Navigating energy efficiency dilemmas in a decarbonisation era

A decision-making framework for choosing the best energy efficiency measures for your vessels.

Table of content

This whitepaper provides an overview of Hempel's decision-making framework for navigating energy efficiency dilemmas. Explore how it can be used to assess different hull coating options as well as other biofouling management and energy saving measures.

The full academic paper is available in the conference proceedings of HullPic 2023 **here (page 171)**.

Making informed decisions to lower vessel emissions

NET ZERO EMISSIONS BY 2050

To meet the International Maritime Organization's (IMO) updated Greenhouse Gas (GHG) Strategy ambition of reaching near net zero shipping by 2050, shipowners and operators must reduce vessel emissions by 40% by 2030, 80% by 2040 against 2008 baselines.

Meeting these requirements must be done at the shipowner and/or operators' own expense.

Today, there are limited alternative fuels widely available. Instead, shipowners and operators need to navigate and evaluate the various emissions reduction devices, technologies and strategies available. A decision-making process that is often full of unknowns.

A decision-making framework for any emissions reduction pathway

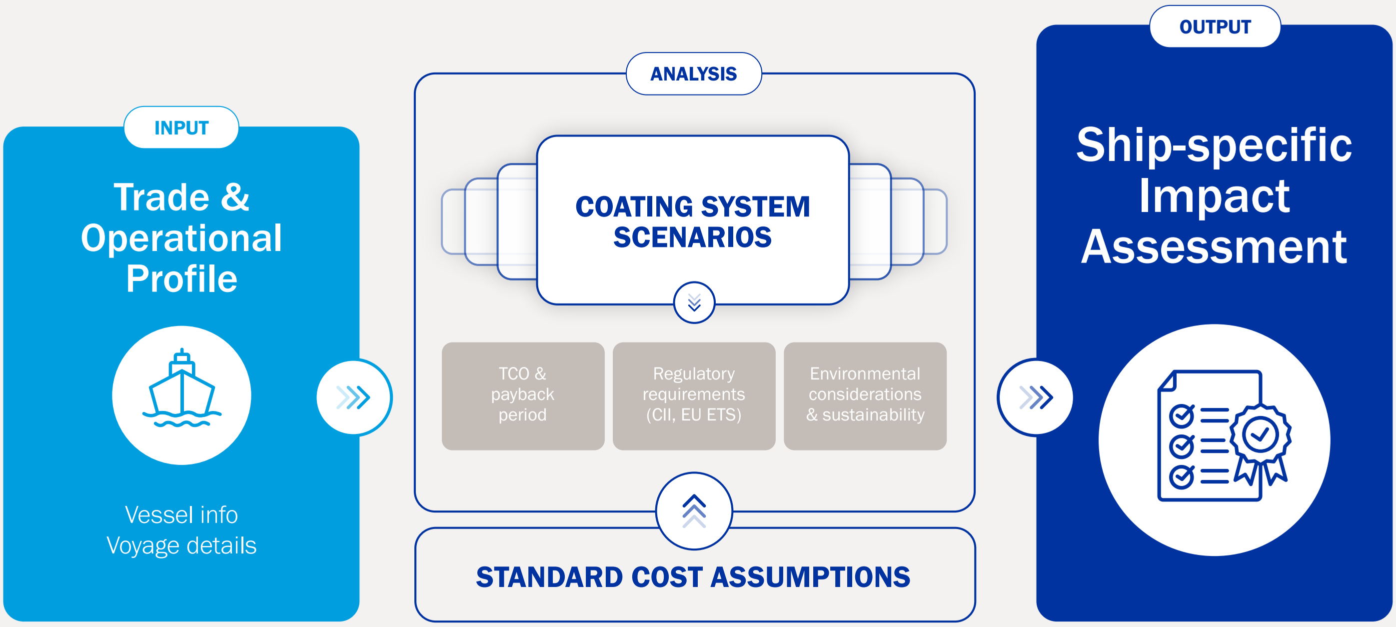
To help shipowners and operators make educated decisions about which energy efficiency measures to employ, Hempel has developed a decision-making framework. This framework evaluates different scenarios for enhancing energy efficiency, before making an investment decision.

By following the framework, you can understand how investment choices will impact your vessel's performance and your bottom-line. This can be done before spending a single dollar on equipment or products.

Introducing the Hempel framework

As a shipowner or operator, you might ask yourself: How can I make a more educated decision in **choosing the right measures for optimising energy efficiency?**

To help find the answer, the Hempel decision-making framework can guide you when evaluating the different pathways to energy efficiency.



Hempel's decision-making framework for ship-specific assessments of ship energy efficiency measures – example

The framework assesses different energy efficiency scenarios across three pillars

1

Total Cost of Ownership (TCO) and payback period

All costs associated with installation/application and in-service operation and maintenance. Also considers expected payback period and fuel cost responsibility (e.g., owner vs. operator)

2

Regulatory requirements and compliance

Carbon Intensity Indicator (CII) rating, Vref for the Energy Efficiency Existing Ship Index (EEXI), EU Emissions Trading System (ETS) compliance and others

3

Environmental considerations and sustainability

The sustainability-related factors including environmental impact during installation and in-service impact, e.g. emissions to sea

To conduct the comparative analysis, we need a good understanding of the vessel's operating profile. This helps us identify the biofouling risk (e.g. how long the vessel is staying idle in warm waters), the risk of increasing CII due to operation (e.g. short voyages, long waiting times) and the risk of poor paint specification (e.g. product, number of coats and DFT not aligned with expected trade requirement).

Case study: comparing four biofouling management scenarios

We have illustrated the application of the decision-making framework in a case study of a bulk carrier to identify the optimal hull coating solution and biofouling management strategy.[1]

VESSEL TYPE

Bulk carrier

OPERATING REGION

Mediterranean region

OPERATION PERIOD

5 years

DEADWEIGHT	LENGTH	BREADTH
40,000 t	179 m	28 m
DESIGN DRAFT	WETTED SURFACE AREA	SPEED
10.6 m	7,350 m²	14 knots
FUEL CONSUMPTION (CLEAN - SPC)		
20.4 t/day		

1. The vessel used for this case study is based Glofouling's report GEF-UNDP-IMO (2022)

Using Hempel's decision-making framework, we evaluate **four biofouling management scenarios** that is applied to the specific vessel particulars (trade and operational profile data). This enables us to understand the direct impact of the chosen hull coating product and hull maintenance strategy.

	SCENARIO[2] 1	SCENARIO[2] 2	SCENARIO[2] 3	SCENARIO 4
HULL COATING	**SPC AF coating**	**SPC AF coating**	**SPC AF coating**	**Silicone-based low friction coating[3]**
HULL RELATED MEASURES	**No**	**Hull cleaning after 3 & 4 years**	**Hull cleaning after 1 ½, 2, 2½, 3, 3½, 4, 4½ years**	**No**
PROPELLER RELATED MEASURES	**No**	**Propeller cleaning after 3 & 4 years**	**Propeller cleaning after 1½, 2, 2½, 3, 3½, 4, 4½ years**	**Propeller polishing, twice a year**

This case study analyses the four Biofouling Management Scenarios' impact on the ship's **required power, fuel consumption, fuel costs, and total CO_2 emissions over a 5-year docking cycle**, which includes an analysis of:

- Total fuel consumption and power penalty over time
- Impact on Carbon Intensity Indicator (CII) rating
- EU ETS carbon costs
- Total Cost of Ownership and payback period

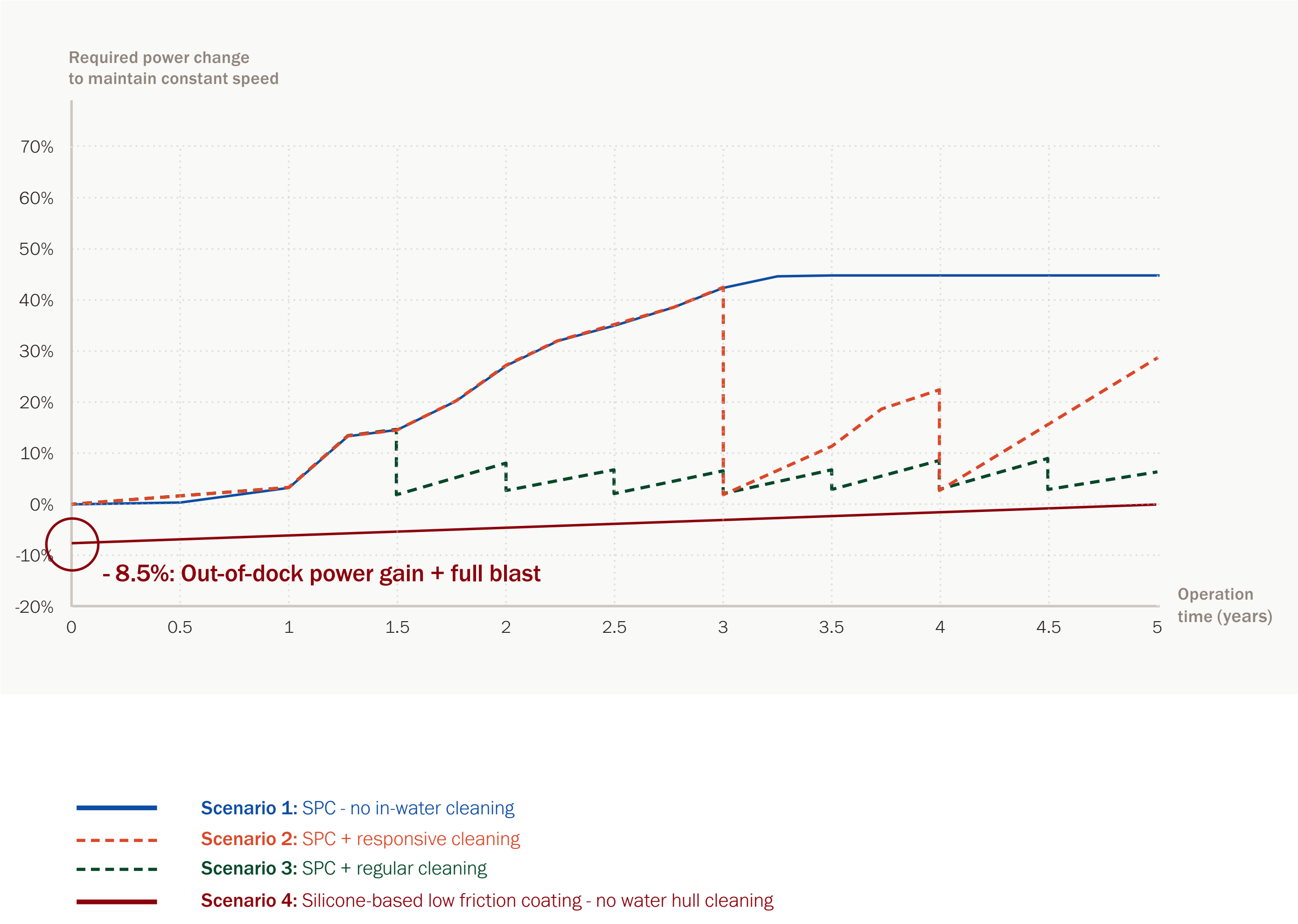
2. The scenarios used for this case study are based Glofouling's report GEF-UNDP-IMO (2022)

3. Hempaguard X7 has been used for this scenario

Required power change assessment

The different scenarios analysed in the study show varying effects on the required power for ship operation (14 kn design speed) for the specific vessel.

As you can see in the table, scenario 4 has an impressive 8.5% out of-dock-power saving. Therefore, the required power starts at -8.5% and linearly increases to -0.1% compared to a clean SPC coated surface (if always clean and free from fouling).

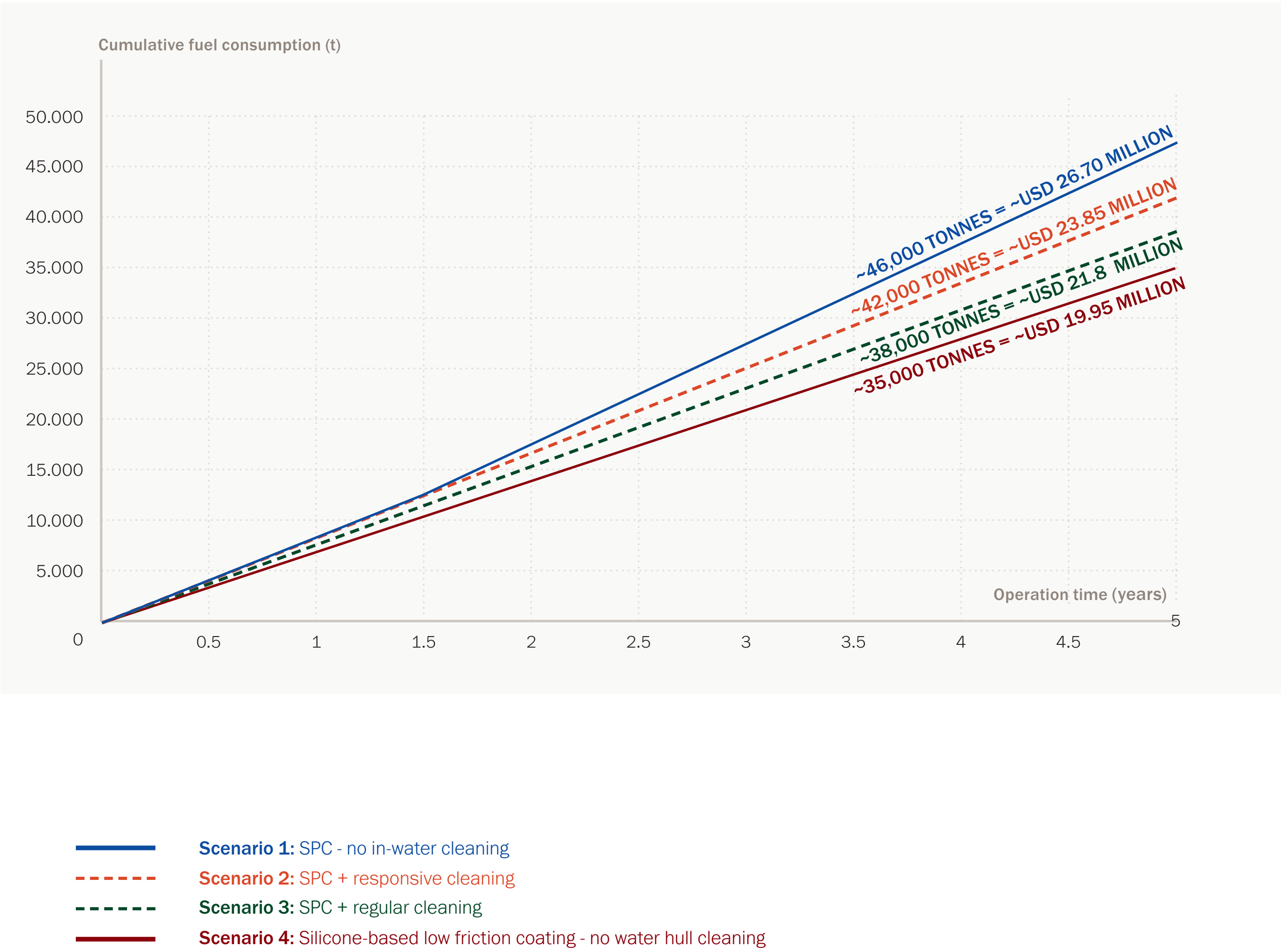


Required power increase of a bulk carrier with different biofouling management strategies over the 5-year operation, adapted from GEF-UNDP-IMO (2022)

Cumulative fuel consumption

The cumulative fuel consumption is an important factor to include in evaluating the full operational costs between each docking interval.

From the graph, you can see that as the operation time extends, the variations in cumulative fuel consumption between the scenarios become more distinct. **The difference between scenario 1 and scenario 4, sums up to a difference of 11,000 tonnes ~USD 6,75 million, based on a fuel price of USD 572.5 per metric ton of FO fuel.**



Cumulative fuel consumption of the bulk carrier with different biofouling management strategies over the 5-year operation, adapted from GEF-UNDP-IMO (2022)

Carbon Intensity Indicator (CII) assessment

The CII (Carbon Intensity Indicator) is a measure for a ship's energy efficiency and is given in grams of CO_2 emitted per cargo-carrying capacity and nautical mile. According to IMO regulations, a vessel that receives three consecutive "D" ratings or a single "E" rating in a given year is mandated to develop and present a corrective action plan for attaining a CII index of "C" or higher.

In assessing the four scenarios of our case study, we can see that only scenario 4 maintains a CII rating throughout the docking cycle that keeps the shipowner/operator from developing a corrective plan.

	2024	2025	2026	2027	2028
SCENARIO 1	6.12 (C)	7 (E)	8.19 (E)	8.72 (E)	8.76 (E)
SCENARIO 2	6.12 (C)	7 (E)	8.09 (E)	6.74 (E)	6.69 (E)
SCENARIO 3	6.12 (C)	6.49 (D)	6.33 (D)	6.38 (D)	6.35 (D)
SCENARIO 4	5.59 (B)	5.69 (C)	5.8 (C)	5.9 (C)	6 (D)

The CII values of the ship under different biofouling management scenarios

EU ETS Carbon Costs

The European Union Emissions Trading Scheme (EU ETS) is a cap-and-trade system designed to reduce GHG emissions by imposing a cap on emissions for specific economic sectors, including shipping from 2024.

This case study assumes that all operations occur within the Mediterranean Sea throughout the 5-year docking cycle. It is also based on an assumption that 60% of the operations involve travel between EU ports, while the remaining 40% involve journeys between EU and non-EU ports. EU ETS carbon price is assumed to be USD 90. This carbon price represents the cost of emitting one ton of carbon dioxide equivalent (CO_2e) into the atmosphere under the European Union Emissions Trading System (EU ETS).

These costs are closely aligned with the fuel consumption trends observed in each scenario. **Notably, scenario 4 stands out with the lowest total EU ETS carbon cost, totalling USD 6,449,000 over the five year period. Compared to the total cost of scenario 1, USD 8,900,000, this further reinforces scenario 4's position as a compelling option for reducing emissions and costs, optimising operational efficiency.**

	2024	2025	2026	2027	2028	TOTAL
SCENARIO 1	$659,000	$1,321,000	$2,207,000	$2,351,000	$2,362,000	**$8,900,000**
SCENARIO 2	$659,000	$1,321,000	$2,182,000	$1,816,000	$1,805,000	**$7,783,000**
SCENARIO 3	$659,000	$1,225,000	$1,708,000	$1,719,000	$1,712,000	**$7,023,000**
SCENARIO 4	$603,000	$1,075,000	$1,563,000	$1,590,000	$1,618,000	**$6,449,000**

Yearly EU ETS carbon costs of the ship under different biofouling management scenarios[4]

4. In the years 2024, 2025, 2026, 2027, and 2028, the percentages of eligible emissions to consider for EU ETS Carbon costs are 40%, 70%, 100%, 100%, and 100%, respectively.

Total Cost of Ownership and payback period

The Total Cost of Ownership (TCO) for the four Biofouling Management Scenarios provides insights on the overall financial implications of each option. The initial investment costs, including coating purchase cost and rental of repair yard cost, differ for each scenario.

Scenario 4 requires an initial investment of USD 581,500, while scenarios 1, 2, and 3 have an initial investment cost of USD 213,500. **Despite the higher initial investment cost of Scenario 4, this is quickly compensated due to the increased fuel savings provided.**

ELEMENTS OF COST		SCENARIO 1	SCENARIO 2	SCENARIO 3	SCENARIO 4	SCENARIO 1 VS SCENARIO 4
PAINT	Paint purchasing cost	$62,000	$62,000	$62,000	$305,000	$243,000
REPAIR YARD	Surface preparation cost	$21,000	$21,000	$21,000	$55,000	$34,000
	Washing cost	$4,500	$4,500	$4,500	$4,500	$0
	Paint application	$12,000	$12,000	$12,000	$65,000	$53,000
	Repair yard rent	$30,000	$30,000	$30,000	$40,000	$10,000
	Off hire cost	$84,000	$84,000	$84,000	$112,000	$28,000
CLEANINGS	Diver cost	$0	$40,000	$140,000	$27,000	$27,000
	Off hire cost	$0	$14,000	$70,000	$0	$0
FUEL	Fuel Cost (HSFO) 5 Years	$26,700,000	$23,850,000	$21,800,000	$19,950,600	-$6,749,400
	CO_2 emission tonnes (HSFO) 5 Years	145,043	129,549	.118,425	108,517	-36,526
TCO	Total Cost of Ownership (HSFO) 5 Years	**$26,913,500**	**$24,117,500**	**$22,223,500**	**$20,559,100**	-$6,354,400

Savings over 5 years **6,354,400**

Expected Payback Period (Months) **12**

The cost element for different biofouling management scenarios[5]

5. The case study scenario assumes that fuel and voyage costs are paid by the vessel owner for the duration of the 5-year dry-docking period

Since **EU ETS carbon costs are dependent on the trading patterns of each vessel, they are not included in the TCO overview.** When tying together this data with the TCO, we gain an even more complete picture of the costs associated with each biofouling management scenario.

The cost element for different biofouling management scenarios

ELEMENTS OF COST	SCENARIO 1	SCENARIO 2	SCENARIO 3	SCENARIO 4	SCENARIO 1 VS SCENARIO 4
TCO Total Cost of Ownership	$26,913,500	$24,117,500	$22,223,500	$20,559,100	**-$6,354,400**
EU ETS carbon cost Total EU ETS carbon cost	$8,900,000	$7,783,000	$7,023,000	$6,449,000	**-$2,451,000**
Total TCO + EU ETS Carbon Cost	$35,813,500	$31,900,500	$29,246,500	$27,008,100	**-$8,805,400**

"Within just a short timeframe, the accumulated savings in fuel costs from the enhanced fuel efficiency of applying a silicone-based hull coating will recuperate the upfront investment. In this case study, the vessel owner could save USD 8,805,000 by using a silicone-based hull coating."

Why it pays to invest in high-performance

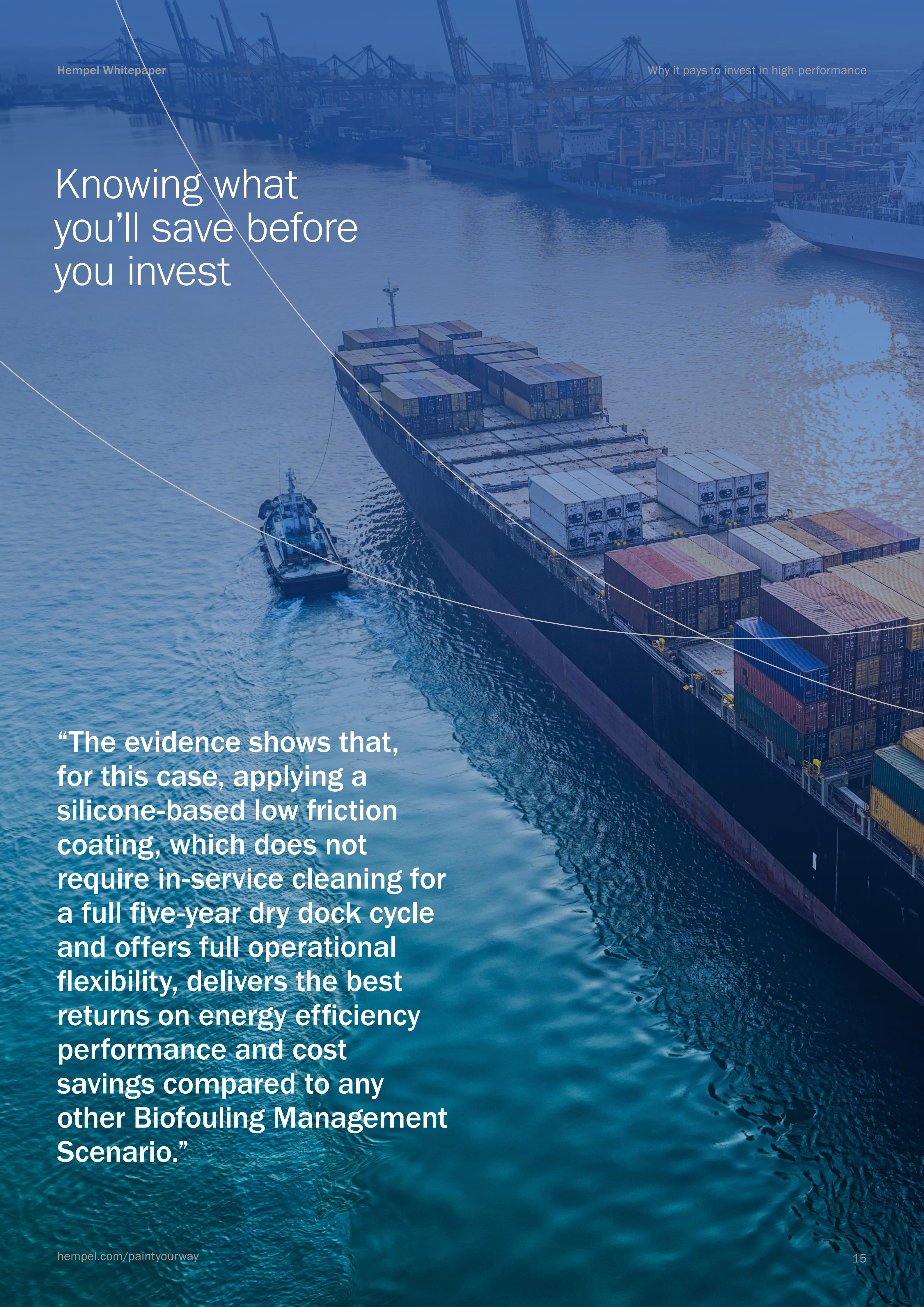
The case study highlights the significance of evaluating Total Cost of Ownership before making investments in alternative technologies. While initial investment costs are important, the long-term operational costs, particularly fuel costs, play a crucial role to both the vessel efficiency and its profitability.

Although applying a silicone-based hull coating requires a higher initial investment, its lower fuel costs and absence of hull-cleaning expenses contribute to its favourable TCO. The findings also reveal that opting for Scenario 4 over Scenario 1 leads to an impressive payback period of 12 months which may be even shorter for other vessel types and trading patterns.

	SCENARIO 1	SCENARIO 2	SCENARIO 3	SCENARIO 4
Power penalty over time	★	★★	★★★	★★★★
Total fuel consumption	★	★★	★★★	★★★★
CII	★	★★	★★★	★★★★
Total EU ETS carbon cost	★	★★	★★★	★★★★
Upfront investment cost	★★★★	★★★★	★★★★	★
Cleaning cost	★★★★	★★	★	★★★
Total Cost of Ownership (TCO)	★	★★	★★★	★★★★
Overall evaluation of scenarios	★	★★	★★★	★★★★

★ Denotes the least favourable scenario

★★★★ Denotes the most favourable scenario across each perspective



Knowing what you’ll save before you invest

“The evidence shows that, for this case, applying a silicone-based low friction coating, which does not require in-service cleaning for a full five-year dry dock cycle and offers full operational flexibility, delivers the best returns on energy efficiency performance and cost savings compared to any other Biofouling Management Scenario.”

Let us help you evaluate what the best strategy is for your vessel, book a vessel specific assessment here:

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