Examining the possibility of designating the Mediterranean Sea, as a whole, as NOx ECA, pursuant to MARPOL Annex VI

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RICARDO
Member of WSP

UN environment programme | Mediterranean Action Plan Barcelona Convention | REMPEC | IMO INTERNATIONAL MARITIME ORGANIZATION

Technical and feasibility study

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Agenda

Introduction

Section 1: Introduction and review of the current policy landscape

Section 2: Shipping NO_x emission methodology and results

Section 3: Impact assessment and cost-effectiveness results

Section 4: Recommendations and roadmap

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Introduction and review of the current policy landscape

- Criteria for the designation of an ECA
- Review of NO_x emission control policies and technologies
- Possible designation of the Med NO_x ECA

Introduction to the study

Context and background

Regulation 13 of the MARPOL Annex VI intends to control emissions of nitrogen oxides (NOx) from applicable marine diesel.

- The NOx Regulation applies to marine diesel engines with a power output of more than 130 kW installed on a ship, including those that are converted (not directly replaced) from 2000 onwards.

According to MARPOL Annex VI, **Emission Control Areas** (ECAs) are defined as:

- Sea and port areas where special mandatory measures are required to control emissions from ships to prevent, reduce, and control air pollution from nitrogen oxides (NOx), sulphur oxides (SOx), and particulate matter (PM), or all three.

- For NOx ECAs, emissions by vessels sailing on marine diesel engines above 130 kW and constructed on or after the date of adoption of the NOx ECA need to be below Tier III limits.

Introduction to the study

Overall objective of the technical and feasibility study

The objective of this Study is to enable REMPEC to assist the Mediterranean coastal States to prepare a submission to IMO proposing the designation of the Med NOx Emission Control Area (Med NOx ECA). The study aims to provide evidence needed to address criteria set out in Appendix III of MARPOL Annex VI, relating to the designation of Emission Control Areas (ECAs).

The final outputs of the technical and feasibility study will include the following:

- Final technical and feasibility study report
- A comprehensive set of recommendations
- A strategic roadmap detailing the path towards Med NOx ECA designations, including information on milestones, timeline and stakeholder engagement necessary for its successful implementation

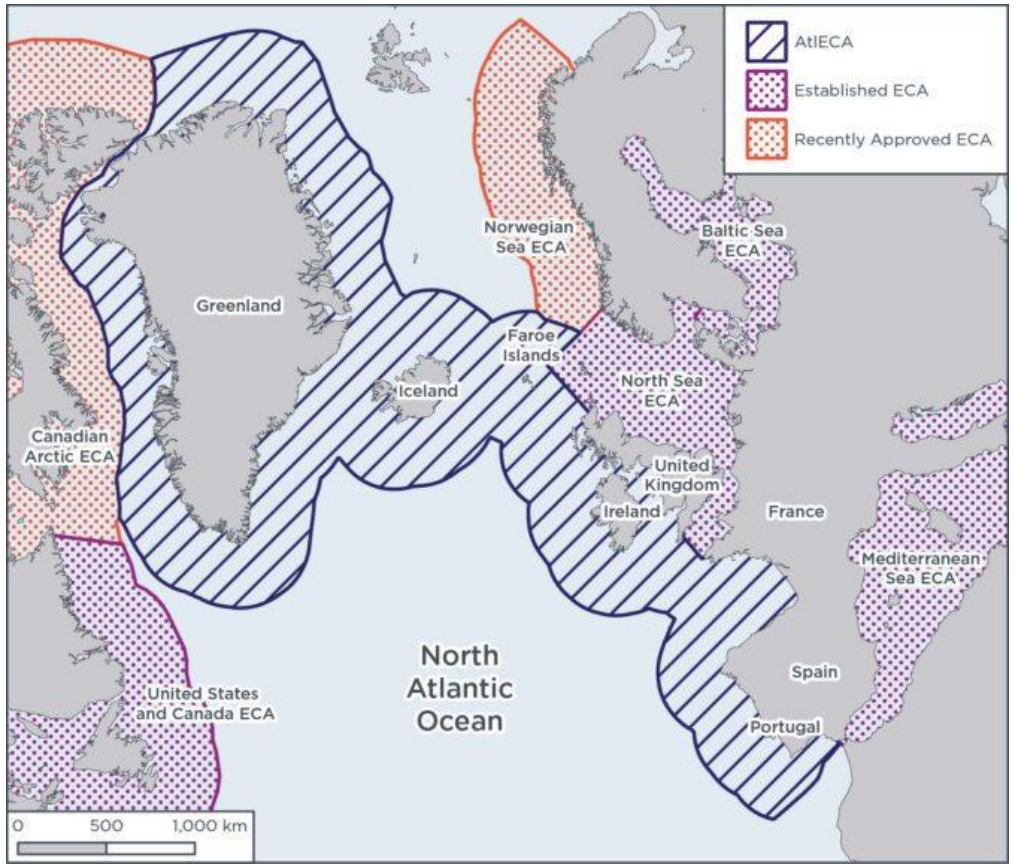
Criteria for designation of an ECA

- Under MARPOL Annex VI, the adoption of an ECA may be considered by the Organisation if there is a demonstrated need to prevent or reduce air pollution from ships.
- The criteria for the designation of an ECA are outlined in Section 3 of Appendix III to MARPOL Annex VI.

Ref.	Criteria
3.1.1	a clear delineation of the **proposed area of application**, along with a reference chart on which the area is marked
3.1.2	the type or **types of emission(s)** that is or are being proposed for control
3.1.3	a description of the **human populations and environmental areas at risk** from the impacts of ship emissions
3.1.4	an **assessment that emissions from ships operating in the proposed area of application** are contributing to ambient concentrations of air pollution or to adverse environmental impacts, including a description of the impacts of the relevant emissions on human health and the environment, such as adverse impacts on terrestrial and aquatic ecosystems, areas of natural productivity, critical habitats, water quality, human health, and areas of cultural and scientific significance, if applicable.
3.1.5	**relevant information**, pertaining to the meteorological conditions in the proposed area of application, to the human populations and environmental areas at risk, in particular prevailing wind patterns, or to topographical, geological, oceanographic, morphological or other conditions that contribute to ambient concentrations of air pollution or adverse environmental impacts
3.1.6	the **nature of the ship traffic** in the proposed emission control area, including the patterns and density of such traffic;
3.1.7	a **description of the control measures** taken by the proposing Party or Parties addressing land-based sources of NO_x, SO_x and particulate matter emissions affecting the human populations and environmental areas at risk that are in place and operating concurrently with the consideration of measures to be adopted in relation to provisions of regulations 13 and 14 of Annex VI;
3.1.8	the **relative costs of reducing emissions from ships** when compared with land-based controls, and the economic impacts on shipping engaged in international trade.

Review of current policy landscape

Summary of existing ECAs



Name of ECA	Proposal date	Pollutants	Entry into force date
North American	2009	SO_x, PM	1st August 2011
		NO_x	1 January 2016
United States Caribbean Sea	2010	SO_x, PM	1st January 2014
		NO_x	1st January 2016
Baltic Sea	1997	SO_x, PM	19 May 2006
	2016	NO_x	1st January 2021
North Sea	2005	SO_x, PM	22 November 2006
	2016	NO_x	1st January 2021
Mediterranean	2022	SO_x, PM	1st May 2025
Canadian Arctic Waters	2023	SO_x, PM	1st March 2026
		NO_x	1 January 2025
Norwegian Sea	2023	NO_x, SO_x, PM	1st March 2026[1]
North East Atlantic	2025	NO_x, SO_x, PM	TBC *

**Adoption of the North East Atlantic ECA was originally scheduled for 2027, but postponement of adoption of MARPOL amendments at the IMO meeting in 2025 means the earliest entry into force date is 2028 and is yet to be confirmed.*

Review of current policy landscape

Review of NOx emission control policies and technologies

MARPOL Annex VI Regulation 13 states that applicable engines are required to meet:

- Tier 1 if installed between 2000 and 2011 and prior to 2000
- Tier 2 if installed after 2011
- Tier 3 if installed after the introduction of a NOx ECA and operating in the NOx ECA

Three-dates criteria for NO_x ECA introduction

A delay in the keel-laying dates and ship delivery dates prior to the introduction date of existing NOx ECAs has been identified, resulting in lower NOx emission reductions than expected due to the delayed implementation of the Tier III regime

To resolve the issue of the high keel rate before NO_x ECA introduction dates, the Norwegian Sea Proposal proposed the application of the '**Three Dates Criteria**', as introduced by the IMO *Guidance on drafting of amendments to the 1974 SOLAS Convention and related mandatory instruments*

The Three Dates Criteria states that the application of regulation to a ship is governed by the dates:

1. For which the building contract is placed on or after dd/mm/yyyy; or
2. In the absence of a building contract, the keel of which is laid, or which is at a similar stage of construction on or after dd/mm/yyyy; or
3. The delivery of which is on or after dd/mm/yyyy.

Review of current policy landscape

Review of NOx emission control policies and technologies

MARPOL Annex VI Regulation 13 states that applicable engines are required to meet:

- Tier 1 if installed between 2000 and 2011 and prior to 2000
- Tier 2 if installed after 2011
- Tier 3 if installed after the introduction of a NOx ECA and operating in the NOx ECA

Development of NOx emissions control technology: SCR and ECR

- SCR and EGR are key technologies for meeting ECA Tier III NOx standards.
  - SCR operate better at high exhaust temperatures; performance drops below 25% engine load.
  - EGR suits large 2-stroke engines where exhaust temps are too low for SCR.
- Low-load operations (ports, coastal zones) risk non-compliance despite certification.
- Future Tier III compliance depends on advances in SCR/EGR, as well as on a greater adoption of alternative fuels (e.g. LNG), and engine optimisation.

Possible designation of the Med NOx ECA

Area of application

The area of application of the potential Med NOx ECA would align with the existing Med SOx ECA, following the International Hydrographic Organization (IHO) definition of the Mediterranean Sea.

Emissions proposed for control

- NOx emissions from ships in the Mediterranean Sea
- This would be introduced alongside the existing Med SOx ECA already in place to control SOx and PM emissions from ships in the Mediterranean Sea

Possible entry into force dates

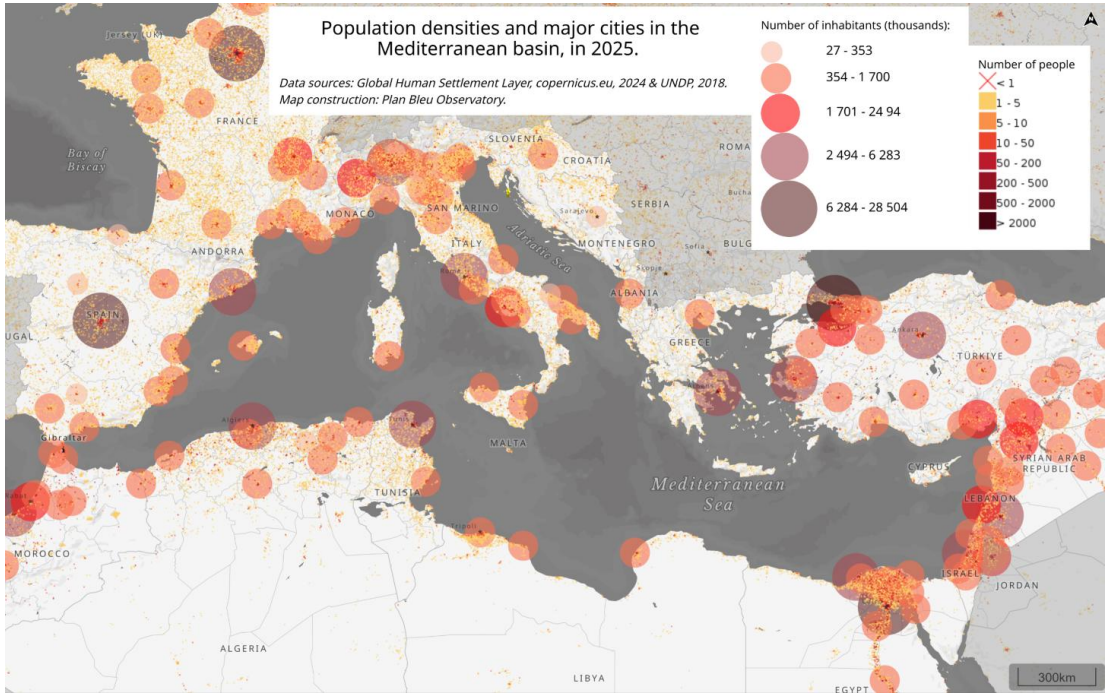
The proposed Med NOx ECA uses the 'three dates criteria' approach.

'Entry into force date' →

'Introduction date' for modelling purposes →

	Option 1	Option 2	Option 3
Build contract date	2029	2032	2035
Keel laying date	Late 2029 – early 2030	Late 2032 – early 2033	Late 2035 – early 2036
Delivery date of the ship	2032	2035	2038

Possible designation of the Med Nox ECA



Population and environment at risk from exposure to ship emissions

Population: In 2018, Mediterranean coastal States hosted ~512 million people (6.7% of global population); about one-third live in coastal areas. By 2025, this is expected to reach ~529 million.

Environmental sensitivity: dense population centres and numerous high-value cultural and ecological sites, including UNESCO World Heritage areas, archaeological landmarks, and fragile marine ecosystems.

Local conditions influencing air pollution

- Prevailing **onshore winds** in the Mediterranean carry NOx and secondary pollutants from ships inland, spreading impacts far from their source.
- Around **70% of shipping emissions occur within 400 km of the coast**, exposing coastal populations and ecosystems to elevated pollution levels.
- **Pollutants can persist 5-10 days**, transported across land and sea; wet and dry deposition processes contribute to acidification and eutrophication in sensitive coastal and marine areas.

Introduction and review of the current policy landscape

Review of feedback received and questions

- Entry into force dates

Any other comments or questions?

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Shipping NO_x emission methodology and results

- Methodology for the calculation of baseline NO_x emissions
- Key assumptions used during the modelling
- Results for current shipping emissions

Shipping NOx emissions methodology and results

Method of calculating baseline NOx emissions

- In-house model provided by Marine Benchmark to estimate number of vessels, energy use and NOx emissions data in scope (2021-2024)
- This model combines AIS data with ship register data. The ships data is primarily provided by S&P Global, the formal UN supported IMO ship register operating the IMO number scheme.

Element	Description
Source of NO_x emissions	Those arising from the combustion of marine diesel engines (both main engines and auxiliary engines). Emissions from slippage are excluded from the analysis
Period	• Base year: 2023. Emissions for years 2021, 2022 and 2024 are also presented. • Year 2024 not considered for the base year due to the Red Sea crisis.
Geographical scope	Area of application of the possible NO_x ECA
Vessels in scope	• Vessels operating in the Mediterranean Sea in a given year and within the scope of NO_x Regulations. • Vessels include those across all gross tonnage (GT) categories and vessel types, with engine power exceeding 130 kW. • Vessels with an operational time of over 95% within the exclusive economic zone (EEZ) of the own flag are assumed to operate only within their own flag State waters. This 95% threshold was applied to avoid disturbances.

Key assumptions used during the modelling

Emission factors for conventional engines/fuels

Two sets of NOx emission factors per energy consumed:

- **Regulatory values**: emission factors based on maximum permissible values in NOx Regulation for Tier I-III engines, classified by engine group (including Tier 0, 1, 2, 3 and RPM settings: low, medium, and high)
- **Real-world values**: real world emission factors based on sniffer measurements defined in terms of a NOx curve per engine load and engine group

RPM	Tier I (gNO_x/kWh)	Tier II (gNO_x/kWh)	Tier III (gNO_x/kWh)	Tier III reduction (%Tier II)
100	17.00	14.40	3.40	76%
300	14.38	11.85	2.88	76%
600	12.52	10.10	2.50	75%
1000	11.30	8.98	2.26	75%

Adjustment for alternative fuels

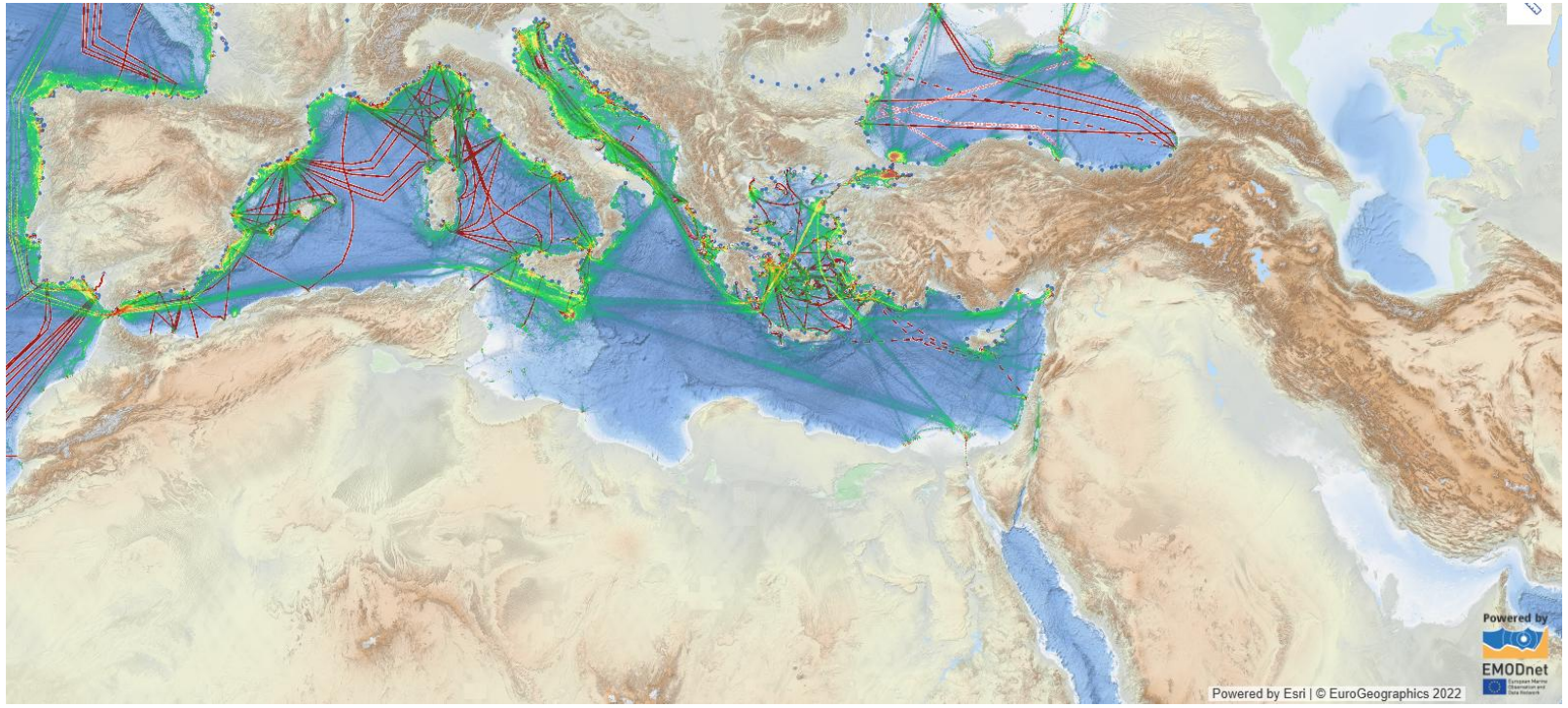
- Alternative marine fuels typically have lower NOx emission factors (vs. conventional fuels)
- A fleet-average scale factor using the fuel-specific scale factors was applied to adjust for the use of alternative fuels
- Range of emission reduction values for LNG and assumption that all new vessels will be Tier III compliant

Fuel type	Range of NO_x emissions	Value used as scale factor
HFO + scrubber, VLSFO/MGO/HVO (Baseline fuels)	100%	100%
Methanol	30% to 40%	35%
LNG	**5% to 80%**	**15%**
Hydrogen	50%	50%
Ammonia	40%	40%
Electricity	0%	0%

Results for current NOx shipping emissions

Ship traffic in the Mediterranean Sea

Map of maritime traffic – the green lines indicate vessel traffic density (2021) and the red lines illustrate regular ferry routes

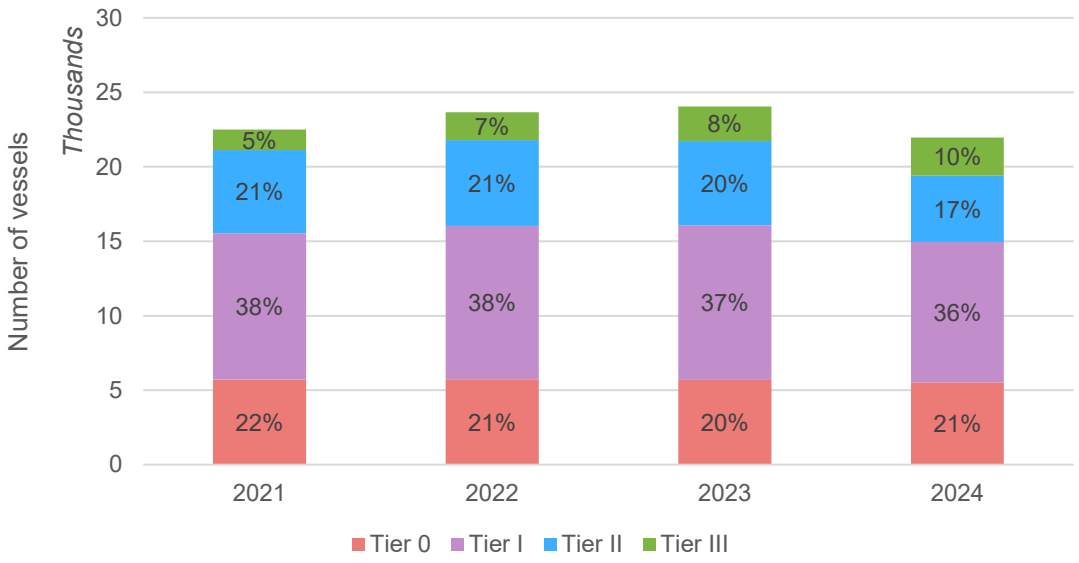


- A third of world trade is shipped through the Mediterranean through the Suez Canal to the Strait of Gibraltar
- The most significant traffic flows are the Asia-Europe trade route (from Suez Canal to Gibraltar)
- The Mediterranean is busy with routes for intra-mediterranean traffic flows which represented 58% of total Mediterranean traffic in 2016
- Second biggest cruising region in the world after the Caribbean

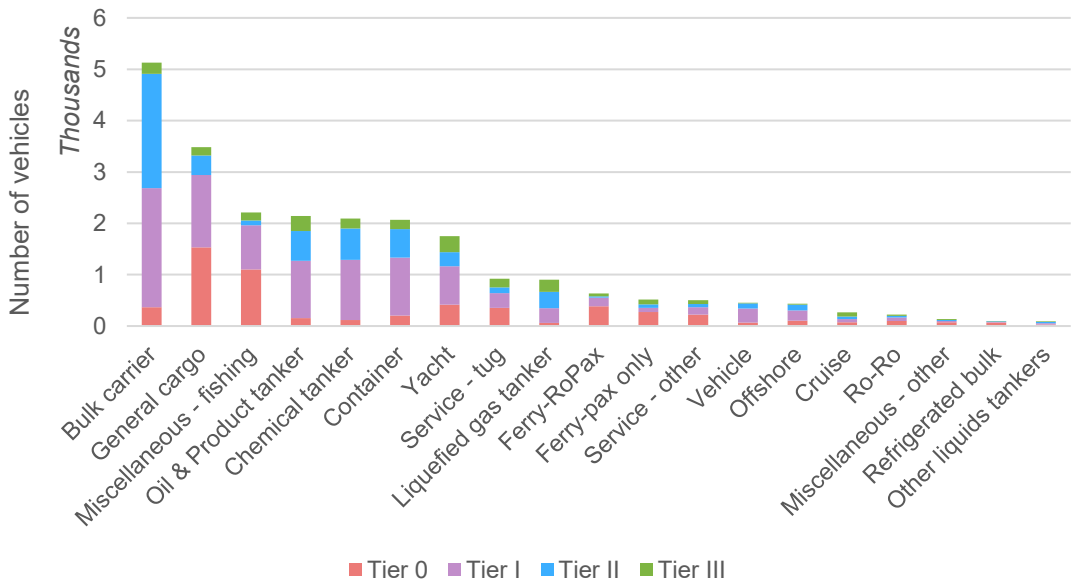
Results for current NOx shipping emissions

Fleet operating in the Mediterranean Sea

Number of vessels per Tier and year



Number of vessels in 2023 by Tier and type

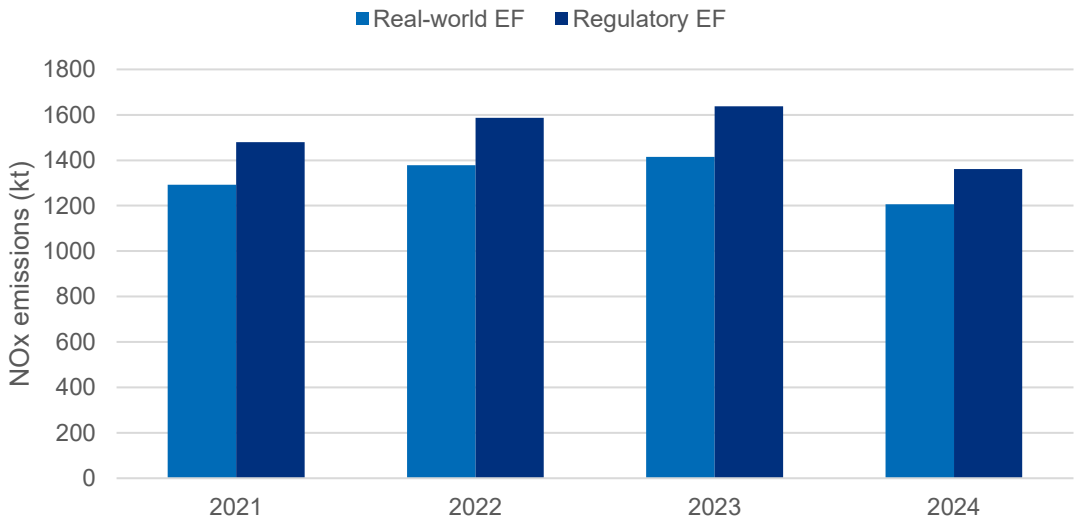


Number of vessels in 2024 is slightly lower compared to 2023, primarily due to the Red Sea crisis. As a result, 2023 is used as the reference year for this analysis.

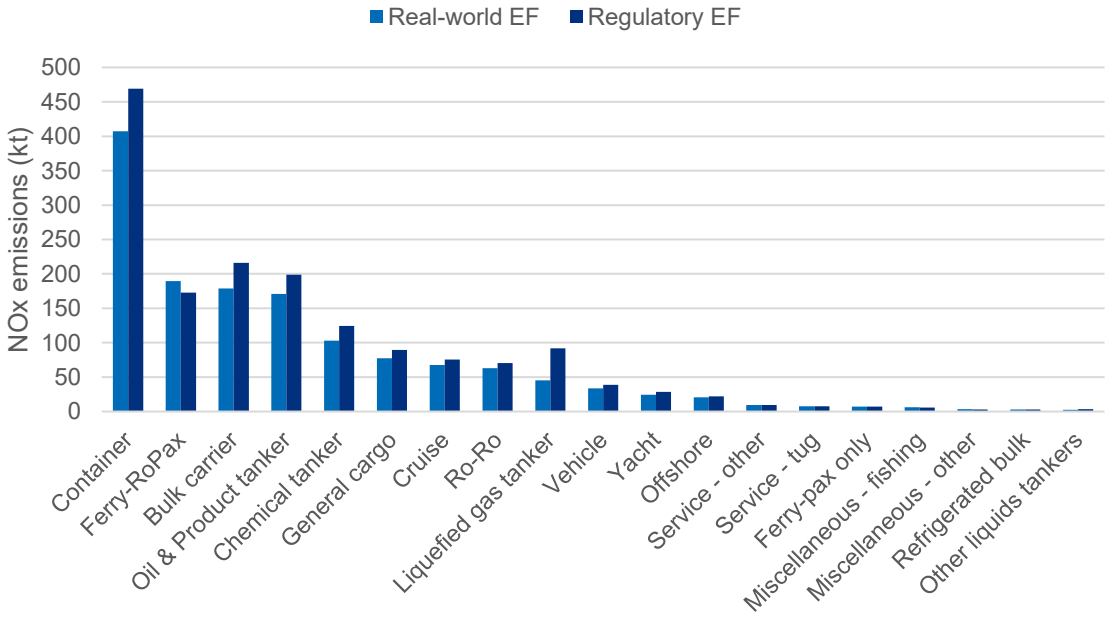
Shipping Nox emissions methodology and results

Estimation of current NO_x emissions from shipping

NO_x emissions from shipping within the scope of a potential NO_x ECA in the Mediterranean Sea over the period 2021-2024, based on real-world and regulatory emission factors



NO_x emissions from shipping within the scope of a potential NO_x ECA in the Mediterranean Sea over the period 2021-2024 by vessel category, based on real-world and regulatory emission factors



Shipping NO_x emission methodology and results

Review of feedback received and questions

- Scope of application – Tier III vessels

Any other comments or questions?

3

Impact assessment and cost-effectiveness results

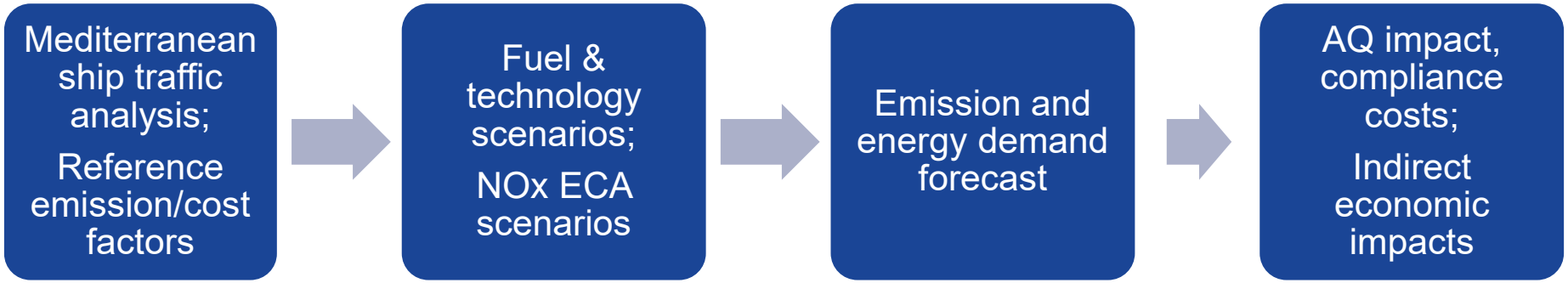
- Methodology for the impact assessment
- Review of the results

Methodology for the impact assessment

Process for assessing the impact of introducing a Mediterranean NOx ECA

1. **Mediterranean shipping emissions and energy demand** using AIS-based traffic data and reference energy demand and emission factors for baseline (without NOx ECA) and NOx ECA (with NOx ECA introduction) scenarios.
2. **Economic (compliance) and AQ impacts** for different NOx ECA introduction dates (2032, 2035, 2038) calculated using unit costs for ship compliance and emission external costs.
3. **Indirect impacts** on the maritime sector, economies and citizens within the Mediterranean Sea area are assessed through a mixture of quantitative (using E3-Modelling's GEM-E3 model) and qualitative assessments.

E3-Modelling's GEM-E3 model is a multi-regional, multi-sectoral, recursive dynamic computable general equilibrium (CGE) model which provides details on the macro-economy and its interaction with the environment and the energy system



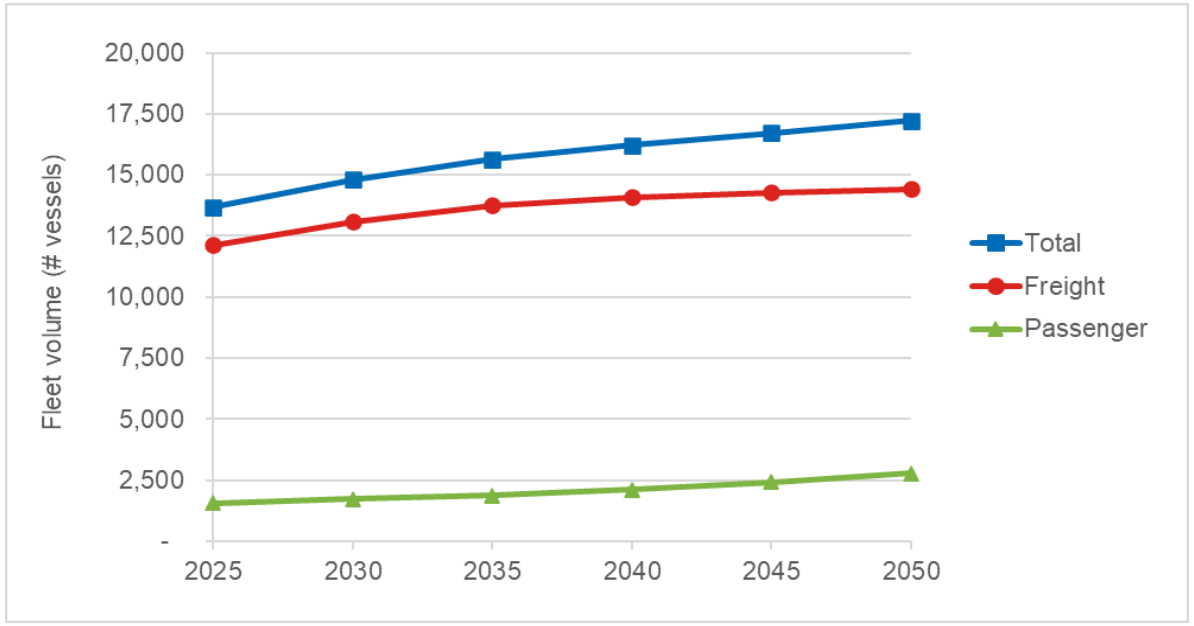
Methodology for the impact assessment

Mediterranean ship traffic analysis

- The projected ship traffic between 2025-2050 (number of vessels and energy consumption) within Mediterranean waters is estimated using the Marine Benchmark fleet projection model
- The number of new build vessels is projected by considering future trends in supply and demand for shipping
  - Fleet demand trends are driven by GDP growth, environmental regulations, among others
  - Fleet supply trends reflect demand trends, as well as the age, new investment activity, safety and environmental regulations, and market factors

Total shipping fleet operating in the Mediterranean Sea are expected to **increase by 26%** between 2025-2050, from around 13,600 ships in 2025 to 17,200 ships in 2050, driven largely by freight ships

Fleet projection model assumes **all new ships will be equipped with Tier III-capable emission control equipment**, due to large proportion of vessels operating in the Mediterranean Sea are likely to sail across NO_x ECAs (i.e., expected North East Atlantic ECA)



Mediterranean fleet stock projections, 2025-2050. *Source: Marine Benchmark Fleet Projection model*

Methodology for the impact assessment

Fuel and technology mix scenarios

Specific alternative fuel and technology uptake scenarios are considered to form the baseline NOx ECA scenario of this impact assessment.

Two fuel and technology mix scenarios are considered to model the difference between NO_x emissions performance and potential decarbonisation scenarios, based on the 2023 IMO GHG Strategy:

- No global mid-term measures (NGMT) scenario: Business-as-usual scenario (BAU) in the IMO Comprehensive Impact Assessment
- Global mid-term measures (GMT) scenario: Scenario 50 of the IMO Comprehensive Impact Assessment

GMT scenario is treated as the central fuel and technology scenario, which reflects the current ambition of the IMO towards international shipping decarbonisation, with the revised timeline to adopt the revised GHG strategy at the IMO meeting in 2026.

Fuel type	2030	2040	2050
HFO	20%	10%	5%
VLSFO/MGO/HVO	50%	30%	15%
Bio-methanol/e-methanol	5%	5%	10%
LNG/bio-methane/e-methane	20%	25%	20%
Hydrogen	-	2%	5%
Ammonia	3%	20%	30%
Electricity	2%	8%	15%

Share of energy use per fuel type in Scenario with global mid-term measures (GMT)

Methodology for the impact assessment

Alternative methods for NOx ECA compliance

NOx abatement technologies are the main compliance mechanisms considered in this study.

The main technologies are Exhaust Gas Recirculation (EGR) and Selective Catalyst Reduction (SCR) technologies, which are assigned to vessel types based on the most cost competitive options:

- EGR for low-speed, 2-stroke engines
- SCR for higher-speed, 4-stroke engines

Low NOx emission fuels are the main alternative method for NOx ECA compliance, in a dual fuel engine or through onshore power supply, such as LNG fuels and (battery) electric.

- **LNG fuel** provides ~80% NOx emissions reduction compared to MGO fuel use
- **Battery electric** propulsion can provide no NOx emissions for short-range journeys
- NOx abatement technologies **will not be required** for these ship types to be compliant with Tier III emission limits in a NOx ECA

Option 1: NOx abatement technologies

- **Main** compliance mechanism in study
- More competitive price, resource availability, and reliable reduction potential expected to be drive uptake for NOx ECA compliance

Option 2: Low-NOx alternative fuels

- **Secondary** compliance mechanism
- Uptake assumed to be driven by decarbonisation targets at regional and IMO-level

Technologies and fuels available for NOx ECA compliance.

Air quality impacts

Projections in the baseline

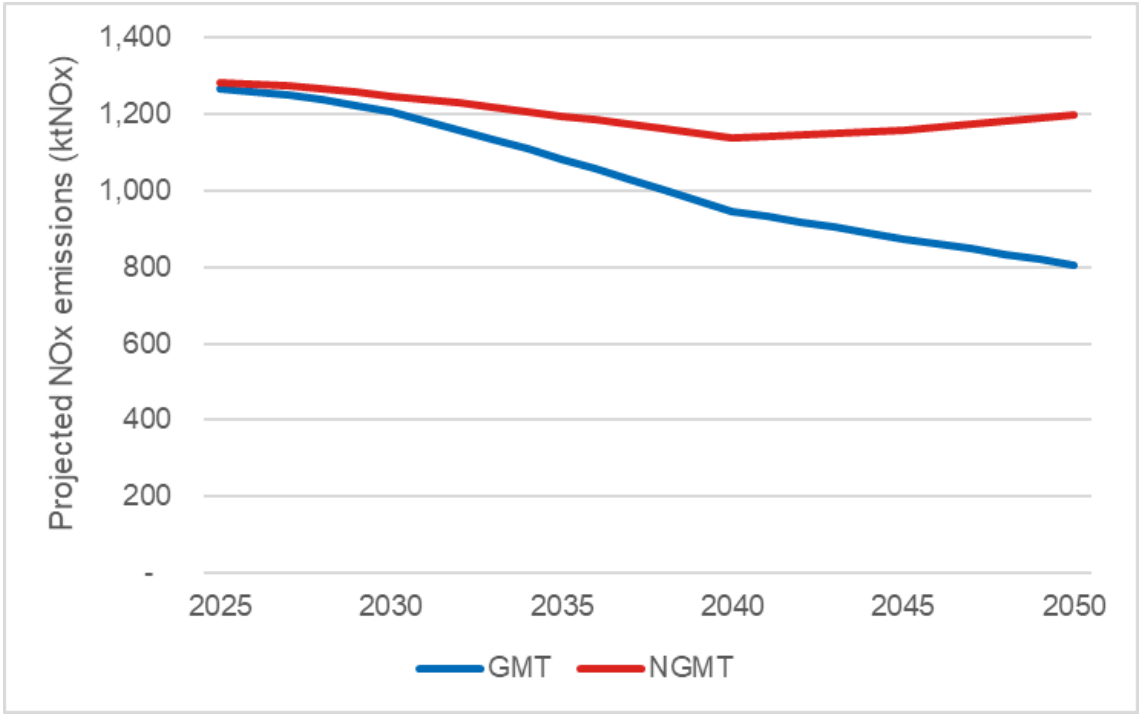
Baseline: NOx emissions from shipping, in the absence of a Med NOx ECA, have been estimated over the period 2025-2050 for the two decarbonisation scenarios (GMT and NGMT)

NOx emissions projections in the baseline are **driven by two key factors**:

- Increasing energy consumption in line with increased transport activity.
- A higher uptake of alternative fuels leads with lower NOx emissions.

Results indicate:

- NOx emissions decline in both scenarios relative to 2025, with a steeper reduction under the GMT scenario due to greater adoption of alternative fuels.
- Under the NGMT scenario, NOx emissions rise again after 2040, as growing transport activity offsets emission reductions from cleaner fuels.

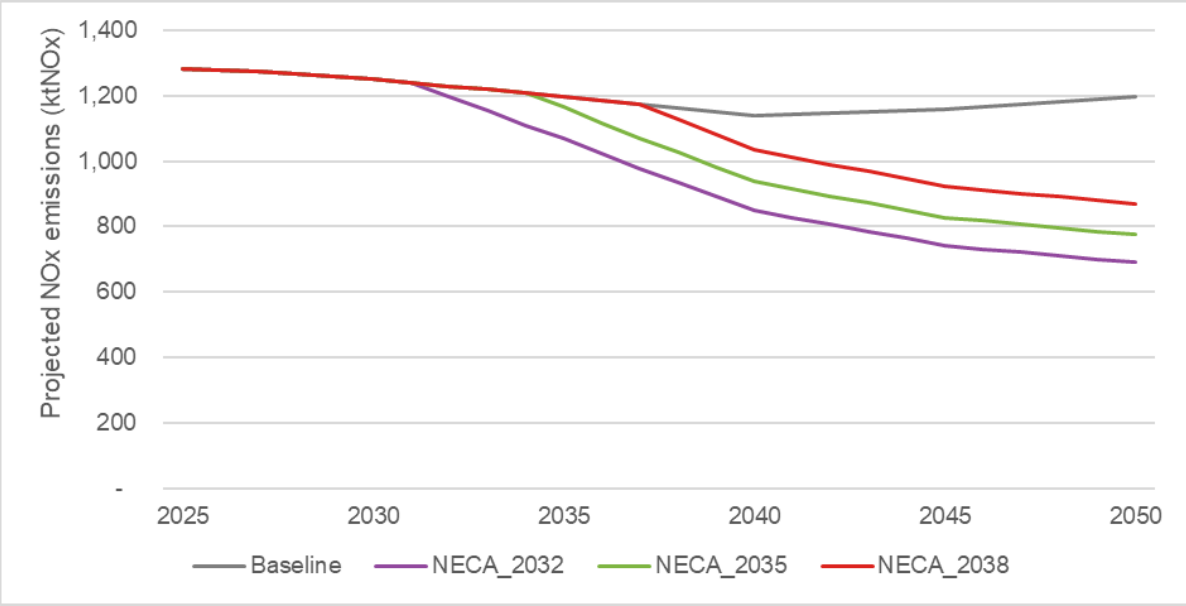


Projected NOx emissions from shipping in the baseline, under global mid-term measures (GMT) and no global mid-term measures (NGMT) scenarios

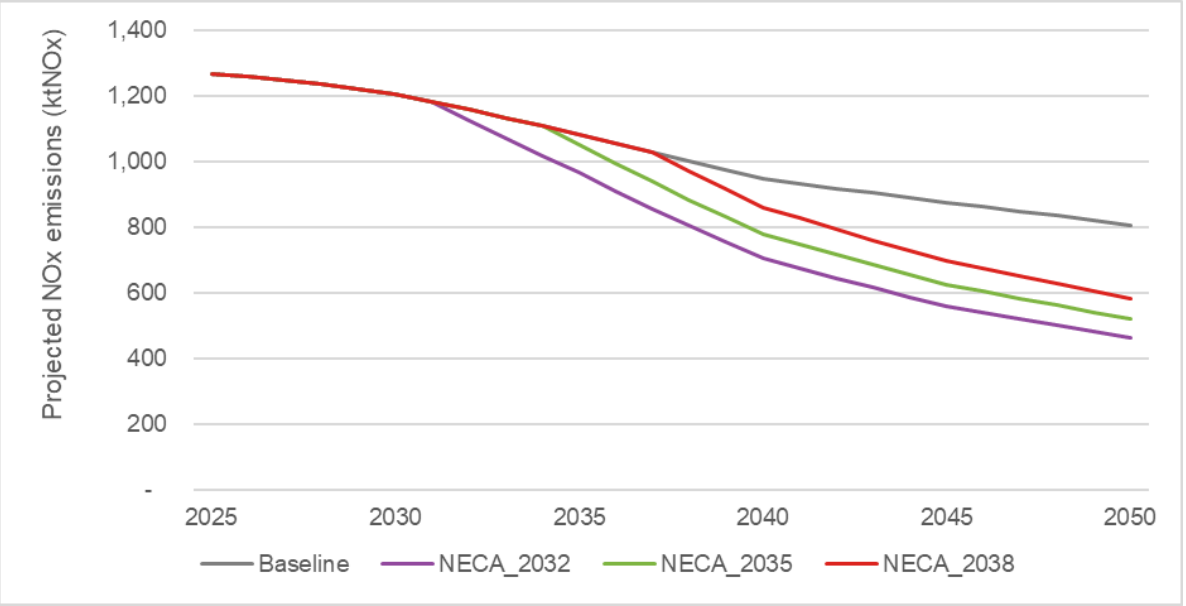
Air quality impacts

Projections in NOx ECA scenarios

Projected NOx emissions from shipping under the NGMT scenario for different NOx ECA implementation dates



Projected NO_x emissions from shipping in the Mediterranean under the GMT scenario for different NO_x ECA implementation dates



Air quality impacts

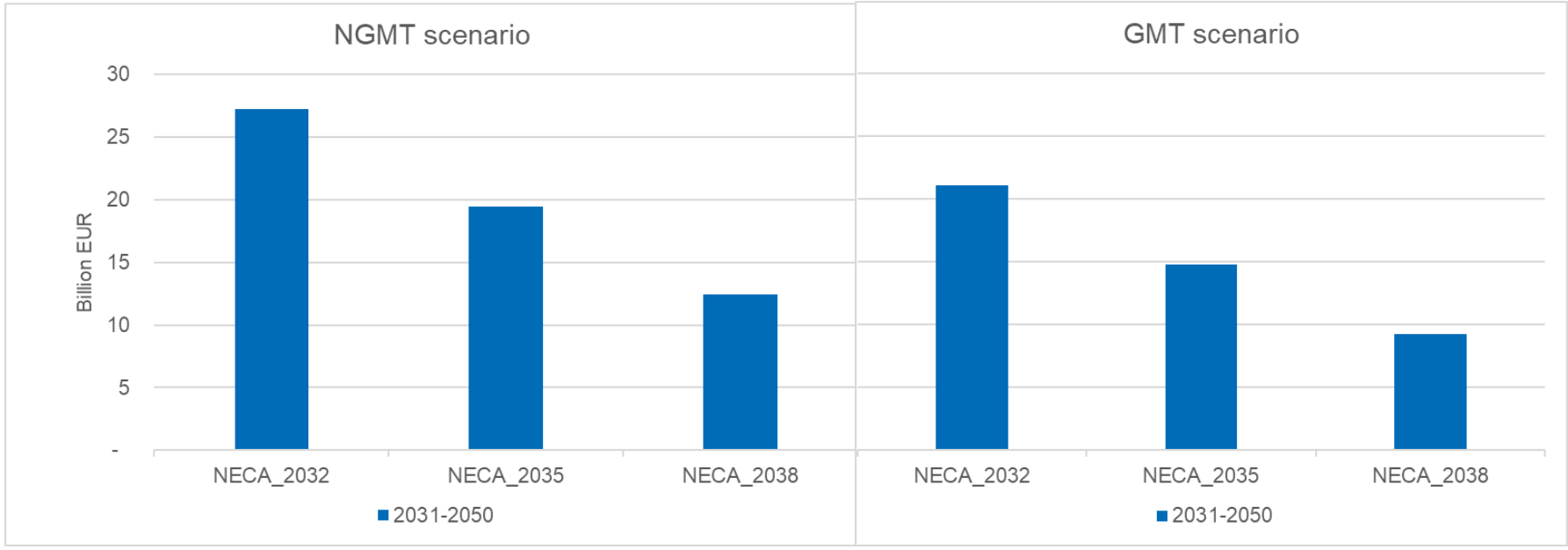
Health impacts

Health impact	Unit	NECA 2032		NECA 2035		NECA 2038	
		NGMT	GMT	NGMT	GMT	NGMT	GMT
Chronic Mortality (30yr +) deaths	Total life years lost	-219,648	-169,872	-156,978	-119,040	-100,398	-74,522
Infant Mortality (1 month-1yr)	Total life years lost	-1,771	-1,370	-1,266	-960	-809	-601
Chronic Bronchitis (18yr +)	Change in cases	-42,728	-33,045	-30,537	-23,157	-19,530	-4,497
Bronchitis in children aged 6 to 12	Change in cases	-12,648	-9,782	-9,040	-6,855	-5,781	-4,291
Stroke	Change in cases	-2,929	-2,266	-2,094	-1,588	-1,339	-994
Myocardial infarction	Change in cases	-1,955	-1,512	-1,397	-1,060	-894	-663
Diabetes Mellitus Type 2	Change in cases	-397	-307	-284	-215	-181	-135
Lung Cancer	Change in cases	-743	-574	-531	-402	-339	-252
Asthma symptom days (children 5-19yr)	Change in cases	-8,460	-6,543	-6,047	-4,585	-3,867	-2,870
Cardiovascular hospital admissions	Change in hospital admissions	-3,470	-2,684	-2,480	-1,881	-1,586	-1,177
Respiratory Hospital Admissions (All ages)	Change in hospital admissions	-3,603	-2,787	-2,575	-1,953	-1,647	-1,222
Minor Restricted Activity Days (MRADs all ages)	Number of restricted activity days	-8,391	-6,490	-5,997	-4,548	-3,836	-2,847
Workday Lost	Number of workdays lost	-2,677	-2,070	-1,913	-1,451	-1,224	-908

Air quality impacts

Air quality impact results

Cumulative air quality benefits for each NOx ECA implementation start date in both the NGMT and GMT scenarios (billion EUR)



Economic impact

Total compliance costs placed on fleet operators with activities in the Mediterranean Sea resulting from Med NOx ECA introduction can be separated into two components:

- the investment cost required to purchase and install additional Tier III-compliant NOx abatement technology (capital expenditure, CAPEX)
- the ongoing cost of operating the equipment through additional energy and feedstock requirements (operating expenditure, OPEX)

CAPEX and OPEX for NOx abatement technology

EGR and SCR as the main NOx abatement technologies:

- **EGR** reduces NO_x emissions by modifying the inlet air to reduce the internal temperature and subsequent NO_x emissions produced during combustion
- **SCR** is an exhaust aftertreatment system which splits NOx emissions into molecular nitrogen and water vapor after production and release from the engine

Engine type	Technology	Cost type	Study value	Literature Range [1]
2-stroke	EGR	CAPEX	**52 EUR/kW**	49 – 60 EUR/kW
2-stroke	EGR	OPEX	**2.7 EUR/MWh**	1.85 - 3.96 EUR/MWh
4-stroke	SCR	CAPEX	**69.4 EUR/kW**	26.3 – 143 EUR/kW
4-stroke	SCR	OPEX	**9.11 EUR/MWh**	3.2 – 9.5 EUR/MWh

Economic impact

Results on fleet-wide compliance costs

Results for fleet-wide compliance costs resulting from introduction of a Med NOx ECA for the range of start years (2032, 2035, 2038), above the costs arising from the Baseline scenario without NOx ECA introduction

Additional cumulative (average annual for period) costs in million €

NO_x ECA introduction year	2031-2040	2041-2050	Total (2031-2050)
2032	667 (83)	1,638 (215)	2,305 (121)
2035	319 (61)	1,305 (171)	1,624 (101)
2038	91 (35)	933 (123)	1,025 (79)

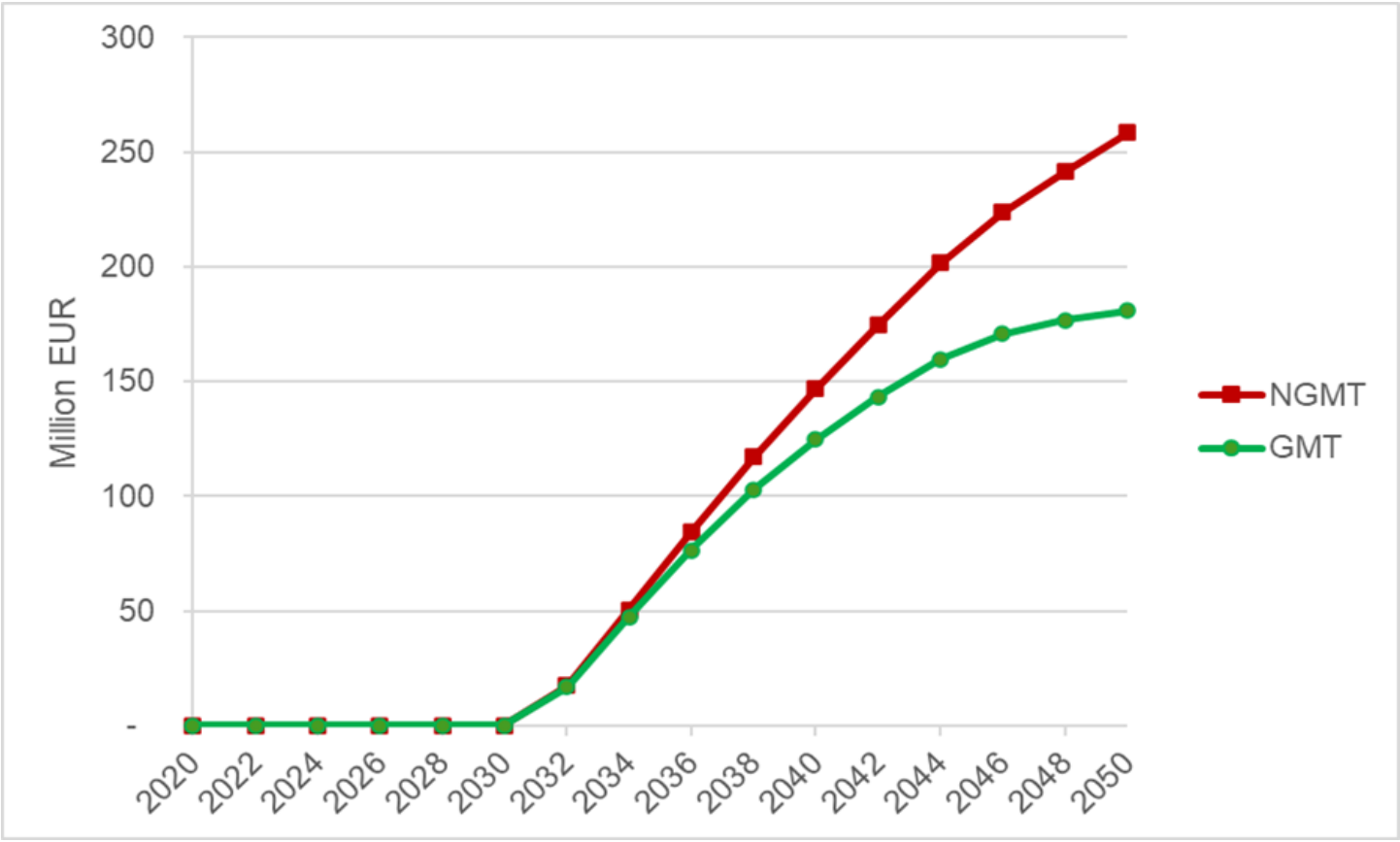
Percentage cumulative cost (OPEX only) increase due to NOx ECA compliance for freight vessels only, by introduction date and interval period

NO_x ECA introduction year	2031-2040	2041-2050
2032	0.06%	0.14%
2035	0.03%	0.11%
2038	0.01%	0.08%

Economic impact

Comparison to NGMT scenario

- The GMTM decarbonisation scenario is considered the most realistic fuel and technology mix scenario reflective of decarbonisation targets for the maritime sector announced by the IMO and EU
- The NGMTM scenario was included within the impact assessment as a sensitivity to explore the impact of lower decarbonisation ambition



Impacts on the maritime sector

Impacts on shipping costs

- The average increase in total shipping costs for freight vessels is below 0.3%, assuming full cost pass-through to shippers.
- Freight rates are therefore expected to rise only marginally, with limited overall cost impact.
- For passenger vessels, cost increases are expected to be even lower, as cruise operating costs are already high, making the impact on prices negligible.

Impacts on short sea shipping

- Smaller coastal vessels, including Ro-Ro and Ro-Pax ships, will face higher capital costs to meet Tier III standards due to new engine and compliance technologies.
- Around 71% of Ro-Ro and Ro-Pax vessels are currently non-compliant, compared with 68% of the overall Mediterranean fleet.
- Passenger vessels are older on average and replaced more slowly, leading to a gradual transition to Tier III systems and higher short-term operating costs that may be passed on to passengers.

Case study: Barcelona-Rome ferry (Ro-pax) short sea shipping connection

Vessels operating on this route were built on 2008 and may be replaced in 2038 assuming a 30 years lifespan

Results on increased ticket prices show a relatively modest price increase in the short-mid term, with more significant price raises in the long term

Variable	2031-2040	2041-2050
% increase in 2025 ticket price	2-4%	7-13%

Impacts on the maritime sector

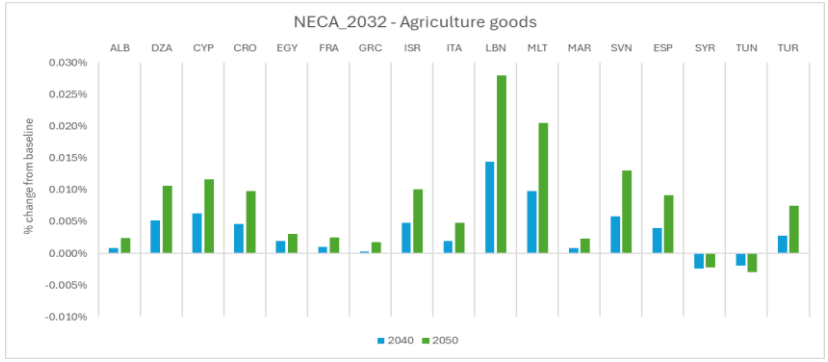
Impacts on modal shift

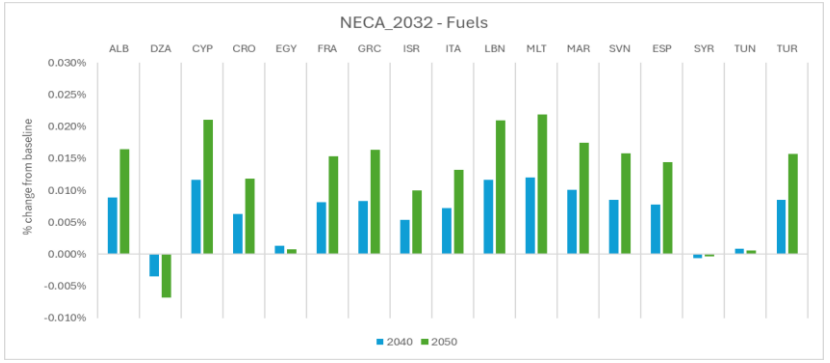
- **No significant modal shift expected** as a result of the Med NOx ECA, since the projected increase in voyage costs is minimal (<0.3%) and maritime transport remains the most cost-effective option.
- **Shipping benefits from strong economies of scale**, making it far cheaper than all-land alternatives, which would require freight rates to increase 1.6-32 times to become competitive.
- **Containerised goods** would need cost increases of 1.6-4.3 times for a land-based switch to be viable, while bulk and agricultural goods are even less likely to shift modes.
- **Potential risks for short sea shipping** may warrant closer monitoring, though stakeholders agree the Med NOx ECA alone is unlikely to trigger a shift to road transport; any changes would more likely stem from broader EU climate policies (e.g., EU ETS, FuelEU Maritime).

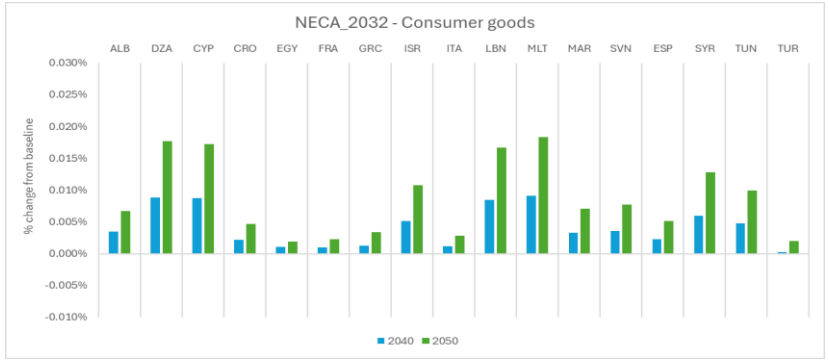
Other impacts on economies, citizens and authorities

Impact on prices

- Higher shipping costs slightly raise import prices, depending on each country's economic structure and import profile
- In highly import-dependent sectors, prices rise modestly, while reduced demand can lower production costs in other areas, especially labour-intensive ones like construction
- Increases in goods prices remain minimal, with a maximum estimated rise of 0.03%
- Countries such as Malta and Cyprus face slightly higher effects due to their heavy import reliance, though these impacts are still marginal



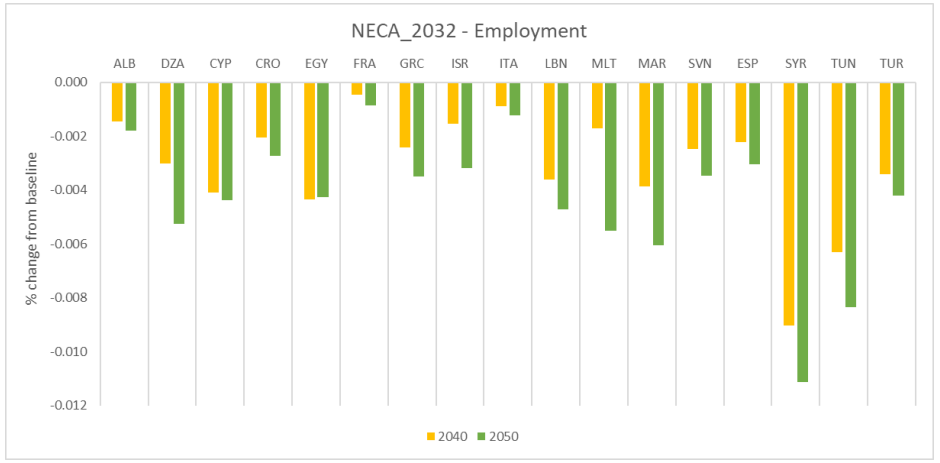


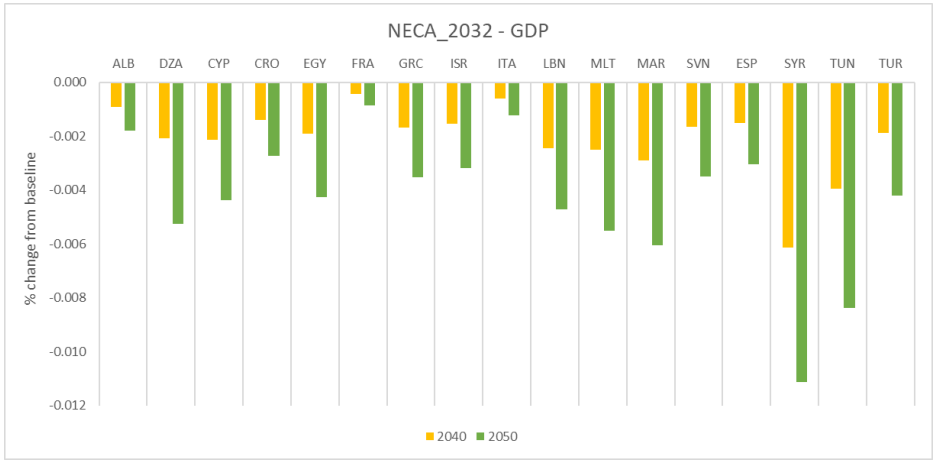


Other impacts on economies, citizens and authorities

Impact on gross economic domestic product and total employment

- Higher transport costs affect both the prices of imported goods and the prices of exported goods, when using water transport means.
- Macroeconomic impacts are marginal, given small changes in transport costs (i.e. less than 0.3%)
- Highest impacts are equivalent to 0.01% of baseline GDP in the medium and long-term for some countries.
- Highest GDP losses are registered in Syria and Tunisia, although still marginal. The first is a consumption-based economy with high exposure on agricultural goods, for which transport margins are an important price component. The second economy is more open (i.e. more dependent on maritime trade) and is affected by higher export and import costs particularly in consumer goods.
- Employment effects follow macroeconomic trends and are of a small magnitude.





Other impacts on economies, citizens and authorities

Impact on environmental biodiversity

- Reduced NOx emissions will lower nitrogen deposition, acidification, and eutrophication, helping protect the Mediterranean's rich and sensitive marine ecosystems.
- Positive long-term effects expected for marine and terrestrial biodiversity, though recovery may be gradual; EGR water discharge impacts are regulated and limited.

Impact on cultural heritage

- Lower NOx and PM emissions will reduce corrosion and soiling of coastal UNESCO World Heritage Sites, preserving monuments and historic buildings.
- Benefits mirror other ECAs, such as in the North-East Atlantic, where similar designations have supported heritage protection.

Impact on authorities

- Increased administrative needs for enforcement, monitoring, and coordination, though synergies with existing SOx ECA can reduce the burden.
- Harmonised enforcement through regional cooperation (e.g. REMPEC-led working group) is essential to ensure consistent and effective implementation across ports.

Cost-effectiveness of NOx introduction

Net Present Value (NPV)

- Absolute NPV is the difference between total discounted benefits and costs, with a positive value reflecting net benefit of implementation and negative values reflecting net cost.
- A social discount rate of 3.5% was assumed.
- The NPV is positive across all scenarios considered, reflecting that benefits outweigh costs for all introduction years and fuel/technology mix sensitivities.

NO_x ECA introduction date	GMT	NGMT
2032	9,818	12,546
2035	6,596	8,631
2038	3,956	5,308

Cost-effectiveness of NOx introduction

Benefit-cost ratio (BCR)

- The BCR compares total discounted benefits from emission reductions against discounted compliance costs over 2025–2050, indicating overall cost-effectiveness
- Under the **GMT scenario**, the BCR ranges from 9.04 to 9.16, while under **NGMT** it is slightly higher, between 9.32 and 9.41, due to greater reliance on NOx abatement technologies
- These high ratios show that the Med NOx ECA delivers **benefits more than nine times greater than the required investment**

NOx abatement cost

- The abatement cost measures the **compliance cost per tonne of NOx reduced**, a key metric for comparing with land-based reduction measures.
- Estimated at around €530 per tonne under the GMT scenario and slightly lower for NGMT, reflecting more efficient use of abatement technologies.
- The Med NOx ECA's abatement cost is at the low end of previous ECA studies, confirming strong cost-effectiveness.
- Lower costs are driven by technological progress in SCR and EGR systems and broader adoption of Tier III compliance, reducing additional capital expenditures.

In conclusion, the **proposed designation of the Med NO_x ECA offers strong cost-effectiveness compared to both land-based measures and previously implemented NO_x ECAs**

Impact assessment and cost-effectiveness results

Review of feedback received and questions

- Geopolitical developments in the region
- Developments related to the decarbonisation of shipping
- Potential operational challenges, e.g. limited availability of Very Low Sulphur Fuel Oil (VLSFO)

Any other comments or questions?

4

Recommendations and roadmap

- Summary of key recommendations
- Roadmap for Med NOx ECA designation
- Results for current shipping emissions

Key recommendations

- Contracting Parties are encouraged to work together on a **joint and coordinated proposal** on the designation of the Mediterranean Sea an ECA for NOx.
- Contracting Parties are encouraged to **explore bringing forward**, to the extent possible, **the entry-into-force date** of a potential Med NO_x ECA.
- Contracting Parties are encouraged to **incorporate any unforeseen shortcomings or lessons learnt** identified during the **implementation of the SO_x ECA** in the Mediterranean Sea into the proposal for a potential Med NO_x ECA.
- Contracting Parties are encouraged to set up a **dedicated monitoring and evaluation framework** to assess environmental, economic and social impacts following implementation of a potential Med NO_x ECA.
- It would be important for all Mediterranean coastal states to **ratify and effectively implement MARPOL Annex VI** by the date of the submission of the Med NO_x ECA proposal to the International Maritime Organisation (IMO).
- It would be important that **targeted capacity building and awareness-raising activities** are further strengthened at the national and regional levels to support the consistent and effective implementation of a potential Med NO_x ECA.
- REMPEC, in cooperation with the IMO, will **continue to provide technical assistance and capacity-building** support on MARPOL Annex VI to Contracting Parties, including guidance on its ratification as well as support for the effective implementation and enforcement of its provisions, as well as financial support and resource mobilisation.

Roadmap towards the designation of a Med NO_x ECA

The roadmap outlines the process leading to a potential proposal to designate the Mediterranean Sea

Developed within the framework of the Barcelona Convention, the roadmap includes information on key milestones, timeline, and actions required to support this designation

Regional actions (2025-2027):

- Activities related to REMPEC coordination, consultations and endorsement by Focal Points of REMPEC, and review and approval processes by the MAP Focal Points and Contracting Parties to the Barcelona Convention (COP).
- These steps focus on regional consensus-building, technical and feasibility studies, and preparation of the joint and coordinated proposal.

Global actions (beyond 2027):

- Submission of the formal proposal to the International Maritime Organization (IMO), engagement with IMO's Marine Environment Protection Committee (MEPC), participation in global regulatory review and approval processes, adoption of amendments to MARPOL Annex VI, and eventual entry into force of the Mediterranean NO_x ECA

Roadmap towards the designation of a Med NO_x ECA

Milestones	Dates	Actions
Regional actions (2025-2027)		
Technical and Feasibility Study	January-December 2025	Completion of a study to address the criteria and procedures for designation of emission control areas laid down in Appendix III to MARPOL Annex VI (this Study) and a draft Roadmap outlining the process leading to a potential proposal to designate the Mediterranean Sea.
Regional Expert Meeting on the possible designation of the Med NO_x ECA pursuant to MARPOL Annex VI	18-19 November 2025 (TBC)	Presentation of the results of the Study and discussion on the submission process for a potential proposal to designate the Med NOx ECA under MARPOL Annex VI.
Submission of draft IMO proposal to **Focal Points of REMPEC**	April 2027 *Q2 2027* (TBC)	Submission of a Note by the Secretariat (REMPEC), including draft IMO submission and the draft Roadmap, to the 17th *(TBC)* Meeting of the Focal Points of REMPEC.
Review and consideration by **Focal Points of REMPEC** *17th (TBC) Meeting of Focal Points of REMPEC*	May 2027 *Q2 2027* (TBC)	Review and consideration of the Note by the Secretariat (REMPEC), including draft IMO submission and the draft Roadmap. Discussion on: • whether or not to submit a proposal to IMO for the designation of the proposed Med NO_x ECA, • the most appropriate timing for such a submission, if any, and • the effective date of entry into force of the proposed Med NO_x ECA, if any.

Roadmap towards the designation of a Med NO_x ECA

Milestones	Dates	Actions
Regional actions (2025-2027)		
Submission of draft IMO proposal to **MAP Focal Points**	July 2027 (TBC) *Q3 2027*	Submission of a draft COP Decision on the joint and coordinated proposal for the designation of the proposed Med NO_x ECA and the Roadmap to the IMO to the Meeting of the MAP Focal Points. *Subject to agreement being reached at the 17th (TBC) Meeting of the Focal Points of REMPEC.*
Endorsement of ECA proposal by **MAP Focal Points** *Meeting of MAP Focal Points*	September 2027 (TBC) *Q3 2027*	Approval of the draft COP Decision on the joint and coordinated proposal for the designation of the proposed Med NO_x ECA and the Roadmap towards its designation to the IMO.
Submission of draft IMO proposal to **Contracting Parties to the Barcelona Convention and its Protocols**	October 2027 (TBC) *Q4 2027*	Submission of draft COP Decision on the joint and coordinated proposal for the designation of the proposed Med NO_x ECA and the Roadmap towards its designation to the IMO to COP 25 (*TBC*). *Subject to agreement being reached at the Meeting of the MAP Focal Points.*
Endorsement of ECA proposal by **Contracting Parties to the Barcelona Convention and its Protocols** *25th (TBC) Meeting of the Contracting Parties (COP 25, TBC)*	December 2027 (TBC) *Q4 2027*	Adoption of COP Decision on the joint and coordinated proposal for the designation of the proposed Med NO_x ECA and the Roadmap towards its designation to the IMO.

Roadmap towards the designation of a Med NO_x ECA

Milestones	Dates	Actions
Global actions (beyond 2027)		
Submission of the proposal to the IMO	Winter 2028 *Q1 2028* (TBC)	Submission of the joint and coordinated proposal for the designation of the proposed Med NO_x ECA to the IMO. This will include a proposed amendment to MARPOL Annex VI. *Subject to agreement being reached at COP 25 (TBC).*
Presentation and review of the proposal *87th (TBC) session of the IMO's Marine Environment Protection Committee (MEPC 87)*	Spring 2028 *Q2 2028* (TBC)	• Presentation of the joint and coordinated proposal for the designation of the proposed Med NO_x ECA to the IMO, together with a proposed amendment to MARPOL Annex VI); • Assessment of and, agreement to, the said proposal, if any; and • Consideration and approval of a draft amendment to regulation 13 of MARPOL Annex VI related to the designation of the proposed Med NO_x ECA, if any, and request to the IMO Secretary-General to circulate it in accordance with article 16(2) of MARPOL, with a view to adoption at the next session of the IMO's MEPC, if any.
Circulation of the draft amendment to regulation 13 of MARPOL Annex VI	Spring 2028 *Q2 2028* (TBC)	Circulation of the draft amendment to regulation 13 of MARPOL Annex VI related to the designation of the proposed Med NO_x ECA by the IMO Secretary General to all Members of the Organisation and all Parties, *at least six months prior to its consideration*. *(Provided agreement was reached at MEPC 87 [TBC])*

Roadmap towards the designation of a Med NO_x ECA

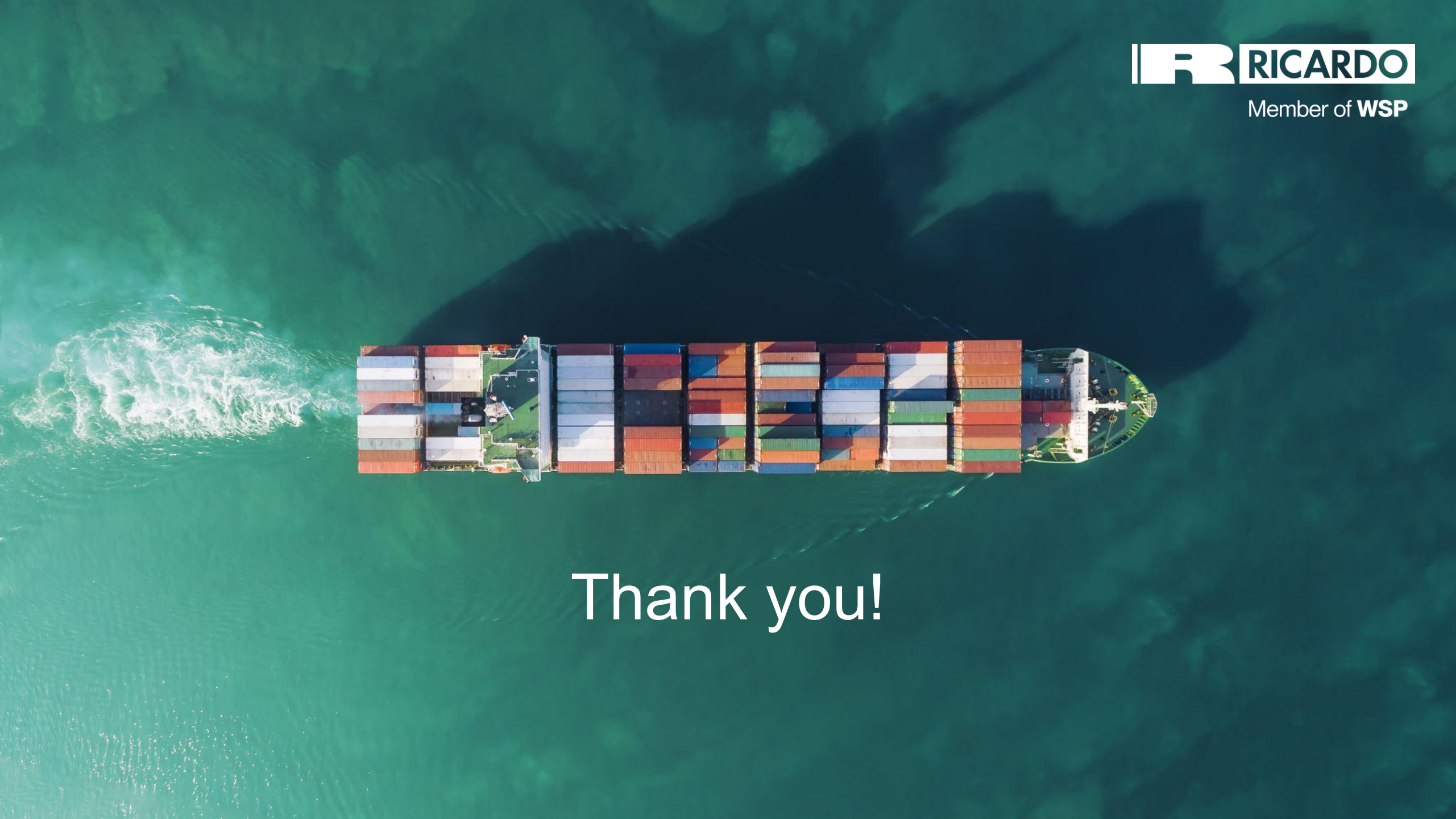
Milestones	Dates	Actions
Global actions (beyond 2027)		
Adoption of the draft amendment regulation 13 of MARPOL Annex VI *88th (TBC) session of the IMO's Marine Environment Protection Committee (MEPC 88)*	Autum 2028 *Q4 2028* (TBC)	• Consideration and adoption of the draft amendment to regulation 13 of MARPOL Annex VI related to the designation of the proposed Med NO_x ECA, if any; and • Determination of the date of bringing into force of the amendment to regulation 13 of MARPOL Annex VI related to the designation of the proposed Med NO_x ECA, if any, in accordance with article 16(2)(f)(iii) of MARPOL.
Acceptance of the amendment to regulation 13 of MARPOL Annex VI	Summer 2029 *Q2 2029* (TBC)	Deemed acceptance of the amendment to regulation 13 of MARPOL Annex VI related to the designation of the proposed Med NO_x ECA, if any. In accordance with article 16(2)(f)(iii) of MARPOL: *period shall be not less than ten months*.
Entry into force of the amendment to regulation 13 of MARPOL Annex VI	Autum 2029 *Q4 2029* (TBC)	Bringing into force of the amendment to regulation 13 of MARPOL Annex VI related to the designation of the proposed Med NO_x ECA, if any. In accordance with article 16(2)(g)(ii) of MARPOL: *six months after its acceptance*.
Entry into force of the Med NO_x ECA	TBC *(earliest Q4 2029)*	Effective entry into force of the Med NO_x ECA, if any.

Recommendations and roadmap

Review of feedback received and questions

- Timeline for the recommendations

Any other comments or questions?


RICARDO
Member of WSP
Thank you!