposed to operational and compliance challenges, especially in the absence of targeted financial and technical support. In both cases, uneven cost burdens risk amplifying existing disparities: in maritime transport, between large, modern fleets and smaller short-sea operators; in fisheries, between well-capitalised industrial segments and vulnerable small-scale coastal fishers.

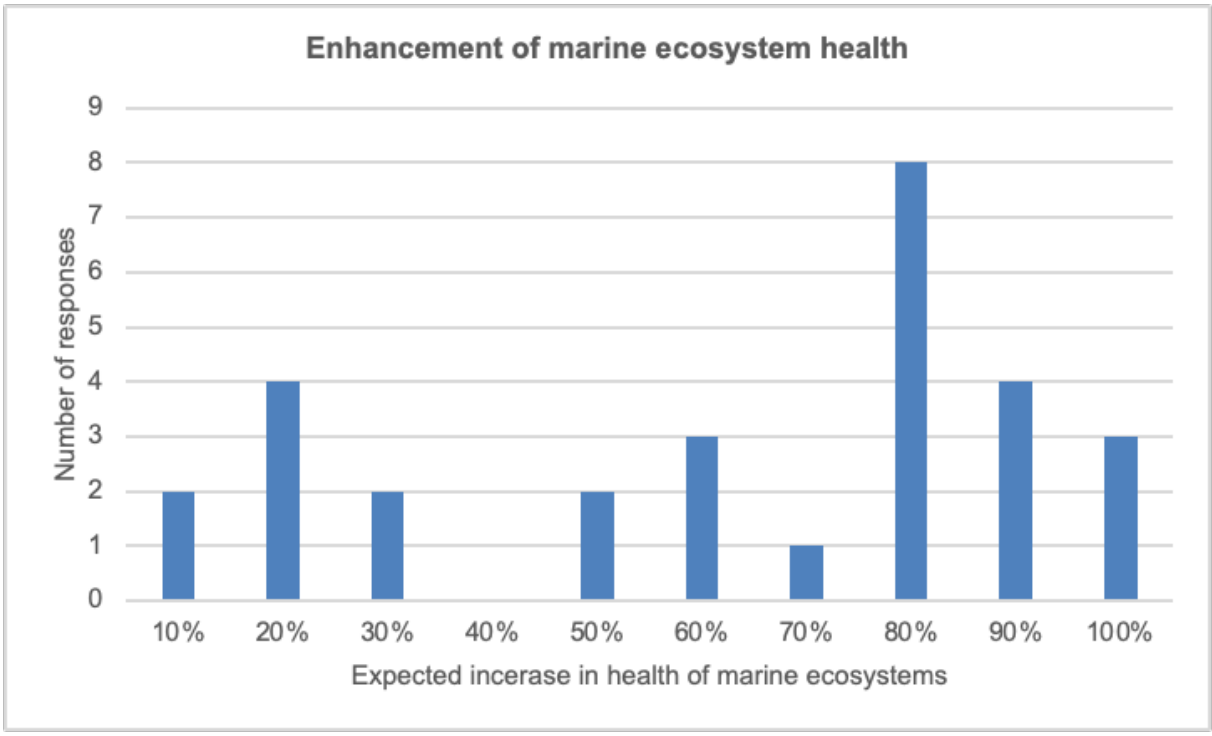
Policy design will need to account for these distributional dynamics. For shipping, differentiated compliance timelines, technical assistance, and investment support for smaller operators could prevent competitive distortions. For fisheries, safeguarding small-scale operators through phased implementation, capacity-building, and access to low-cost finance will be critical to avoid disproportionate socio-economic impacts on already vulnerable coastal communities. Without such measures, NOx control policies risk concentrating economic strain in the most vulnerable segments of both sectors, potentially undermining compliance and stakeholder support.

1.3.2 Anticipated Benefits

Stakeholder expectations regarding the benefits of implementing NOx emission controls in the Mediterranean reveal broad recognition of their potential to generate positive environmental, economic, and social outcomes. Across the responses, three main benefit areas were assessed: improvements in marine ecosystem health, increases in tourism revenues linked to a cleaner and more attractive maritime environment, and wider social benefits, including public health gains, enhanced well-being, and other positive spillovers. While the magnitude of anticipated benefits varies across respondents, initial patterns suggest that perceived gains are less polarised than the cost estimates reported in Section 4.1, with a majority expecting moderate-to-high improvements in at least one benefit category. As with costs, the distribution of responses likely reflects differences in sectoral perspectives, geographical context, and underlying assumptions about the scale and speed of environmental recovery. Figures presented in the following subsections provide a detailed breakdown of the distribution of benefit expectations for each category.

The distribution of responses to the question “Rate the effectiveness of NOx controls in enhancing the health of marine ecosystems” reveals a strong overall expectation of positive ecological outcomes. While opinions span the full range from minimal (10%) to complete (100%) effectiveness, the data are notably skewed toward the higher end of the scale. A small share of respondents anticipates relatively modest improvements (10–30%), while a much larger proportion foresee substantial benefits, with peaks at 80% and 90%. In fact, the single most common response was 80%, followed closely by 90% and 100%, suggesting that most stakeholders expect NOx controls to have a decisive effect in improving Mediterranean marine ecosystem health. The median expected improvement across all respondents is approximately 80%, indicating a high level of confidence in the environmental efficacy of the proposed measures. Figure 6 presents these results below:

Figure 6. Increases in the health of marine ecosystems derived from NOx controls



When filtering responses to include only those from participants who self-identified as experts in Marine Protected Area (MPA) management, the results show an even stronger inclination toward high-impact expectations. While some experts still anticipate modest improvements (with small clusters in the 10–30% range), the distribution becomes more concentrated toward the top end, with a substantial share rating effectiveness at 80% or higher. In particular, ratings of 80%, 90%, and 100% together account for a dominant portion of expert responses, indicating a clear consensus within this group that NOx controls could deliver major ecological gains. The median expected improvement for MPA management experts remains close to 80%, aligning with the overall sample but with a more pronounced concentration in the highest categories. This reinforces the perception that, from the standpoint of those with direct experience in marine conservation, NOx controls are likely to be a highly effective tool for improving Mediterranean marine ecosystem health.

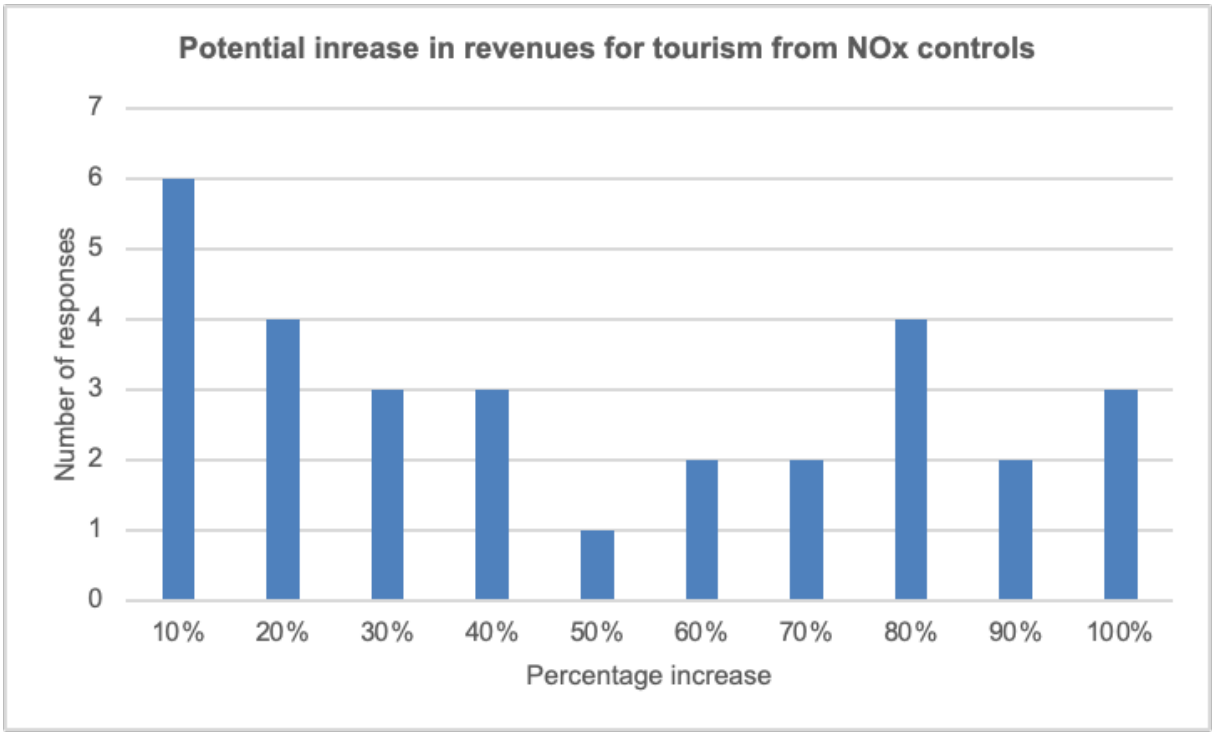
Next, we inquired about the potential increase in tourism revenues that could result from the implementation of NOx controls. Such gains are expected to arise indirectly, as improved marine and coastal ecosystem health, through reduced eutrophication, enhanced water clarity, and the recovery of habitats such as seagrass meadows and coral reefs, can boost the attractiveness of Mediterranean destinations. In a region where tourism is closely tied to the quality of beaches, dive sites, and marine wildlife experiences, these ecological improvements could enhance visitor satisfaction, extend average stays, and increase per-visitor spending.

That said, these gains remain hypothetical and represent potential rather than guaranteed returns. Their realisation depends on the tourism sector's capacity to capture and monetise ecological improvements, for instance through expanded nature-based tourism offerings, premium eco-tourism experiences, and competitive destination branding. Without supporting measures, such as sustainable tourism planning, marketing strategies, and adequate infrastructure, the link between ecosystem recovery and actual tourism revenue growth may be weaker than anticipated.

Responses on the potential revenue gains for the tourism sector from NOx control implementation displayed a broad spread, though with a slight clustering toward the lower and mid-range estimates. Around one-fifth of respondents anticipated only modest gains of 10–20%, while roughly a quarter projected moderate increases in the 30–50% range. Higher-end expectations were also present: approximately one-third of respondents estimated revenue growth of 70% or more. This distribution indicates substantial uncertainty among stakeholders regarding the tourism sector's ability to translate ecosystem improvements into tangible economic gains. The relatively even spread across benefit brackets suggests that while some anticipate incremental improvements, others foresee major revenue opportunities, likely reflecting differences in assumptions about the market value of improved marine environments, the readiness of

tourism operators to adapt their offerings, and the competitive position of Mediterranean destinations in attracting nature-oriented visitors. Figure 7 below showcases the survey results.

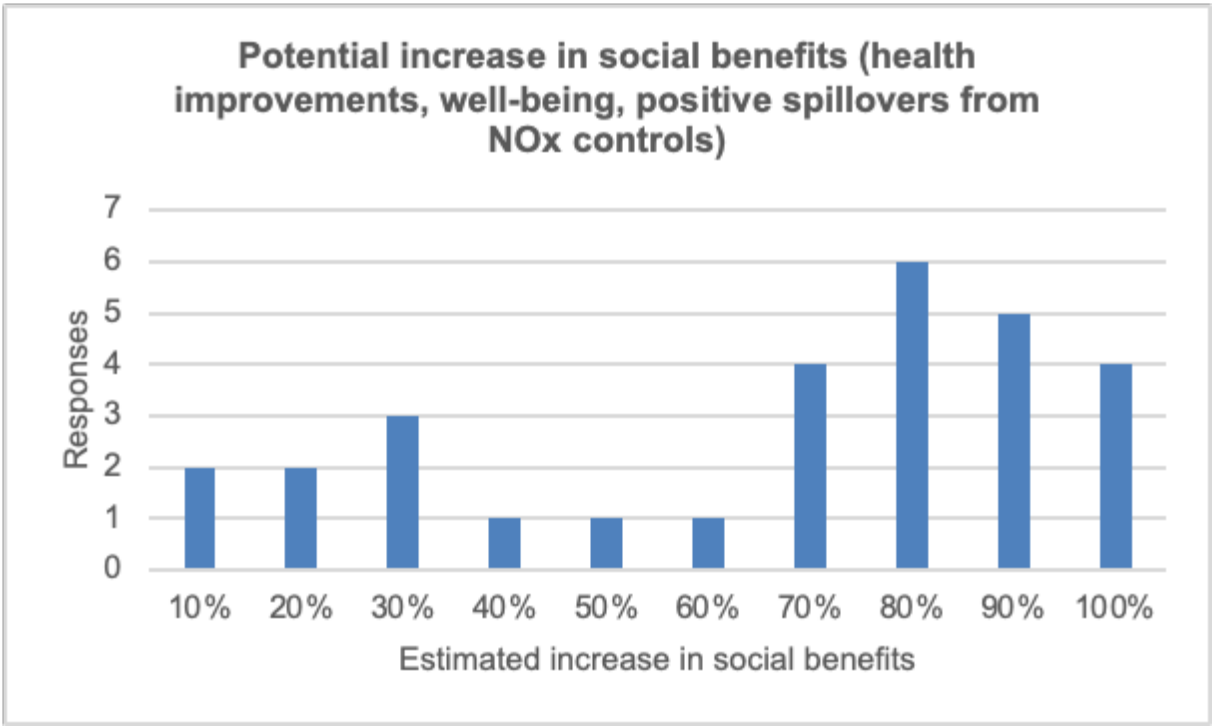
Figure 7. Potential revenue increases from NOx controls



Next, we inquired about the broader societal gains expected from NOx control implementation, focusing on potential increases in social benefits such as public health improvements, enhanced well-being, and other positive spillovers for local communities. Unlike sector-specific impacts, these benefits extend beyond direct industry stakeholders, potentially reaching entire coastal populations through cleaner air, healthier marine environments, and associated cultural and recreational values. Such gains are inherently diffuse and often undervalued in market transactions, yet they can be substantial drivers of quality-of-life improvements and long-term community resilience, and are at the core of emission control regulation.

Responses on the potential increase in social benefits from NOx controls show a clear skew toward higher-impact expectations. While a small share of respondents (under 20%) rated potential gains at 20% or less, the majority placed their estimates in the upper half of the scale, with a noticeable concentration in the 70–100% range. In fact, over half of all responses indicated expected benefits of 80% or more, suggesting strong confidence in the ability of NOx reductions to translate into significant health and well-being improvements. The median rating falls around 80%, underscoring that most stakeholders anticipate substantial positive outcomes for communities. This high-benefit clustering reflects the public-good nature of many of these outcomes, improved air quality, healthier coastal ecosystems, and enhanced recreational opportunities, which are widely shared across society. Such benefits are not only environmentally valuable but can also reduce healthcare costs, improve labor productivity, and strengthen social cohesion. The results therefore indicate a broad perception that NOx controls can deliver far-reaching societal gains, with a magnitude potentially greater than the economic costs identified in earlier sections. Figure 8 below showcases the results from the survey.

Figure 8. Expected increase in social benefits from NOx controls



1.3.3 Policy Support and Readiness

The survey's findings on costs and benefits present a clear trade-off: while stakeholders foresee moderate to, in some cases, substantial cost increases, particularly for maritime transport and fisheries, the anticipated benefits, especially for marine ecosystem health and wider social well-being, are generally viewed as significant and widely shared. In economic terms, this creates a classic externality problem: many of the benefits of NOx reductions are public goods, not directly monetized by those investing in compliance. Without effective policy mechanisms to internalise these externalities, ensuring that the value of cleaner air, healthier ecosystems, and improved public health is reflected in decision-making, there is a risk that the scale of benefits identified will not be realised.

In practice, internalisation requires policy tools that both incentivise investment in cleaner technologies and prevent free-riding, while also addressing the uneven distribution of costs across sectors. This makes the choice of policy instrument, be it tax incentives, subsidies, emissions trading, or performance standards, central to the feasibility of implementation. However, the adoption of any policy tool operates within the constraints of political economy. Sectoral lobbying power, conflicting priorities between economic competitiveness and environmental protection, and the degree of coordination among maritime, fisheries, tourism, and environmental policy bodies all influence the likelihood of effective policy action.

Ultimately, achieving the projected benefits of NOx controls depends not only on selecting the right instruments but also on the readiness of governance systems to implement them. This readiness is shaped by institutional capacity, stakeholder trust, and the ability of regulatory bodies to enforce compliance while providing transitional support to the most affected sectors. The following section examines how stakeholders assess both the policy tools available and the readiness of the governance landscape to deliver on NOx emission reductions in the Mediterranean.

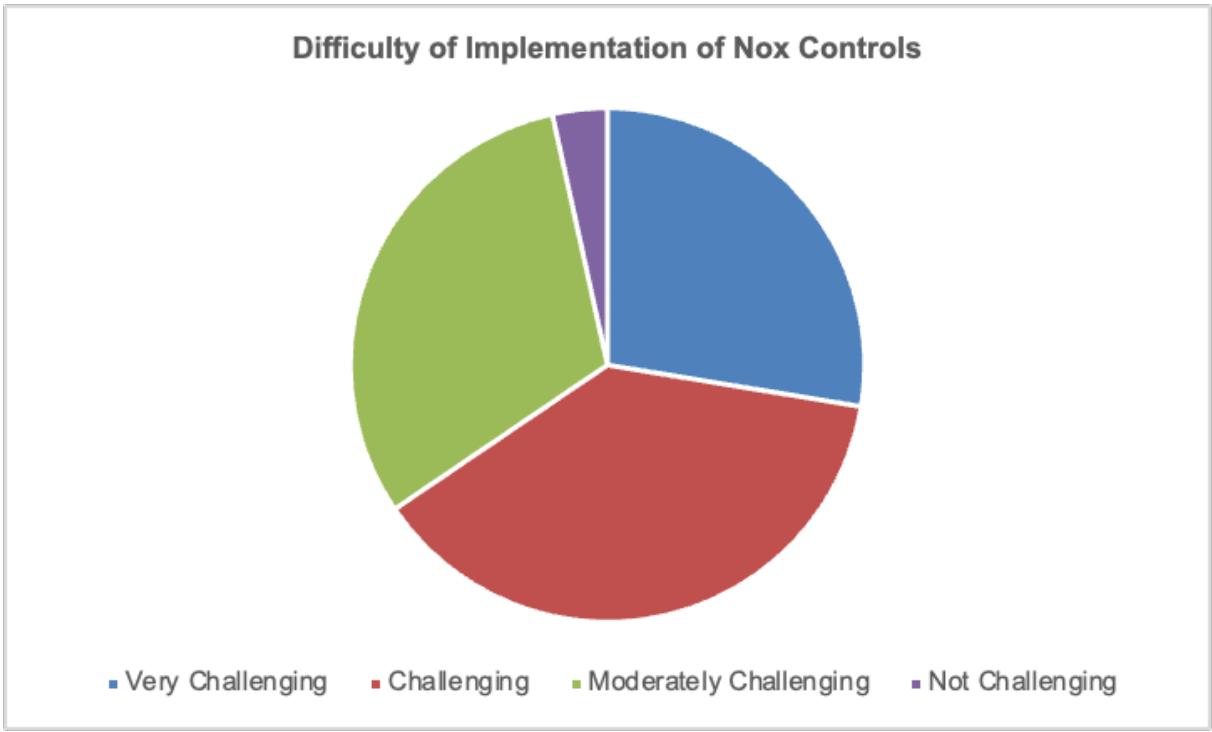
Survey responses on the perceived difficulty of implementing NOx control policies reveal that a substantial majority of experts view the process as highly challenging. Combining the "Very Challenging" (27%) and "Challenging" (37%) categories, nearly two-thirds of respondents anticipate significant barriers to implementation. An additional 30% rated the process as "Moderately Challenging," suggesting that even among those less pessimistic, the expectation remains that meaningful obstacles will arise. Only a single respondent (3%) considered implementation "Not Challenging," underscoring the broad consensus that successful policy adoption will require overcoming technical, financial, and political hurdles.

These overall patterns are echoed in the subgroup of respondents self-identifying as experts in MPA management. Within this group, none considered implementation "Not Challenging," and a majority placed it in the "Very

Challenging" or "Challenging" categories, reinforcing the perception that governance capacity and stakeholder alignment may be insufficient without targeted support. While these specialist insights align broadly with the general sample, their slightly higher concentration in the most challenging categories suggests a heightened awareness of the administrative complexity and cross-sector coordination required in marine conservation contexts.

This distribution suggests that while there is recognition of the potential benefits of NOx controls, stakeholders remain acutely aware of the political economy constraints, sectoral resistance, and capacity limitations that could slow or complicate effective enforcement.

Figure 9. Proportion of responses pertaining degree of difficulty in NOx control Implementation



Next, the survey explored perceptions of stakeholder backing for NOx controls, recognising that even well-designed policies can stall without adequate buy-in from key sectors. Respondents were asked to assess the level of support they believed such measures would receive within their own professional domain, using a scale from "No Support" to "Strong Support." This question aimed to capture not only the formal positions of organisations but also the broader sentiment within sectors such as maritime transport, fisheries, tourism, environmental policy, and research, as these perceptions can strongly influence both the speed and the smoothness of implementation.

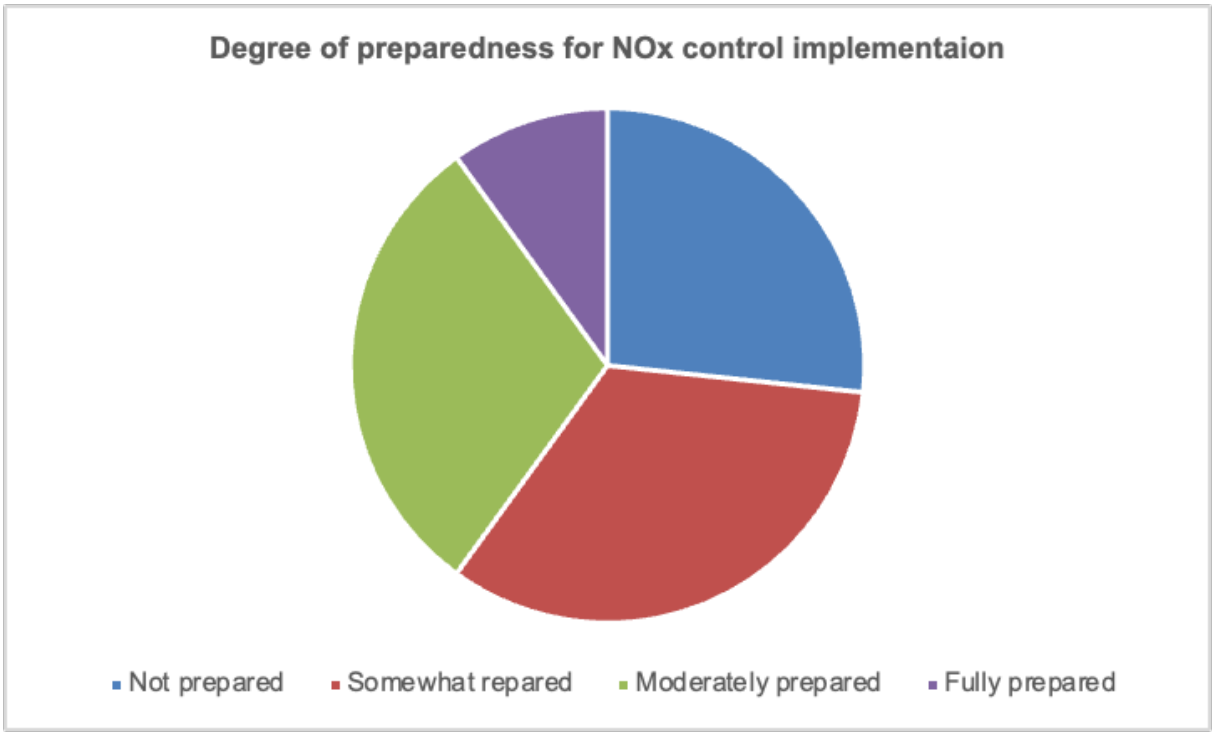
Overall, responses indicate a generally favourable outlook toward the implementation of NOx controls, with approximately two-thirds of stakeholders expressing either moderate (around 45%) or strong support (about 25%), and a smaller share showing limited (roughly 25%) or no support (around 3%). This distribution suggests broad acceptance of the measure, with most stakeholders recognising its potential benefits while remaining mindful of the economic, operational, and political challenges it may entail. The predominance of moderate support reflects a cautious optimism—acknowledging the policy's environmental value but tempered by considerations of feasibility and sector-specific constraints.

When examined by sector, additional patterns emerge. Government responses tend to cluster around moderate support, balancing awareness of environmental imperatives with sensitivity to the administrative and economic implications of enforcement. Academia and research stakeholders are divided between moderate and strong support, reflecting both alignment with the scientific rationale for NOx controls and relative distance from direct compliance costs. Private sector actors, including consultancy, shipping, and industrial representatives, show a more mixed picture, with some signalling strong support, often linked to reputational or innovation advantages, and others favouring a more measured position due to concerns over investment needs, operational adjustments, and competitive impacts. It should be kept in mind that these sectoral nuances reflect our sample only and are therefore indicative rather than exhaustive. They indicate that while support is relatively strong across the board, its durability will depend on policy approaches that address cost concerns, demonstrate equitable implementation, and clearly communicate co-benefits.

Following the examination of stakeholder support, the analysis turned to preparedness, recognising that even broad endorsement of NOx controls will not translate into tangible outcomes without the institutional, technical, and financial capacity to act. Preparedness is a critical determinant of whether the anticipated environmental and social benefits can be realised within the proposed timelines, particularly given the cross-sectoral nature of maritime regulation and the need for coordination across governance levels.

The assessment of stakeholder preparedness to implement NOx controls shows a relatively even spread across most categories, but with a leaning toward lower readiness levels. Around one-third of respondents reported being "not prepared," while another third indicated they were "somewhat prepared." A slightly smaller share described themselves as "moderately prepared," and only a small minority reported being "fully prepared." This distribution suggests that while there is general awareness of the forthcoming requirements, substantial gaps remain in technical capacity, resources, or institutional arrangements necessary for effective implementation. The low proportion of respondents reporting full preparedness underlines the need for targeted capacity-building, transitional support, and clear regulatory guidance to ensure that willingness to adopt NOx controls can be translated into operational capability. Figure 10 presents the results below.

Figure 10. Degree of preparedness for NOx control implementation



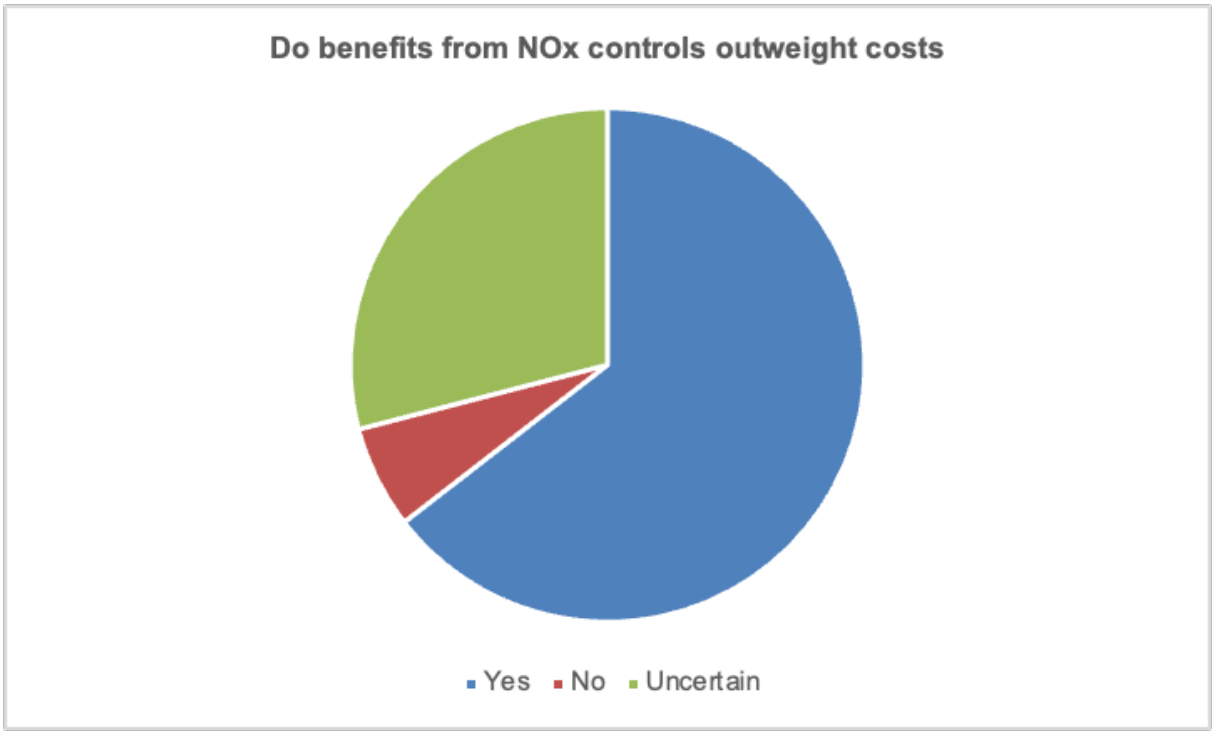
1.3.4 Stakeholder beliefs and preferred policy tools

This subsection examines stakeholder perceptions on the overall desirability and fairness of NOx controls, focusing on whether the anticipated benefits are seen as outweighing the costs and how equitably these costs are expected to be shared across sectors. It further identifies which stakeholder groups are perceived to face the greatest compliance burdens and which are expected to benefit most from implementation. In addition, respondents were asked to indicate the policy instruments they consider most effective for mitigating cost impacts, as well as their views on whether the current policy framework, economic conditions, and stakeholder relationships provide a supportive environment for advancing NOx reduction measures. Together, these perspectives offer valuable insights into the distributional and political economy dimensions of policy implementation, complementing the technical and economic assessments presented earlier.

First, we explore two closely linked aspects of stakeholder perceptions: whether respondents believe the benefits of NOx controls outweigh their costs, and whether they think those costs will be distributed equitably across stakeholders. These questions provide insight into not only the perceived net value of the policy but also its political economy dimension—how fair and acceptable the implementation might be in practice.

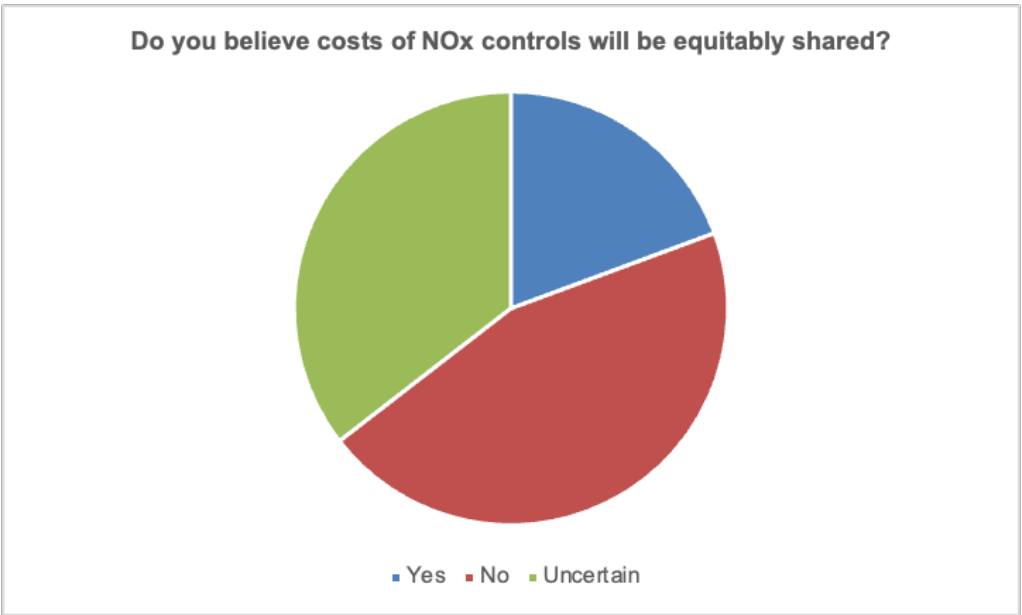
Across respondents, there is a clear tendency to view the benefits of NOx controls as outweighing their costs, with a strong majority expressing this belief. However, a substantial minority remain uncertain, and a small proportion outright disagree, signalling that while the environmental and health advantages are widely acknowledged, some stakeholders remain unconvinced—likely due to concerns about implementation challenges, sectoral competitiveness, or cost burdens.

Figure 11. Benefits from NOx controls



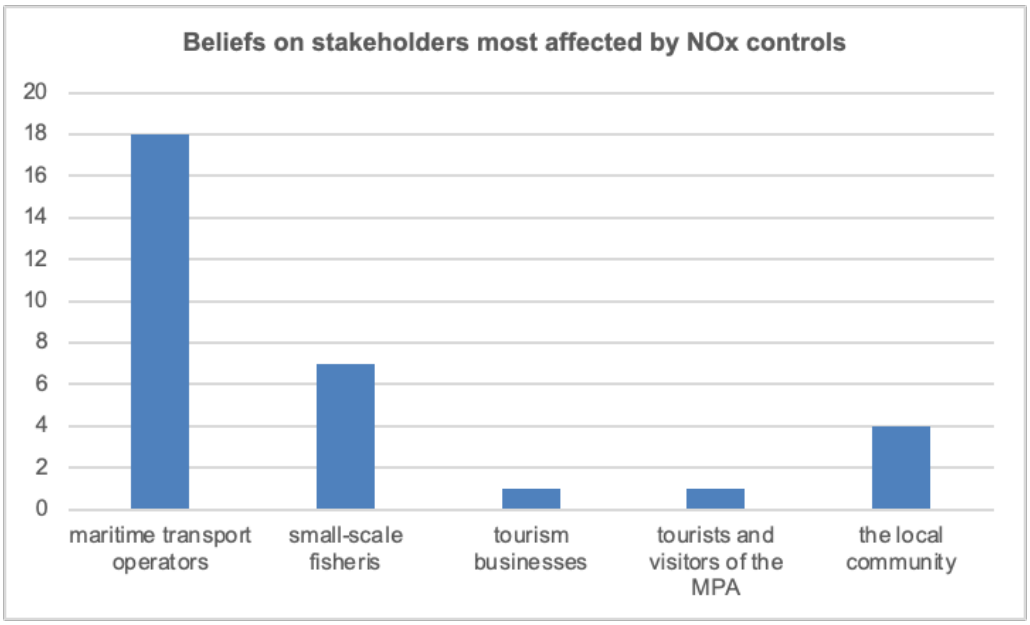
When the focus shifts to perceptions of equity in cost distribution, support becomes notably more fragmented. Responses reveal a high degree of scepticism, with many believing costs will not be shared fairly among stakeholders, and a sizeable portion expressing uncertainty. This contrast suggests that even among those who see NOx controls as net beneficial, apprehensions about fairness and burden allocation persist. Such perceptions are critical, as doubts about equity could undermine political will, stakeholder buy-in, and long-term compliance—making them an important consideration in designing and communicating policy measures.

Figure 12. Opinion on NOx costs



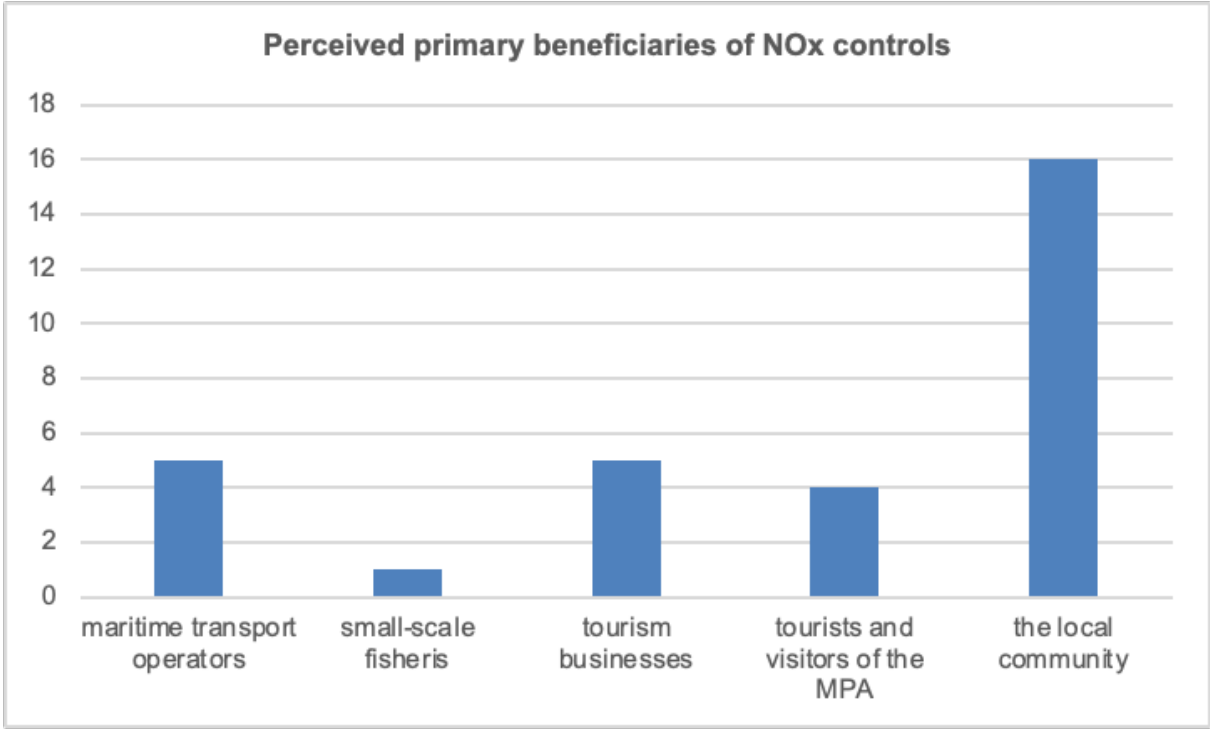
We then turn to stakeholder perceptions of which sectors are likely to bear the greatest share of the costs associated with NOx controls. This question is essential for understanding the anticipated distribution of economic impacts and identifying potential points of resistance or lobbying pressure during policy development. By highlighting the sectors seen as most financially exposed, we gain insight into where targeted support measures, transitional assistance, or compensatory mechanisms might be most necessary to ensure both fairness and feasibility in implementation. The responses overwhelmingly point to maritime transport operators as the most affected group, far outnumbering mentions of any other sector. Small-scale fishers emerge as the second most frequently identified group, followed by the local community, while tourism-related stakeholders (including tourism businesses and visitors to MPAs) were mentioned only occasionally. This distribution suggests that stakeholders anticipate the financial burden will fall most heavily on sectors directly linked to vessel operation and marine resource use, with relatively less impact expected for more peripheral or indirect beneficiaries of improved air quality. Below is the graph showcasing the responses from the surveyed experts.

Figure 13. Beliefs on NOx controls' impacts



Perceptions of who stands to bear the costs versus who will benefit the most from NOx controls reveal a marked asymmetry. The Figure 14 below showcases the results of the question assessing what stakeholder would be the biggest beneficiary from NOx controls according to the experts opinion. Respondents overwhelmingly identified maritime transport operators as the sector most burdened by compliance costs, followed at a distance by small-scale fishers and, to a lesser extent, local communities, tourism operators, and MPA visitors. In contrast, when asked about who would benefit the most, the majority pointed to the local community, with smaller shares citing the tourism sector, environmental stakeholders, and the broader public. This contrast underscores a common feature in environmental regulation debates: the sectors incurring the highest direct costs are not necessarily the primary beneficiaries, while benefits are perceived to accrue more diffusely to communities and the environment. Such a divergence highlights the importance of targeted cost-mitigation strategies to balance stakeholder interests and foster broader support for policy adoption.

Figure 14. Perceived primary beneficiaries of NOx controls



After analysing stakeholder perceptions of beneficiaries, costs, and equity, we turn to the policy toolkit available for implementing NOx controls. Experts were presented with a range of policy instruments grounded in environmental economics theory, each designed to internalise the negative externalities associated with NOx emissions but differing in their mechanisms, incentives, and behavioural impacts.

From a theoretical perspective, these tools can be positioned within the classic “prices versus quantities” framework. Price-based instruments, such as Pigouvian taxes and targeted tax incentives, influence the marginal cost of polluting or abating emissions, allowing total emissions to adjust according to market forces. Quantity-based instruments, such as cap-and-trade systems or binding performance standards, instead fix the allowable emissions level or performance threshold, with the price of compliance determined by the market or by enforcement mechanisms. The choice between these approaches involves a trade-off between cost certainty and environmental certainty, and is often shaped by political and administrative feasibility.

Tax incentives for cleaner technologies act as a reverse Pigouvian measure, lowering the marginal cost of adopting low-emission solutions. Rather than taxing emissions directly, they reward the uptake of abatement technologies, using positive financial signals to encourage change.

Emission trading systems (ETS) or cap-and-trade programmes achieve internalisation by setting an overall emissions cap and allowing trading of allowances, ensuring that reductions occur where they are cheapest. While this approach guarantees environmental outcomes, compliance costs fluctuate with market dynamics.

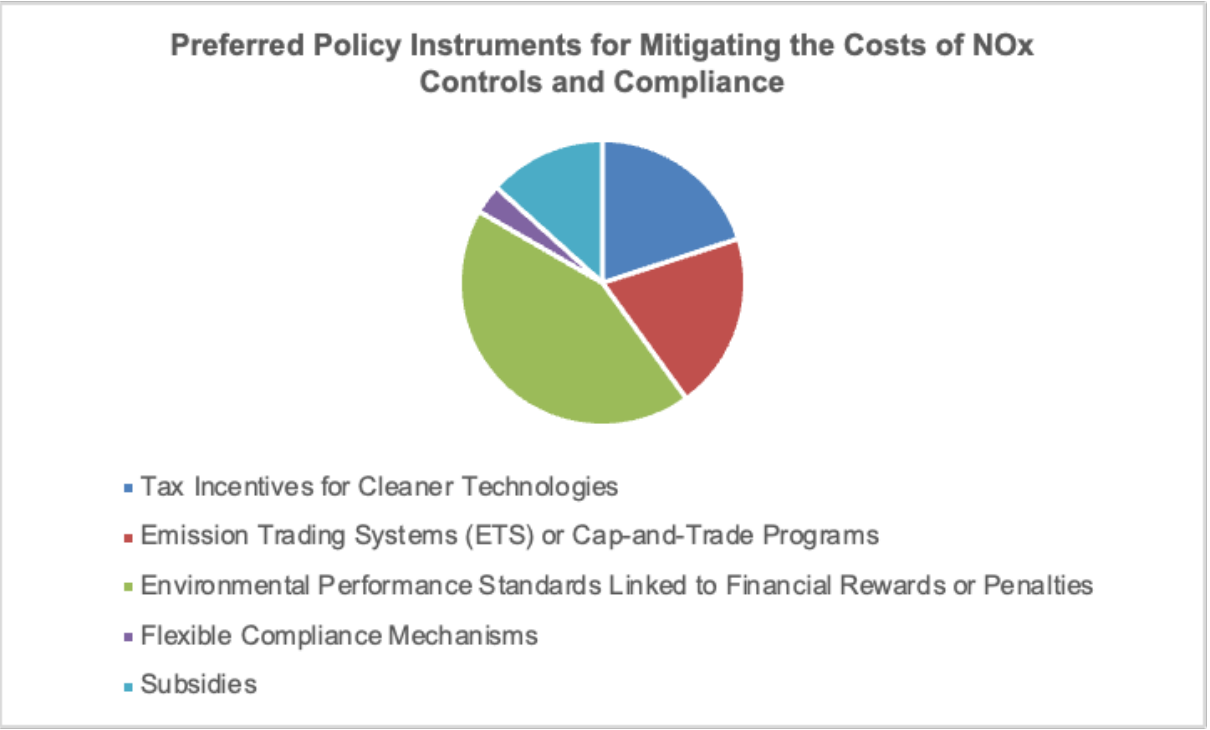
Environmental performance standards linked to financial rewards or penalties blend regulatory certainty with economic incentives. By imposing clear benchmarks and attaching financial consequences to compliance or over-compliance, they provide direction while maintaining flexibility for operators to exceed targets profitably.

Subsidies also reduce the cost of cleaner technologies but do so through direct public expenditure rather than foregone tax revenue. While effective at overcoming high upfront investment costs, they require sustained financing and carry risks of inefficiency if not carefully targeted.

Flexible compliance mechanisms allow operators to choose among approved abatement strategies, tailoring solutions to operational realities. However, their credibility depends heavily on robust monitoring and enforcement to ensure equivalent environmental benefits.

When asked which policy tool would best mitigate the costs of NOx controls and compliance, environmental performance standards with financial rewards or penalties emerged as the leading choice, supported by approximately 42 percent of respondents. Tax incentives for cleaner technologies ranked second at 23 percent, followed by ETS at 19 percent. Subsidies accounted for 13 percent of preferences, and flexible compliance mechanisms received only about 3 percent. Figure 15 below presents said results.

Figure 15. Preferred Policy instruments



The strong preference for performance-based standards suggests that stakeholders value clear environmental requirements paired with economic consequences, offering a hybrid of quantity control certainty and price-based incentives. The relatively high support for tax incentives and ETS reflects recognition of the role of financial signals in shaping behaviour, while the lower preference for subsidies and flexible compliance options may reflect concerns over cost-effectiveness, long-term sustainability, and reliability of environmental outcomes. These findings set the stage for the next section, where we examine whether the political economy and governance structures are sufficiently prepared to implement these preferred policy tools, and whether current institutional capacity, stakeholder relationships, and economic conditions can support effective adoption.

1.4 QUALITATIVE INSIGHTS FROM EXPERTS

Following the assessment of beneficiaries, costs, equity considerations, and preferred policy instruments, we also examined whether these tools could realistically be implemented under current governance conditions. To explore this, respondents were asked:

Do you think the current policy framework, economic conditions, and relationships with stakeholders support the implementation of policies to reduce NOx emissions?

Participants could answer “Yes”, “No”, or “Maybe” and were invited to briefly explain their reasoning. This follow-up question was designed to capture governance readiness, political feasibility, and institutional capacity, factors that often determine whether even well-designed policy tools succeed in practice.

The analysis proceeded in two steps. First, we looked at the distribution of categorical responses (Yes, No, Maybe) to gauge overall sentiment on readiness. Second, we conducted a qualitative narrative analysis of the open-ended explanations provided. This involved systematically identifying recurring themes, drivers, and barriers mentioned by respondents, and grouping them into categories such as regulatory alignment, stakeholder coordination, financial constraints, political will, and technical capacity. This thematic coding allowed us to see not just whether respondents were optimistic or sceptical, but *why* and to identify patterns that cut across the “Yes”, “No”, and “Maybe” groups.

This qualitative approach complements the earlier quantitative analysis of preferred policy instruments. While the preference data reveals which tools stakeholders see as most effective or acceptable, the governance readiness narratives explain the enabling conditions and constraints that could accelerate or block their adoption.

The responses show a clear divide. The “Yes” group points to existing enablers such as the incorporation of Annex VI of MARPOL into domestic law, established regional cooperation mechanisms, and access to funding instruments like low-interest loans for fleet upgrades. These respondents suggest that the institutional scaffolding for measures such as environmental performance standards is already in place in parts of the region.

The “No” group, in contrast, emphasises fragmented regulatory frameworks, high compliance costs for industries under economic pressure, limited harmonisation of standards, and insufficient political will. Several cited the ageing fleet in the Mediterranean, industry resistance, and the lack of public pressure as reasons NOx reduction policies remain low on the political agenda.

The largest group, “Maybe”, expressed conditional optimism, progress is possible if coordination improves, targeted financial support is provided, and rollout is carefully sequenced. This group often stressed that stakeholders understand the concepts but lack the financial and institutional tools to apply them equitably. They also underscored the need for harmonisation across countries, stronger monitoring, and the inclusion of enabling measures like subsidies, awareness campaigns, or technical assistance to build capacity before introducing stricter limits.

Taken together, these governance-readiness findings nuance the earlier conclusion that environmental performance standards linked to financial incentives are the most favoured instrument. While this hybrid tool offers both regulatory certainty and market incentives, the qualitative evidence suggests its success will hinge on addressing cost barriers, improving regulatory coordination, and expanding capacity. A two-stage sequencing emerges: in the near term, focus on supportive, incentive-based measures that build institutional capacity and political momentum; in the medium term, transition to more stringent, performance-based or quantity-controlled measures once enabling conditions are in place.

1.5 RECOMMENDATIONS

The survey results and accompanying qualitative insights point to a set of actionable recommendations for policymakers, regulators, and stakeholders engaged in designing and implementing NOx control measures in the Mediterranean:

1. **Prioritise performance-based standards with economic incentives**
   Given the strong support for environmental performance standards linked to financial rewards or penalties, these should form the backbone of the policy approach. Such measures offer the dual advantage of providing regulatory certainty while encouraging innovation and over-compliance. To maximise effectiveness, performance benchmarks should be ambitious yet achievable, with transparent monitoring and reporting frameworks.

2. **Complement with targeted market-based instruments**
   Tax incentives for cleaner technologies and emissions trading systems enjoy considerable backing and can play a supporting role in reducing compliance costs and fostering technological adoption. Where feasible, these tools should be integrated into a broader compliance framework, ensuring flexibility for operators while safeguarding environmental integrity.

3. **Address equity concerns through tailored support mechanisms**
   The perception that maritime transport operators will bear disproportionate costs suggests the need for sector-specific relief measures, such as phased implementation timelines, low-interest financing, or targeted

subsidies for vessel retrofits. Similar support should be considered for small-scale fishers and coastal communities where economic resilience is more fragile.

4. **Strengthen governance readiness and coordination**
   The mixed confidence in the current policy framework underscores the need for improved coordination across Mediterranean states, harmonisation of regulations, and engagement with industry and community stakeholders early in the design process. International bodies such as the IMO and regional cooperation platforms should be leveraged to align standards and share best practices.

5. **Implement gradual but irreversible timelines**
   Qualitative feedback reveals an appetite for gradual progress toward full compliance, allowing time for adaptation and capacity building. A stepwise approach paired with clear end dates for full enforcement can secure buy-in while maintaining momentum toward environmental goals.

6. **Integrate supporting measures for innovation and capacity building**
   Several respondents highlight the importance of innovation, knowledge transfer, and financing. Complementary measures such as R&D grants, training programs, and public-private partnerships should be embedded in the policy mix to ensure that compliance stimulates long-term competitiveness and environmental leadership in the Mediterranean maritime sector.

By combining regulatory certainty, market flexibility, and targeted support, these recommendations translate stakeholder preferences and concerns into a coherent policy pathway that balances ambition with fairness and feasibility.

1.6 CONCLUSION

This report and assessment reveals a broadly favourable stance among stakeholders toward the implementation of NOx controls in the Mediterranean, tempered by a recognition of sector-specific challenges and equity concerns. While most respondents agree that the benefits of NOx reduction outweigh its costs, there is less confidence that these costs will be distributed equitably, with maritime transport operators most often identified as bearing the heaviest burden. Conversely, the perceived beneficiaries are more dispersed, with coastal communities, the environment, and the tourism sector viewed as likely to gain the most from cleaner air and healthier ecosystems.

Policy preferences lean strongly toward environmental performance standards linked to financial rewards or penalties, reflecting an appetite for measures that combine clear regulatory expectations with economic incentives for over-compliance. Tax incentives and emissions trading systems also receive notable support, underscoring the value stakeholders place on flexible, market-oriented mechanisms. However, subsidies and flexible compliance mechanisms are viewed less favourably, possibly due to concerns about efficiency, predictability, and long-term sustainability.

The qualitative evidence adds critical nuance, showing that governance readiness is viewed as partial and uneven. Many respondents emphasise the need for stronger coordination, harmonised regulations, and targeted support to address capacity gaps, especially in contexts facing high compliance costs or outdated fleets. Others highlight the importance of international cooperation and gradual implementation to secure buy-in across diverse sectors.

Taken together, these findings suggest that the policy landscape is fertile for action but will require careful calibration to ensure equitable cost distribution, maintain sectoral competitiveness, and leverage existing international frameworks. The combination of strong stated support, clear policy tool preferences, and candid recognition of implementation barriers provides a practical roadmap for advancing NOx control measures, provided that policymakers pair ambition with tailored, context-sensitive strategies that align environmental goals with economic realities.

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2 Paper 2. Potential Impacts of the implementation of the NOx Emission Control Area on Tourism in the Mediterranean region

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Key Takeaways

The implications on tourism of the potential **NOx Emission Control Area** (ECA) in the Mediterranean region (Med), as drawn from the literature research, case studies analysis, interviews and survey, reveal a complex interplay of environmental, economic, and social factors. Overall, while significant challenges are associated with implementing a NOx ECA—particularly technical and economic pressures on operators—the overall sentiment leans toward optimism about its potential to transform the Mediterranean into a **sustainable tourism hub.** Effective **policy measures, financial support, and stakeholder collaboration** are crucial to realizing these positive benefits while minimizing adverse impacts.

Environmental and Tourism Branding

Strengthened Regional Branding: Implementing the Med NOx ECA could enhance the Mediterranean's reputation as an eco-friendly destination. This aligns with global trends in sustainable tourism, potentially attracting and retaining tourists who prioritize environmental responsibility.

Improved Air Quality: reduced NOx emissions would lead to better air quality, benefiting both residents and tourists. Cleaner environments could enhance the appeal of coastal areas, boosting their attractiveness for leisure activities.

Economic and Operational Challenges

Compliance Costs: Some tourism actors express concerns about the financial burden of adopting cleaner technologies. Investments in retrofitting ships or transitioning to alternative fuels could strain smaller operators.

Impact on Cruise Tourism: stricter emission regulations might increase operational costs, potentially leading to higher ticket prices or reduced itineraries in the region.

Tourist Behaviour and Preferences

Willingness to Pay: A growing segment of tourists are willing to pay a premium for eco-friendly services. However, this willingness varies by demographic and may not fully offset increased costs for operators.

Shift in Preferences: A gradual shift toward sustainable travel options is observed, including preferences for destinations with visible environmental commitments. This trend could favour regions that implement NOx controls effectively.

Local Community Perspectives

- **Health Benefits:** Local communities near ports and coastal areas will benefit health improvement from reduced air pollution. It is seen as a critical factor in gaining public support for the initiative.
- **Job Market Concerns**: While some stakeholders see opportunities for job creation in green technologies, others fear job displacement in traditional maritime and tourism sectors.

Implications for Jobs

- **Job Creation Potential:** The implementation of the Med NOx ECA is expected to generate new jobs in sectors like green technology, ship retrofitting, and sustainable tourism infrastructure.
- **Job Displacement Risks:** Some stakeholders express concerns about job losses in traditional maritime and tourism industries due to increased operational costs and potential shifts in tourist behaviour.

Policy and Support Mechanisms

- **Need for Incentives:** Financial incentives are important to facilitate compliance. Stakeholders suggest subsidies for clean technology adoption and public-private partnerships to share costs.
- **Capacity Building:** Training programs are recommended to help workers transition into roles aligned with sustainable tourism and green maritime practices.
- **Transition Pathway:** The need to develop a phased implementation plan to allow stakeholders time to adapt is also stressed.

Long-Term Impacts

- **Innovation Driver:** The Med NOx ECA is seen as a potential catalyst for innovation in green technologies within the tourism sector. Stakeholders believe it could position the Mediterranean as a leader in sustainable travel.
- **Global Competitiveness:** By adopting stringent environmental standards, the region could enhance its competitiveness in attracting high-value tourists who prioritize sustainability.

Stakeholders Insights

- **Tourism Operators:** Express mixed feelings—while some see opportunities to differentiate their offerings through sustainability, others worry about increased operational costs.
- **Local Communities:** Favour the initiative due to expected health benefits but stress the need for inclusive policies to mitigate economic disruptions.
- **Environmental NGOs:** Advocate strongly for implementation, emphasizing long-term environmental and societal gains over short-term costs.

Points Clés

*Les implications sur le tourisme de la mise en place potentielle de la **zone de contrôle des émissions (ECA) de NOx** pour la région méditerranéenne, tirées de l'analyse de la littérature, d'études de cas, d'entretiens et des enquêtes détaillés dans cette étude, révèlent une interaction complexe entre les facteurs environnementaux, économiques et sociaux. En général, bien que les parties prenantes reconnaissent les défis importants liés à la mise en œuvre d'une ECA Med NOx—en particulier les pressions techniques et financières sur les opérateurs—le sentiment global est plutôt optimiste quant à son potentiel de transformation de la Méditerranée en un centre de tourisme durable. Des mesures politiques efficaces, un soutien financier et une collaboration entre les parties prenantes seront essentiels pour réaliser ces avantages tout en minimisant les impacts négatifs.*

Environnement et Image du Tourisme

- ***Renforcement de l'Image Régionale :** La mise en place de l'ECA Med NOx pourrait améliorer la réputation de la Méditerranée en tant que destination écologique. Cela s'inscrit dans les tendances mondiales du tourisme durable, attirant des touristes qui privilégient la responsabilité environnementale.*
- ***Amélioration de la Qualité de l'Air :** La réduction des émissions de NOx conduirait à une meilleure qualité de l'air, bénéficiant ainsi tant aux résidents qu'aux touristes. Un environnement plus propre pourrait renforcer l'attractivité des zones côtières, stimulant leur attrait pour les activités de loisirs.*

Défis Économiques et Opérationnels

- ***Coûts de Conformité** : Certains opérateurs touristiques expriment leurs préoccupations concernant le fardeau financier de l'adoption de technologies plus propres. Les investissements nécessaires pour*

moderniser les navires ou passer à des carburants alternatifs pourraient mettre sous pression les petits opérateurs.

- ***Impact sur le Tourisme de Croisière** : Des réglementations plus strictes sur les émissions pourraient augmenter les coûts opérationnels, ce qui pourrait entraîner une hausse des prix des billets ou une réduction des itinéraires dans la région.*

Comportement et Préférences des Touristes

- ***Volonté de Payer**: Un segment croissant de touristes est prêt à payer un supplément pour des services écologiques. Cependant, cette volonté varie selon les groupes démographiques et pourrait ne pas compenser complètement l'augmentation des coûts pour les opérateurs.*
- ***Changement de Préférences** : Un changement progressif vers des options de voyage durables est observable, y compris des préférences pour des destinations affichant des engagements environnementaux visibles. Cette tendance pourrait favoriser les régions qui mettent en œuvre efficacement les contrôles sur les NOx.*

Perspectives des Communautés Locales

- ***Bénéfices pour la Santé** : Les communautés locales proches des ports et des zones côtières bénéficieront d'une réduction de la pollution de l'air. C'est un facteur clé pour obtenir le soutien du public à l'initiative.*
- ***Préoccupations concernant le Marché de l'Emploi** : Bien que certains acteurs voient des opportunités de création d'emplois dans les technologies vertes, d'autres craignent des pertes d'emplois dans les secteurs traditionnels du maritime et du tourisme.*

Conséquences pour l'Emploi

- ***Potentiel de Création d'Emplois**: La mise en œuvre de la zone ECA en Méditerranée devrait générer de nouveaux emplois dans des secteurs tels que la technologie verte, la modernisation des navires et l'infrastructure de tourisme durable.*
- ***Risques de Suppression d'Emplois**: Certaines parties prenantes expriment des inquiétudes quant aux pertes d'emplois dans les industries maritimes et touristiques traditionnelles en raison de l'augmentation des coûts opérationnels et des changements potentiels dans le comportement des touristes. Cela souligne la nécessité de mesures de soutien ciblées.*

Mécanismes de Politique et de Soutien

- ***Besoin d'Incitations** : Les incitations financières sont essentielles pour faciliter la conformité. Les parties prenantes ont suggéré des subventions pour l'adoption de technologies propres et des partenariats public-privé pour partager les coûts.*
- ***Renforcement des Capacités** : Des programmes de formation sont recommandés pour aider les travailleurs à se reconvertir dans des rôles liés au tourisme durable et aux pratiques maritimes écologiques. Il a été souligné qu'il est nécessaire de développer un plan de mise en œuvre par phases pour permettre aux parties prenantes de s'adapter.*

Impacts à Long Terme

- ***Moteur d'Innovation** : L'ECA Med NOx est perçue comme un catalyseur potentiel d'innovation dans les technologies écologiques au sein du secteur du tourisme. Les parties prenantes estiment qu'elle pourrait positionner la Méditerranée comme un leader du voyage durable.*
- ***Compétitivité Mondiale** : En adoptant des normes environnementales strictes, la région pourrait améliorer sa compétitivité pour attirer des touristes à forte valeur ajoutée, sensibles à la durabilité.*

Perspectives Spécifiques des Parties Prenantes

- ***Opérateurs Touristiques** : Les opinions sont partagées—tandis que certains voient des opportunités pour différencier leurs offres grâce à la durabilité, d'autres s'inquiètent des coûts opérationnels accrus.*

- ***Communautés Locales*** *: Elles soutiennent l'initiative en raison des avantages attendus pour la santé, mais insistent sur la nécessité de politiques inclusives pour atténuer les disruptions économiques.*
- ***ONG Environnementales*** *: Elles soutiennent la mise en œuvre, soulignant les gains environnementaux et sociétaux à long terme au-delà des coûts à court terme.*

2.1 INTRODUCTION

2.1.1 Objective and Context

The Mediterranean region is one of the world's most sought-after tourist destinations, renowned for its rich cultural heritage, natural beauty, and diverse ecosystems. Its pristine beaches, historical landmarks, and vibrant local cultures attract millions of visitors annually, making **tourism and travel** a cornerstone of the region's economy. However, this popularity comes with significant environmental challenges, particularly related to maritime activities. The heavy reliance on **maritime transport** for trade, tourism, and leisure activities has resulted in substantial **air, land and sea pollution** which are **harmful to human health and the natural environment**[2].

In response to these environmental challenges, discussions are ongoing to designate the Mediterranean (Med) as a **Nitrogen Oxide (NOx) Emission Control Area** (ECA) under the **International Maritime Organization**'s (IMO) MARPOL Annex VI regulation. This initiative comes at a time when total NO_x emissions in Mediterranean countries remain among the highest in Europe, particularly in countries with dense coastal populations and major port infrastructure such as **Spain, France, Italy, Turkiye, and Egypt**. Maritime transport plays a significant role in this dynamic. Globally, it is estimated that **shipping** contributes approximately **18% of nitrogen oxide** (NO_x) emissions from the transport sector, and in the Mediterranean region, **ship-sourced NO_x emissions a**re believed to represent around **10–20% of total NO_x emissions**, a proportion higher than in many other enclosed seas[3].

Coastal hotspots such as the **Adriatic Sea**, the **Strait of Gibraltar**, and the **Eastern Mediterranean** are particularly affected due to intense shipping activity. While total NO_x emissions across sectors have slightly declined over the past decade, Mediterranean coastal areas continue to experience elevated concentrations, especially during peak tourism and shipping seasons. If adopted, this designation would mandate stricter controls on NOx emissions from ships operating in the region, complementing the existing **Sulfur Oxide (SOx) Emission Control Area** (Med SOx ECA) already in place[4]. These measures aim to further reduce air pollution, protect marine and coastal ecosystems, and improve the quality of life for local populations. The Med NOx ECA is part of broader initiatives to promote sustainable development in the Mediterranean in the framework of **Multilateral Commitments** such as the **2030 Agenda, Paris Agreement, UN Ocean conferences** or the **Barcelona Convention** for the Protection of the Mediterranean Sea Against Pollution (BC), among others.

The introduction of the Med NOx ECA is expected to drive changes in the region's tourism and travel infrastructures. It presents both opportunities and challenges: while reducing air pollution could enhance the attractiveness of the Mediterranean as a sustainable tourist destination, the costs associated with compliance might pose challenges for industry stakeholders. This duality underscores the need to comprehensively evaluate the environmental and economic impacts of this initiative on the Mediterranean's tourism sector.

2.1.2 Research Problem and Significance

The potential implementation of the Med NOx ECA raises emerging questions about the intersection of environmental regulation and sustainable tourism development. Tourism in the Mediterranean is highly dependent on the quality of its natural and cultural assets, which are increasingly threatened by environmental degradation. The designation of the Med NOx ECA offers an opportunity to address these challenges, but it would also necessitate significant investment in sustainable infrastructures and adjustments by tourism and travel stakeholders.

Understanding the potential **socio-economic impact** of the Med NOx ECA is essential for several reasons. First, the **tourism industry** in the Mediterranean contributes significantly to the economies of coastal nations, supporting millions of jobs and generating substantial revenue. Any changes in tourist behaviour, spending patterns, or industry competitiveness due to environmental regulations could have wide-reaching socio-economic implications.

[2] European Environment Agency, *Europe's air quality status*, 2024.
[3] Le Berre, L., et al. (2024). Measurement report: In-depth characterization of ship emissions during operations in a Mediterranean port. Research Square
[4] New sulphur emission limits enter into effect in the Mediterranean (IMO, 01/05/25)

Second, the potential ECA aligns with the global push toward sustainable development, particularly the **Sustainable Development Goals** (SDGs). While its primary objective is to reduce emissions from maritime transport, the initiative indirectly supports broader SDG targets such as Climate action, improved air quality, Ocean protection and more sustainable coastal and port-area development**.** However, the success of these efforts depends on the region's ability to balance environmental goals with economic growth and community well-being.

Finally, evaluating the impacts of the potential Med NOx ECA can provide valuable insights for policymakers and stakeholders. By identifying opportunities for job creation, innovation, and green investments, this research can help guide the development of strategies that maximize the benefits of the ECA while minimizing potential challenges. These findings could also serve as a blueprint for other regions considering similar environmental regulations.

2.1.3 Geographic and Thematic Scope

The geographic scope of this study is centered on the **Mediterranean region**, encompassing countries and stakeholders directly involved in or affected by the implementation of a potential NOx Emission Control Area (ECA). This focus reflects the region's unique ecological, cultural, and economic characteristics, as well as its reliance on maritime and tourism industries. The Mediterranean serves as a critical case study for balancing environmental regulations with sustainable tourism development. To enrich the analysis, **case studies** were included to provide comparative insights and best practices. These examples offer valuable lessons in managing emission control areas, implementing ecotourism strategies, and fostering community engagement, which can be tailored to the Mediterranean context.

The thematic scope of the study encompasses three **interrelated dimensions**: environmental regulation, sustainable tourism infrastructure, and stakeholder adaptation. The surveys and interviews conducted are specifically targeted at stakeholders operating within the Mediterranean zone, including tourism operators, cruise and port managers, local communities, policymakers, and environmental NGOs. The primary goal is to assess the readiness, challenges, and opportunities presented by the potential Med NOx ECA while focusing on themes such as eco-friendly destinations, sustainable transportation, and recreational facilities. By integrating global case studies and locally sourced data, the study aims to develop actionable recommendations that align with the Mediterranean's environmental, social, and economic goals.

2.1.4 Methodology

To assess the impacts that a potential Med NOx ECA would have on tourism development, the study employs a multi-method approach through qualitative research. This methodology provides an understanding of the complex and diffuse interactions between environmental regulations, tourism activities, and socio-economic development.

2.1.4.1 Survey

An (on-line) survey was designed to serve to collect **qualitative information** from a diverse pool of stakeholders within the Mediterranean tourism sector. By utilizing a structured and concise format, the survey aims to capture detailed perspectives about participants' familiarity with environmental policies, their perspectives on sustainable tourism, and the anticipated challenges and opportunities associated with a potential NOx ECA.

The survey (see details in Annex) consisted of a combination of **multiple-choice and open-ended questions**. It begins by collecting basic demographic and professional information, such as the respondent's role in the tourism sector and their country of operation, to contextualize their responses. The subsequent sections explore the respondent's familiarity with the potential implementation of a NOx ECA and their perceptions of its possible significance for the tourism industry.

Key themes addressed in the survey include the importance of reducing NOx emissions, the willingness of tourists to pay a premium for eco-friendly destinations, observed changes in tourist preferences, and the financial and infrastructural implications of adopting sustainable practices. The survey also integrates questions about barriers to implementing green initiatives and the types of support or incentives that could facilitate sustainability transitions.

To ensure that our study considers a wide range of perspectives on the potential impacts of future NOx regulation on the tourism sector, the survey was disseminated electronically to a diverse set of stakeholder organizations across the Mediterranean region. The outreach targeted entities representing various sectors including maritime operations, environmental conservation, tourism management, regional governance, academic research, and specialized advisory services (see chapter 1.4.3).

2.1.4.2 Interviews

As for the survey, the interviews were developed as a **qualitative tool** to explore nuanced perspectives from key stakeholders in the Mediterranean tourism sector. These stakeholders include tourism operators, policymakers, researchers, representatives of local communities, and NGOs, all of whom play pivotal roles in shaping and adapting to the evolving landscape of sustainable tourism (see chapter 1.4.3).

Participants were provided with a list of curated questions (see Annex), divided into primary and secondary themes. The main questions focused on understanding the respondents' roles in the tourism sector, their views on the Mediterranean's reputation as an eco-friendly destination, and their predictions about how a Med NOx ECA might influence local tourism and economies. Additional questions delved into perceived challenges and opportunities in adopting eco-friendly infrastructure, potential impacts on jobs or business operations, and the kinds of support or incentives necessary to encourage sustainability initiatives.

Through these discussions, we aimed to gather rich qualitative data to complement broader quantitative findings. The overarching goal is to better understand how stakeholders perceive the potential for regulatory changes to drive sustainability in Mediterranean tourism, the barriers they face, and the recommendations they propose for effective implementation.

2.1.4.3 Mapping of Stakeholders

To ensure that our study considers a wide range of perspectives on the potential impacts of future NOx regulation on the tourism sector, the request for interviews and survey was disseminated electronically to a diverse set of stakeholder organizations across the Mediterranean region. The outreach targeted entities representing various sectors including maritime operations, environmental conservation, tourism management, regional governance, academic research, and specialized advisory services. More specifically, the invitation was addressed to a wide range of stakeholders across the Mediterranean region, structured into the following categories[5]:

- **Public institutions and regional authorities:**
  - Provincial Council of Barcelona (Spain);
  - Visit Valencia (Spain)*;
  - Barcelona municipality (Spain);
  - Union for the Mediterranean (UfM, regional);
  - Government of Malta;
  - Conference of Peripheral Maritime Regions (CPRM, regional);
  - Regional Activity Centers of the Barcelona Convention (REMPEC, Plan Bleu)*^.
- **Ports and maritime stakeholders:**
  - Port of Genoa (Italy)*;
  - Port Authority of Alexandria (Egypt)*;
  - Maritime Administration (Turkiye)*;
  - Ports & Maritime Transport Authority (Libya)*;
  - Medcruise business association (regional);
  - West Mediterranean secretariat (WestMED, regional);
  - Yacht Club of Monaco*.
- **Environmental NGOs and conservation bodies:**
  - Pelagos Sanctuary;
  - Marine Protected Area of Portofino (Italy);
  - WWF Mediterranean Marine Initiative (WWF MMI, regional);
  - IUCN – Mediterranean (IUCN-Med, regional);
  - Coastal Conservatory (Conservatoire du Litoral, France);
  - Small Island Organization (SMILO, regional).
- **Tourism and cruise industry organizations:**
  - World Ocean Council (WOC);
  - Iberostar Hotels (regional);

[5] (*) : through survey; (^) : through interviews.

- Catalan Tourism Agency (Spain)*^;
- Global Sustainable Tourism Council (GSTC, global)*^;
- World Travel & Tourism Council (WTTC, global);
- United Nations World Tourism Organization (UNWTO, global).

- **Academic and research institutions:**
  - University of Toulon (France);
  - University of Genoa (Spain);
  - National Research Council – Institute of Marine Sciences (CNR-ISMAR, Italy):
  - Damascus University (Syria)*.

2.1.4.4 Case Studies

Pieces of evidence from existing case studies are also pivotal in shaping the insights and conclusions presented in this report. They provided practical data on how NOx emission controls, sustainable practices, and environmental regulations have impacted tourism and maritime industries in regions comparable to the Mediterranean. These case studies offer lessons that inform the research, analysis and recommendations for the Med NOx ECA initiative.

2.1.5 Overview of Case studies

Below is a detailed account of the case studies identified in the literature to provide real-world examples on how NOx emission controls, sustainable practices, and environmental regulations have impacted tourism and maritime industries in regions comparable to the Mediterranean.

2.1.5.1 Baltic Sea Emission Control Area[67]

The Baltic Sea was designated as a Sulphur Emission Control Area (SECA) in 2006, followed by its inclusion as a Nitrogen Emission Control Area (NECA) in 2021. This case study provided insights into the implementation of emission control measures, their impact on maritime industries, and the broader economic and environmental outcomes. The transition to **low-sulfur fuels** and cleaner technologies significantly improved air quality in port cities such as Helsinki and Stockholm. These improvements also enhanced the perception of these cities as **sustainable destinations**, leading to increased eco-tourism. Maritime operators in the region adopted selective **catalytic reduction systems** (SCR) and alternative propulsion methods like LNG-powered engines to meet emission requirements, offering valuable insights into the technical and financial challenges faced during the transition.

Data from the Baltic SECA/NECA highlights quantifiable and **monetized economic benefits** of aligning regulatory compliance with sustainable tourism goals, including **€4.4–8.0 billion in public health** savings due to improved air quality, while additional fuel costs for the shipping industry were approximately €2.3 billion, yielding a net socio-economic benefit. Furthermore, port activity across the ten largest Baltic ports increased by 3.5% in 2024, equivalent to an additional 16.9 million tonnes of cargo throughput, signaling a positive correlation between environmental regulation and port growth. While these findings provide valuable insights for the potential design of the Med NOx ECA, it is important to recognize key regional differences. For example, the Mediterranean region features a higher concentration of small-scale operators and exhibits varying levels of regulatory enforcement across its countries. Tailoring Baltic lessons (such as developing robust support mechanisms for smaller operators and enhancing cross-border regulatory coordination) to the Mediterranean's unique economic landscape and stakeholder dynamics can lead to effective and balanced outcomes.

2.1.5.2 Los Angeles and Long Beach Green Ports Program (USA)[8]

The Green Ports Program in Los Angeles and Long Beach provided an example of sustainable port development and its effect on tourism and local communities. The ports introduced **shore-side electrification**, enabling vessels to connect to renewable energy grids while docked, thereby significantly reducing emissions. The program also enforced stringent emission standards for trucks and cargo-handling equipment, which led to measurable improvements in air quality in surrounding communities. These improvements enhanced the ports' reputations as sustainable hubs, attracting cruise lines and tourists with an interest in eco-friendly travel.

[6] Helcom, *Baltic Sea Action Plan 2021 Update*, 2021.
[7] Port Monitor, *Report The impact of the geopolitical situation on the largest Baltic Ports in 2024*, 2024.
[8] California Environmental Protection Agency, *Emission Reduction Plan for Ports and Goods Movement in California*, 2006.

This case study highlights how green port initiatives might be integrated into a potential Med NOx ECA, providing a preliminary roadmap for electrification infrastructure and stakeholder engagement in sustainability programs. However, caution is warranted when translating lessons from U.S.-based programs to the Mediterranean context. Unlike the **unified federal framework** in the U.S. (where ports benefit from substantial federal and state funding) the Mediterranean region comprises multiple countries with diverse regulatory systems and generally faces more constrained financial resources. That said, similarities do exist: European ports can also access multi-level funding, including from the European Union (e.g., CEF, Horizon Europe) and national governments. However, coordinating initiatives across multiple nations and stakeholders in the Med is inherently more complex than managing programs within a single-nation context.

2.1.5.3 Port of Barcelona (Spain)[9]

The Port of Barcelona (Spain) has also taken substantial steps towards environmental sustainability, aligning with the broader goals that a potential Med NOx ECA may have. The port is implementing the **Nexigen electrification project**, with a total budget exceeding €110 million, including €90 million dedicated to OPS (onshore power supply) and €20–21 million for the substation and medium-voltage network infrastructure. This scheme is expected to cut 38% of NO_x and CO_2 emissions from ships at berth, eliminating up to 1,234 tonnes of NO_x and 66,000 tonnes of CO_2 annually. In addition, the port is investing €124 million to develop new **green fuel berths** for sustainable fuels logistics. Overall, sustainability investments have surged from €17 million during 2020–2024 to €163 million planned in 2025–2030, nearly a tenfold increase.

2.1.5.4 Marine transport in Norway[10]

Norway has emerged as a pioneer in sustainable maritime transport, particularly through the deployment of **electric boats**. The country's ambitious goal of achieving zero emissions from cruise ships and ferries in its fjords by 2026 has spurred significant innovation in the maritime sector. This initiative has led to the development and implementation of electric and hybrid-electric propulsion systems for ferries, resulting in substantial reductions in air pollution and noise.

Crucially, the strict regulatory framework, effectively **banning emissions in protected fjords**, has acted as a catalyst for technological innovation. Faced with non-negotiable compliance requirements, maritime stakeholders have accelerated research, development, and deployment of cutting-edge solutions, such as battery-electric vessels, hydrogen fuel cells, and autonomous navigation systems. This innovation push has not only benefited the Norwegian market but has also positioned the country as a global exporter of sustainable maritime technologies. These efforts align closely with the broader objectives of potential emission control initiatives like a Med NOx ECA, showcasing the potential for electric propulsion to transform maritime transportation and support sustainable tourism development in coastal and island destinations.

2.1.5.5 North American Emission Control Area[11]

The North American ECA also offers important insights into the challenges of implementing NOx regulations. According to the 2023 assessment by the International Maritime Organization (IMO), sulphur restrictions in this region have produced measurable environmental improvements, particularly in air quality near ports. However, the results of NOx-specific regulations have so far been less convincing. This limited impact is attributed to a combination of factors, including the slow renewal of the maritime fleet towards Tier III-compliant vessels, the partial deactivation of NOx emission control systems such as Selective Catalytic Reduction (SCR) through auxiliary control devices (ACDs), and the technical difficulty of distinguishing NOx emissions from ships from other major sources such as land-based transport and industry.

These findings suggest that while regulatory frameworks are essential, their effectiveness depends on fleet modernization, reliable emissions monitoring, and robust enforcement mechanisms. In the context of the Mediterranean, these lessons underscore the need for phased implementation, financial and technical support for ship retrofitting, and cross-border coordination to ensure compliance and prevent circumvention. They also illustrate that environmental policy alone is not sufficient; real and lasting improvements will require active engagement from both public authorities and private operators.

[9] Port de Barcelona, *Environmental sustainability*, 2024

[10] Marco Gallo, Daniele Kaza, Fabio D'Agostino, Matteo Cavo, Raphael Zaccone, Federico Silvestro, *Power plant design for all-electric ships considering the assessment of carbon intensity indicator*, Science Direct, 2023.

[11] U.S. Environmental Protection Agency & IMO, Assessment of the impacts of the MARPOL Annex VI emission control regulations in the United States portion of the North American Emission Control Area, (PPR-11/INF.4), 2023.

2.2 POTENTIAL IMPACTS IN THE MEDITERRANEAN TOURISM SECTOR

The designation of the Mediterranean as a NOx Emission Control Area (Med NOx ECA) is poised to bring significant transformations to the region's tourism sector. These changes are expected to occur across several dimensions, including the development of greener tourism infrastructure, the promotion of environmental sustainability, and the enhancement of eco-friendly leisure facilities. The adoption of stricter environmental standards for maritime activities presents challenges and opportunities, pushing stakeholders toward innovative solutions to meet the growing demand for sustainable tourism practices.

2.2.1 Tourism infrastructures

The Mediterranean's tourism infrastructure is under increasing pressure to adapt to principles of sustainability, driven both by regulatory imperatives and evolving consumer preferences. Stricter NOx emissions standards are expected to create ripple effects across the region. For example, they can drive significant investments in green technologies as ports and related facilities upgrade to meet new benchmarks.

This is confirmed by case studies such as the **Port of Los Angeles and Long Beach**, where ECA-related restrictions (e.g., a 2-hour limit on running auxiliary engines while at berth) have led to large-scale investments in shore-side electrification. Similarly, the **Port of Barcelona** has begun electrifying its docks to reduce emissions from berthed ships, aligning with international best practices. These mechanisms force ports to adapt their infrastructure by installing "**cold ironing**" systems that allow ships to shut down engines and connect to onshore power, particularly when regulations impose time-based emission limits.

These standards also encourage a shift towards **cleaner fuels** and the adoption of advanced **emission control technologies,** fostering a culture of environmental accountability. It indirectly impacts **fuel producers and suppliers**, who are compelled to adapt their product offerings (such as LNG, methanol, or biofuels) to meet compliance standards. This transition also stimulates market development for compliant fuel types across port supply chains. Moreover, the enhanced focus on reducing NOx emissions can stimulate broader **infrastructural reforms**, indirectly benefiting eco-conscious travel by improving air quality and boosting the overall sustainability profile of tourist destinations.

In the **Baltic Sea** NECA and SECA, emission regulations have led to demonstrable improvements in air quality in cities like Stockholm and Helsinki, which in turn enhanced their appeal as sustainable tourism destinations. Improved air clarity and reduced pollution levels have become key marketing points for eco-conscious travel. Consequently, the potential Med NOx ECA initiative could act as a catalyst for transforming the Mediterranean tourism sector, aligning infrastructure development with both environmental standards and the rising demand for sustainable travel options.

Sustainable transportation infrastructure is a cornerstone of achieving the Mediterranean’s environmental and tourism goals under the Med NOx Emission Control Area (ECA). Transportation, particularly maritime and urban mobility systems, plays a crucial role in ensuring smooth and eco-friendly travel for tourists. By integrating cleaner technologies and prioritizing low-carbon mobility solutions, the region can significantly reduce emissions while enhancing the quality of visitor experiences.

Maritime transport is a primary focus of the Med NOx ECA due to its significant contribution to nitrogen oxide emissions. The regulations require certain ships, notably those equipped with marine diesel engines over 130 kW output power, to adopt cleaner technologies, including engines compliant with Tier III NOx standards or systems such as **Selective Catalytic Reduction** (SCR). The level of control depends on the ship's construction date and the rated speed of the engine, in accordance with IMO MARPOL Annex VI Regulation 13. These technologies can reduce NOx emissions by up to 90%, substantially improving air quality in and around ports and harbors. For example, the installation of SCR systems on cruise ships and ferries has demonstrated effectiveness in reducing harmful emissions, ensuring compliance with international standards while maintaining operational efficiency. In addition, **alternative propulsion systems,** such as LNG-powered or hybrid-electric engines, are increasingly being deployed to further reduce the carbon footprint of maritime transport..

Ports and harbors are pivotal points in the tourism transport network and are undergoing significant transformations to align with sustainability goals. Shore-side electrification systems allow docked vessels to connect to cleaner onshore power sources, eliminating the need for polluting diesel generators. This reduces emissions in densely populated coastal areas, improving air quality for both residents and visitors. Notable examples include ports in Spain and Italy that have integrated renewable energy sources, such as solar and wind power, into their operations, positioning themselves as leaders in green port infrastructure.

2.2.2 Tourist Behaviour

The Mediterranean region has long been celebrated for its scenic landscapes, pleasant climate, and rich cultural heritage, making it one of the world's top tourist destinations. However, the environmental impacts of mass tourism, on air, land and sea is putting in danger its attractiveness. The potential designation of the Mediterranean as a Nitrogen Oxides Emission Control Area (NOx ECA) aims to address some of these challenges by improving air quality and promoting greener practices. This initiative is expected to influence tourist behaviour and preferences, reshaping the region's tourism landscape while fostering its transition towards sustainability.

2.2.2.1 The Mediterranean as an environmentally friendly Destination

Despite being historically related to mass tourism, the Mediterranean is aiming to become a more environmentally-friendly destination, through increasing environmental awareness and policy-driven sustainability efforts[12]. However, as interviewees pointed out, the region is still in transition, with **significant disparities between northern and southern Mediterranean countries in their approach to sustainability**. Northern destinations, often perceived as more advanced, actively market themselves as eco-conscious locations to attract environmentally aware travelers, while the south sees sustainability as an opportunity to enhance its appeal and benefit from spillover tourism.

According to the survey, the Med NOx ECA could enhance this reputation by directly improving air quality in coastal cities—one of the most pressing environmental concerns linked to maritime tourism. Reduced nitrogen oxide emissions would lead to clearer skies, less smog, and improved visibility, particularly in high-traffic areas such as Barcelona, Marseille, and Venice. These changes could make coastal landscapes more visually appealing, enhancing the visitor experience and potentially increasing positive tourist reviews. Additionally, cleaner air would reduce respiratory issues among both residents and tourists, making the region more attractive for health-conscious travelers, including those seeking wellness tourism experiences.

However, according to interviewees, while many tourists claim to value sustainability, there remains a **gap between stated preferences and actual travel decisions.** However, initiatives like the Med NOx ECA could help bridge this gap by providing tangible benefits that directly enhance tourist satisfaction. High-end travelers, in particular, who prioritize exclusivity and well-being, may be more inclined to choose Mediterranean destinations known for their clean air and commitment to sustainability. By capitalizing on these improvements, Mediterranean coastal cities could see increased tourist loyalty, higher satisfaction ratings, and greater economic benefits from the shift toward sustainable tourism.

2.2.2.2 Strengthening Sustainability to Attract Eco-Conscious Tourism

Rebranding the Mediterranean towards sustainable tourism requires integrating environmental stewardship into its core identity. For decades, the region's appeal has centered around its natural beauty, historical landmarks, and culinary heritage. While these elements remain vital, they must now coexist with a clear narrative of sustainability. By showcasing the Mediterranean as a destination that actively invests in protecting its ecosystems, air quality, and marine life, the region can stand out in a competitive global market.

However, **perceptions** of the Mediterranean as an environmentally-friendly destination remain mixed. Responses from the survey indicate that many still view its sustainability reputation as weak, with only a minority considering it "very strong." Similarly, interviewees noted that while efforts are being made, significant gaps remain between ambition and reality. One respondent highlighted the contrast between northern and southern Mediterranean countries in their sustainability positioning—while the north actively brands itself as eco-conscious, the south sees sustainability as an opportunity but still has work to do to meet these expectations[13].

This perception contrast should be approached with nuance. Per capita environmental impact (e.g., CO_2 or NOx emissions per resident or per tourist) is often higher in northern countries due to greater industrial activity and cruise ship density. A deeper analysis could help balance the narrative and highlight under-recognized efforts in southern destinations.

The NOx ECA designation provides a tangible foundation for shifting these perceptions. By significantly improving air quality in coastal areas, the initiative could offer visible and measurable progress that can enhance the Mediterranean's credibility as a sustainable destination. Clearer skies, reduced pollution, and healthier urban environments could improve tourist satisfaction, particularly in popular coastal cities like **Barcelona, Marseille,** and **Dubrovnik**, where maritime emissions have been a growing concern. Cleaner air could also make the region more

[12] See Objectives 2, 3 and 5 of the Mediterranean Strategy for Sustainable Development (MSSD) of the Barcelona Convention.
[13] Regional Marine Pollution Emergency Response Centre for the Mediterranean Sea (REMPEC), *Mediterranean Sea Emission Control Area for Sulphur Oxides and Particulate Matter (Med SOx ECA)*, 2022.

attractive to health-conscious travelers and luxury tourism markets, where wellness and environmental quality are key decision factors.

Protected natural areas and **UNESCO World Heritage Sites** across the Mediterranean can play a pivotal role in reinforcing this brand. Many of these locations are already celebrated for their ecological or cultural significance, making them ideal ambassadors for sustainable tourism[14]. In several cases, this success stems from concrete tools such as participatory governance, integrated management plans, visitor flow control, and education programs, approaches promoted by UNESCO's Sustainable Tourism Toolkit. These methods could be adapted to other natural and cultural sites across the region, particularly in areas with emerging tourism infrastructure.

Collaboration among Mediterranean countries is equally critical. As the region spans multiple nations, creating a unified approach to sustainability can amplify its branding. Joint projects, such as shared marine conservation efforts, cross-border eco-tourism initiatives, and collective investment in green technologies, can demonstrate a cohesive commitment to environmental stewardship. However, as noted in the interviews, differences in economic and political priorities between Mediterranean nations could pose challenges in implementing a harmonized strategy. Addressing these disparities and ensuring that sustainability efforts benefit all parts of the region—north and south—will be key to making the Mediterranean's eco-friendly rebranding a success.

Table 1. Shaping Perceptions through communication

Effective communication is essential in shaping how tourists perceive the Mediterranean's sustainability efforts. With the growing demand for environmentally responsible tourism, communication strategies must highlight the region's eco-friendly initiatives and their impact. This requires a shift in storytelling; from merely showcasing picturesque landscapes and historic sites to emphasizing the region's commitment to preserving them for future generations.

Campaigns should emphasize the Mediterranean's progress in reducing maritime emissions under the NOx ECA framework. Narratives about cleaner ports, improved air quality, and restored marine ecosystems can illustrate how the region is tackling environmental challenges. These stories can be paired with testimonials from local communities, policymakers, and tourists to add authenticity and emotional resonance.

To enhance credibility and marketability, specific **cross-border campaigns and certifications** can be developed to highlight compliance with the Med NOx ECA. For example, the **"Med NOx Green Ports" Certification** could be introduced to recognize ports that meet strict NOx reduction and sustainability criteria. These certified ports would be promoted in joint marketing campaigns by regional tourism boards, emphasizing cleaner air, shore power availability, and sustainable port operations.

Similarly, an **"Eco-Friendly Cruise Zones" Label** could be created for coastal areas enforcing stringent emissions reductions for cruise ships. Destinations meeting these standards would be featured in collaborative marketing efforts between cruise operators and Mediterranean tourism authorities, positioning them as premium, low-impact travel choices. A broader initiative such as **"Blue Horizon: Sustainable Mediterranean Travel"** could serve as a cross-border campaign promoting eco-certified cruises, ferries, and waterfront destinations compliant with ECA standards. This campaign could include a **digital platform** showcasing compliant businesses, traveler testimonials, and real-time air quality improvements in key ports. Evidence from the Baltic Sea and North American ECAs suggests that such recognition frameworks have indeed encouraged ports and cruise operators to invest in cleaner technologies, including shore-side electrification and SCR systems, as part of broader marketing and compliance incentives.

In addition, **public-private partnerships** could drive initiatives like **"Clean Cruise Itineraries,"** which prioritize stops at Med NOx-compliant ports and offer eco-conscious excursions. These itineraries would not only attract environmentally aware travelers but also encourage cruise operators to invest in cleaner technologies. While this impact is expected, it depends on the visibility and commercial value associated with such itineraries, as observed in cases like the Port of Seattle or Copenhagen, where low-emission port recognition is linked to increased cruise traffic and partnerships with green-certified lines.

Finally, a **consumer-facing awareness effort** such as "Breathe the Med" is suggested as a hypothetical initiative. It could leverage before-and-after visuals of air quality improvements in major port cities like Barcelona, Marseille, and Athens. This campaign would provide tangible proof of NOx reduction benefits, reinforcing the Mediterranean's appeal as a sustainable tourism destination. By integrating these types of

[14] UNESCO, World Heritage Centre, *Sustainable Tourism Toolkit*, 2024.

communication initiatives into promotional efforts, the Med NOx ECA could evolve from a purely regulatory tool into a competitive advantage for Mediterranean tourism and maritime industries. This approach mirrors how Scandinavian destinations have leveraged emission-control zones as part of their tourism marketing.

Partnerships with influencers who advocate for sustainable travel can further enhance the region's visibility among eco-conscious audiences. These influencers can share first-hand accounts of their experiences in the Mediterranean, showcasing its eco-friendly accommodations, green urban spaces, and low-impact recreational activities. Studies[15] show that travel influencers can effectively shape tourist perceptions and influence destination choices, especially among younger travelers. Collaborations must, however, be transparent and consistent with the destination's sustainability messaging[16].

Finally, incorporating clear and consistent **eco-labeling** into communication materials can solidify the region's identity as a sustainable destination. Tourists often rely on such certifications to guide their choices. However, consumer trust in eco-labels depends significantly on the credibility of the certifying body. Academic research (e.g., Bouhaddane, 2022)[17] highlights that third-party certifications by recognized organizations (e.g., EU Ecolabel, Green Globe) carry more weight than self-declared claims, and this nuance must be considered in communication strategies.

2.2.3 Spending Patterns changes

The introduction of the Med NOx Emission Control Area (ECA) in the Mediterranean is poised to significantly influence tourist behavior and spending patterns. These changes will not only reflect shifts in individual preferences and priorities but will also have broader socio-economic impacts on the region's tourism industry. By addressing issues such as willingness to pay for **eco-friendly services**, changes in activity and transportation preferences, and the reallocation of spending, the Med NOx ECA initiative can help redefine the Mediterranean as a leading sustainable tourism destination.

2.2.3.1 Willingness to Pay for Eco-Friendly Services

A growing body of research indicates that travelers increasingly prioritize environmental sustainability when choosing their travel destinations and services. In the Mediterranean, a region celebrated for its unique ecosystems and historical landmarks, this trend is especially pronounced. Tourists are demonstrating a strong willingness to pay for services that align with **eco-friendly principles**, reflecting a broader cultural shift toward environmental responsibility.

This willingness is particularly evident in the accommodations sector, where **eco-certified hotels, resorts, and short-term rentals** are gaining popularity. Travelers are drawn to establishments that utilize renewable energy, adopt water conservation techniques, and minimize waste. For example, properties employing solar panels, rainwater harvesting systems, and waste segregation practices often charge premium rates (typically around 5% more per night)[18] without deterring environmentally conscious customers. Such **pricing strategies** capitalize on the growing demand for sustainable travel without sacrificing profitability[19].

Beyond accommodations, tourists are showing an increasing propensity to support restaurants and cafes that emphasize **local sourcing and organic products**. A 2021 study on ecotourism in Mediterranean natural parks revealed that travelers valued experiences and services that reduced their ecological footprint while enhancing their cultural understanding. This indicates that the demand for eco-friendly services is not limited to a specific demographic but cuts across various tourist profiles, from luxury travelers to backpackers[20].

By implementing the Med NOx ECA, which directly contributes to improved **air and water quality,** Mediterranean destinations can further enhance their reputation as sustainable travel hubs. This creates opportunities for the tourism sector to leverage the initiative in marketing campaigns and product development, emphasizing the added value of eco-conscious experiences. For instance, **eco-certified accommodations** often receive higher guest satisfaction scores, stronger reputational ratings on platforms like Booking.com, and increased repeat bookings; up to 15% more compared to non-certified competitors[21]. These benefits contribute to long-term **customer loyalty** and **destination**

[15] https://www.sciencedirect.com/science/article/pii/S2212571X23000045
[16] OECD, *OECD Tourism Trends and Policies 2022*, 2022.
[17] https://theses.hal.science/tel-04673752/file/2022UCFAD009_BOUHADDANE-1.pdf
[18] (PDF) How Much Are Consumers Willing to Pay for a Greener Hotel Industry? A Systematic Literature Review
[19] Dimitris Damigos, *How Much Are Consumers Willing to Pay for a Greener Hotel Industry? A Systematic Literature Review*, 2023.
[20] Mauricio Carvache-Franco, Conrado Carrascosa-López & Wilmer Carvache-Franco, *The Perceived Value and Future Behavioral Intentions in Ecotourism: A Study in the Mediterranean Natural Parks from Spain*, 2021.
[21] Dimitris Damigos, *How Much Are Consumers Willing to Pay for a Greener Hotel Industry? A Systematic Literature Review*, 2023.

competitiveness. Destinations that effectively communicate their commitment to environmental stewardship are likely to attract a growing segment of travelers willing to invest in sustainability-focused tourism.

However survey responses from tourism operators and local stakeholders reveal a **nuanced perspective** regarding tourists' willingness to pay a premium for eco-friendly destinations in the Mediterranean. While a majority of respondents (64%) indicated that "some are willing, but not all," a few highlighted a stronger trend, with one stating that "most are willing to pay more." There remains a notable segment of respondents who believe that many tourists "prefer lower-cost options," suggesting that **price sensitivity** still plays a significant role in travel decisions. These insights point to a growing—but not universal—market for sustainable tourism products, where eco-conscious travelers coexist with more cost-driven segments. This highlights the importance for tourism businesses to balance affordability with sustainable offerings, catering to varying expectations. Ultimately, while the Med NOx ECA could enhance the **attractiveness of destinations** for environmentally aware travelers, its success will depend on how effectively operators can position their eco-friendly services while remaining accessible to broader tourist demographics.

2.2.3.2 Changing Preferences for Activities and Transportation

The potential establishment of a Mediterranean Nitrogen Oxides Emission Control Area (Med NOx ECA) could influence **tourist preferences**, steering them toward more eco-friendly activities and transportation options. Insights from industry experts and recent studies highlight that Mediterranean destinations are increasingly seeking to position themselves as sustainable travel hubs, particularly in the northern regions. This effort aligns with growing awareness among travelers regarding environmental issues. However, as noted in the interviews, the perception of the Mediterranean as an eco-friendly destination varies greatly between regions, and there is still much work to be done to ensure consistency in sustainability efforts.

Tourists are increasingly showing interest in **low-impact recreational activities** such as eco-parks, marine reserves, and hiking trails. The improvement in air quality resulting from NOx reductions will likely enhance the appeal of these options, making nature-based tourism more attractive. Interviews indicate that while some travelers express a strong preference for sustainable experiences, a gap remains between their stated values and actual booking behaviors. Experts in sustainable tourism, destination marketing, and behavioral economics (including those from the Global Sustainable Tourism Council (GSTC) and the European Travel Commission) highlight that this "value-action gap" is a recurring barrier. They suggest that destinations must not only provide eco-friendly options but also implement clear communication strategies to help visitors recognize and prioritize sustainability. Some of these strategies have already shown tangible results. For example, the **Azores Destination Management Organization** implemented a clear eco-certification system combined with visitor education campaigns, leading to a measurable increase in bookings for certified nature-based tours. Similarly, **Slovenia**'s "Green Scheme" has significantly boosted awareness and demand for eco-certified destinations through consistent branding, visual labels, and integration into online booking platforms[22].

However, the transition to more sustainable tourism is not without challenges. Interviewees emphasize that a major barrier is the **cost of green infrastructure**s, both in transportation and tourism services. While some companies are willing to invest in cleaner technologies, financial support and incentives remain crucial[23]. Additionally, concerns over **greenwashing** persist, as some businesses may claim to be eco-friendly without making meaningful operational changes. Experts warn that clearer r**egulatory frameworks** and monitoring mechanisms are needed to ensure that sustainability claims are backed by real action.

Public awareness campaigns can play a key role in reinforcing these behavioral shifts. Educating tourists about the benefits of the Med NOx ECA and the broader environmental improvements it supports can encourage more conscious choices. Destinations that actively engage travelers through transparent information and participatory programs will likely build long-term loyalty among visitors who prioritize sustainability. Ultimately, while regulatory measures like the Med NOx ECA may initially pose challenges for some sectors, they are expected to drive long-term benefits by enhancing the Mediterranean's reputation as a clean, responsible, and forward-thinking tourism destination.

[22] Eco-union, *Towards a Sustainable Blue Tourism in the Mediterranean Regional Governance, Environmental Management and Sustainable Recovery of the Mediterranean Coastal and Maritime Tourism*, 2021.
[23] Interreg Mediterranean, Urban Transports, *Tourism and mobility in the Mediterranean Sustainable mobility solutions for a greener & respectful experience living in and visiting the Mediterranean*, 2022.

2.2.3.3 Reshaping Tourist Spending, Jobs, and Business Models

The potential implementation of the ECA might influence (and be influenced by) how tourists allocate their spending, leading to a ripple effect on the regional economy. As preferences evolve toward sustainable services and experiences, spending patterns will reflect this shift, benefitting certain sectors while challenging others.

Indeed tourists are expected to allocate a larger share of their budgets to **eco-friendly accommodations, transportation, and activities.** For instance, travelers may prioritize stays in eco-certified resorts or boutique hotels that advertise their commitment to reducing carbon footprints. These establishments often charge premium rates, allowing them to invest in green infrastructure, such as energy-efficient designs, solar power, and waste recycling systems. This spending pattern not only supports the growth of sustainable tourism enterprises but also encourages the proliferation of environmentally responsible practices across the industry[24].

However, sustainable investment is not always more expensive than conventional development. When economic instruments that internalize environmental externalities (such as carbon pricing, tax incentives, or life cycle cost analysis) are taken into account, **green infrastructures** can often yield better long-term returns and lower operating costs[25].

Insights from the interviews confirm that while some tourists are willing to pay more for eco-friendly services, this willingness is not universal. Interviewees highlight that a significant portion of travelers express interest in sustainability but may not always translate that into higher spending. That said, sustainable choices are not necessarily more expensive for tourists. Some eco-friendly options, such as walking tours, public transport, or agritourism stays, may be equal or even lower in cost than traditional offerings, depending on the context. However, as regulatory frameworks evolve and awareness campaigns strengthen, an increasing number of tourists could align their spending with their values. This trend reflects a broader behavioral shift observed in tourism studies, where regulatory “nudges” and consistent sustainability communication lead to more conscious consumer choices; even without price differentials. Survey results further suggest that many professionals in the tourism sector acknowledge a **moderate shift toward eco-conscious consumption**, with respondents noting a "slight increase" in demand for green accommodations and transport.

Despite this trend, the **economic barriers** to adopting sustainable practices remain a key challenge. Three interviewees emphasize that eco-friendly infrastructure requires substantial investment, which is often a deterrent for businesses. **Financial incentives**, such as tax breaks and government subsidies, are widely seen as crucial mechanisms for encouraging the transition to sustainable tourism. According to survey responses, a majority of tourism professionals agree that targeted support would accelerate the adoption of green technologies and practices.

Another concern raised in the interviews is the potential for "**greenwashing**," where businesses claim to be sustainable without implementing meaningful changes. The interviewee warns that stronger regulatory oversight is needed to ensure that sustainability claims are backed by verifiable actions.

Regulating **environmental performance** across the Mediterranean presents specific challenges, including diverse legal frameworks, varying enforcement capacities, and uneven economic development among coastal nations. Political coordination across borders and alignment with international standards (such as IMO or UNEP-MAP frameworks) are therefore essential. This is particularly relevant as travelers become more discerning, seeking third-party certifications and transparency in environmental commitments. Indeed, research shows that consumers tend to place more trust in independent third-party certifications (e.g., Green Globe, EarthCheck) than in state-sponsored labels, which are sometimes perceived as lacking neutrality. Public-private partnerships should therefore ensure that certification schemes are both credible and widely recognized by consumers.

Spending allocation toward **green transportation** is another key area of economic impact. Tourists may increasingly opt for electric car rentals, bicycle-sharing systems, and low-emission public transport, contributing to the profitability of these services. Similarly, ports and ferry operators investing in clean technology can capitalize on this trend by offering eco-labeled transport options, which appeal to environmentally conscious travelers.

The demand for **sustainable activities**, such as visiting marine protected areas or participating in cultural conservation programs, also translates into higher spending on local goods and services. This shift benefits small-scale producers, artisans, and community-led initiatives, reinforcing the socio-economic benefits of sustainable tourism. Additionally,

[24] Sustainable Hospitality Alliance, *Business Case for Sustainable Hotels*, 2020.
[25] G20/OECD report on approaches for financing and investment in climate-resilient infrastructure, 2024

as tourists engage with eco-friendly experiences, they may be more inclined to support conservation initiatives through donations or participation fees, creating a direct link between tourism revenue and environmental protection[26].

Economic impacts extend beyond spending patterns to include **job creation** and industry transformation. **Investments** in green infrastructure and technologies generate employment opportunities in sectors such as renewable energy, sustainable construction, and environmental management. For example, the installation of solar panels or electric vehicle charging stations creates demand for skilled labor, while ecotourism ventures provide jobs in guiding, education, and hospitality.

Interviewees and survey respondents highlight that the transition to sustainable tourism will likely **reshape the labor market,** creating new roles while necessitating workforce upskilling. One interviewee notes that green transformation will require education and capacity building to equip professionals with the necessary skills to work in eco-friendly tourism and infrastructure development. This also implies a growing need for qualified educators, trainers, and academic institutions capable of delivering such content, creating a secondary job market in green skills training. Similarly, survey respondents identify the need for training programs to support jobs related to emissions monitoring, sustainable transport, and renewable energy integration.

Beyond direct job creation, experts also point to shifts in **business operations**. The implementation of stricter environmental regulations encourages tourism enterprises to innovate, leading to the growth of sectors such as green suppliers and sustainable hospitality services. For instance, a second interviewee emphasizes that businesses engaged in sustainable practices may gain a competitive advantage as regulatory frameworks evolve and consumer awareness increases.

However, concerns over potential job displacement persist. Some respondents express apprehension that compliance with environmental regulations may increase **operational costs**, leading to economic strain on businesses that are unable to adapt. This challenge underscores the importance of financial incentives, such as tax reductions and public-private partnerships, to ensure a just transition for workers in the tourism industry.

Importantly, this transition also offers an opportunity to address persistent **gender inequalities** in tourism employment. Targeted upskilling and inclusive hiring policies could help increase women's access to emerging green jobs, particularly in management, technical roles, and entrepreneurship.

The transition to sustainability is not without challenges. Traditional tourism businesses that fail to adapt may face reduced **competitiveness**, particularly if their services are perceived as outdated or environmentally harmful. Compliance with new standards may also involve significant costs, particularly for smaller operators lacking access to capital. To mitigate these challenges, policymakers and industry stakeholders should prioritize support mechanisms, such as subsidies for retrofitting facilities and training programs for employees.

2.2.4 Stakeholders Perspectives

Understanding how the Med NOx Emission Control Area (ECA) impacts tourism requires insights from key stakeholders in the tourism sector. Tourism operators and local communities are central to interpreting the direct and indirect effects of these changes. Their perspectives reveal the challenges and opportunities associated with adapting to evolving tourist expectations driven by environmental regulations. By integrating their viewpoints, policymakers and industry leaders can design strategies that address stakeholder concerns while capitalizing on the benefits of sustainable tourism.

2.2.4.1 Insights from Tourism Operators

Tourism operators are among the most affected stakeholders as they are directly exposed to shifts in tourist behavior and spending patterns. On one hand, compliance with stricter environmental regulations may require significant investment in cleaner technologies and infrastructure. On the other, the improved environmental quality resulting from reduced NOx emissions is expected to enhance the region's appeal as a sustainable destination, attracting a growing market of eco-conscious travelers.

Cruise lines, ferry companies, and port authorities, for instance, can anticipate substantial changes in operational requirements. Adopting emission-reduction technologies, such as Tier III engines and selective catalytic reduction (SCR) systems, entails high upfront costs. However, these measures can increase the attractiveness of their services,

[26] Elsadig Musa Ahmed, *The Role of Local Communities in Sustainable Tourism Development*, 2024.

particularly as tourists become more aware of environmental issues. A cleaner Mediterranean environment—marked by reduced air pollution and improved visibility—can enhance passenger satisfaction and encourage repeat visits[27].

Similarly, **hotel and accommodation** providers will have to adjust their offerings to align with changing preferences. Insights from surveys suggest that operators are exploring green certifications, energy-efficient upgrades, and waste reduction programs to appeal to sustainability-minded travelers. Hoteliers highlight the importance of marketing these initiatives effectively, as tourists are willing to pay a premium for eco-friendly accommodations that demonstrate tangible environmental benefits.

Operators of **tourist attractions** will also have to adapt. Marine parks, cultural heritage sites, and eco-tourism ventures are integrating environmental education and sustainability into their services. Tour guides, for example, are increasingly trained to emphasize conservation efforts and the benefits of environmental sustainability, leveraging these improvements as unique selling points. Some operators report higher interest in activities such as wildlife observation, diving in protected areas, and cultural immersion programs, which align with the eco-tourism trend.

While many operators can be optimistic about the long-term benefits of the Med NOx ECA, some express concerns about the cost and pace of adaptation. **Smaller businesses**, in particular, highlight the need for financial support to implement green practices and meet compliance requirements. Grants, subsidies, and technical assistance are critical enablers for successfully navigating this transition.

Survey data collected from tourism operators further illustrates these dynamics, highlighting both opportunities and concerns related to the Med NOx ECA. Responses from **tourism operators,** including Destination Management Organizations (DMOs) such as the **Catalan Tourist Board** and **Visit València**, as well as private sector actors, shed light on industry perspectives regarding the Med NOx ECA and shifting tourist expectations. All respondents recognized the importance of reducing air pollution from ships in the Mediterranean, confirming a shared awareness of the environmental stakes. However, there is a nuanced view of tourist willingness to pay for sustainability: while operators acknowledge growing interest, they agree that "some are willing, but not all." When asked about the Mediterranean's image as an eco-friendly destination, responses varied from "weak" to "very strong," suggesting that perceptions depend on specific regional contexts or market positioning.

A majority of operators observed a "slight change" in tourist preferences toward **eco-friendly services**, while one reported a "significant change," indicating a gradual but noticeable shift in demand patterns. In terms of economic impact, most expect a "slight increase" in costs associated with the Med NOx ECA, though one operator anticipates "no change" in operating costs, not due to a lack of action, but because they have already implemented relevant adjustments or benefit from infrastructure compatibility, while another foresees a "significant increase," reflecting diverse operational realities across the sector. Notably, most respondents agree on the need for new infrastructures to meet regulatory demands, signaling a readiness to adapt. Finally, there was unanimous agreement on the effectiveness of **financial incentives** (such as tax breaks or subsidies) in facilitating the adoption of sustainable practices. These insights suggest that while tourism operators are generally supportive of environmental regulations and recognize their potential market benefits, they also stress the importance of external support to ease the financial and logistical burden of transition.

2.2.4.2 Community Perspectives

Local communities in the Mediterranean region play a dual role as both hosts and beneficiaries of tourism. Their perspectives on the environment reflect the potential for improved quality of life as well as the socio-economic implications of changing tourist behavior.

Community members living in popular tourist areas usually welcome the **improvements** associated with environmental regulations. Cleaner air, healthier marine ecosystems, and lower levels of noise pollution enhance the livability of these areas, creating a more pleasant environment for both residents and visitors. For coastal communities, the reduction in maritime pollution is particularly significant, as it directly impacts public health, fisheries, and local biodiversity[28].

Economic impacts are also a key concern for local communities. Many rely heavily on tourism for employment and income, and shifts in tourist behavior can have a direct bearing on their livelihoods. Residents involved in ecotourism ventures, such as community-led guided tours or locally produced crafts, can view the ECA as an opportunity to attract high-value visitors. These tourists are more likely to support local businesses and participate in activities that benefit the community, such as cultural exchanges and conservation programs.

[27] Jiaguo Liu, Haonan Xu, Yibing Lyu, *Emission reduction technologies for shipping supply chains under carbon tax with knowledge sharing*, 2023.
[28] Office of Air and Radiation United States Environmental Protection Agency, *Nitrogen Oxides: Impacts On Public Health and the Environment*, 1997

Another critical perspective from local communities revolves around their involvement in **decision-making.** Residents often stress the importance of participatory governance, where they are included in planning and implementation processes for environmental regulations and tourism strategies. Ensuring that community voices are heard can foster trust, improve policy acceptance, and create a sense of ownership over sustainable tourism initiatives.

Local stakeholders also highlight the educational value of environmental regulations such as ECA. By raising awareness of environmental issues and promoting sustainable practices among tourists, the initiative can strengthen community engagement in conservation efforts. For instance, community-led campaigns to reduce plastic waste or protect marine habitats can be amplified through collaboration with eco-tourists, creating a virtuous cycle of environmental stewardship and economic benefit[29].

Overall, stakeholder perspectives underscore the **transformative potential of environmental regulations** while highlighting the challenges that require careful management. By addressing the concerns of tourism operators and local communities, the Mediterranean can position itself as a model for sustainable tourism, ensuring both environmental and socio-economic resilience.

These general insights are supported by **qualitative evidence** gathered through the survey conducted among Civil Society stakeholders in the Mediterranean region. The feedback illustrates local community perspectives on tourist behavior in relation to the potential implementation of the Med NOx ECA.

The survey responses from community stakeholders, including **SEA Index** Superyacht Eco Association YCM, provide further insight into local perspectives on tourist behavior in the context of the Med NOx ECA. All respondents considered reducing air pollution from ships to be important, reinforcing the strong environmental concerns within coastal communities. When asked whether tourists are willing to pay a premium for eco-friendly destinations, stakeholders acknowledged that while there is growing interest, this willingness is selective, as “some are willing, but not all.” Interestingly, the Mediterranean's current reputation as an eco-friendly destination was generally perceived as weak, with two stakeholders out of eleven rating it as “weak” and one as “somewhat strong,” suggesting room for improvement in how the region markets and delivers sustainable tourism experiences.

A slight shift in tourist preferences toward **eco-friendly services** was noted by all respondents, indicating a nascent but positive trend toward sustainability. Economic considerations also emerged, as stakeholders predicted that the Med NOx ECA could lead to a “slight” to “significant” increase in costs, highlighting concerns about the financial burden on local tourism businesses. Moreover, while two out of three stakeholders agreed on the necessity of new infrastructure to comply with the regulation, one disagreed, suggesting differing views on readiness and capacity across the region. Finally, there was unanimous agreement that financial incentives would play a decisive role in encouraging tourism actors to adopt more sustainable practices. These insights reveal a cautious optimism among local communities, who recognize both the environmental and economic stakes of the Med NOx ECA and the evolving demands of tourists seeking greener experiences.

2.2.5 Long-Term Impacts

The potential Med NOx Emission Control Area (ECA) represents a critical juncture for Mediterranean tourism, offering an opportunity to redefine the region’s identity while addressing pressing environmental challenges. The long-term impacts of this initiative extend beyond immediate environmental benefits, industry innovation, and global competitiveness. By adapting to these shifts, the Mediterranean can secure its position as a sustainable and attractive destination for future generations.

2.2.5.1 Transforming the Mediterranean’s Tourism Model

The introduction of the Med NOx ECA - together with stricter environmental regulations - has the potential to contribute to reshaping the Mediterranean’s tourism model by prioritizing sustainability as a cornerstone of its appeal. Historically, Mediterranean tourism has been heavily reliant on mass tourism, with large numbers of visitors flocking to coastal areas and popular cities. While economically lucrative, this model has placed immense pressure on the region’s natural and cultural resources, contributing to environmental degradation, overcrowding, and loss of local identity[30].

With the implementation of stricter environmental regulations such as ECAs or others, the region has an opportunity to transition from mass tourism to more sustainable and **higher value tourism**. This shift entails emphasizing eco-tourism, cultural heritage, and community-based travel experiences. For instance, destinations can develop and

[29] Miguel Cardenas-Montes, *Evaluation of the Impact of Low-Emission Zone: Madrid Central as a Case Study*, 2021.
[30] European Commission, *Sustainable tourism: a priority for Western Mediterranean*, 2024.

promote environmentally friendly attractions such as marine reserves, eco-parks, and cultural immersion programs that highlight local traditions. These activities appeal to a growing demographic of tourists seeking meaningful and responsible travel experiences[31].

Moreover, sustainable tourism practices foster **resilience against environmental and economic shocks**. By reducing reliance on resource-intensive activities and diversifying offerings, the Mediterranean can ensure that its tourism industry remains viable in the face of climate change, regulatory shifts, and fluctuating tourist preferences. This transformation requires coordinated efforts between governments, businesses, and local communities to align economic development with environmental stewardship.

2.2.5.2 Driving Innovation in the Tourism Industry

Environmental regulations such as the Med NOx ECA can catalyze innovation across the tourism industry, driving the adoption of cleaner technologies, sustainable practices, and new business models. Compliance with emission regulations will push stakeholders to explore innovative solutions, such as alternative propulsion systems for ships, energy-efficient building designs, and waste reduction technologies. For example, **cruise lines and ferry operators** are likely to invest in cleaner propulsion systems to meet emission standards, reducing their environmental impact while improving operational efficiency[32].

In the **hospitality sector,** advancements in green architecture and renewable energy integration are gaining momentum. Hotels and resorts are increasingly adopting practices such as solar panel installation, smart energy management systems, and water recycling technologies. These innovations not only reduce operating costs but also enhance the attractiveness of accommodations to eco-conscious travelers[33].

Innovation is also evident in the development of digital tools and platforms to support sustainable tourism. Applications that provide real-time information on air quality, sustainable travel options, and eco-friendly attractions are becoming increasingly popular. These tools empower tourists to make informed decisions that align with their values, while also serving as marketing channels for destinations committed to sustainability[34].

Additionally, the Med NOx ECA can create opportunities for collaborative **research and development** between public and private sectors. By investing in pilot projects, testing new technologies, and sharing best practices, stakeholders can accelerate the adoption of sustainable innovations. For example, partnerships between environmental organizations, technology companies, and tourism operators can lead to breakthroughs in pollution monitoring, green mobility, and waste management**.**

2.2.5.3 Enhancing Global Competitiveness

One of the most significant long-term impacts of environmental regulations such as the Med NOx ECA is its potential to enhance the Mediterranean's **global competitiveness** as a tourism destination. Travelers are increasingly seeking destinations that prioritize sustainability, and the region's commitment to reducing pollution positions it as a leader in this growing market. The environmental improvements brought about by the Med NOx ECA—such as cleaner air, healthier marine ecosystems, and reduced noise pollution—can significantly enhance the region's appeal.

However, it is important to note that the direct environmental effects of the Med NOx ECA may be relatively limited at first, given that the regulation applies only to newly built ships or those undergoing major conversions, and only to vessels equipped with Tier III engines operating in the region. As such, the overall emission reduction will be gradual and contingent upon fleet renewal and enforcement levels. Nonetheless, the symbolic and strategic value of such regulation, especially in signaling a regional commitment to sustainability, should not be underestimated.

Destinations that adopt environmental protection as part of their **branding strategies** stand to attract a higher proportion of high-value tourists. These visitors, often referred to as "quality over quantity" tourists, typically spend between 33% and 70% more per trip compared to average tourists, according to recent studies by the UNWTO and the European Travel Commission. They spend more per visit and are more likely to return. By emphasizing sustainability credentials, Mediterranean destinations can differentiate themselves from competitors and tap into niche markets such as wellness tourism, eco-tourism, and cultural travel[35].

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[31] European Commission, Promoting ecotourism in Mediterranean protected areas, 2024.
[32] Shipuniverse, *Fuel Efficiency and Emission Control: The Dual Promise of Hybrid Propulsion in Shipping*, 2023.
[33] Oscar Trull, Angel Peiro-Signes, J.Carlos Garcia-Diaz, Marival Segarra-Ona, *Prediction of energy consumption in hotels using ANN*, 2024.
[34] Ashmi Banerjee, Tunar Mahmudov, Emil Adler, Fitri Nur Aisyah & Wolfgang Wörndl, *Modeling Sustainable City Trips: Integrating CO_2e Emissions, Popularity, and Seasonality into Tourism Recommender Systems*, 2025.
[35] Kyriaki Glyptou, Nikos Kalogeras, Dimitrios Skuras & Ioannis Spilanis, *Clustering Sustainable Destinations: Empirical Evidence from Selected Mediterranean Countries*, 2022.

The initiative also bolsters the Mediterranean's **reputation** on the global stage as a model for sustainable tourism development. By demonstrating leadership in environmental governance and showcasing successful examples of green innovation, the region can inspire similar efforts in other parts of the world. This not only strengthens its position in international tourism networks but also attracts investment and partnerships from global stakeholders.

Moreover, compliance with the Med NOx ECA aligns the Mediterranean with international sustainability standards, such as the United Nations **Sustainable Development Goals** (SDGs). This alignment enhances its credibility and visibility in global forums, creating opportunities for collaboration with international organizations, governments, and businesses committed to advancing sustainable development. It could also facilitate access to international funding mechanisms, such as climate finance or green transition funds, that support broader sustainability initiatives, including renewable energy, coastal resilience, or sustainable mobility infrastructure.

2.3 ECONOMIC DEVELOPMENT AND JOB CREATION

The potential implementation of the Med NOx Emission Control Area (ECA) can generate significant economic impacts, particularly in terms of job creation and the transformation of employment patterns within the Mediterranean's tourism and maritime sectors. While it holds the potential to foster new economic opportunities, it also poses challenges for workers in traditional sectors that may face disruption. Addressing these dual effects requires targeted strategies to maximize job creation while supporting those whose livelihoods are adversely impacted by the transition to greener practices.

2.3.1 Job Creation and Displacement in Eco-Tourism and Clean Technologies

The Med NOx ECA is poised to stimulate job creation in sectors linked to environmental sustainability, clean technologies, and eco-tourism. As the tourism industry aligns with stricter environmental standards, demand for skilled labor in areas such as green construction, renewable energy, and waste management is expected to rise. For example, hotels and resorts transitioning to energy-efficient systems or solar power will require engineers, technicians, and project managers specialized in sustainable infrastructure.

In the maritime sector, efforts to comply with NOx emission reductions shall create opportunities in **shipbuilding and retrofitting industries**. The installation of Tier III-compliant engines, selective catalytic reduction (SCR) systems, and alternative propulsion technologies like liquefied natural gas (LNG) engines necessitates a workforce skilled in cutting-edge technologies. Ports, too, would benefit from increased demand for cleaner shore power systems, fostering jobs in renewable energy generation and electrical engineering[36].

In the tourism sector, **eco-tourism ventures** are likely to see growth, creating new employment opportunities for guides, naturalists, and operators offering sustainable activities such as marine conservation tours, eco-parks, and cultural heritage programs. Small and medium-sized enterprises (SMEs) focused on sustainable goods and services, such as locally sourced food or artisanal crafts, stand to benefit from the increased spending power of eco-conscious travelers.

Despite these positive trends, the transition to sustainability may also result in **job displacement,** particularly in industries heavily reliant on traditional practices. Workers employed in high-emission activities (such as conventional cruise operations, mass tourism services, and fossil-fuel-based transportation) may face declining demand for their skills and services. For instance, smaller ferry operators unable to afford the high costs of retrofitting vessels may scale back operations, potentially affecting jobs in the maritime sector[37]. However, in the long term, these impacts may be limited, as the NOx regulations apply primarily to new vessels or those undergoing major engine replacements, reducing immediate compliance pressure on existing fleets.

The effects on employment will **vary across regions and industries**, depending on the extent to which local economies rely on traditional tourism models and the availability of resources to support transitions. Coastal areas heavily dependent on maritime tourism or mass tourism might experience greater initial disruptions but could gain long-term competitive advantages by adopting sustainable practices early, positioning themselves as leaders in eco-tourism and green innovation.

Survey data from tourism and maritime stakeholders further illustrate the **complexities** surrounding job creation and displacement in the context of the Med NOx ECA. Survey responses reflect this nuanced reality. When asked about concerns related to job or tourist displacement due to environmental regulations such as the Med NOx ECA, the

[36] U.S. Department of Energy, *Maritime Decarbonization*, 2024.
[37] World Economic Forum, *Here's why skills are central to shipping's green transition*, 2023.

majority of respondents expressed moderate concern, with several indicating they were "somewhat concerned" and others stating they were "not concerned." Only one respondent reported being "very concerned." This suggests that while stakeholders recognize the potential for disruption, there is no consensus on the severity of its impact, and many remain cautiously optimistic.

Interestingly, when questioned about the positive impacts of eco-friendly initiatives on job creation and quality improvement, most respondents reported tangible benefits. Several highlighted the creation of new positions, such as jobs related to emissions measurement, the promotion of sustainable practices, and the development of eco-friendly tourism experiences, particularly within the hospitality sector. For instance, one respondent noted the expansion of sustainable tourism offerings, including enogastronomy and eco-experiences within hotel accommodations. Another pointed to the **SEA Index initiative**, which has expanded across 16 ports, fostering job creation linked to promoting and implementing sustainability standards for yachts.

Some stakeholders also mentioned indirect benefits, such as cost savings and improved service quality, as eco-friendly measures become embedded in business models. While a few respondents noted that they had not yet observed significant job creation, others emphasized the growing opportunities emerging from sectors like alternative fuel supply chains for maritime transport. These insights underline the perception among tourism operators and local organizations that, despite some uncertainties, eco-friendly initiatives—including the Med NOx ECA—are contributing to job diversification and improving employment quality across various segments of the tourism and maritime sectors.

2.3.2 The need for Support Measures for Affected Workers

Addressing the challenges of job displacement requires proactive support measures to help workers adapt to the evolving demands of a greener economy. One critical strategy is investing in **reskilling and upskilling** programs that equip affected workers with the competencies needed for employment in sustainable sectors. For example, Spain's "*Programa Empleaverde*," co-financed by the European Social Fund, offers training in green jobs such as sustainable tourism, waste management, and renewable energy. Between 2007 and 2020, it supported over 90,000 participants, including workers in the tourism and maritime sectors. Similarly, in Italy, the "*Green Jobs Programme*" by Legambiente and Fondazione Cariplo provided technical training in energy efficiency and eco-tourism across Lombardy, with measurable impacts on job placement rates. These kinds of programs enable workers from traditional industries to transition smoothly into emerging fields[38].

Government initiatives and **public-private partnerships** play a pivotal role in facilitating these transitions. **Subsidized training programs, apprenticeship opportunities, and scholarships** for green education can help build a workforce capable of supporting stricter environmental regulations. In the tourism sector, workshops on eco-tourism, digital marketing for sustainable travel, and community-led conservation efforts can empower local workers and small businesses to capitalize on the growing demand for sustainable experiences[39].

Social protection mechanisms are another essential component of support for displaced workers. Temporary unemployment benefits, job placement services, and financial aid for small businesses can help mitigate the short-term economic impacts of the transition. This is not purely speculative: the French government, through its "*Fonds de Transition Juste*," has already allocated funds to help SMEs in coastal regions adapt to environmental regulations, including emissions control. Likewise, Greece's "*Green Jobs in Islands*" initiative combines unemployment insurance with green business incubation for displaced maritime workers. For instance, grants or low-interest loans for ferry operators, tour companies, and small hotels could ease the financial burden of adopting cleaner technologies, allowing these businesses to retain employees while meeting compliance requirements.

Collaborative efforts between governments, industry associations, and labor unions are crucial to ensuring that workers' needs are addressed equitably. Stakeholder consultations can help identify the specific challenges faced by different sectors and develop tailored solutions. One example is the "*EU Eco-Tandem*" program, which connects SMEs in tourism with sustainability experts to co-design greening strategies and includes technical assistance and certification pathways. In Portugal, the "*Biosphere Responsible Tourism*" certification has also been used to guide small tourism enterprises through the sustainability transition. For instance, tourism boards could establish green certification programs that incentivize businesses to adopt sustainable practices while offering technical assistance to navigate the transition.

Finally, fostering **awareness and acceptance** among affected workers is critical for the success of support measures. Public communication campaigns that highlight the long-term benefits of the Med NOx ECA (such as improved quality

[38] See Green Job assessment reports from ILO
[39] See SwitchMed Initiative: https://switchmed.eu/policy/regional-action-plan-sustainable-consumption-production/tourism/

of life, increased competitiveness, and enhanced job opportunities) can build trust and encourage participation in reskilling initiatives. By demonstrating a clear pathway to a more sustainable and inclusive tourism model, these measures can ensure that the transition benefits all stakeholders in the Mediterranean.

2.4 INDUSTRY COMPETITIVENESS AND INNOVATION

The implementation of stricter environmental regulations such as the Med NOx Emission Control Area (ECA) can be a catalyst for innovation and technological advancement, transforming the Mediterranean tourism and maritime industries. By encouraging the adoption of clean technologies and fostering a culture of research and development (R&D), the initiative can enhance the region's competitiveness on a global scale. The dual focus on reducing environmental impact and improving operational efficiency presents significant opportunities for businesses to lead in the evolving green economy.

2.4.1 Role of Innovation and Technology

Innovation and technology are at the core of industry adaptation to the Med NOx ECA. The need to comply with stricter emissions standards is driving businesses to adopt cutting-edge solutions that enhance efficiency while reducing environmental impact[40]. The maritime industry is undergoing a technological transformation, with advancements in ship propulsion systems, energy efficiency, and emissions monitoring.

A key area of focus is the development and deployment of **Tier III engines** and **Selective Catalytic Reduction** (SCR) systems. These technologies significantly reduce NOx emissions by converting harmful gases into inert substances, thereby ensuring compliance with Med NOx ECA requirements. In addition, **alternative propulsion technologies**, such as liquefied natural gas (LNG) engines, hybrid-electric systems, and hydrogen fuel cells, are gaining traction as viable solutions for reducing both NOx emissions and greenhouse gas outputs. Innovative vessels using renewable energy are also emerging, such as the cargo sailboats developed by the French company Grain de Sail, which transport goods across the Atlantic using wind propulsion and are expanding operations in the Mediterranean. Similarly, solar-powered vessels like the "*Race for Water*" project and catamarans equipped with photovoltaic panels demonstrate the viability of clean maritime transport. For instance, cruise lines and ferry operators are investing in LNG-powered vessels, which offer a cleaner and more sustainable alternative to conventional fuel-powered ships[41].

In the **tourism sector**, **innovation** is equally crucial. Hotels and resorts are adopting **eco-smart technologies** to optimize energy use, including automated energy management systems, solar panel installations, and water recycling systems. These advancements not only reduce operational costs but also appeal to eco-conscious travelers. Similarly, sustainable infrastructure projects, such as green marinas and eco-friendly recreational facilities, integrate cutting-edge materials and designs to minimize environmental impact while enhancing visitor experiences.

Digital technology is also playing a pivotal role in enhancing industry competitiveness. Platforms that provide real-time data on air quality, sustainable travel options, and eco-friendly activities empower businesses to communicate their sustainability credentials effectively. For example, the *"GreenGo*" app (France) and "*Bookdifferent.com*" (Netherlands) enable travelers to search for and book eco-certified accommodations, while "AirVisual" and "Plume Labs" provide real-time air quality data relevant to sustainable travel choices. Mobile applications that guide tourists to green-certified hotels or showcase low-emission transport options align with growing consumer demand for environmentally responsible travel.

Collaboration between private companies, research institutions, and government bodies is essential for driving technological advancement. Pilot projects, knowledge-sharing initiatives, and industry forums provide opportunities to test and refine innovative solutions. Such collaboration ensures that the technologies adopted are both effective and scalable, benefiting the broader industry.

2.4.2 Incentives for R&D and Clean Technology

The successful implementation of clean technologies and innovative practices hinges on robust incentives for research and development (R&D). Governments and regional organizations must play a proactive role in fostering an environment that encourages innovation and investment in sustainability.

Financial incentives, such as grants, subsidies, and tax breaks, are critical tools for stimulating R&D in clean technology. For instance, maritime companies retrofitting vessels with NOx-reducing technologies could benefit from subsidies

[40] ECB. The impact of environmental regulation on clean innovation.
[41] International Maritime Organisation (IMO), *Nitrogen Oxides (NOx) – Regulation 13*, 2024.

that offset the high initial costs. Similarly, hotels adopting renewable energy systems or sustainable construction practices may qualify for tax incentives, reducing the financial burden of transitioning to greener operations[42].

Public funding for collaborative research projects is another effective strategy. Partnerships between universities, private companies, and public institutions can accelerate the development of innovative solutions tailored to the Mediterranean context. For example, while NOx control under MARPOL Annex VI applies only to engines above 130 kW, research could still explore adaptations of SCR or alternative reduction techniques for smaller vessels below this threshold. The objective here is to promote voluntary compliance among small craft frequently operating near densely populated coastal zones, thereby maximizing local air quality benefits. Joint research initiatives could focus on optimizing SCR systems or developing cost-effective methods for electrifying ports and harbors. These efforts not only address the region's unique challenges but also position Mediterranean industries as global leaders in clean technology innovation.

Regulatory frameworks that reward sustainable practices further incentivize R&D. Certification programs recognizing businesses that achieve significant emissions reductions or invest in eco-friendly infrastructure provide a competitive advantage in the marketplace. However, not all certification schemes are equally robust or transparent. Effective programs (such as the Global Sustainable Tourism Council (GSTC) criteria or the EU Ecolabel) adhere to internationally recognized sustainability benchmarks and include regular third-party audits. Promoting these high-quality schemes helps ensure that environmental claims are credible and that R&D investments translate into meaningful impact.

Public-private partnerships (PPPs) are also instrumental in mobilizing resources for large-scale projects. Governments can provide seed funding or co-financing for initiatives that demonstrate potential for significant environmental and economic impact. For example, investments in electrified public transport at port terminals (including electric buses and shuttles) may offer more sustainable alternatives than individual electric vehicles, given concerns over battery production, rare earth mining, and lifecycle emissions. Similarly, deploying electric vehicle charging networks at major ports can support multimodal clean mobility strategies.

To further encourage innovation, governments and regional organizations can establish **technology incubators and innovation hubs** dedicated to sustainable tourism and maritime practices. These centers can provide resources, mentorship, and funding for startups and small businesses working on groundbreaking solutions. By fostering a culture of entrepreneurship, these initiatives ensure a continuous pipeline of innovative ideas and technologies.

Finally, **knowledge-sharing platforms** that disseminate best practices and lessons learned from other Emission Control Areas (ECAs) can guide Mediterranean industries in adopting effective strategies. Although the long-term impacts of NECA implementation on NOx emissions are still being studied (given the relatively recent application of these zones in the Baltic and North American coasts) early results show promising trends in emission reduction and stakeholder adaptation. For example, port authorities in the Baltic Sea region have already reported significant progress in compliance and air quality monitoring systems, which can serve as interim benchmarks for the Mediterranean.

By prioritizing innovation and providing robust support for clean technology development, the Med NOx ECA could contribute to positioning the Mediterranean as a global hub for sustainable tourism and maritime practices. This dual focus on competitiveness and environmental stewardship ensures long-term resilience and prosperity for the region.

2.5 MECHANISMS TO ENCOURAGE GREEN INVESTMENT

The successful implementation of the Med NOx Emission Control Area (ECA) and the transition to a more sustainable tourism and maritime industry in the Mediterranean hinge on the availability and effectiveness of mechanisms to encourage green investment. Financial incentives and public-private partnerships (PPPs) are two pivotal approaches that can stimulate the adoption of environmentally friendly practices, reduce emissions, and foster long-term economic growth.

2.5.1 Utilizing Subsidies, Tax Incentives, and Green Financing to Support the Transition

Financial incentives are critical for motivating businesses and stakeholders to invest in green technologies and infrastructure. These incentives help offset the initial costs of transitioning to sustainable practices, making it feasible for more operators to comply with Med NOx ECA requirements and adopt innovative solutions. The survey responses clearly show strong support for financial incentives, with many participants agreeing that these measures would

[42] Clara Paola Camargo-Díaz,Edwin Paipa-Sanabria,Julian Andres Zapata-Cortes,Yamileth Aguirre-Restrepo & Edgar Eduardo Quiñones-Bolaños, *A Review of Economic Incentives to Promote Decarbonization Alternatives in Maritime and Inland Waterway Transport Modes*, 2022.

encourage tourism actors to adopt more sustainable practices, often citing the significant role they play in overcoming economic barriers.

Subsidies and grants are among the most direct forms of financial support. Governments and international organizations can provide targeted funding for businesses retrofitting ships with Tier III engines or installing Selective Catalytic Reduction (SCR) systems to reduce NOx emissions. Similarly, to align with the shipping sector's transition, subsidies for port infrastructure (such as LNG bunkering facilities or shore-side power) should be reinforced to support decarbonization in a coherent and integrated way. Similarly, subsidies for energy-efficient upgrades, such as solar panel installations or waste management systems in hotels and resorts, can lower operational costs and make green practices more attractive. Priority should also be given to supporting small and medium-sized enterprises (SMEs), particularly in southern Mediterranean countries, to ensure an equitable transition.

Tax incentives also play a significant role in promoting green investment. Tax breaks or deductions for companies investing in sustainable technologies encourage widespread adoption across sectors. For instance, ports that implement shore-side electrification systems to reduce emissions from docked vessels could benefit from reduced property or corporate taxes. This creates a win-win situation by incentivizing cleaner practices while maintaining the economic viability of these operations. Additionally, some respondents suggested targeted incentives such as tax reductions for winter-season employment in tourism, a particularly vulnerable period. While empirical studies are limited, this measure echoes recommendations from regional tourism recovery plans, including those developed in response to the COVID-19 pandemic, that stress the need to support year-round employment to ensure sustainable sectoral transformation.

Another mechanism to encourage green investment is low-interest loans or **green financing** programs. Development banks, such as the European Investment Bank (EIB), and other financial institutions can offer favorable loan terms for projects that contribute to sustainability goals. These programs could target maritime operators transitioning to LNG-powered vessels, hotels retrofitting for energy efficiency, or transport companies adopting electric vehicle fleets. In line with previous feedback, electric public transport systems (such as shuttles or port buses) should be prioritized over private vehicles due to their greater potential for emissions reduction and reduced resource consumption[43].

In addition to direct financial incentives, the creation of **green certification schemes** can indirectly encourage investment by enhancing market competitiveness. Certifications recognizing environmentally friendly practices, such as sustainable tourism or low-emission shipping, allow businesses to market themselves as eco-conscious and attract premium customers. However, the effectiveness of these schemes depends on their robustness, transparency, and third-party verification. International standards such as GSTC or the EU Ecolabel should be prioritized to avoid greenwashing and ensure credible incentives.

Despite the strong support for financial incentives, several barriers remain, such as high costs, lack of awareness, and insufficient information. These barriers can make it difficult for businesses to prioritize sustainability, especially in the short term. Many survey participants indicated that convincing tourism actors to invest in sustainable practices often requires overcoming initial financial concerns, as the return on investment may only be seen in the long term. Additionally, beyond policymakers, actors such as civil society organizations, environmental NGOs, and popular influencers (previously mentioned) can serve as powerful levers to shift public and industry perception toward sustainability, particularly through storytelling and community-led campaigns.

To address these barriers, a comprehensive framework should combine financial incentives with targeted education and awareness campaigns. These efforts must emphasize the long-term benefits of sustainability, not only for the environment but also for businesses and local communities. Such an approach would help bridge the gap between economic constraints and the need for greener practices, ensuring the successful adoption of sustainability measures across the tourism sector.

2.5.2 Public-Private Partnerships for Green Projects

Public-private partnerships (PPPs) are essential for scaling up investments in green initiatives across the Mediterranean. These collaborations leverage the strengths of both sectors, public institutions provide regulatory support and funding, while private entities contribute technical expertise and innovation[44].

One of the most impactful applications of PPPs is in the development of **green infrastructure**. For instance, partnerships between governments and port authorities can drive the installation of shore-side power systems,

[43] European Investment Bank, *Green Shipping Programme Loan*, 2025.
[44] UNECE, Green and sustainable PPP procurement for the SDGs

enabling docked ships to use cleaner electricity instead of polluting diesel generators. Similarly, PPPs can support the creation of LNG bunkering facilities, ensuring that maritime operators have access to cleaner fuel options while reducing the cost burden on individual companies[45].

PPPs are also instrumental in developing **sustainable tourism initiatives**. Governments can collaborate with private tour operators, hotels, and local communities to create eco-parks, marine reserves, and cultural heritage trails. These projects not only promote environmental conservation but also stimulate local economies by generating employment and attracting high-value tourists. For example, PPPs could fund the development of interpretive centers at protected sites, blending educational programming with conservation efforts.

In addition to physical infrastructure, PPPs can drive innovation by funding **research and development** (R&D) projects. Governments can partner with universities, technology firms, and maritime companies to explore new emission reduction technologies, such as hydrogen fuel cells or advanced battery systems. These collaborations ensure that cutting-edge solutions are tested, refined, and implemented at scale, benefiting the broader industry while aligning with Med NOx ECA goals.

PPPs also play a key role in **capacity building**. Joint training programs for workers transitioning to green jobs—such as technicians for SCR systems or tour guides specializing in eco-tourism—can equip local populations with the skills needed to thrive in a sustainable economy. By pooling public resources and private expertise, these initiatives foster long-term resilience and economic growth[46].

Finally, PPPs can enhance **stakeholder engagement** and foster trust in green initiatives. By involving private companies, local communities, and civil society in the planning and execution of projects, governments can ensure that investments align with the needs of all stakeholders. This participatory approach enhances the legitimacy and acceptance of sustainability measures, paving the way for broader adoption.

By leveraging financial incentives and public-private partnerships, the Mediterranean region can accelerate **green investment,** meet the objectives of the Med NOx ECA, and establish itself as a global leader in sustainable tourism and maritime practices. These mechanisms provide a roadmap for aligning economic growth with environmental preservation, ensuring long-term prosperity for the region.

However, insights from stakeholders suggest that the current landscape of public-private partnerships (PPPs) in the Mediterranean is uneven and, in many cases, insufficient. In addition to Libya, respondents also flagged **limited PPP engagement** in Algeria, parts of Tunisia, and the Palestinian Territories, where tourism governance is still under development. While a few participants pointed to successful collaborations focused on green suppliers and capacity-building, others noted major disparities in institutional support. To address this imbalance, lessons from structured initiatives (such as the Interreg MED Sustainable Tourism Community or the WestMED Initiative) can provide replicable models for regionally tailored PPP development, including governance templates, financing models, and impact metrics. By leveraging financial incentives and public-private partnerships, the Mediterranean region can accelerate green investment, meet the objectives of the Med NOx ECA, and establish itself as a global leader in sustainable tourism and maritime practices. These mechanisms provide a roadmap for aligning economic growth with environmental preservation, ensuring long-term prosperity for the region.

2.6 POLICY AND REGULATORY FRAMEWORKS

The Med NOx Emission Control Area (ECA) introduces an intricate policy and regulatory landscape aimed at reducing nitrogen oxide emissions and promoting sustainability across the Mediterranean region. Achieving the initiative's environmental and economic goals requires robust regulatory compliance mechanisms and strategic recommendations for policymakers. These frameworks ensure that stakeholders align their operations with emission standards while addressing challenges related to enforcement and stakeholder engagement.

2.6.1 Regulatory Compliance and Environmental Policies

The potential Med NOx ECA mandates strict compliance with International Maritime Organization (IMO) MARPOL Annex VI regulations, requiring ships operating in the region to adopt advanced technologies and cleaner fuels to minimize NOx emissions. These standards align the Mediterranean with global efforts to combat air pollution, as seen in other established Emission Control Areas, such as the Baltic Sea and North America. By enforcing these regulations, policymakers aim to achieve significant improvements in air quality, public health, and marine ecosystem resilience[47].

[45] Future Bridge NetZero Events, *Port Infrastructure Upgrades to Support Alternative Fuels*, 2024.
[46] Georgetown Climate Center, *Equitable Adaptation Legal & Policy Toolkit*, 2024.
[47] UNEPMAP, *Tackling air pollution from ships: three facts about the freshly adopted Med SOx ECA*, 2022.

To comply with these regulations, maritime operators must **retrofit existing vessels** with Tier III engines or install technologies like Selective Catalytic Reduction (SCR) systems. New ships are required to meet Tier III emission standards, ensuring long-term alignment with environmental objectives. Compliance also entails the use of cleaner fuels, such as liquefied natural gas (LNG) or ultra-low-sulfur fuel oil, which significantly reduce NOx and other pollutants.

Monitoring and enforcement mechanisms are critical to ensuring compliance. Governments and port authorities play a central role in conducting inspections, monitoring emissions, and imposing penalties for non-compliance. Technologies like remote sensing and real-time emissions monitoring systems are increasingly employed to detect violations and maintain regulatory oversight. Additionally, harmonized reporting standards across Mediterranean countries facilitate transparency and data sharing, enabling coordinated enforcement efforts. However, significant obstacles to effective emissions control remain. Lessons from the United States segment of the North American Emission Control Area (ECA) highlight persistent challenges, including inconsistent enforcement capacity, limited technical expertise in some ports, and difficulties in verifying compliance for vessels using alternative compliance methods (IMO 2023). These experiences underscore the need for the Mediterranean region to invest not only in monitoring technologies, but also in institutional capacity-building, training, and interagency cooperation to ensure robust enforcement[48].

Environmental policies supporting the Med NOx ECA extend beyond maritime operations to encompass the broader tourism and transport sectors. For instance, policies incentivizing green infrastructure—such as electric bus networks, bike-sharing systems, and pedestrian-friendly urban designs—complement maritime emission reductions by reducing overall carbon footprints in tourist destinations. Moreover, destination management plans integrating ecotourism principles ensure that local economies align with the region's environmental goals.

2.6.2 Main challenges and barriers for Med NOx ECA

A key challenge for an effective Med NOx ECA is the **lack of comprehensive and transparent data on emissions** linked to port activities, particularly those associated with tourism. While global datasets on emissions from shipping and industrial activities do exist, tourism-related emissions in ports are often not disaggregated or systematically reported, limiting their utility for targeted policy-making. According to the interviews conducted, while some ports and cruise operators are making significant progress, there is still a critical gap in monitoring systems, making it difficult to fully assess compliance with emission regulations. This observation is supported by the IMO's 2023 report on the North American ECA, which highlights persistent shortcomings in compliance monitoring and enforcement mechanisms, even in advanced regulatory environments. Strengthening data collection and transparency is therefore essential to ensuring that emission reduction measures, including those linked to a potential Mediterranean NOx Emission Control Area (ECA), are effectively implemented and enforced.

Furthermore, the interviews highlighted that **technological advancements** in alternative fuels and energy-efficient port infrastructure must be supported by adequate **availability and affordability** of these solutions. Without sufficient access to cleaner fuels and electrification infrastructure, the transition towards low-emission ports could lead to increased costs for the cruise and tourism industry, potentially affecting the overall economic viability of these sectors. This underscores the need for coordinated policies that balance environmental objectives with economic sustainability.

Finally, beyond the technical and economic dimensions, the interviewee emphasized the importance of raising **awareness** among both policymakers and travellers. The future of cruise tourism in the Mediterranean is increasingly linked to **consumer expectations** regarding sustainability, but also to regulatory developments at the European level. However, a long-term perspective is crucial: significant reductions in NOx emissions often depend on the progressive renewal of fleets with Tier III-compliant vessels, which can take a decade or more. As of 2024, only a limited proportion of ships operating in the Mediterranean are equipped with Tier III engines, meaning that the full impact of an NOx ECA would likely unfold over several years.

Moreover, while regulatory action is advancing at the European level; such as through the **Fit for 55** and **European Green Deal** package, international cooperation through the IMO and regional frameworks (e.g., the Barcelona Convention) is equally important to ensure alignment and effectiveness.

[48] IMO, *Index of MEPC Resolutions and Guidelines related to MARPOL Annex VI*, 2024

2.6.3 Recommendations for Policymakers

To ensure the successful implementation of the Med NOx ECA, policymakers could adopt a multifaceted approach that balances environmental, economic, and social objectives. Insights gathered from the survey conducted for this paper emphasize the importance of strengthening regional collaboration, as the transboundary nature of maritime emissions requires harmonized regulatory frameworks and shared enforcement mechanisms across Mediterranean countries. Coordinated efforts facilitated by regional bodies such as UNEP/MAP and its Regional Activity Centres (RACs) can help streamline compliance processes, ensuring consistent application of emission standards across the region.

2.6.3.1 Providing Financial incentives

Providing **financial support** for stakeholders is another essential component. The costs associated with transitioning to cleaner technologies can be prohibitive, particularly for smaller operators and businesses. Many survey respondents highlighted the need for financial aid programs such as subsidies, grants, and low-interest loans to alleviate the financial burden on these stakeholders and accelerate the adoption of necessary technologies.

2.6.3.2 Investing in Research and development

Encouraging **research and development** (R&D) was also identified as a key strategy for achieving cost-effective compliance and innovation. Respondents recommended implementing incentives for R&D initiatives focused on alternative fuels, emission-reducing technologies, and green infrastructure. Collaborative partnerships with research institutions and private companies should be prioritized to ensure that these technologies are tested, refined, and implemented efficiently across the region.

2.6.3.3 Supporting Capacity building

In addition, **capacity building** emerged as a critical aspect of the transition. Many survey participants stressed the importance of investing in training programs to equip workers with the skills needed for emerging green industries. This is particularly crucial for small businesses and local communities, where knowledge gaps may hinder the adoption of sustainable practices.

2.6.3.4 Building Public awareness

Public awareness campaigns are also vital to garner support for the Med NOx ECA. Survey responses emphasized the importance of highlighting the benefits of emission reductions, such as improved air quality and healthier ecosystems, while educating the public about the available support mechanisms and compliance requirements. Equity in policy implementation must remain a central consideration. The survey revealed that ensuring the economic benefits of the Med NOx ECA are distributed fairly is key, with special attention given to vulnerable groups such as small businesses and underserved communities. This can be achieved by prioritizing funding for regions in need of additional support and involving diverse stakeholders in decision-making processes.

2.6.3.5 Integrating climate and tourism policies

Integrating **climate and tourism policies** was another critical recommendation from survey participants. Policymakers must align emission reduction objectives with broader tourism strategies to enhance the region's reputation as a sustainable destination. Initiatives promoting eco-tourism, cultural preservation, and sustainable transportation can complement the Med NOx ECA, creating synergies between economic development and environmental protection.

2.6.3.6 Improving Monitoring systems

Lastly, robust **monitoring systems** must be put in place to track the progress of the Med NOx ECA. Transparent data collection and reporting, as suggested by the survey, will allow policymakers to evaluate the initiative's impact and refine strategies as needed, ensuring that it delivers its intended environmental and economic benefits over the long term.

2.7 CONCLUSION: LONG-TERM GAINS, BUT ECONOMIC AND INFRASTRUCTURE CHALLENGES

The **Med NOx Emission Control Area (ECA)** initiative presents an opportunity for the Mediterranean to redefine its tourism sector with more focus on sustainability. By reducing NOx emissions, this measure aims to improve air quality, protect ecosystems, and enhance the region's appeal as a more eco-friendly destination. However, while the long-term environmental and economic benefits are undeniable, it is crucial to acknowledge and address the **challenges** that come with this transition.

One of the primary concerns is the **cost of compliance** for stakeholders in the maritime and tourism industries. The adoption of clean technologies, such as **Selective Catalytic Reduction (SCR) systems** or **shore-side electrification**, requires significant upfront investments. Many businesses, particularly **small and medium-sized enterprises (SMEs) and ferry operators**, are worried about the economic feasibility of these measures. There is also concern that rising operational costs could lead to **higher prices for tourism services**, potentially deterring certain visitor segments.

Additionally, the shift towards **sustainable tourism** demands substantial adaptation in infrastructure and business strategies. Investments in **eco-friendly accommodations, clean transportation, and low-carbon tourism activities** are crucial for maintaining the Mediterranean's attractiveness, yet their implementation will vary across different regions. **Economic disparities** between Mediterranean countries may lead to uneven adoption, creating competitive imbalances. To mitigate this, **targeted financial support mechanisms**, including **government incentives and public-private partnerships**, will be essential.

Finally, for this transformation to be successful, a **coordinated approach** among **policymakers, industry leaders, and local communities** is necessary. Implementing **strong but flexible regulatory frameworks**, providing **financial assistance**, and raising **awareness** about the benefits of sustainable tourism will be crucial to ensuring a smooth transition. By addressing these concerns and developing strategies to mitigate the associated costs, the Mediterranean can fully leverage the Med NOx ECA—not only as an environmental initiative but also as a catalyst for a more balanced and prosperous tourism sector.

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2.9 APPENDIX: INTERVIEWS AND SURVEY

2.9.1 Interview Questions

Main Questions

1. Could you briefly describe your role in the Mediterranean tourism industry and your involvement in environmental initiatives?
2. How would you describe the reputation of the Mediterranean as an eco-friendly destination? How does this affect tourism trends?
3. What impact do you foresee from initiatives like the Med NOx ECA on the local tourism and economy? Do you think it will increase or decrease tourism attractiveness?
4. What challenges and opportunities do you see in developing eco-friendly infrastructure in Mediterranean destinations? What impact might this have on job creation or business displacement?
5. What type of support or incentives would encourage your business to adopt more sustainable practices?

Secondary Questions

6. Have you noticed a shift in tourist preferences towards more eco-friendly options?
7. What sustainable investments are most needed in the region (e.g., renewable energy, eco-friendly facilities)?
8. What barriers do you face in implementing eco-friendly tourism (costs, regulations, etc.)?
9. Do you anticipate any changes in your business operations due to evolving environmental regulations?
10. What recommendations would you give to policymakers to foster sustainable tourism development?

2.9.2 Survey Questions

Demographic and Professional Information

1. What is your full name?
2. Which institution or organization do you belong to?
3. What is your current position or role within this institution?
4. What is your professional email address?
5. Which country do you currently work in?

Tourism and Environmental Perspectives

6. What is your role in the tourism sector?
    - Tourism business owner/manager
    - Cruise/port operator
    - Destination Management Organization (DMO)
    - Online/traditional travel agency (OTA/TA)
    - Local community / NGO
    - Academia / Researcher
    - Other (please specify)
7. How familiar are you with environmental policies in the tourism sector?
    - Very familiar

- Somewhat familiar
- Not very familiar
- Not familiar at all

8. How familiar are you with the Med NOx ECA regulation?
    - Very familiar
    - Somewhat familiar
    - Not very familiar
    - Not familiar at all
9. How important do you consider reducing air pollution (NOx emissions) from ships in the Mediterranean?
    - Important
    - Neutral
    - Not important
    - I don't know / No answer
10. Do you believe tourists are willing to pay a premium for eco-friendly destinations?
    - Yes, most are willing to pay more
    - Some are willing, but not all
    - No, they prefer lower-cost options
    - Not sure
11. Do you think the Mediterranean has a strong reputation as an eco-friendly tourism destination?
    - Yes, very strong
    - Somewhat strong
    - Weak
    - Not at all
12. Have you observed a change in tourist preferences toward eco-friendly services, transport, or accommodations?
    - Yes, significant change
    - Yes, slight change
    - No noticeable change
    - No, preferences remain the same
13. What impacts on costs can environmental regulations such as the Med NOx ECA have?
    - Significant increase
    - Slight increase
    - No change
    - Slight decrease
    - Significant decrease
14. Do you expect a need for new infrastructures to adapt to the Med NOx ECA regulation?
    - Strongly agree
    - Agree
    - Neutral
    - Disagree
    - Strongly disagree
15. Would financial incentives (e.g., tax breaks, subsidies) encourage tourism actors to adopt more sustainable practices?
    - Yes, definitely
    - Yes, but only slightly
    - No, they wouldn't have a significant impact
    - Not sure
16. Are you concerned about potential job or tourist displacement due to environmental regulations?

- Yes, very concerned
- Somewhat concerned
- Not concerned
- Not sure

Open-Ended Questions

17. What specific support or other incentives would be most effective in supporting sustainable tourism?

18. How would you describe the primary barriers to adopting sustainable practices in tourism?

19. Have you observed any benefits (job creation, quality improvement, etc.) due to eco-friendly initiatives?

20. Are there sufficient public-private partnerships supporting green tourism projects?

21. How would you rate the effectiveness of current environmental regulations on tourism?

22. What recommendations do you have for balancing tourism sustainability with economic growth and social inclusiveness?

Consent and Report Sharing

23. Would you like to receive a copy of the final report based on this survey? - If yes, please provide your email address.

Data Privacy Notice: *By participating in this survey, respondents consent to the processing of their personal data in compliance with the European Regulation on Data Privacy (GDPR). Personal data will only be used by ECO-UNION Association for research purposes and will not be shared with third parties.*