

WHITEPAPER

Clean green marine

The race to achieve zero-emission shipping
by 2050



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(expleo)

Fast facts



Shipping consumes
more fuel
than any other mode of transport



Up to **60%**
of a ship's operating cost
is fuel, depending on the
type of ship and service

About Expleo

Expleo is a trusted partner for end-to-end, integrated engineering, quality services and management consulting for digital transformation. We help businesses harness unrelenting technological change to successfully deliver innovations that will help them gain a competitive advantage and improve the everyday lives of people around the globe. We operate in 30 countries.

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In this whitepaper, we discuss the challenges and opportunities of a green transformation in the industry. Expleo is investigating alternative energy sources to diesel and diesel-electric propulsion and developing an AI neural network to optimise fuel consumption.



Introduction

As part of its Green Industrial Revolution, the UK Government has set out a roadmap of activity and investment to support the transition to net zero carbon.

The aim is to support **difficult-to-decarbonise** industries, like shipping, to become greener through research projects for zero-emission vessels.

Let's be in no doubt here. Decarbonising shipping over the next three decades will prove extremely difficult. Replacing hydrocarbons with clean energy sources is like the shift from sail to steam in the 19th Century and will require considerable investments from both government and business. This would include supporting green marine technology developments and significant CAPEX investment from vessel owner/operators and will require the support of government funded initiatives, although inevitably consumer costs may increase in order to fund this transition.

The best minds from across the industry will need to share and accelerate their thinking, because the clock is already ticking. The International Marine Organisation is targeting a 50% reduction of GHG emissions by 2050. In the UK, the government has set a target for 78% by 2035 and net zero carbon by 2050. So, strap yourself in!

But let's also park any concerns that this critical transformation can't or won't be achieved. As one of the world's largest producers of greenhouse gases, the shipping industry will play a leading role in the fight against climate change. In its Clean Maritime Plan, the UK Government – alongside other governments worldwide – has made it clear that operators that fail to meet the milestones will not be allowed to sail their ships.

While the commercial threat of non-compliance is clear, the UK Government is also taking steps to stimulate innovation. For example, the £20 million DfT Clean Maritime Demonstration Competition will 'springboard' transformation of the shipping industry, and also fund ship-to-shore innovations in port and bunkering (refuelling) infrastructure. A significant increase in government funding support will be required if the marine industry has any chance of meeting the maritime decarbonisation challenge.

Space for bold thinking

Research by the UK Government indicates that the global market for maritime emission reduction technologies could reach \$15 billion per year by 2050, potentially resulting in economic benefits to the UK of \$690 million annually by the middle of the century.

Expleo is working on a number of projects here in the UK but also across our organisation globally. In the UK our marine division is working on two particular projects – a feasibility study into the decarbonisation of a retrofit short-sea-shipping vessel investigating alternative energy storage and reduced carbon power and propulsion solution, and an AI neural network to deliver improved energy efficiency on all types of vessels – which are discussed further in this paper. They offer exciting opportunities to help our maritime partners on their journey to net zero carbon and also develop new skills in house for the future. With an emphasis on transferable and scalable innovation, our learnings are to be shared with the open market.

Alongside the challenges, there are exciting opportunities for designers, technologists and operators that can set the pace of change.



Expleo's vision is to develop a range of power and propulsion solutions for all vessel sizes and types, selecting the optimal energy carrier(s)/ fuels and green technology that complements a specific vessels operational profile. The realisation of the problem has brought to light that not one solution fits all.

The maritime industry recognises that there is currently no single 'silver bullet' solution for delivering net zero carbon shipping and a combination of different approaches are required to solve the problem. We must stay alive to the possibilities, yet be decisive when a clear opportunity emerges. Above all, the maritime industry needs to work together to meet this challenge. The scope of transformation is so massive – and the window for change so small – that every designer and shipyard in the world will be needed to see it through.

We're all in this together

Of course, it's not just shipping in the time trial. All transport businesses have the same challenge across industries: how to replace diesel-powered engines with something much greener. We're already seeing the rapid expansion of electric cars and planes, hydrogen-powered buses and trains and Expleo are collaborating across Europe with a number of blue chip clients in all these transport sectors. All this technical know-how needs to feed into a common mission, and the R&D work undertaken to date around Expleo's global divisions is well positioned to deliver knowledge transfer into the marine domain from these other industries, which are chasing the same goal of decarbonisation.

In a few years from now, we can look back and reflect on a truly remarkable accomplishment.



Expleo on the frontline of change

Expleo is working on two projects in partnership with Bibby Marine, a Liverpool based ship owner/operator that runs service operating vessels (SOVs) in support of offshore wind farms further improving the well-to-wake energy path (as opposed to tank-to-wake).



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Project
#1

Feasibility study for decarbonisation of a short-sea-shipping vessel

Fast fact

According to UK Government research, the global market for the elements of alternative fuel production technologies (for example, upfront design) could rise to around \$11–15 billion per year by 2050.

Expleo is studying the zero- and low-emission options available to retrofit mid-to-large size vessels with alternative green power and propulsion systems. Expleo is providing significant design and analysis work, investigating alternative energy technologies – hydrogen, methanol, ammonia, batteries and hybrid solutions – as well as a range of supporting technologies such as reformers, fuel cells and energy reclaim.

Expleo will garner an in-depth understanding of the operational profile of a donor vessel, in this case an SOV, to assess its suitability for decarbonisation. For example, what are the practicalities of modifying an existing vessel's design infrastructure, such as conversion of the vessels existing engines and tanks, and how best to retrofit novel decarbonisation technologies.

The project will include a qualitative design study to determine environmental credentials, technical feasibility, economic viability, regulatory compliance and alignment with industry innovations such as in-field offshore wind farm bunkering facilities.

As the learnings will be shared with the open market, Bibby Marine and other UK operators could benefit from being an early adopter or fast mover.

Alternative fuels: 6 problems that need solving soon

- 1 There is no one-fuel-suits-all solution. Each type of vessel and operational profile demands different specifications, which might be better suited to ammonia, say, instead of hydrogen or methanol. Or a better result might be the use of a hybrid solution.
- 2 Technologies are currently immature, so we need to exhaust all possibilities and keep open minds. With 30-year lifespans, operators don't want to back a solution that becomes obsolete in five or even 10 years' time.
- 3 Fuel supply is another factor. There's no point developing the optimal power and propulsion system for a vessel, if the operator can't then source the fuel. Production, storage, and distribution infrastructure of alternative fuels is as an important factor as the onboard solution.
- 4 Net zero carbon status demands that all aspects of the shipping lifecycle, including manufacture and infrastructure, must be carbon neutral too. This consideration will greatly influence the choice of fuel and propulsion system, and the ship's design (see point 5). Green hydrogen may prove cleaner to generate, but if it requires extensive infrastructure and complex onboard storage, then a higher power density fuel may prove a better bet.
- 5 The green maritime revolution could in fact demand a complete change of ship design for new builds and or a significant change to a vessels operating logistics. Long journeys might be split up with three or four refueling stops – just as electric cars are needing to recharge every 200 miles. Current standard ship designs could be enlarged to carry more quantities of lower power density fuel.
- 6 To retrofit or new build? With a 30-year lifespan of a ship, the majority of the vessels sailing around the world at the moment are still going to be operable in 2035. A global fleet of over 100,000 vessels may mean many more refit opportunities than new builds. UK shipyards are well positioned and experienced to play a major role with providing the specialist skills required for such refits.

Chicken or egg?

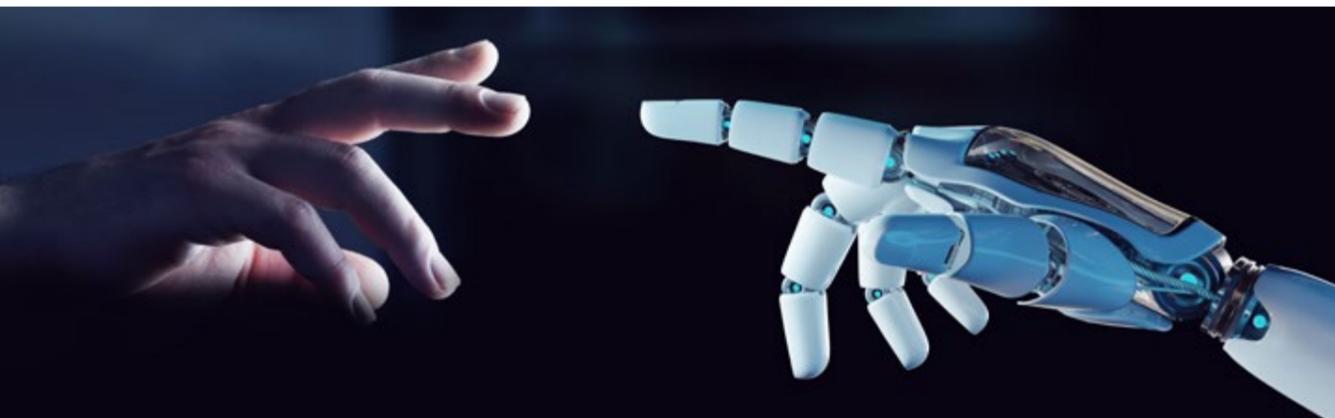
Bibby Marine required a partner that could navigate complexity and find the right solution for both new build and retrofit projects. Each fuel type has its pros and cons and the industry is currently in a chicken-or-egg situation. Who takes the first leap forward?

This feasibility study offers Expleo an opportunity to play a leading role in answering these complex questions and then to communicate openly with the rest of the shipping industry.



Project
#2

Deep learning neural network to deliver improved energy efficiency on vessels



Fast facts

- Using our AI solution, we predict potential energy savings between 5–15% (Ships are responsible for roughly 3% of Global CO₂ equating to approximately 830 million tonnes of GHGs per year, based on 2020 figures, with the complete roll out of this technology there is a potential reduction of 83 million tonnes of CO₂ per year.)
- The majority of vessels in service could benefit from this technology, that's over 100,000 vessels

Efficient ship design and provisioning have rapidly risen up the agenda with the need to reduce fuel consumption and greenhouse gases.

The ability to track fuel consumption in line with mission parameters will net both a carbon and financial dividend.

Our second project with Bibby will therefore use artificial intelligence (AI) to deliver carbon and cost savings by optimising the fuel consumption. We will deploy a deep neural network to understand and predict settings on the vessel.

This is especially relevant for the green maritime revolution, as alternative fuels are lower energy density than diesel, so they will take up more space. Reducing the fuel load will accelerate the take-up of clean technologies and make retrofitting easier and more affordable.

Fuel is a massive cost: up to 60% of operating costs. Even a 2.5% fuel saving makes a strong business case for an AI solution that is paid back within four months. Our system can be installed on any ship during refit or routine servicing, or on new build vessels. Therefore, all ships and super yachts operating today can be considered potential customers. More than 100,000 vessels in-service could benefit from this technology.

What is a neural network?

Neural networks have been around for 70 years, in varying forms. Computers perform machine learning or deep learning by analysing training examples. Similar to the human brain, the AI network is made up of thousands or even millions of simple processing nodes that are densely interconnected.

By feeding our onboard network with complex (convolutional) data layers including fuel consumption, engine specifications, sea conditions, mission parameters etc, the computer learns to see patterns and predict outcomes.

Valuable energy savings

The project aims to demonstrate how a deep convolutional artificial neural network and real time data can predict energy consumption, identify optimal system, trim, speed, and engine settings to reduce energy consumption. Research has shown that even simple AI solutions provide a more effective solution, with better accuracy, than other conventional data analytic systems on the market.

In this stage of the project, we will develop and test a laboratory-based neural network using real ship data from a medium-sized SOV. We predict potential energy savings between 5–15% (equivalent to more than 1,500 tonnes of CO₂ per year).

Bibby will provide the data, operational expertise and financial impact assessment for combination with Expleo's systems engineering and AI expertise.

Assisting seafarers to make better decisions

Ships need to operate close to their design speed, to achieve optimal efficiency. The neural network can help crews make better choices, by monitoring real-time bridge data – whether onboard performance or external influences such as sea and weather conditions – to optimise how the ship should be sailed.

For example: when best to switch off or recharge batteries? When to utilise more hydrogen? When to start up diesel generators? Whatever the fuel being used, the system will analyse the rate of consumption and recommend what to do next. The first step is gathering the necessary data to feed the AI. Ships are set up for a narrow operating envelope. Our decision support system will recommend a set of actions for the crew to keep them within that envelope – providing an additional 'mind' that makes rapid calculations beyond human capability.

The AI takes an overview of all that data every few seconds, with the aim of delivering the most efficient use of whatever fuel the operator has on board. Alongside that, there are up-to-the-minute opportunities to model and extrapolate the data. For example, the console will indicate that the ship has a 99% chance of getting into the port on time, with fuel left on board.

Expleo brings valuable experience of how best to introduce AI. If it's done in an insensitive way, people can fear for their jobs. In reality, the technology is there to assist seafarers. It's about protecting their well-being and taking mundane tasks away, so they can make the best decisions on fuel consumption.

What will the future bring?

Expleo is proud to support the move to net carbon zero. We support the UK's Government's vision that zero emission ships are commonplace globally by 2050. We share their ambition that the UK industry can 'lead the way in taking action on clean maritime growth, enjoying economic benefits from being an early adopter or fast mover'.

Listening to the commitments of shipping operators in recent months, it's clear that the time for action has arrived. Momentum is finally growing. Bill Gates famously said that "most people overestimate what they can do in one year and underestimate what they can do in ten years".

What will the marine industry look like in 10 years' time? It's a mind-bending thought. The work that we do over the next year will make a big difference to where we end up.



Meet the team



JONATHAN TAYLOR

Vice President Marine

Jonathan Taylor began his career with Expleo in 2004 and holds over 17 years' experience within the Nuclear, Aerospace and Defence sectors. As Vice President for the global Marine business, Jonathan is driving Expleo to be recognised as an international Maritime industry solutions provider.



ANDREW KING

Business Manager – Marine

Andrew is the Marine Business Manager for Expleo, a Naval Architect with 37 years' experience in the ship design and ship build/refit sectors of the marine industry. Andrew has worked for industry leading marine companies, including Cammell Laird, BAE Systems, Babcock and James Fisher Defence. He has experience in the commercial shipping, Oil & Gas, Cruise, Superyacht and Naval Defence (surface and subsurface) sectors having worked on a wide range of vessels and project types, encompassing concept design studies, major conversions & newbuild projects, from tugs to aircraft carriers.



JONATHAN WINES

Capability Director

An Engineering Leader with over 22 years of experience working in the Aerospace and Defence sector for Manufacturers, System Suppliers and Engineering Service Providers. Jon's strengths are in leading multi-functional teams to deliver integrated solutions across the lifecycle from new product development to Inservice support.



SEAMUS BROGAN

Operations Director – Marine

Seamus is a Business Manager with over 25 years of experience working in the Marine and Defence sector for BAE Systems, SEA and BMT. Seamus has led numerous successful teams to deliver outstanding results, most notably was the Type 45 Power Improvement Project and Communication Coherency for Submarines. As Marine Operations Director for the UK business Seamus is responsible for delivering projects to time and cost whilst ensuring the customers' needs are being met.



PAUL BURNS

Chief Engineer – Marine

Paul has over 20 years of experience dedicated to the marine industry. Paul has lead numerous RFA Ship Life Extension Plans and was the technical lead for the Type 45 Power Improvement Project. He played a major part in the design and build of both the Strangford Loch Ferry and the SS Sir David Attenborough. More recently he became Technical Authority for Type 26 Global Combat Ship and is now the Chief Engineer of the marine division of Expleo where his duties include technical governance and capability development.



MALCOLM STEIN

Systems Engineering Manager

Mal is an experienced engineer, graduating in Electronic Engineering at University of Glasgow. After a career in telecoms with Marconi, then managing Liverpool JMU Engineering Development Centre, ten years ago Mal moved in to Marine Sector and has recently completed an MBA specialising in adoption of AI technology.

Future-proof your marine engineering, today.

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With results driven end-to-end support for time critical projects we can help you build faster, become more agile and increase quality all the while ensuring you;



Keep pace with innovation



Manage the industry skills shortage



Adapt to a green future



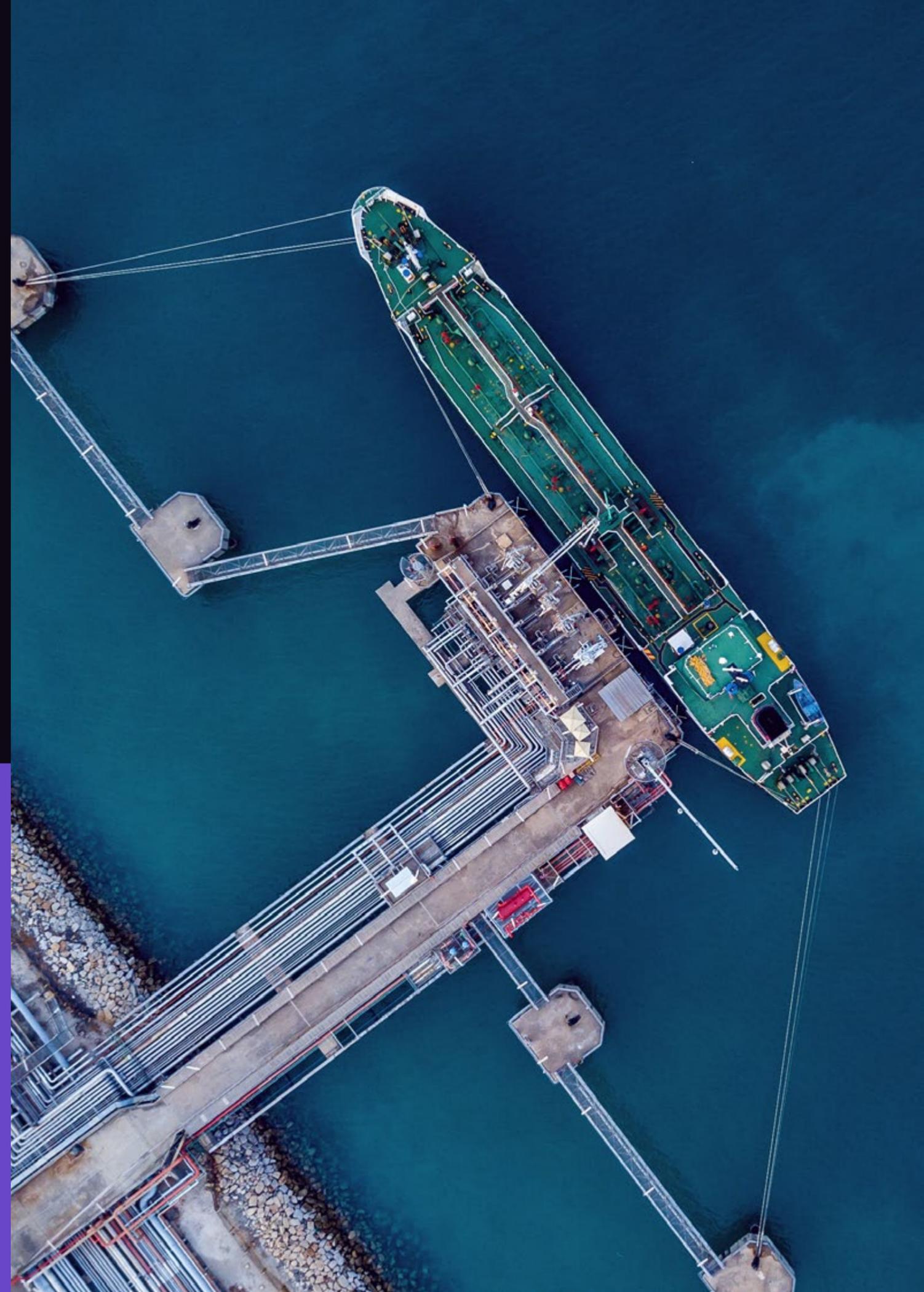
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