Compliance Costs for European Shipping

A Comparative Analysis Across Ship Cases and Different Policy Scenarios

maritime cleantech

Contents

1 Introduction

This policy brief presents an extended analysis of compliance cost modelling originally developed by DNV, in collaboration with Maritime CleanTech.

For detailed methodology and assumptions, see the DNV memo included in the appendix.

This brief focuses on additional analysis and interpretation, including the introduction of implicit carbon price and extended policy scenarios, to support comparison across ship types and regulatory regimes.

1.2 Background

The regulatory landscape for maritime greenhouse gas emissions is evolving rapidly, driven by both EU and IMO in addition to national initiatives. While the direction of travel is clear, significant uncertainty remains regarding the final design and interaction of global and regional measures. In particular, the development of the IMO framework and its alignment with existing EU regulation introduces uncertainty for market actors.

At the same time, there is limited transparency on how different regulatory mechanisms translate into actual cost exposure for shipowners. Policies operate through different instruments and units, making their combined economic impact difficult to assess.

This raises a central question for the industry: What is the real economic cost of continuing fossil fuel operation under emerging regulation?

This policy brief is trying to contribute to gaining more clarity on the answer to this question.

2 Analytic Framework

2.1 Ship-cases and policy scenarios

Five ship-cases are identified based on AIS-data across different segments, operational pattern, size and fuel consumption, and designed three policy scenarios: EU/UK ETS (S1), EU/UK ETS + FuelEU + IMO NZF (S2), and EU/UK ETS + IMO NZF (S3). Please see DNV-memo included in the appendix for more details.

To isolate the impact of IMO NZF, we have included two additional IMO-only scenarios in the brief: IMO NZF with constant RU price $380 (S4) and IMO NZF with RU price rising to $500 in 2035 (S5).

Ship case	Size (GT)	Fuel consumption (t MGO/yr)	Operational Pattern
Ro-Ro vessel	67000	11760	100% EU / 0% UK
LPG Carrier	25500	5070	77% EU / 23% UK
General Cargo	4000	1530	100% EU / 0% UK
Commissioning Service Operation Vessel (CSOV)	6700	1650	100% EU / 0% UK
Plattform Supply Vessel (PSV)	3600	2230	11% EU / 89% UK

Scenario	FuelEU	EU ETS	UK ETS	IMO NZF	IMO Tier 2 Price	Description
S1	Yes	Yes	Yes (if applicable)	No	-	EU Basline (FuelEU + ETS)
S2	Yes	Yes	Yes (if applicable)	Yes	380 USD	Full policy stack (EU + IMO)
S3	No	Yes	Yes (if applicable)	Yes	500 USD from 2035	ETS + IMO without FuelEU (high RU price)
S4	No	No	No	Yes	380 USD	IMO Baseline (IMO Only, RU $380)
S5	No	No	No	Yes	500 USD from 2035	IMO High (IMO Only, RU $500)

Category	Parameter	Value	Notes
Fuel	MGO price	680 USD/tonne	Constant over period
Fuel	Energy density	42,700 MJ/tonne	Used in IMO and EU
Emissions	ETS intensity	76.23 gCO2/MJ	From regulation (Tank-to-Wake)
Emissions	FuelEU intensity	90.77 gCO2/MJ	From regulation (Well-to-Wake)
Emissions	IMO intensity	93.93 gCO2/MJ	From regulation (Well-to-Wake)
FuelEU	Penalty	748 USD/tCO2	Derived from energy defecit pen
IMO	Tier 1 price	100 USD/tCO2	Approved april 2025
IMO	Tier 2 price (low)	380 USD/tCO2	Approved april 2025
IMO	Tier 2 price (high)	500 USD/tCO2	Theoretical from 2035

2.2 Implicit carbon price

To make the results from the modelling comparable across ship-cases and policy scenarios, and creating a link to abatement cost analysis, the term *implicit carbon price*[1] is used. Implicit carbon price expresses the total cost of regulatory compliance as a cost per tonne of CO_2 (USD/tCO_2), translating different policy mechanisms into a single, comparable economic signal.

[1] Implicit Carbon Price = total compliance cost divided by total emissions (USD per tonne CO_2e)

In the maritime context, compliance costs arise from multiple sources, including the purchase of allowances under EU and UK ETS, penalties for exceeding fuel intensity limits under FuelEU Maritime, and the cost of remedial units under the IMO framework. While these instruments differ in design, units, and timing, they all represent a cost of emitting CO_2.

By aggregating these costs and relating them to emissions, implicit carbon price captures the effective carbon cost faced by shipowners. While a simplification, this enables comparison across ship types, policy regimes, and scenarios, and provides a direct link to abatement costs and fuel switching thresholds.

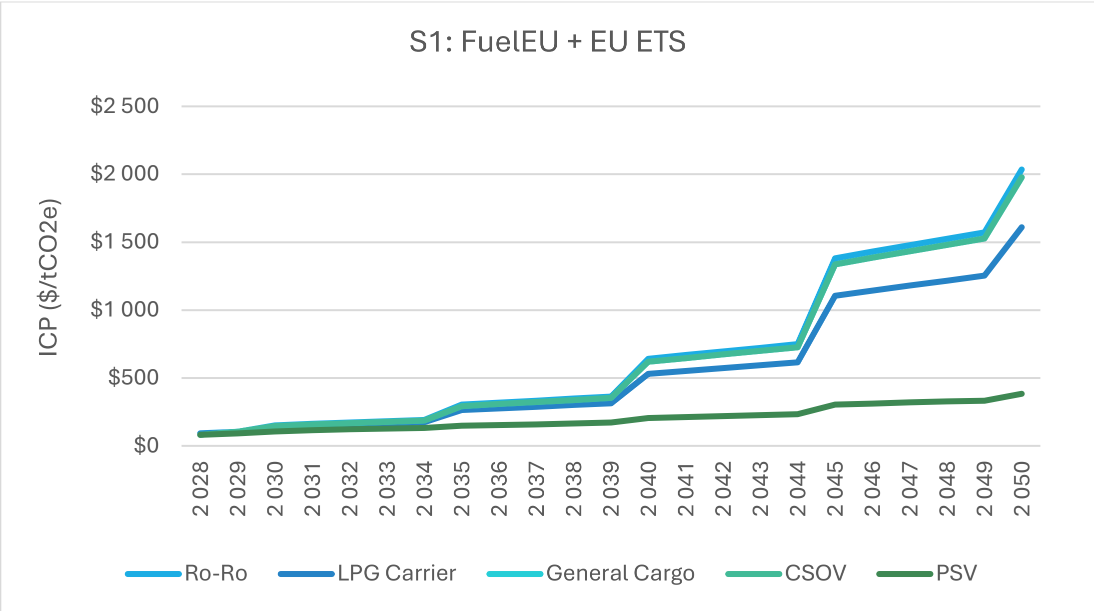
3 Results

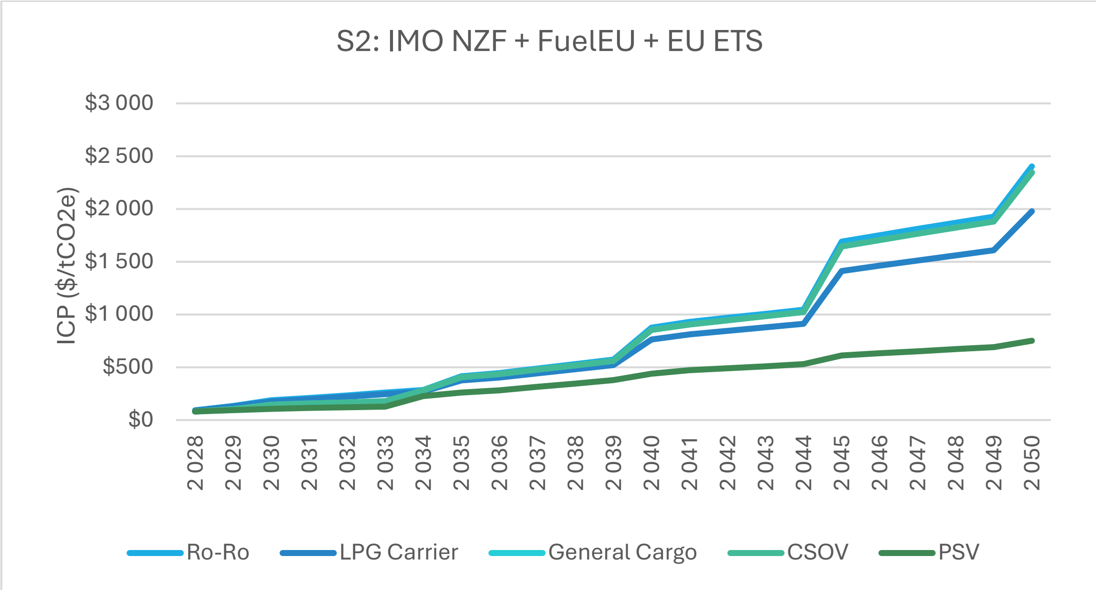
Under follows graphic visualizations of the results with key takeaways.

3.1 Each scenario comparing ship-cases on implicit carbon price:

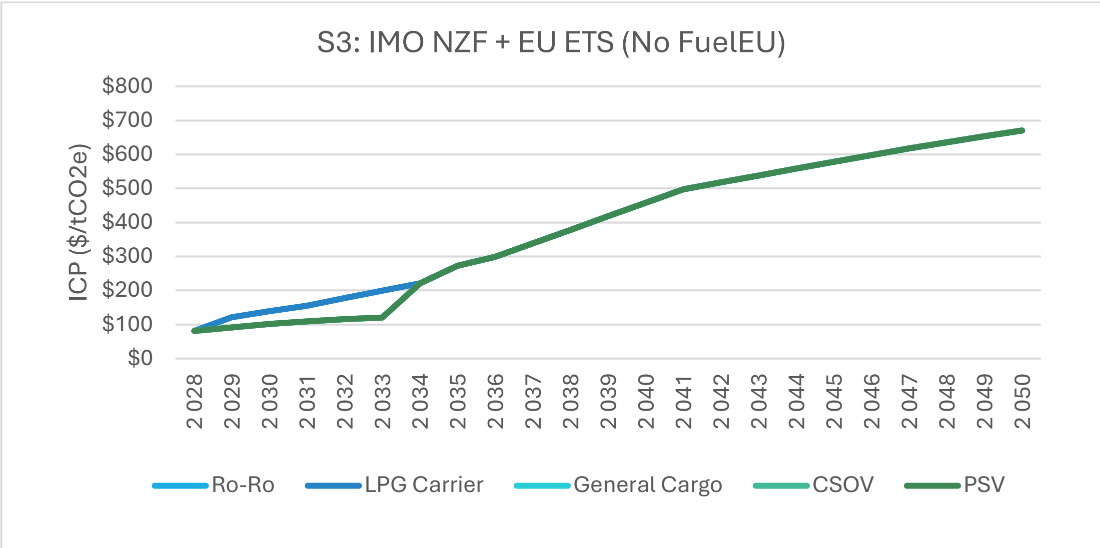
Implicit carbon price increases across all scenarios:

- Strong convergence across ship types. In S3-S5 all ship overlap.
- PSV shows as outlier in S1-S2 due to low FuelEU exposure from UK-operations.
- Differences primarily driven by policy design.
- Full policy stack (S3) most costly – not surprisingly.
- Showcasing that regulation effectively prices emissions rather than vessel characteristics.

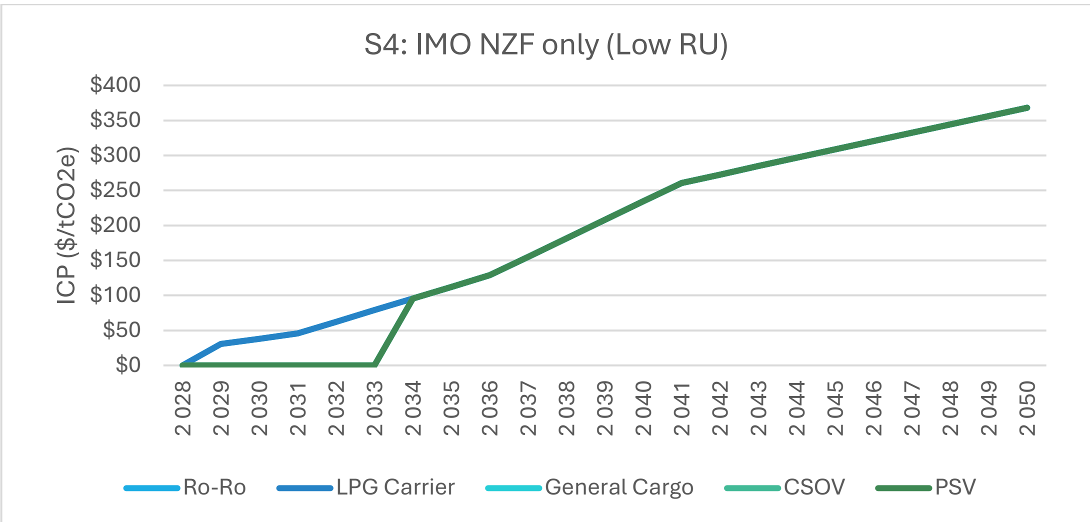




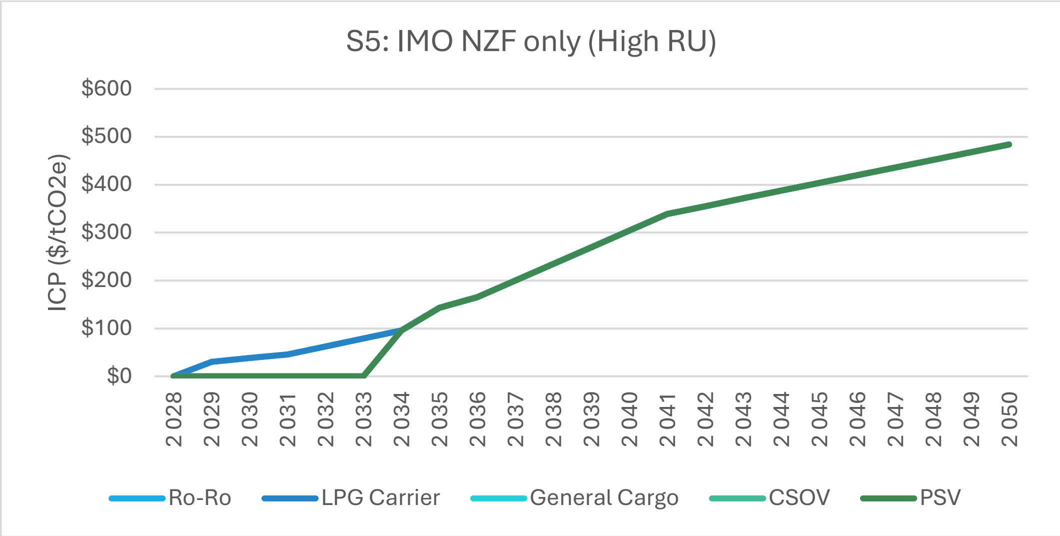
S2: IMO NZF + FuelEU + EU ETS
ICP ($/tCO2e)
$3 000
$2 500
$2 000
$1 500
$1 000
$500
$0
2 028 2 029 2 030 2 031 2 032 2 033 2 034 2 035 2 036 2 037 2 038 2 039 2 040 2 041 2 042 2 043 2 044 2 045 2 046 2 047 2 048 2 049 2 050
Ro-Ro
LPG Carrier
General Cargo
CSOV
PSV



S3: IMO NZF + EU ETS (No FuelEU)
ICP ($/tCO2e)
$800
$700
$600
$500
$400
$300
$200
$100
$0
2 028 2 029 2 030 2 031 2 032 2 033 2 034 2 035 2 036 2 037 2 038 2 039 2 040 2 041 2 042 2 043 2 044 2 045 2 046 2 047 2 048 2 049 2 050
Ro-Ro
LPG Carrier
General Cargo
CSOV
PSV



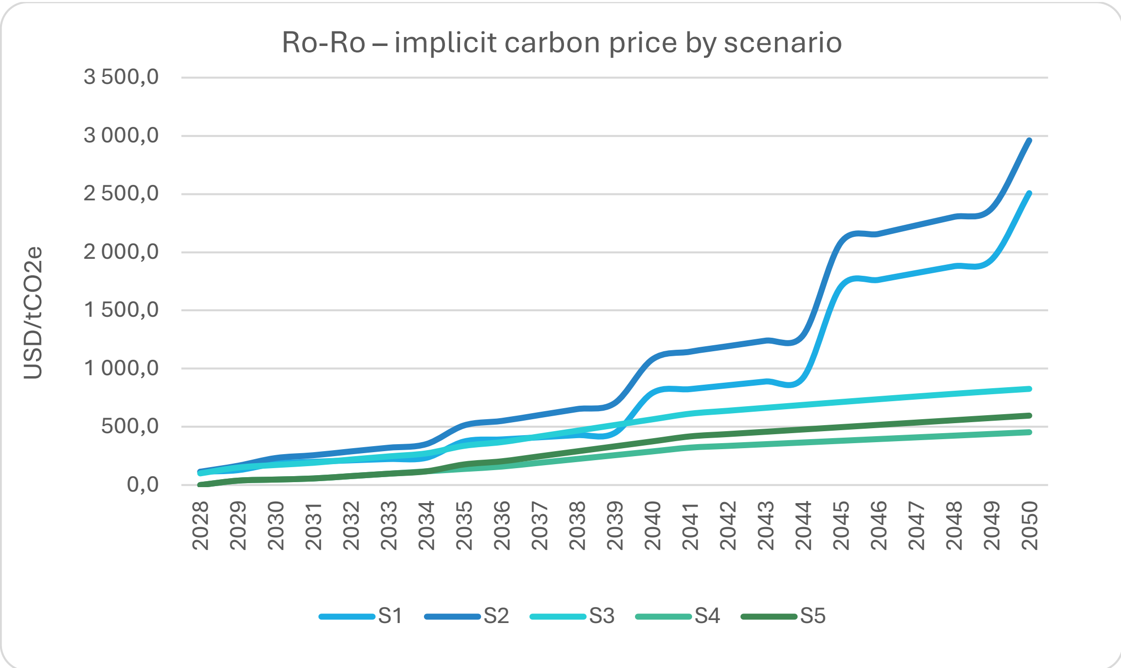
S4: IMO NZF only (Low RU)
ICP ($/tCO2e)
$400
$350
$300
$250
$200
$150
$100
$50
$0
2 028 2 029 2 030 2 031 2 032 2 033 2 034 2 035 2 036 2 037 2 038 2 039 2 040 2 041 2 042 2 043 2 044 2 045 2 046 2 047 2 048 2 049 2 050
Ro-Ro
LPG Carrier
General Cargo
CSOV
PSV

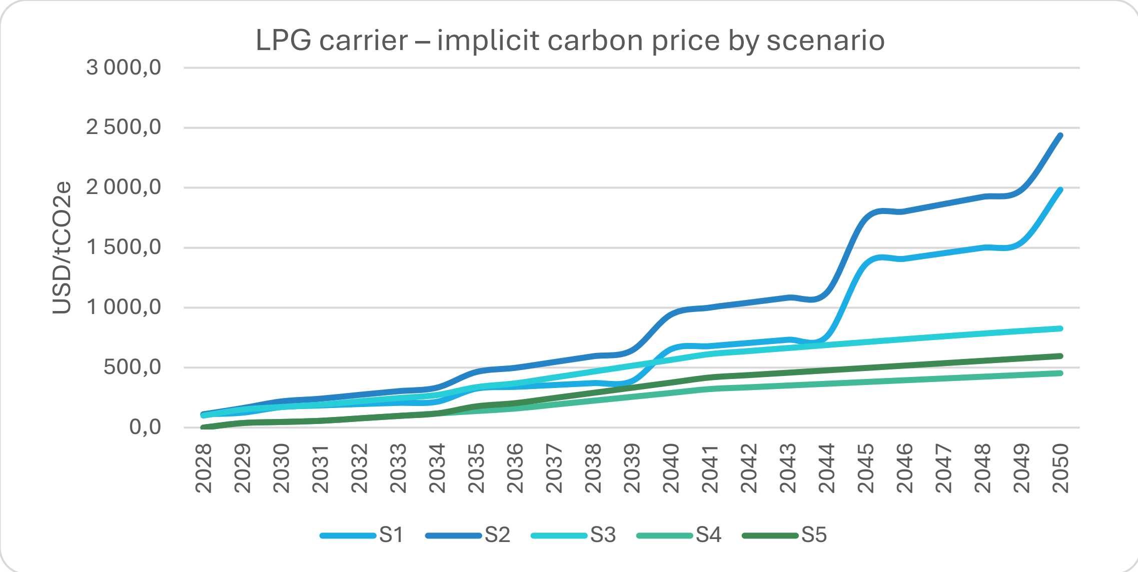


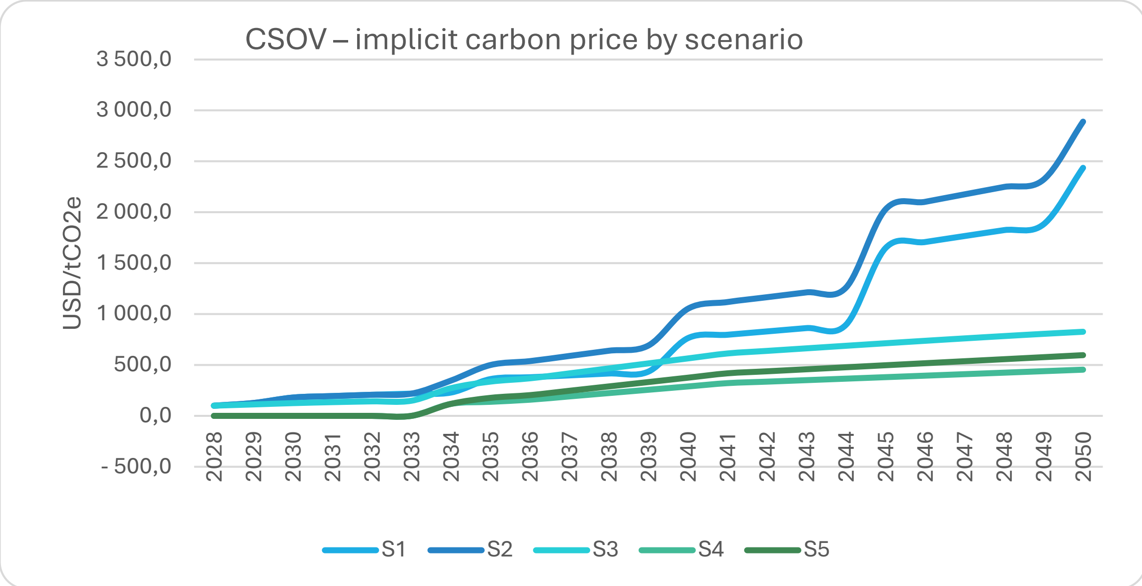
3.2 Each ship-case comparing scenarios on implicit carbon price:

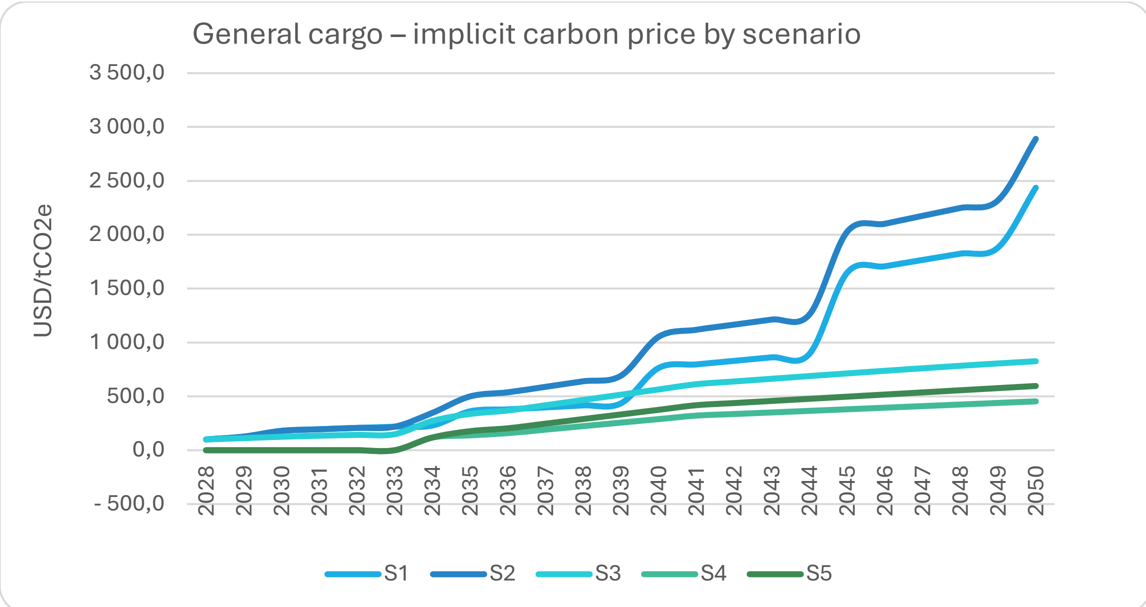
Policy design strongly influences both timing and cost-level:

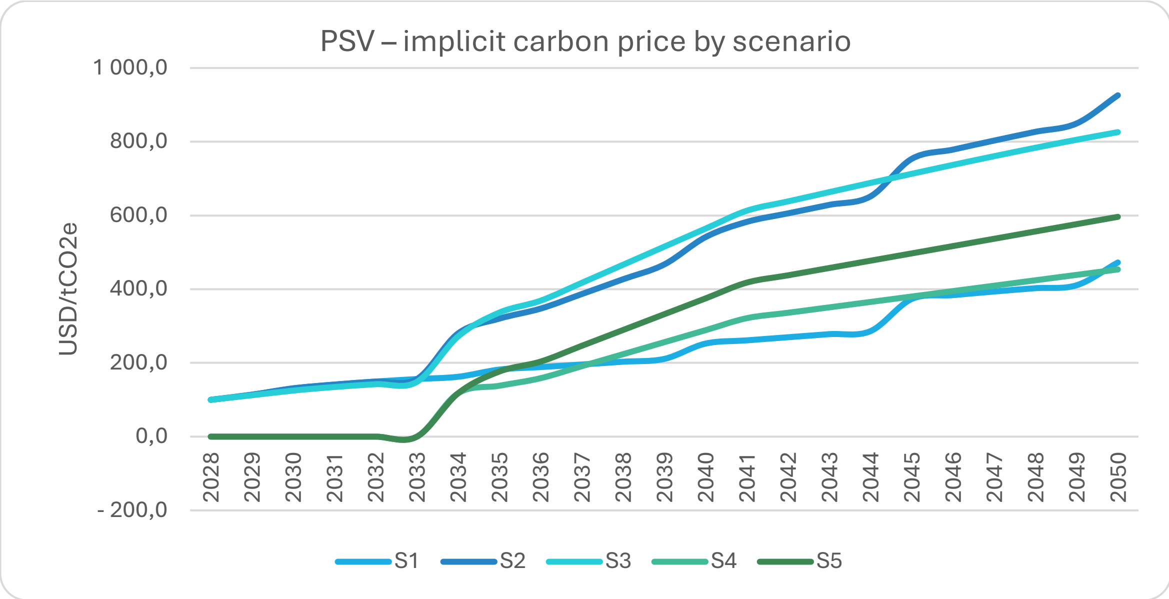
- Full policy stack (S2) creates highest and earliest signal.
- EU-only scenarios follow similar trajectory with slight delay.
- IMO-only scenarios remain significantly lower.
- FuelEU is the dominant driver of cost escalation.




LPG carrier – implicit carbon price by scenario
USD/tCO2e
3 000,0
2 500,0
2 000,0
1 500,0
1 000,0
500,0
0,0
2028 2029 2030 2031 2032 2033 2034 2035 2036 2037 2038 2039 2040 2041 2042 2043 2044 2045 2046 2047 2048 2049 2050
S1 S2 S3 S4 S5


CSOV – implicit carbon price by scenario
USD/tCO2e
3 500,0
3 000,0
2 500,0
2 000,0
1 500,0
1 000,0
500,0
0,0
- 500,0
2028 2029 2030 2031 2032 2033 2034 2035 2036 2037 2038 2039 2040 2041 2042 2043 2044 2045 2046 2047 2048 2049 2050
S1 S2 S3 S4 S5

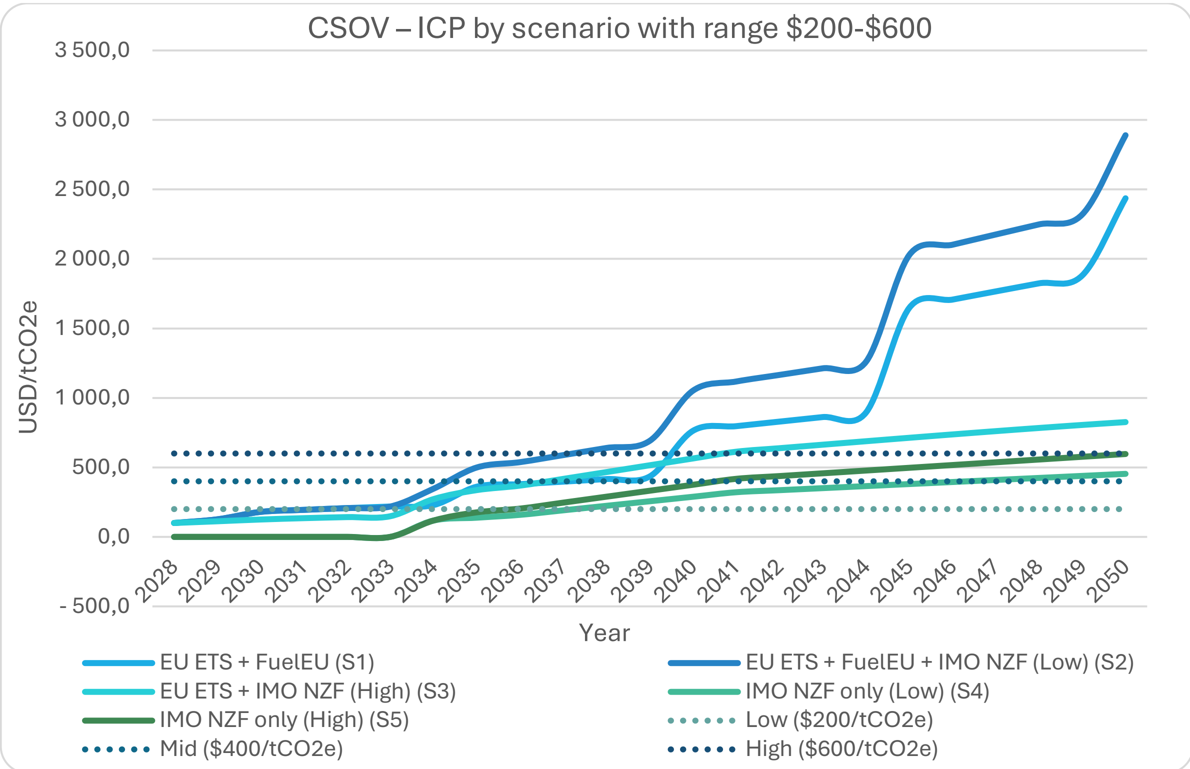

General cargo – implicit carbon price by scenario
USD/tCO2e
3 500,0
3 000,0
2 500,0
2 000,0
1 500,0
1 000,0
500,0
0,0
- 500,0
2028 2029 2030 2031 2032 2033 2034 2035 2036 2037 2038 2039 2040 2041 2042 2043 2044 2045 2046 2047 2048 2049 2050
S1 S2 S3 S4 S5



3.3 Competitiveness range for clean fuels exampled CSOV:

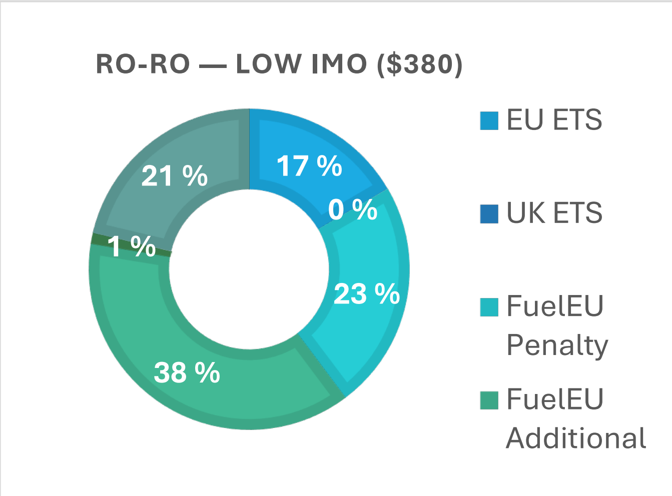
For analytical purposes to benchmark implicit carbon price to abatement cost three dotted lines are added, representing a range from \$200-\$600 per tonne CO_2. This range is used to indicate possible abatement costs for clean fuels based on input from the industry:

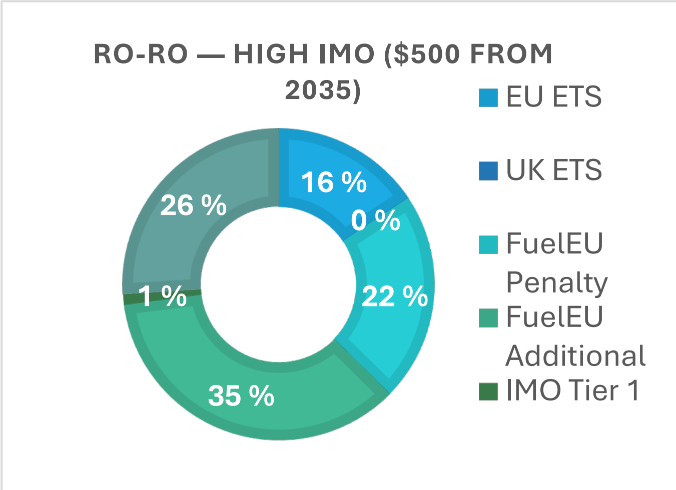
- All scenarios reach the range between 2035-2040, which crystals out this five-year period as crucial.
- IMO-only scenarios are delayed and remain in the lower end of the rage.
- Indicates that EU-driven regulation accelerates alternative fuel-competitiveness.



3.4 Which policy is more expensive when layered together – example with Ro-Ro vessel?

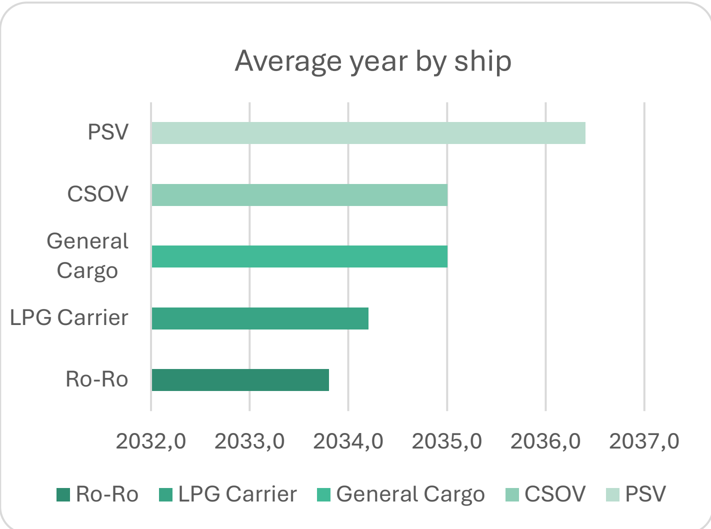
Layered on top of each other, the costs of non-compliance with FuelEU Maritime becomes clear. The figure below also shows the main driver behind the cost escalation of FuelEU Maritime: the additional penalty for consecutive non-compliance which alone represents more than 1/3 of total costs for the Ro-Ro vessel example.

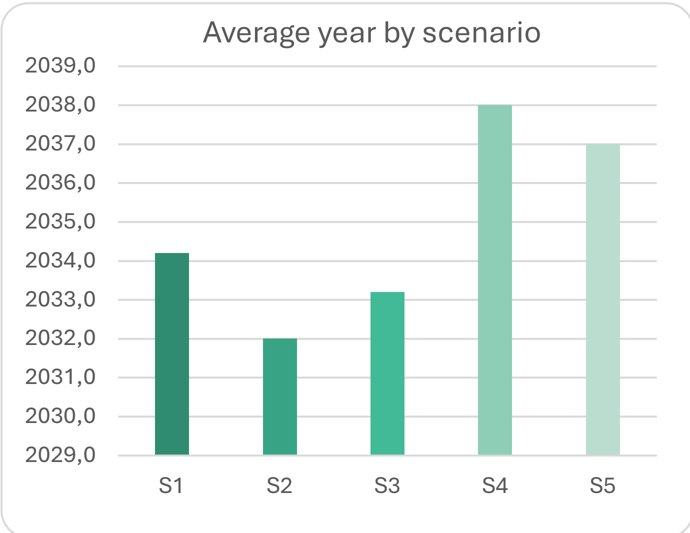




3.5 Compliance costs versus fuel costs – average year compliance cost crossover with fuel cost:

Compliance cost approach or exceed fuel costs by the mid-2030s in all scenarios and ship-cases assuming a constant MGO price at $680 per tonne[2]. The figure below shows average year compliance costs to reach 100% of fuel costs. By 2040 compliance costs reach 200% of fuel costs.





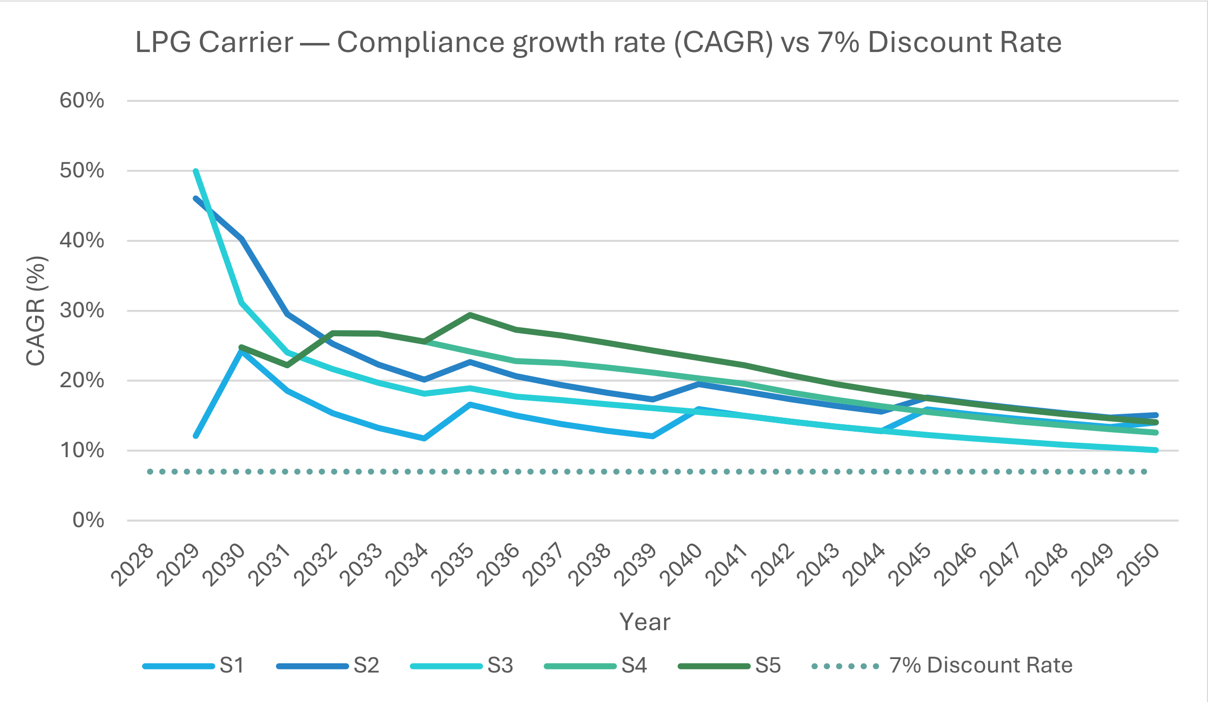
[2] See DNV-memo in appendix for more details.

3.6 Compliance costs could grow significantly faster than the discount rate, increasing financial pressure even more:

While compliance costs increase in nominal terms across all scenarios, shipowners typically evaluate long-term operating costs using discounted cash-flow analysis. If future compliance costs grow more slowly than the discount rate, the present value of those costs declines over time.

For most ship types, average compliance cost growth ranges between 10% and 18% per year – exampled with the LPG carrier below. Assuming a normal discount rate of 7% for the industry, which is significantly the regulatory burden does not decline in present-value terms. Instead, it increases during significant portions of the vessel lifetime.

This means that regulatory pressure is not only rising in nominal terms. It could strengthen in financial terms even after discounting future costs.



4 Appendix: Memo from DNV:

Maritime CleanTech

Fuel and GHG compliance cost for five ship cases

Maritime CleanTech

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Customer contact:	Reber Iversen	Veritasveien 1, 1322 Høvik
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1 INTRODUCTION

This document is intended to support Maritime CleanTech's ongoing work to assess the cost implications of current and future greenhouse gas (GHG) regulations for the maritime sector. DNV has estimated the fuel and GHG compliance costs for five vessel cases operating on marine gas oil (MGO). The analysis is conducted across three regulatory scenarios, each reflecting different potential outcomes of future policy developments, including the FuelEU Maritime regulation, EU ETS, UK ETS, and the IMO Net Zero Framework (NZF).

The selection of ship cases, the definition of regulatory scenarios, and other key assumptions have been developed in close collaboration with Maritime CleanTech. A separate spreadsheet accompanies this document, providing detailed quantitative results for each vessel case. For further background on the regulatory frameworks referenced in this study, readers are encouraged to consult additional sources, including DNV (2025b; 2024).

It is important to note that all cost estimates presented here are associated with significant uncertainties. Future regulatory developments, such as the implementation of the IMO NZF or the outcome of the 2027 revision of FuelEU Maritime may impact GHG compliance costs in the assessed ship cases. Likewise, developments in the price of MGO, and allowance prices under the EU and UK ETS represent additional sources of uncertainty. The use of three regulatory scenarios when assessing fuel and GHG compliance costs, addresses some of this uncertainty.

In this document, we first present the applied methodology and key assumptions in Chapter 2. Chapters 3 to 7 cover the case-specific input parameters and key results. Finally, in Chapter 8, we address some of the regulations that could emerge but are not explicitly covered in the study.

2 METHODOLOGY AND KEY ASSUMPTIONS

Below, we outline the applied methodology and key assumptions applied in the assessment of fuel and GHG compliance costs for a vessel operating on fossil MGO.

2.1 Methodology

The following stepwise approach was applied:

1. **Selection of ship cases.** In collaboration with Maritime CleanTech, five relevant ship cases were identified. Key characteristics of each ship case included: ship-type, size and area of operation. The selection of ship cases was designed to represent a diverse range of vessel types and sizes, as well as different operational areas, with particular attention given to their relevance for Norway's maritime sector. The five ship cases include:
    - Ro-Ro vessel (67 300 GT) operating purely on the European side of the Mediterranean
    - LPG carrier (25 500 GT) transporting LPG from the Norwegian west coast to ports in continental Europe and the UK
    - General cargo vessel (4 000 GT) operating between European ports in the Baltic Sea
    - CSOV (6 700 GT) operating within offshore wind farms off the coast of Denmark
    - PSV (3 600 GT) operating within the boundaries of both the Norwegian and UK continental shelves
2. **Establishment of case parameters for each ship case.** Using AIS-based analysis of representative ships utilizing DNV's MASTERv2-model[1], case parameters were established. This included annual fuel consumption and operational characteristics such as operational pattern, average transit speed, time in port and at sea.
3. **Calculation of fuel and GHG compliance costs.** Using DNV's in-house GHG cost optimizer model, fuel costs and GHG compliance costs are calculated for each ship case. The GHG cost optimiser model serves as a tool for calculating both fuel costs and GHG compliance costs for a specified ship case. Essentially, the model processes a set of input parameters—such as fuel type, annual fuel consumption, operational pattern, and applicable GHG regulations—and determines the corresponding fuel and compliance costs across various regulatory scenarios.

    In this study, the GHG compliance costs are calculated within three different regulatory scenarios (see Table 2-1), as agreed with Maritime CleanTech. The scenarios reflect three possible regulatory futures, addressing some of the uncertainty related to future GHG regulations. This study examines three possible future scenarios:

    - **Scenario 1:** FuelEU Maritime, EU ETS and UK ETS are in effect.
    - **Scenario 2:** IMO NZF, FuelEU Maritime, EU ETS and UK ETS are in effect. IMO NZF is assumed to be adopted and take effect from 2029. IMO Tier 2 Remedial Unit prices are assumed to be 380 USD/tonne CO2-eq throughout the modelling period.
    - **Scenario 3:** IMO NZF, EU ETS and UK ETS are in effect. IMO NZF is assumed to be adopted and take effect from 2029. IMO Tier 2 Remedial Unit prices are assumed to be 380 USD/tonne CO2-eq from 2029 to 2034, and from 2035, 500 USD/tonne CO2-eq.

[1] DNV's model used to estimate fuel consumption of ships based on AIS-data and other ship technical data.

The calculation of fuel costs assumes that each vessel maintains a constant annual consumption of MGO throughout the modelling period. For every regulatory scenario assessed, it is assumed that compliance is achieved by paying penalties under FuelEU Maritime, purchasing remedial units for IMO NZF, and acquiring emission allowances for both the EU and UK ETS. All cost values provided in the study are given in nominal terms for simplicity, within the assessed time-period 2028 to 2050 (23 years).

Table 2-1 Inclusion of regulations within each regulatory scenario assessed.

Scenario	IMO NZF	FuelEU Maritime	EU ETS	UK ETS
1	Not included	Included	Included	Included
2	Included	Included	Included	Included
3	Included	Not included	Included	Included

2.2 Key assumptions

Below, we outline key assumptions made in the assessment of GHG compliance cost for each ship case.

2.2.1 MGO fuel price and GHG emission factors

Fuel prices are influenced by a range of different market factors which, historically, have led to significant volatility. As a simplification, this study applies a constant fuel price for MGO of **680 USD/tonne**, reflecting recent bunker price in Rotterdam.[2]

GHG emission factors for MGO, as per FuelEU Maritime, EU ETS, UK ETS, and the proposed IMO NZF regulation, along with the lower calorific value, are provided in Table 2-2. These values are firm as specified in the regulations, and we assume that they apply throughout the modelling period.

Table 2-2: Overview of GHG emission factors used under various regulatory regimes in the case study.

Fuel type	**Fuel class**	**Lower calorific value (MJ/g)**	**FuelEU Maritime** Well-to-Wake GHG intensity (gCO_{2eq}/MJ)	**IMO Net Zero Framework** Well-to-Wake GHG intensity (gCO_{2eq}/MJ)	**EU & UK ETS** Tank-to-Wake GHG intensity (gCO_{2eq}/MJ)
MGO	Fossil	0.0427	90.77	93.93	76.23

[2] Based on price of MGO in Rotterdam as per 2026-02-18 from Ship & Bunker: EUA Bunker Prices - Ship & Bunker

2.2.2 EU ETS and UK ETS

We assume that emission allowance prices will be equal under the EU ETS and UK ETS, reflecting a possible future in which the two schemes become fully linked.[3] At present, the UK ETS applies only to domestic voyages, but we assume that its scope will expand to include 50% of international voyages, as this extension is currently under consideration by the UK government.[4] If such a linkage and scope expansion are implemented, the EU ETS and UK ETS would in practice function as a single emissions trading system for the shipping sector. The applied projected EU and UK ETS allowance cost is based on the carbon price projection for Europe from DNV's Energy Transition Outlook study (DNV, 2025a). The assumed price per year is illustrated in Figure 2-1.

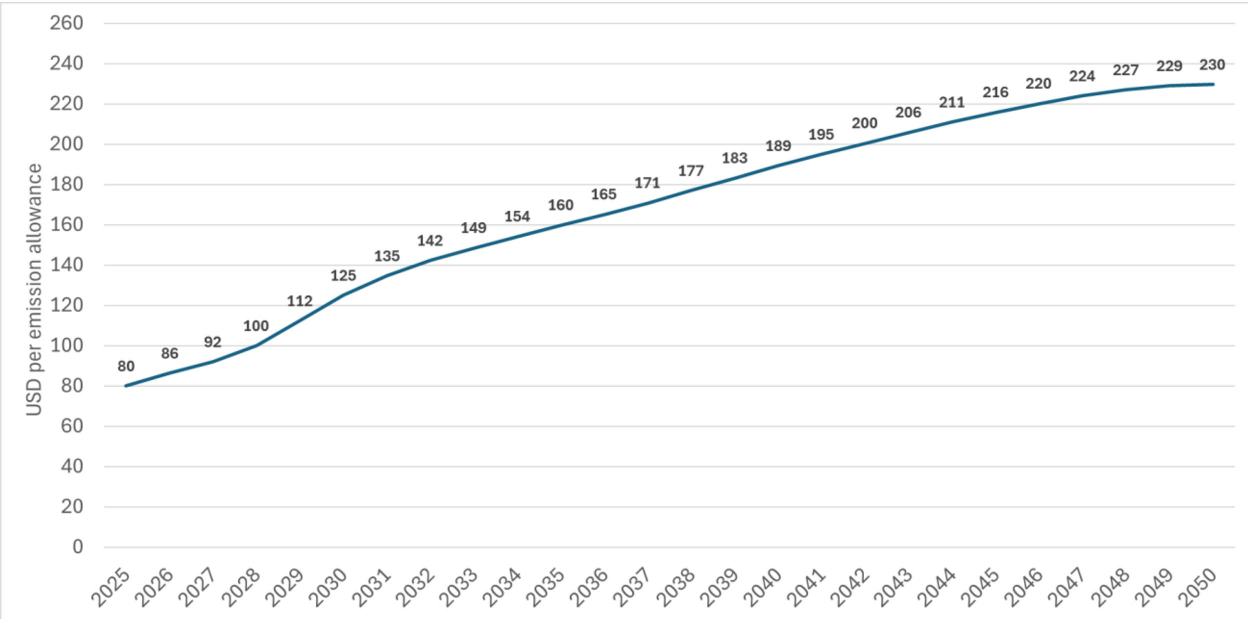

Figure 2-1: Applied cost per EU and UK emissions allowance (DNV, 2025a).

2.2.3 IMO NZF

In Scenarios 2 and 3 (see Table 2-1), we assume that the IMO NZF is adopted and takes effect from 2029, one year later than originally proposed, resulting in all reduction factors being shifted forward by one year (i.e., the reduction factor initially proposed for 2028 now applies to 2029, and so on). The adjusted reduction factors are presented in Table 2-3.

Table 2-3 Updated reduction target trajectories under the proposed IMO NZF. All reduction targets are set relative to a reference of 93.3 gCO2-eq./MJ.

Year	2029	2030	2031	2032	2033	2034	2035	2036	…	2041
Base	4%	6%	8%	12.4%	16.8%	21.2%	25.6%	30%	-	65%
Direct	17%	19%	21%	25.4%	29.8%	34.2%	38.6%	43%	-	-

[3] For more information, see: Linking the EU and UK emissions trading systems

[4] For more information, see: UK ETS scope expansion: domestic maritime - main Authority response (accessible webpage) - GOV.UK

As shown in Table 2-3, reduction factors have not been fully specified for all relevant years. We therefore assume that the base compliance target increases linearly from 30% in 2036 to 65% in 2041. Over the same period, the direct compliance target is assumed to remain 13 percentage points below the Base target. Beyond 2041, we assume that both the base target and the direct compliance target decline linearly to reach zero by 2051.

2.2.4 Expansion of Regulatory Coverage: FuelEU Maritime, EU/UK ETS, and IMO NZF

Today, neither FuelEU Maritime, EU ETS, and UK ETS, cover vessels below 5000 GT. While EU ETS and UK ETS will cover offshore vessels (including PSVs and CSOVs) from 2027, this is not yet decided upon for the FuelEU Maritime regulation. The proposed IMO NZF, if adopted, would cover offshore vessels, though not ships below 5000 GT.

In this study, we assume that the scope of GHG regulations will expand in the future as follows:

- **FuelEU Maritime:** general cargo ships and offshore vessels between 400 GT and 5000 GT included in scope from 2029. This could be a potential outcome from the FuelEU Maritime review to be conducted in 2027.
- **IMO NZF:** general cargo ships and offshore vessels between 400 GT and 5000 GT included in scope from 2034. This could be a potential outcome of an IMO NZF revision in the future.
- **EU ETS:** general cargo ships and offshore vessels between 400 GT and 5000 GT included in scope from 2028. This could be an outcome of the EU ETS revision planned for 2026.[5]
- **UK ETS:** general cargo ships and offshore vessels between 400 GT and 5000 GT included in scope from 2028.

[5] For more information, see: Revision of the EU emissions trading system

3 RO-RO

In this Chapter, we cover ship case assumptions and key results for the ship case: Ro-Ro.

3.1 Ship case assumptions

Table 3-1 presents key characteristics of the ship case, incorporating vessel- and AIS-specific data from DNV's MASTERv2-model.[6]

Table 3-1 Vessel and route characteristics for Ro-Ro ship case

Vessel type	Ro-Ro cargo vessel
Size	67 000 GT
Installed power	25 000 kW
Fuel energy use* (annual)	11 760 tonnes MGO-eq.
Time sailing/time in port*	60% / 40%
Typical sailing speed	17 kn
Area of operation	Exclusively European ports located in the Mediterranean
Distribution of fuel energy use by voyage classification (geographical)	% of fuel consumption in FuelEU Maritime/EU ETS scope: 100% % of fuel consumption in UK ETS scope: 0%
Period to be analyzed	2028-2050 (23 years)

*Data retrieved from analysis of AIS-data.

3.2 Ship case results

Below, in Figure 3-1, Figure 3-2, and Figure 3-3, we provide annual costs (fuel cost and GHG compliance costs) for each regulatory scenario, starting from scenario 1. GHG compliance costs are divided into EU ETS allowance cost (EU ETS), UK ETS allowance cost (UK ETS), penalty cost for FuelEU Maritime (FuelEU Penalty and Additional FuelEU Penalty[7]), and IMO Remedial Unit costs (IMO Tier 1 RU and IMO Tier 2 RU). In Figure 3-4 we compare the three scenarios.

Overall, the annual fuel and GHG compliance cost varies significantly by scenario. For example, in 2050, it varies from 40 million USD (scenario 3) to 121 million USD (scenario 2). As GHG regulations become stricter, the estimated costs for GHG compliance eventually exceed the expenditure on MGO fuel across all scenarios by a significant margin. Scenario 3 presents the lowest annual GHG compliance costs, owing to the assumption that FuelEU Maritime is phased out. The IMO Tier 2 Remedial Unit (RU) costs in scenario 3 are higher than those in scenario 2, reflecting an assumed increase in the price per remedial unit to 500 USD per tonne CO2-eq. from 2035 onwards in scenario 3.

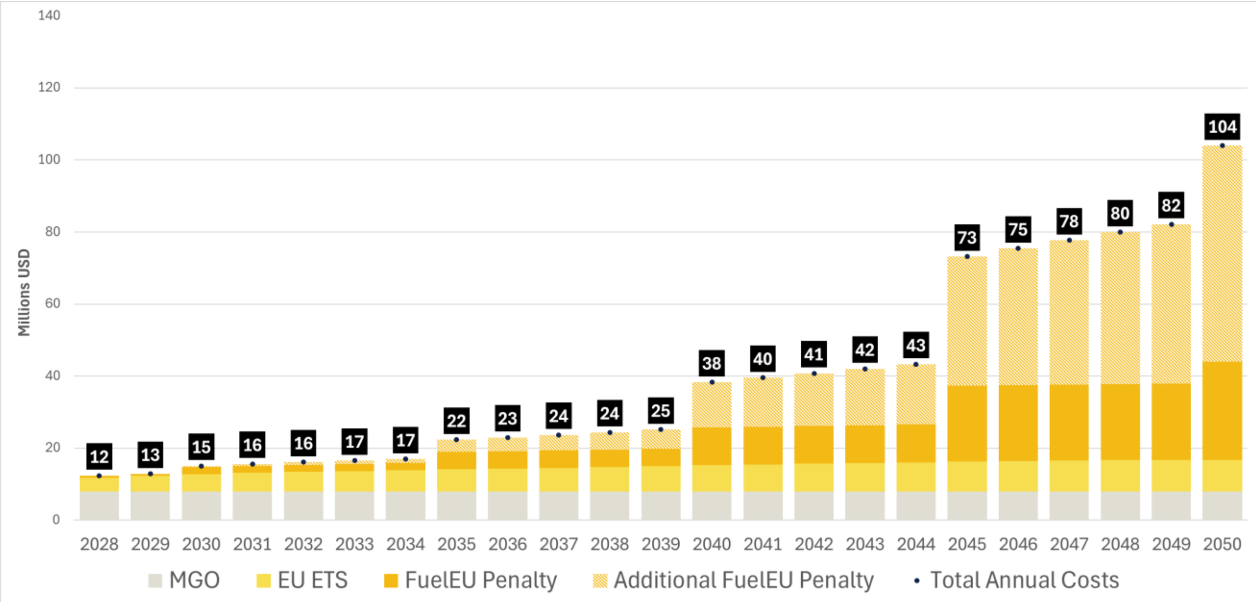

Figure 3-1 Annual costs in Scenario 1 for the Ro-Ro ship case.

[7] The additional FuelEU Maritime penalty cost reflects the extra penalty incurred when one or more consecutive reporting periods rely on penalties as the chosen compliance option.

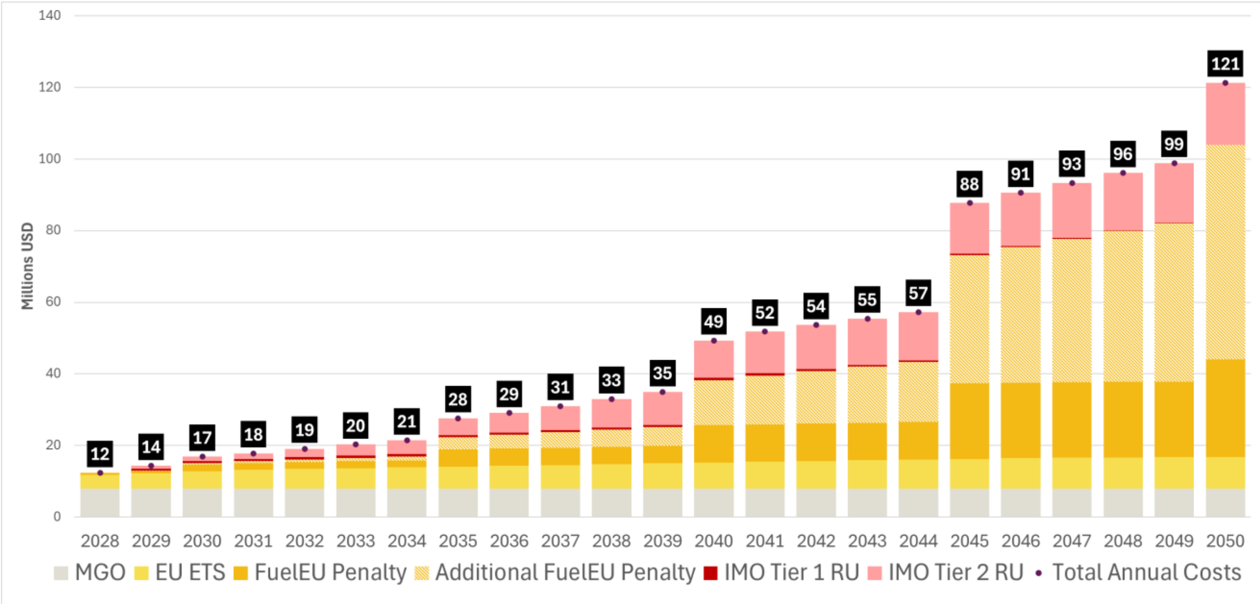

Figure 3-2 Annual costs in Scenario 2 for the Ro-Ro ship case.

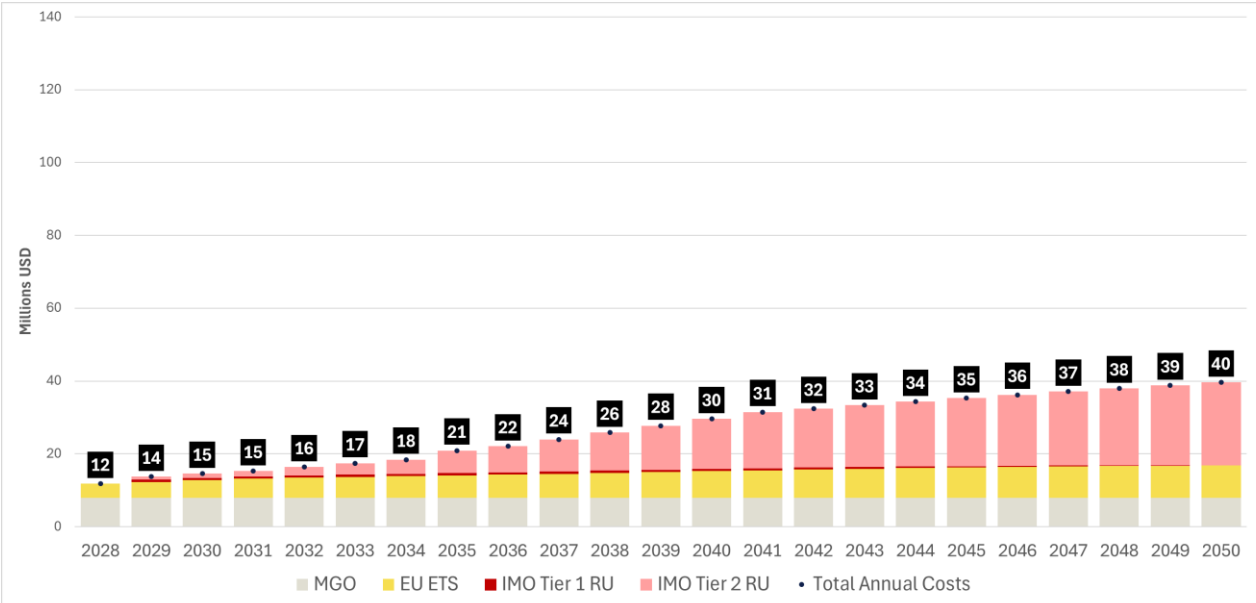

Figure 3-3 Annual costs in Scenario 3 for the Ro-Ro ship case.

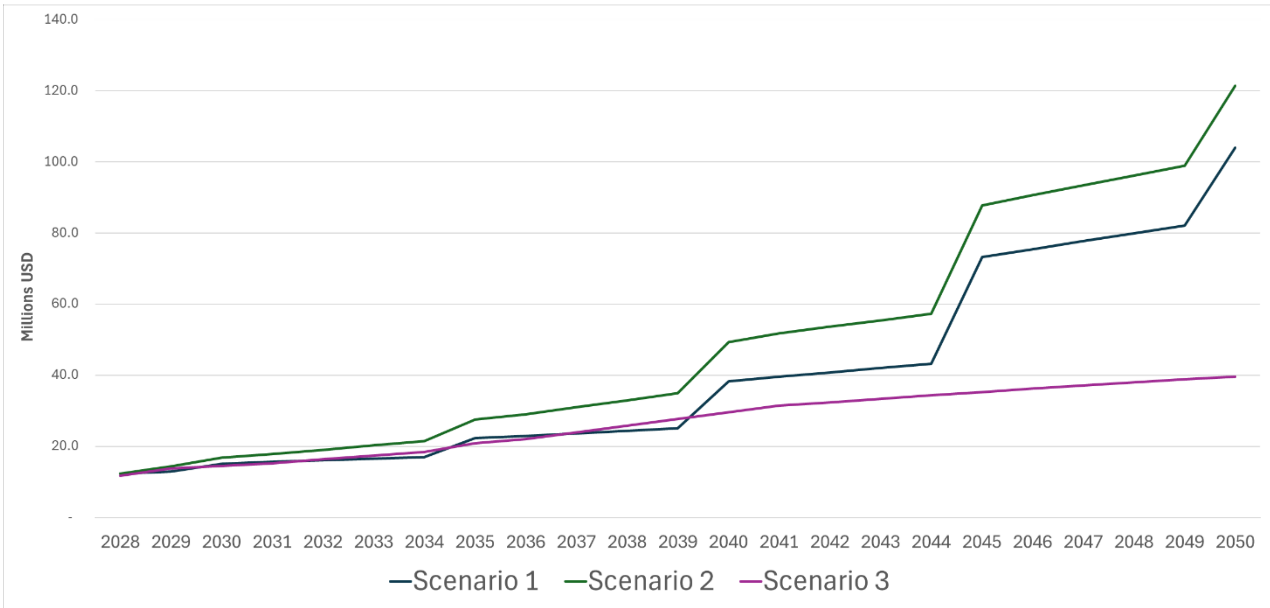

Figure 3-4: Comparison of the fuel and compliance cost by scenario for the Ro-Ro ship case.

4 LPG CARRIER

In this Chapter, we cover ship case assumptions and key results for the ship case: LPG carrier.

4.1 Ship case assumptions

Table 3-1 presents key characteristics of the ship case, incorporating vessel- and AIS-specific data from DNV's MASTERv2-model.

Table 4-1 Vessel and route characteristics for LPG carrier ship case.

Vessel type	LPG carrier
Size	25 500 GT
Installed power	8 000 kW
Fuel energy use* (annual)	5 070 tonnes MGO-eq.
Time sailing/time in port*	67% / 33%
Typical sailing speed	15 kn
Area of operation	North Europe and the UK
Distribution of fuel energy use by voyage classification (geographical)	% of fuel consumption in FuelEU/EU ETS scope: 77% % of fuel consumption in UK ETS scope: 23%
Period to be analyzed	2028-2050 (23 years)

*Data retrieved from analysis of AIS-data.

4.2 Ship case results

Below, in Figure 4-1, Figure 4-2, and Figure 4-3, we provide annual costs (fuel expenditure and GHG compliance costs) for each regulatory scenario, starting from scenario 1. In Figure 4-4 we compare the three scenarios.

We see the same overall pattern in annual costs—comprising both fuel costs and GHG compliance costs—for this ship case as we did for the Ro-Ro vessel covered in Chapter 3. In this case, however, a portion of the vessel's operations falls under the assumed scope of the UK ETS, which is reflected in the results. It is also worth noting that both fuel and GHG compliance costs are lower than those of the Ro-Ro case, primarily due to the LPG carrier's lower fuel consumption.

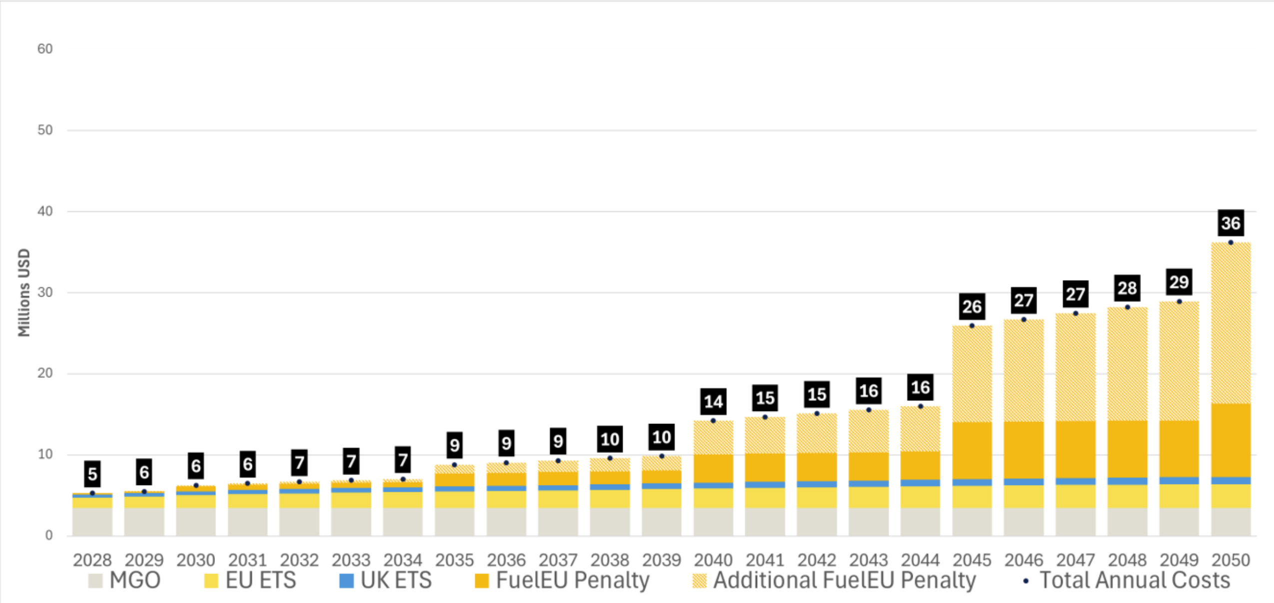

Figure 4-1 Annual costs in Scenario 1 for LPG carrier ship case.

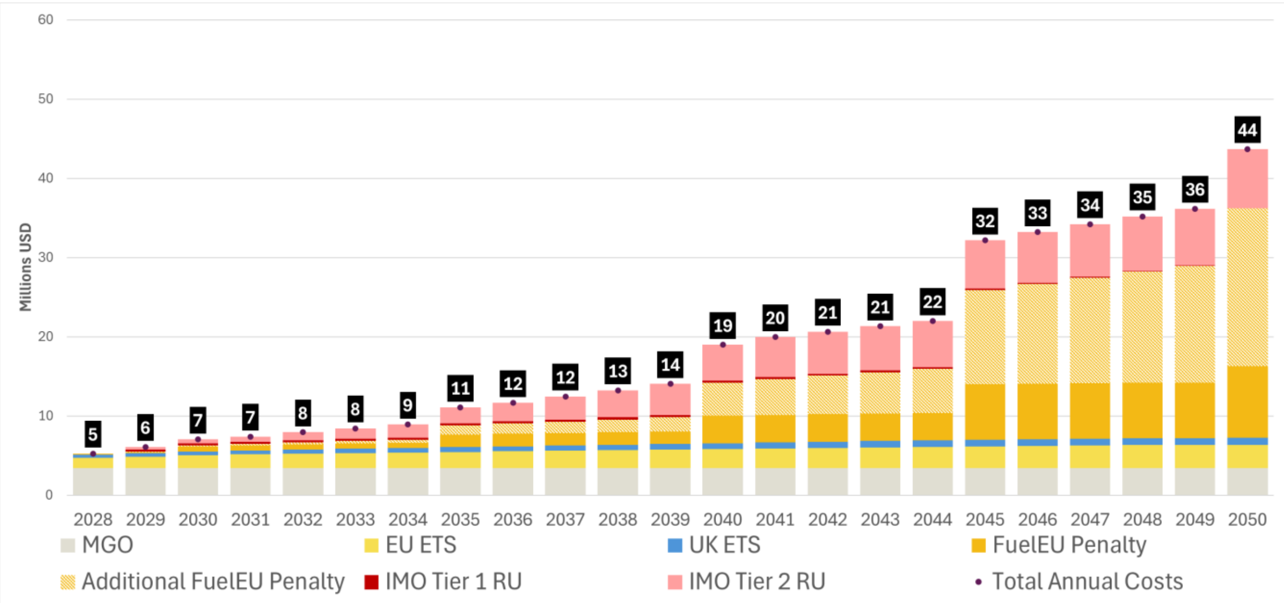

Figure 4-2 Annual costs in Scenario 2 for the LPG carrier ship case.

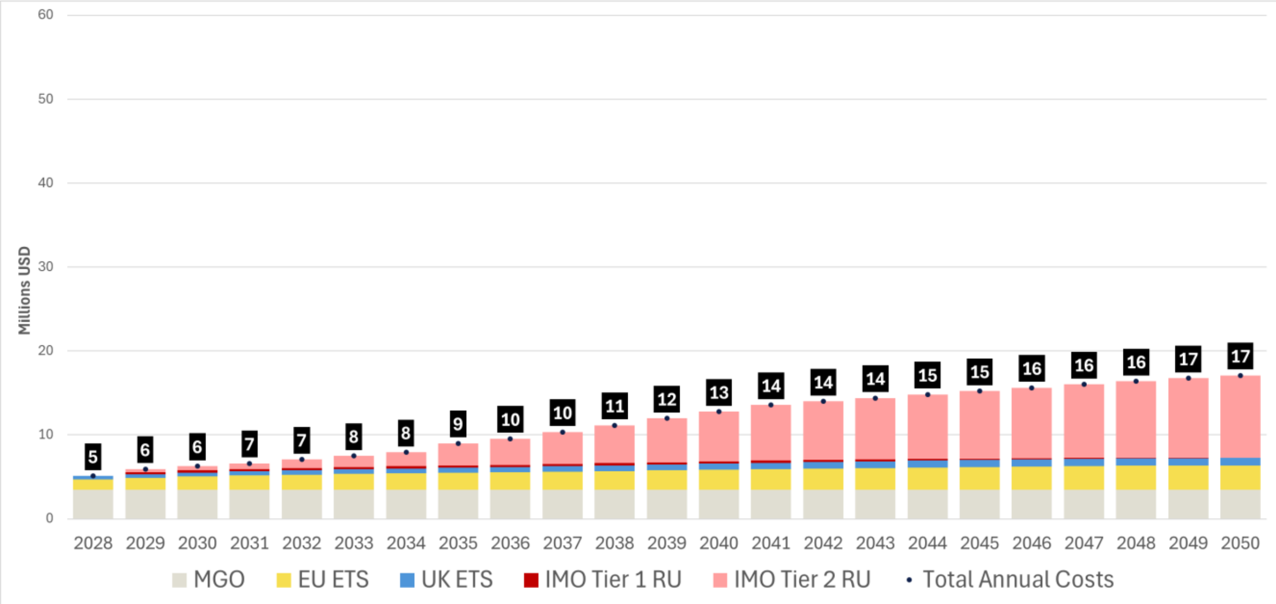

Figure 4-3 Annual costs in Scenario 3 for the LPG carrier ship case.

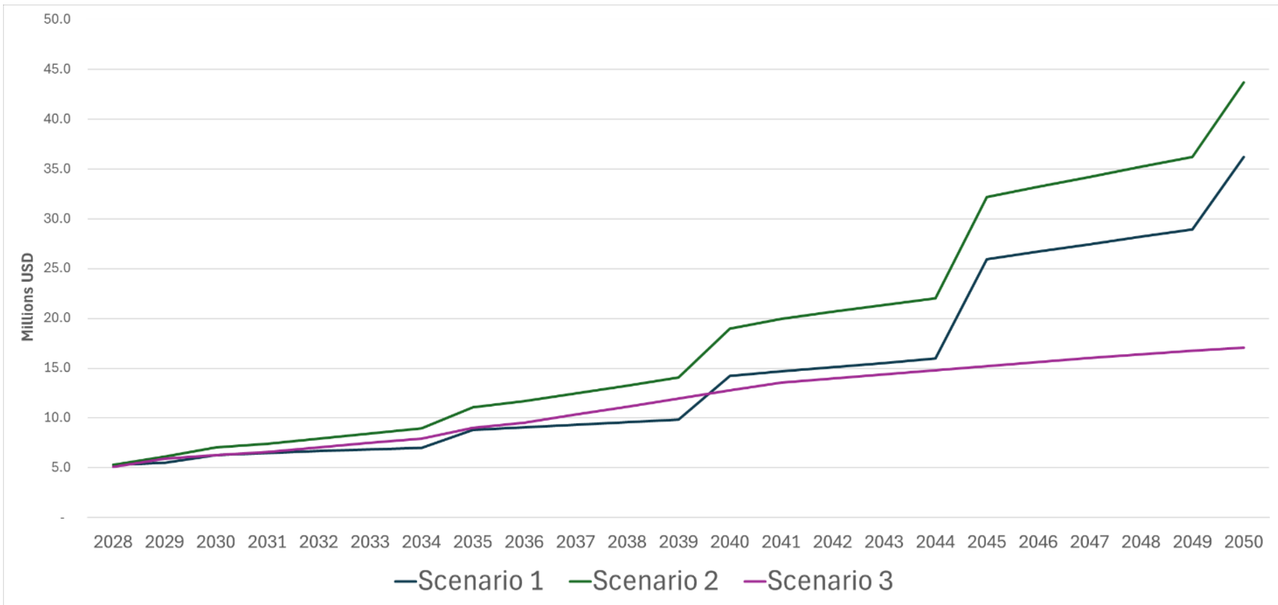

Figure 4-4: Comparison of the fuel and compliance cost by scenario for the LPG carrier ship case.

5 GENERAL CARGO SHIP

In this Chapter, we cover ship case assumptions and key results for the ship case: General cargo ship.

5.1 Ship case assumptions

Table 3-1 presents key characteristics of the ship case, incorporating vessel- and AIS-specific data from DNV's MASTERv2-model.

Table 5-1 Vessel and route characteristics for the general cargo ship case.

Vessel type	General cargo ship
Size	4 000 GT
Installed power	2 700 kW
Fuel energy use* (annual)	1 530 tonnes MGO-eq.
Time sailing/time in port*	52% / 48%
Typical sailing speed	12 kn
Area of operation	Baltic Sea
Distribution of fuel energy use by voyage classification (geographical)	% of fuel consumption in FuelEU/EU ETS scope: 100% % of fuel consumption in UK ETS scope: 0%
Period to be analyzed	2028-2050 (23 years)

*Data retrieved from analysis of AIS-data.

5.2 Ship case results

Below, in Figure 5-1, Figure 5-2, and Figure 5-3, we provide annual costs (fuel expenditure and GHG compliance costs) for each regulatory scenario, starting from scenario 1. In Figure 5-4 we compare the three scenarios.

We see the same overall pattern in annual costs—comprising both fuel costs and GHG compliance costs—for this ship case as we did for the Ro-Ro vessel covered in Chapter 3. In this case, however, both fuel and GHG compliance costs are lower than those of the Ro-Ro case, primarily due to the general cargo vessel's lower fuel consumption.

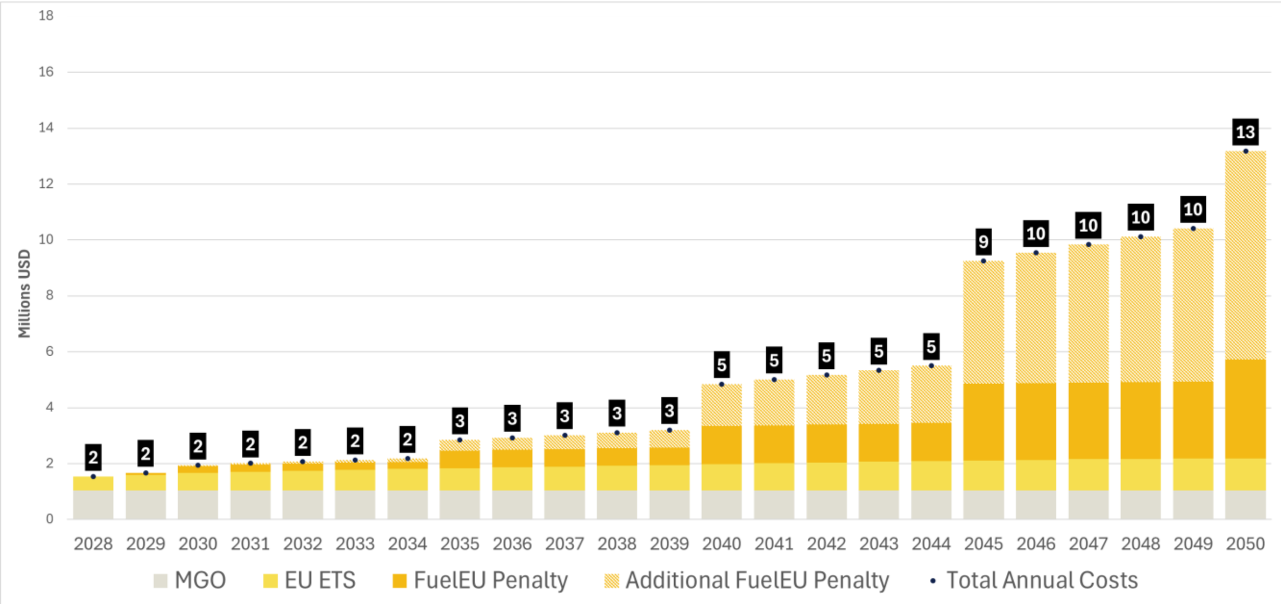

Figure 5-1 Annual costs in Scenario 1 for the general cargo ship case.

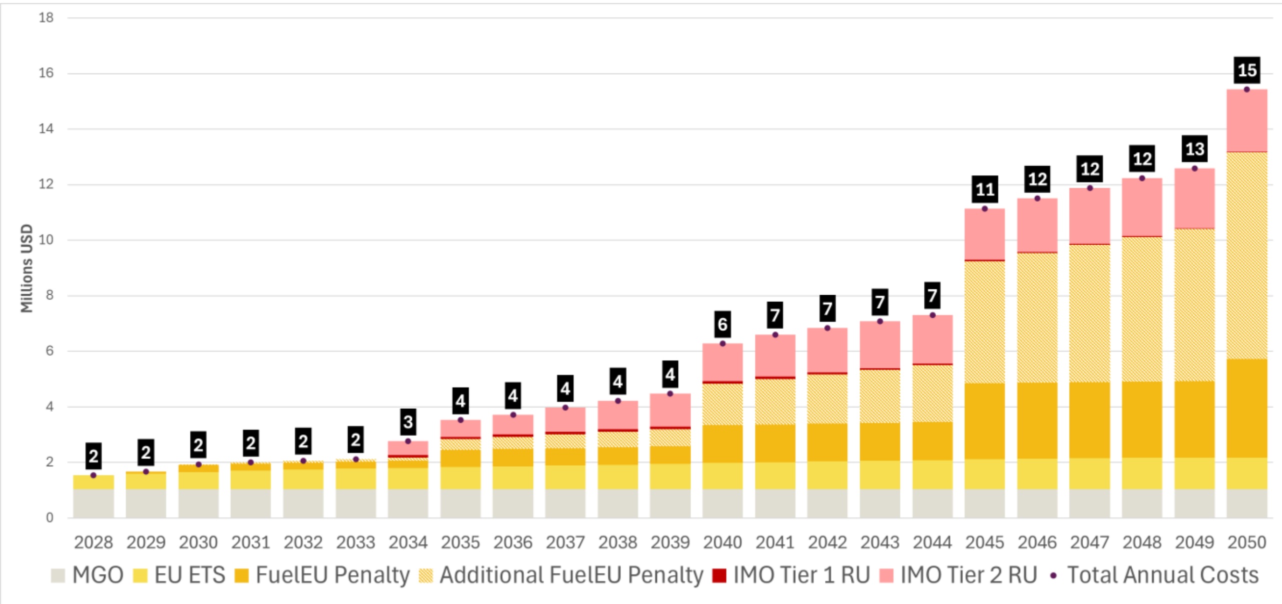

Figure 5-2 Annual costs in Scenario 2 for the general cargo ship case.

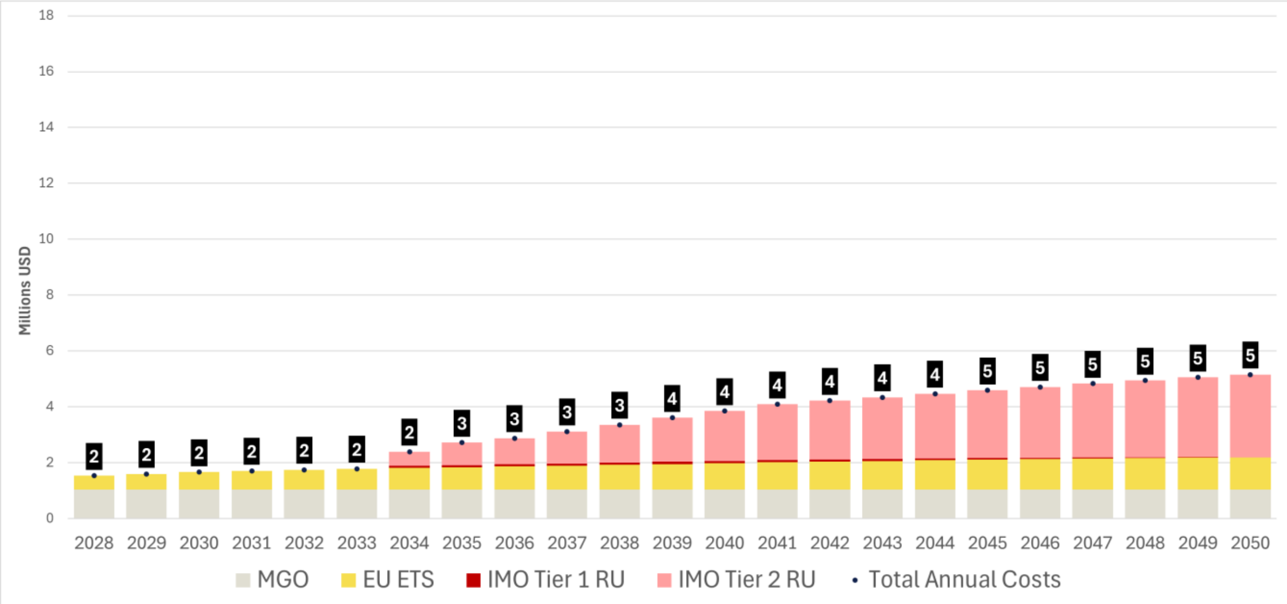

Figure 5-3 Annual costs in Scenario 3 for the general cargo ship case.

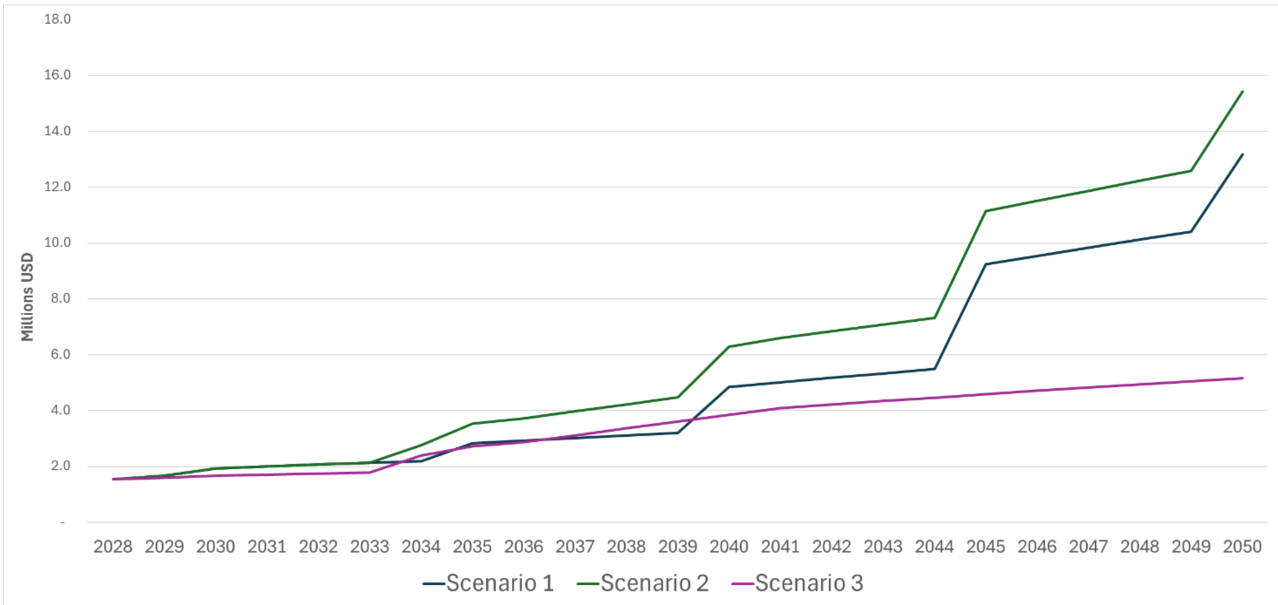

Figure 5-4: Comparison of the fuel and compliance cost by scenario for the general cargo ship case.

6 COMMISSIONING SERVICE OPERATION VESSELS (CSOV)

In this Chapter, we cover ship case assumptions and key results for the ship case: CSOV.

6.1 Ship case assumptions

Table 3-1 presents key characteristics of the ship case, incorporating vessel- and AIS-specific data from DNV's MASTERv2-model[8].

Table 6-1 Vessel and route characteristics for CSOV ship case.

Vessel type	CSOV
Size	6 700 GT
Installed power	5 300 kW
Fuel energy use* (annual)	1 650 tonnes MGO-eq.
Time at sea/time in port*	76% / 24%
Typical sailing speed	15 kn
Area of operation	Offshore wind farms outside Denmark
Distribution of fuel energy use by voyage classification (geographical)	% of fuel consumption in FuelEU/EU ETS scope: 100% % of fuel consumption in UK ETS scope: 0%
Period to be analyzed	2028-2050 (23 years)

*Data retrieved from analysis of AIS-data.

6.2 Ship case results

Below, in Figure 6-1, Figure 6-2, and Figure 6-3, we provide annual costs (fuel expenditure and GHG compliance costs) for each regulatory scenario, starting from scenario 1. In Figure 6-4 we compare the three scenarios.

We see the same overall pattern in annual costs—comprising both fuel costs and GHG compliance costs—for this ship case as we did for the Ro-Ro vessel covered in Chapter 3. In this case, however, both fuel and GHG compliance costs are lower than those of the Ro-Ro case, primarily due to the CSOV's lower fuel consumption.

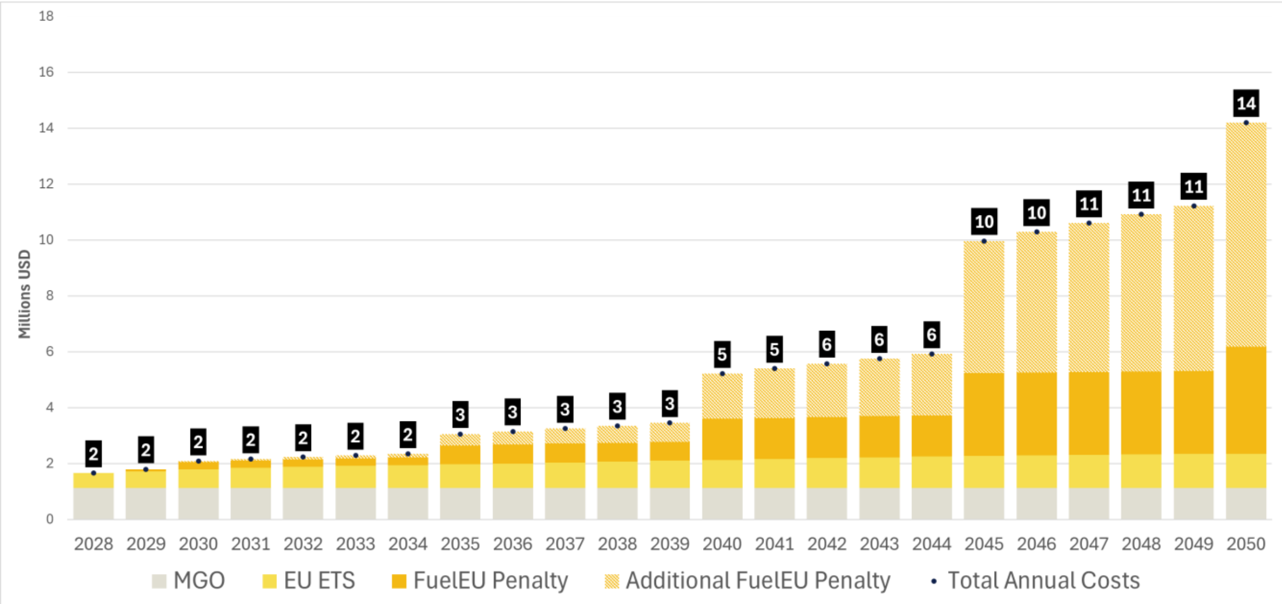

Figure 6-1 Annual costs in Scenario 1 for the CSOV ship case.

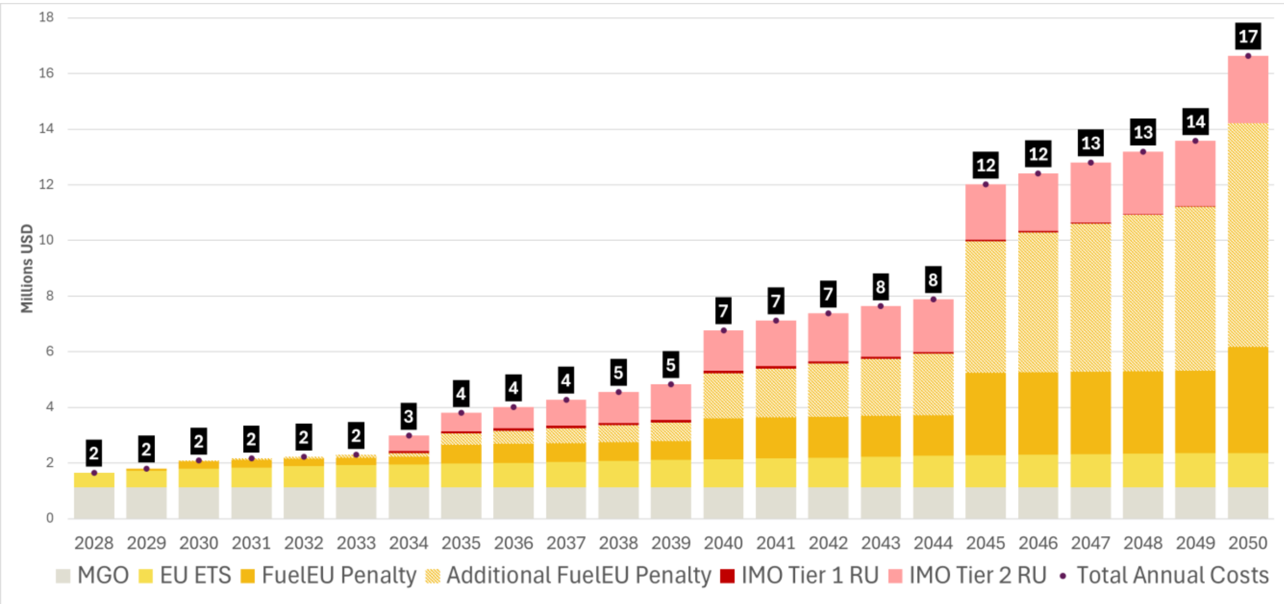

Figure 6-2 Annual costs in Scenario 2 for the CSOV ship case.

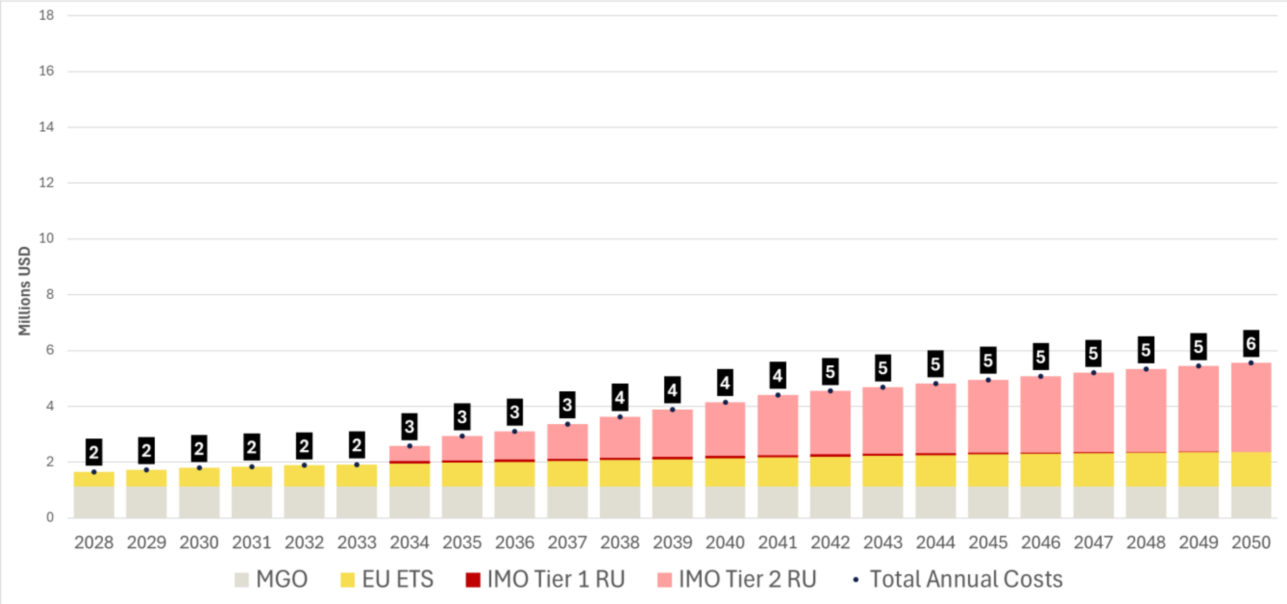

Figure 6-3 Annual costs in Scenario 3 for the CSOV ship case.

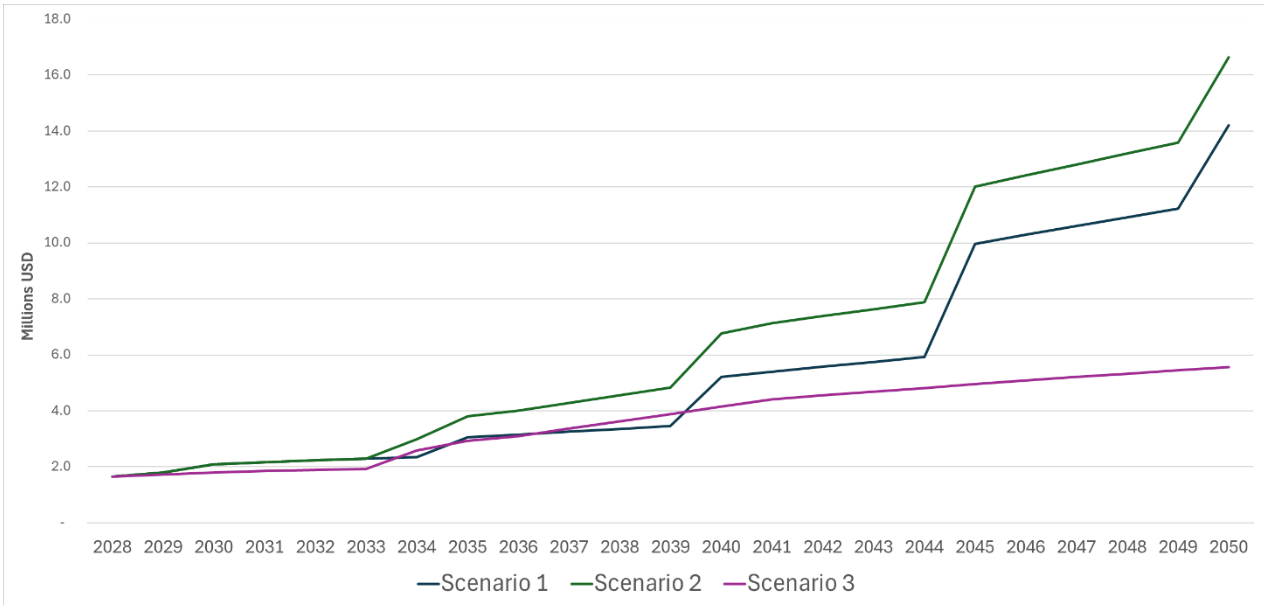

Figure 6-4: Comparison of the fuel and compliance cost by scenario for CSOV ship case.

7 PLATFORM SUPPLY VESSEL (PSV)

In this Chapter, we cover ship case assumptions and key results for the ship case: PSV.

7.1 Ship case assumptions

Table 3-1 presents key characteristics of the ship case, incorporating vessel- and AIS-specific data from DNV's MASTERv2-model.

Table 7-1 Vessel and route characteristics for PSV ship case.

Vessel type	PSV
Size	3 600 GT
Installed power	3 450 kW
Fuel energy use* (annual)	2 230 tonnes MGO-eq.
Time at sea/time in port*	66% / 34%
Typical sailing speed	14 kn
Area of operation	Offshore installations on UK and Norwegian continental shelf
Distribution of fuel energy use by voyage classification	% of fuel consumption in FuelEU/EU ETS scope: 11% % of fuel consumption in UK ETS scope: 89%
Period to be analyzed	2028-2050 (23 years)

*Data retrieved from analysis of AIS-data.

7.2 Ship case results

Below, in Figure 7-1, Figure 7-2, and Figure 7-3, we provide annual costs (fuel expenditure and GHG compliance costs) for each regulatory scenario, starting from scenario 1. In Figure 7-4 we compare the three scenarios.

We see the same overall pattern in annual costs—comprising both fuel costs and GHG compliance costs—for this ship case as we did for the Ro-Ro vessel covered in Chapter 3. In this case, however, a portion of the vessel's operations falls under the assumed scope of the UK ETS, which is reflected in the results. It is also worth noting that both fuel and GHG compliance costs are lower than those of the Ro-Ro case, primarily due to the PSV's lower fuel consumption.

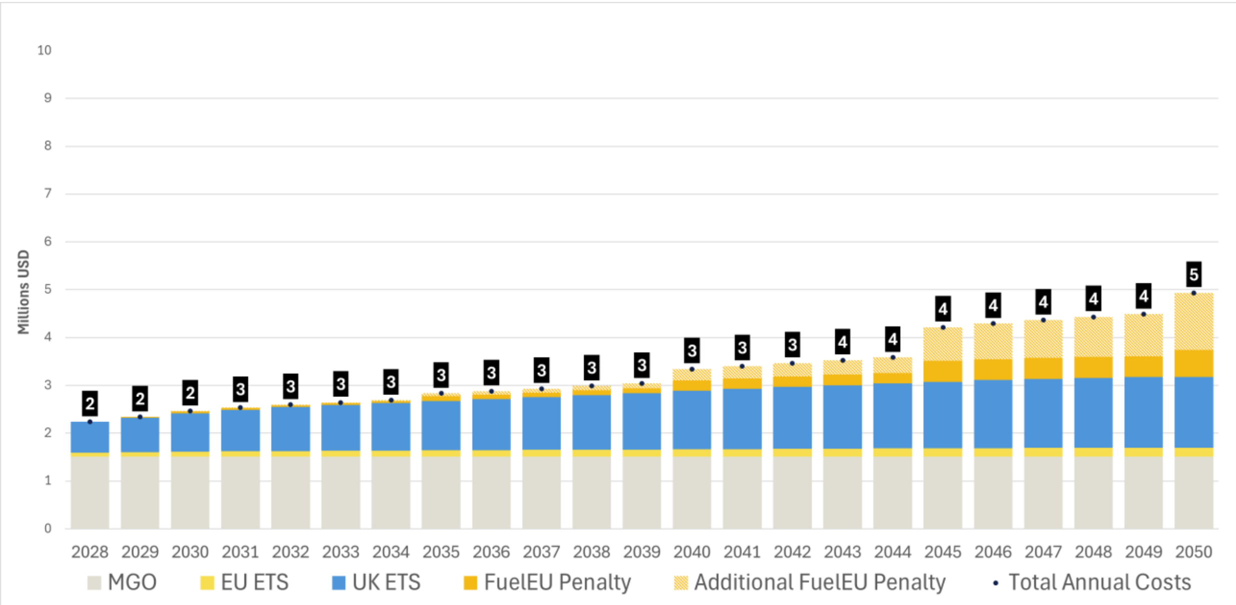

Figure 7-1 Annual costs in Scenario 1 for the PSV ship case.

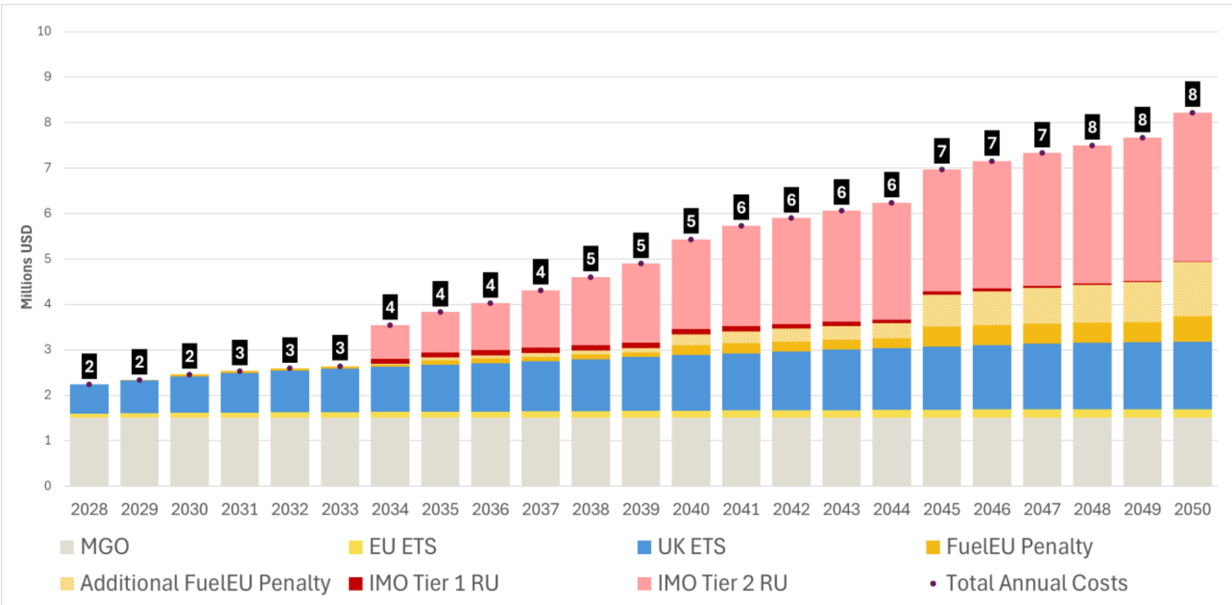

Figure 7-2 Annual costs in Scenario 2 for the PSV ship case.

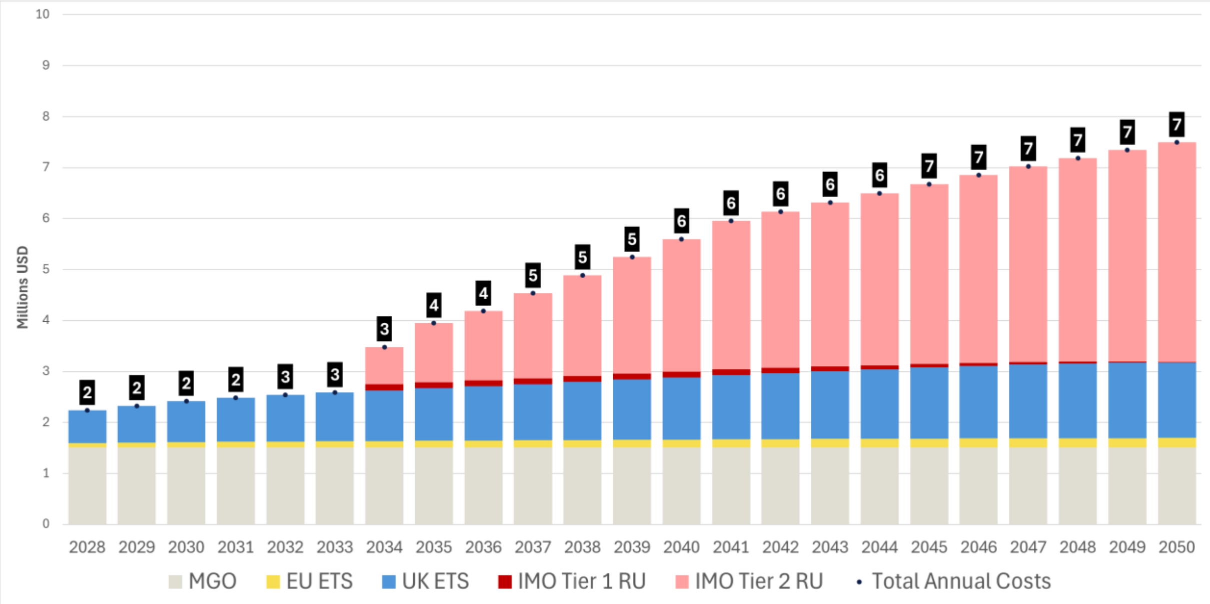

Figure 7-3 Annual costs in Scenario 3 for the PSV ship case.

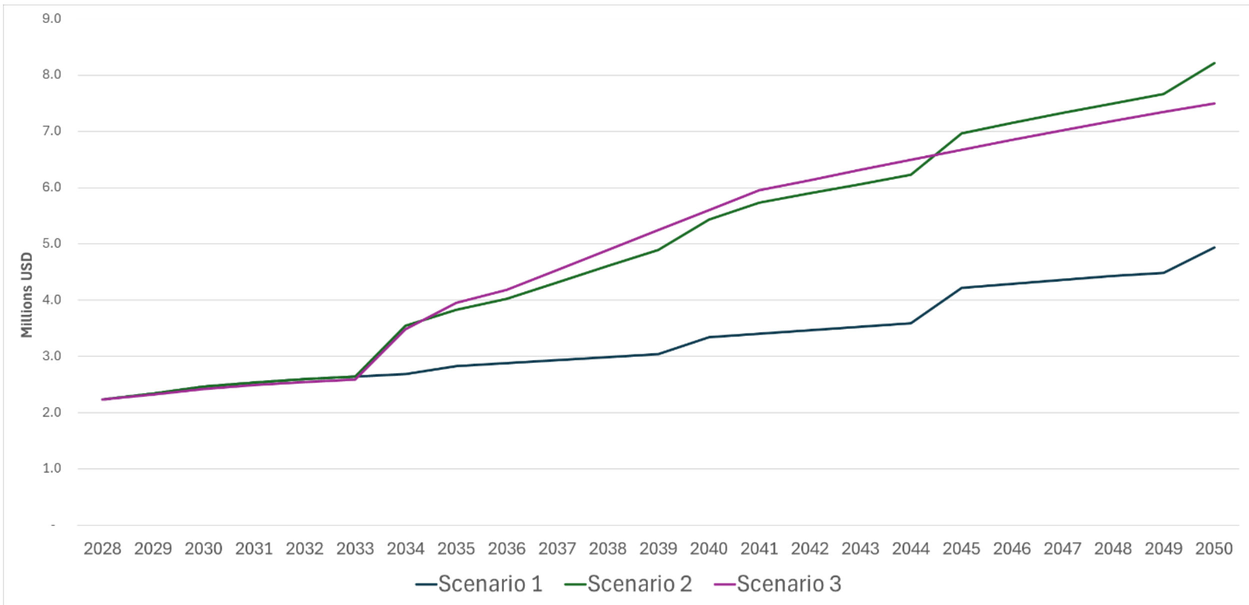

Figure 7-4: Comparison of the fuel and compliance cost by scenario for PSV ship case.

8 REGULATIONS NOT COVERED IN THIS STUDY

Some national regulations that could impose costs on the ship cases were not included, as they remain under development and lack sufficient detail to accurately assess their impact on ship owners. This applies to both the proposed GHG requirements for offshore vessels operating within the bounds of the Norwegian continental shelf and Türkiye's planned CO_2 pricing scheme:

- **Norwegian offshore GHG regulations:** Pending adoption, these rules are expected to apply from 2029, introducing stepwise reductions in GHG intensity through 2040. The regulation targets vessel *operators* rather than owners. Non-compliance may be carried into the next reporting period, and operators may face penalties of up to 15G[9] (approx. 1 952 400 NOK as of February 2026).[10]
- **Türkiye's planned carbon pricing mechanism:** Türkiye intends to introduce a national carbon pricing system covering shipping and other sectors, similar to the EU ETS. Details, including vessel scope, will be clarified in forthcoming presidential regulation.[11]

[9] 15 times the National Insurance basic amount (G), which as of February 2026, amounts to 1 952 400 NOK.

[10] For more information, see proposal and description from the Norwegian Environment Agency: Forslag til klimakrav for offshorefartøy - miljodirektoratet.no

[11] For more information, see Turkey Rolls Out its Own Carbon Price on Shipping

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