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Galician Maritime Technologies

Perspectives for the future: the Naval Sector in Ferrolterra

The naval sector in the Ferrol region is experiencing a prosperous moment and laying the foundations for a solid and successful future.

Navantia is committed to developing its industrial and technological capabilities while maintaining the tradition of Spanish shipbuilding, which has allowed it to become one of the world´s leading companies in Military Shipbuilding, Offshore Wind Energy and Renewables Energies, and Large Ship Repairs.

Navantia has generated almost 9000 quality Jobs, many of them with high technological sophistication, representing 14% of the industrial employment in the province, in the Ría de Ferrol in 2023. Additionally, their contribution to the province´s GDP is 1.5%.

The F110 program is set to construct five frigates for the Ministry of Defense, positioning Ferrol Shipyard as a global reference center in designing and building frigates. This initiative will provide the Navy with unmatched capabilities in multiple scenarios. The frigate will boast leading-edge technologies such as an integrated mast with diverse sensor and antenna solutions, a multi-mission space that expands the ship´s capabilities, and a new hybrid propulsion plant that operates more efficiently and silently, providing the ship with great versatility.

The F-110 frigate is a cutting-edge smart ship, equipped with a Digital Twin that serves as a virtual replica of the entire vessel. This virtual replica is fed with real-time information and data from a network of sensors installed throughout the ship, enabling it to support and optimize the maintenance and operational activities of the ship.

The Digital Twin is accompanied by an Integrated Services System (ISS) developed by Navantia, in collaboration with the Universities of Vigo and A Coruña. ISS will rigged the ship with integrated sensors in its light points, significantly reducing its wiring needs.

Therefore, we guarantee a vessel that not only has high performance and capacity but also offers significant export potential.

Navantia has started a modernization process for its facilities and production processes. The main investment in this process is the construction of the Smart Block Factory, which will have a high degree of automation and robotization. The factory will ensure that the product is optimized for versatility, and delivery times are reduced.

Repairs area continues with the modernization and adaptation of its lines of activity, such as LNGs, life extension projects for offshore units (FPSOs) within the Oil&Gas sector, the transformation of specialized naval units such as generator installation vessels in offshore wind farms and floating LNG liquefaction units.

For its part, the Turbine Factory, now integrated within Seanergies, Navantia's new division for the development of green energies, points to hydrogen as a vector for business growth.

In the Fene Shipyard, we must highlight the growth of Seanergies around offshore wind programs, with the supply of fixed and floating platforms for offshore wind with important growth perspectives that will guarantee projects during the coming years.

Finally, and perhaps most importantly, Navantia has a rejuvenation plan underway, incorporating, in addition to the classic shipbuilding profiles, other new professionals who will contribute to the achievement of our objectives, ensuring industrial competitiveness and sustainability.

In short, Navantia has the challenge and the opportunity to continue advancing to consolidate the Ría de Ferrol as a world reference in the naval sector. The challenge is significant, but we start from the knowledge of our professionals, a prepared collaborating industry, important investments and the necessary projects and products to face it with confidence and optimism.

Eduardo Dobarro
Director of Navantia Ferrol

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Advances in Marine Fuels: Where are we going?

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Throughout 2023, the shipping industry experienced significant developments and modifications, both in the legislative and technological fields.

The Marine Environment Protection Committee (MEPC), a part of the International Maritime Organization (IMO), conducted a comprehensive review of the greenhouse gas (GHG) reduction strategy with the aim of achieving neutrality by 2050. The targets set were ambitious, including a 20-30% reduction by the end of this decade and 70-80% by 2040, compared to the 2008 levels. The ultimate goal is to achieve neutrality by 2050, as shown in Figure 1.

The new strategy aims to reduce the carbon intensity of ships by improving energy efficiency in newly-built ships and by adopting energy sources and fuels with little or no polluting impact on board ships.

However, according to Konica Bhatt, the *Alternative Fuel Reporter* at ENGINE, some experts believe that this strategy is not well-focused towards achieving the decarbonization of the sector by 2050, and lacks a real impact beyond setting final targets without more specific measures..

Many shipping companies like Maersk or MSC have requested organizations to set a completion date for new constructions that use specific fossil fuels for propulsion.

Until this happens, Liquefied Natural Gas (LNG) is becoming a popular alternative marine fuel due to its widespread availability, technological readiness, and competitive pricing compared to new fuels still in development. According to the latest figures from the classification society DNV, more than a thousand LNG-capable ships are already in operation, or on order for delivery by 2028.

Liquefied natural gas (LNG) emits lower CO2 emissions compared to conventional Marine Diesel Oil (MDO), Heavy Fuel Oil (HFO), or Very Low Sulfur Fuel Oil (VLSFO). However, during combustion and transportation, there is a significant problem with unburned and leaking methane, a phenomenon called “methane slip”.

Several projects, such as Nordic Ren-Gas, are underway to produce up to 10,000 mt/year of e-methane using green hydrogen and biogenic CO_2, and production is expected to begin in 2026.

In order to minimize greenhouse gas emissions from the shipping sector, shipping companies must adopt synthetic fuels with zero-emission potential. According to Transport & Environment UK (T&E), the regulations being promoted will encourage investment in these fuels and technologies.

T&E also suggests that at least 6% of all fuel used on board ships by 2030 should be derived from green hydrogens, such as green ammonia and e-methanol, estimating that these measures will help reduce their shipping emissions by 22% by 2035, compared to 2019 levels.

Some ships have been running on methanol since the mid-2010s, and advances in engine technology since then have made it possible to build ever larger ships with methanol-usable capacity.

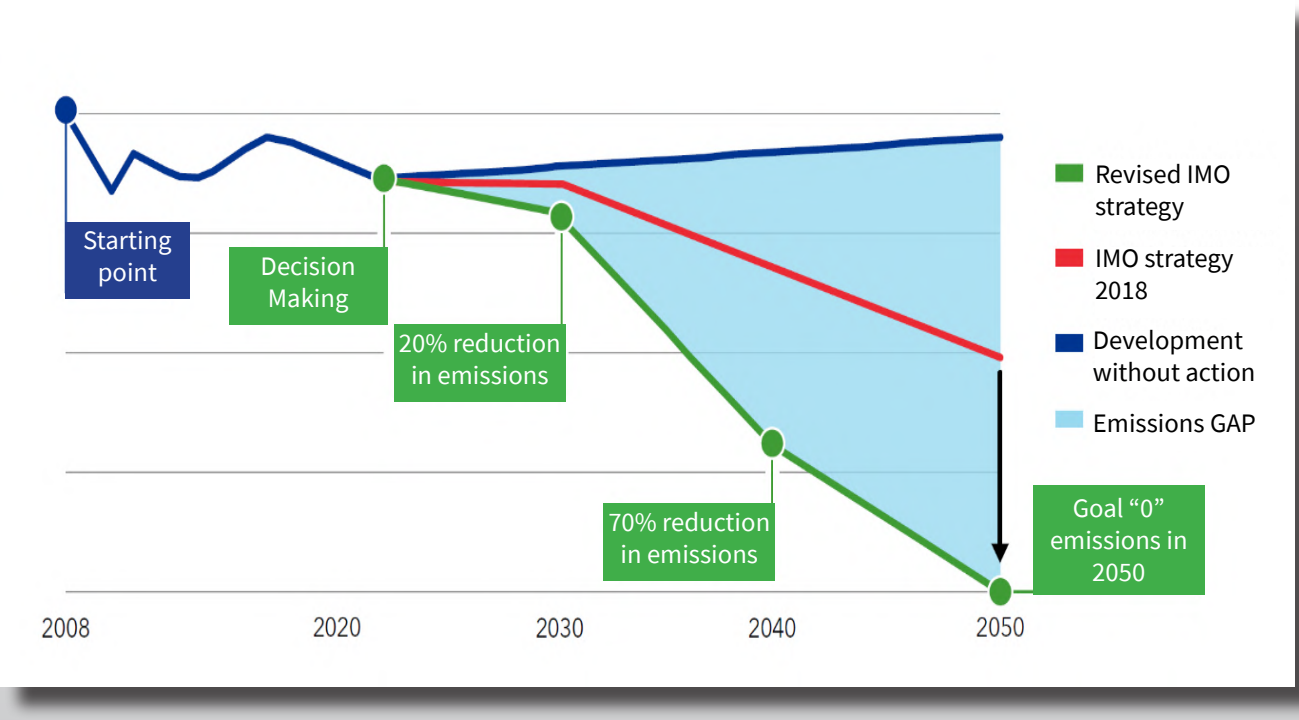

Figure 1. Comparison of IMO strategies. Source: DNV

To put the focus on Galicia and the Ferrol estuary, more specifically in the municipality of Mugardos, Forestal del Atlántico is completing the Triskelion project, which consists of the installation of a hydrogen generation plant, another CO_2 plant, and a third oxygen liquefaction plant, which will allow storage and distribution of the CO_2 generated in the electrolysis unit, and a green methanol manufacturing terminal through the synthesis process and subsequent distillation, using the captured CO_2 and green H_2 as raw materials.

This project will position the Port of Ferrol as the first in the world in the commercialization of green methanol.

Finnish engine manufacturer Wärtsilä has launched the industry's first marine engine that enables ships to use ammonia as fuel when the logistics of supplying it become available.

By using this green ammonia engine, a vessel can lower its GHG emissions by over 70% compared to a conventional HFO-fueled engine. Additionally, it can function on diesel, LNG, and biofuels, which makes it more versatile in fuel use depending on demand, price fluctuations, and market situation.

However, ammonia has poor ignition properties, meaning that ammonia-powered ship engines will require at least 5-20% backup fuel, such as marine gas oil.

DNV reports that three orders have been placed for ammonia-powered vessels, two of which are gas carriers and one is a tug. These orders are expected to be delivered in 2026 and include two new buildings and a modernization project.

Ammonia and green methanol are expected to be key elements in the green transition of the shipping sector by 2050, but there is still a long way to go before they are widely adopted as shipping fuels. For example, although regulatory support is lacking, there is insufficient fuel supply and limited bunkering infrastructure.

From German engine manufacturer MAN Energy Solutions, a two-stroke ammonia-fueled engine is scheduled for launch later this year, making it the

industry's first two-stroke ammonia engine capable of powering large ships. MAN ES expects the final fuel mixture to contain about 95% ammonia and 5% MDO.

Parallel to developments in the methanol and ammonia systems and markets, the shipping company Odfjell SE, fuel cell manufacturer Alma Clean Power, and classification society DNV will test solid oxide fuel cells (SOFC) on a chemical tanker this year.

This system will run on LNG, and could also be used with ammonia, methanol, and green hydrogen to reduce emissions in the future.

SOFCs have a higher energy efficiency than proton exchange membrane (PEM) fuel cells, making them suitable as energy sources on board large ships for long distances.

Fuel cells generate energy through electrochemical reactions instead of combustion. Solid Oxide Fuel Cells (SOFCs) can operate with alternative fuels like methanol, ammonia, and hydrogen, without the need for a backing fuel, unlike internal combustion engines.

However, SOFCs have not yet been tested for long-distance voyages, so their practical potential remains unexplored beyond short-sea shipping.

By 2024, alternative fuels will play an even more significant role in shipping, as regulations will force shipping companies to pay for their carbon dioxide emissions.

The EU has adopted the FuelEU Maritime regulation to increase the share of renewable and low-carbon fuels. Additionally, container ships and passenger vessels will have to connect to the shore power grid when they are docked for more than two hours in a port. The FuelEU also includes a provision to review onboard carbon capture and other new technologies and fuels by January 1, 2027.

In addition to the entry into force of the FuelEU Regulation, which affects any ship calling at a European port regardless of its flag, the entry into force of the Shipping Carbon Cost Contribution Regulation in 2024 imposes all shipping companies with vessels over 5,000 gross tons to pay an increasing percentage of their CO_2 emissions.

€/mtCO_2e	Emissions (€/mtCO_2e)	2025	2026	2027
		40% of emissions by 2024	70% of emissions by 2025	100% of emissions by 2026
65	65.000	1.690.000 €	2.957.500 €	4.225.000 €
70		1.820.000 €	3.185.000 €	4.550.000 €
75		1.950.000 €	3.412.500 €	4.875.000 €
80		2.080.000 €	3.640.000 €	5.200.000 €
85		2.210.000 €	3.867.500 €	5.525.000 €
90		2.340.000 €	4.095.000 €	5.850.000 €
95		2.470.000 €	4.322.500 €	6.175.000 €
100		2.600.000 €	4.550.000 €	6.500.000 €
105		2.730.000 €	4.777.500 €	6.825.000 €

Table 1. Comparison of emission prices. Own elaboration

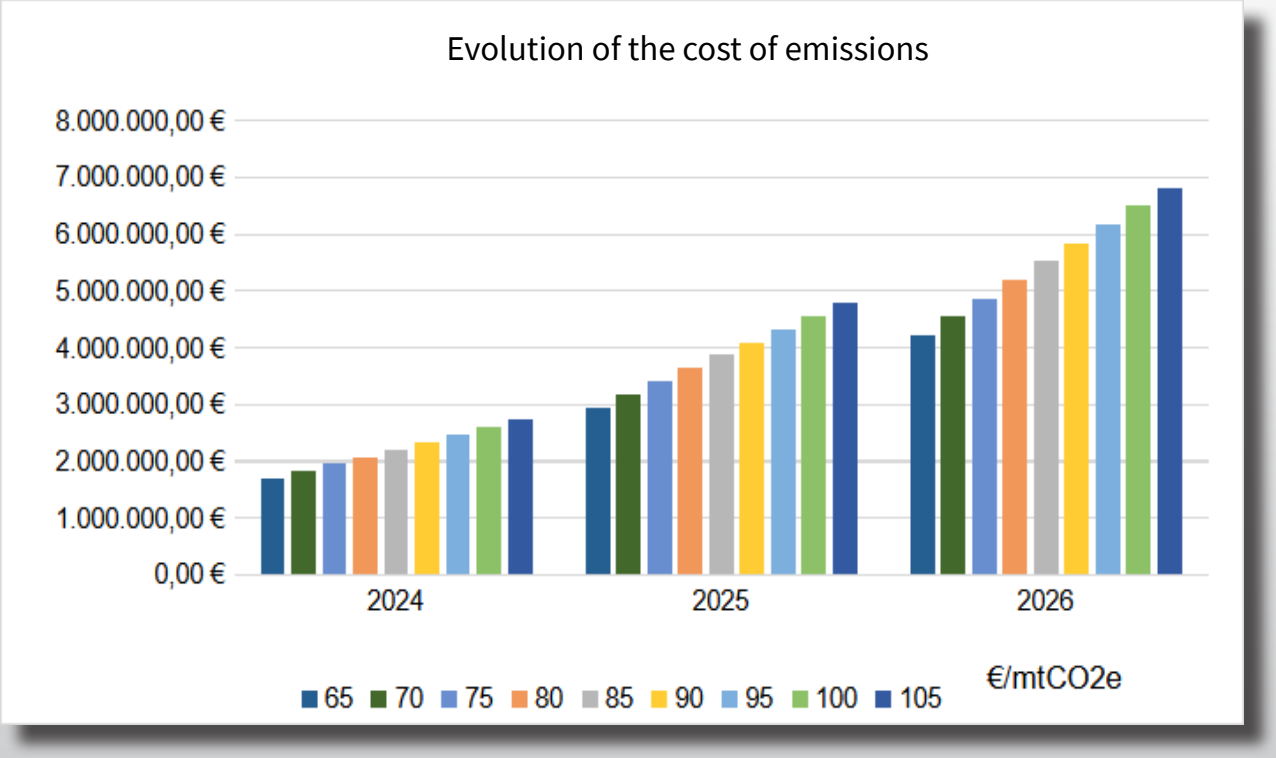

Figure 2. Comparison of the evolution of costs per year of emissions

Shipping companies will have to pay 40% of their carbon dioxide emissions recorded this year, 70% of their emissions recorded in 2025 and 100% of their CO_2 emissions recorded in 2026.

As can be seen in the comparison in Table 1 and Figure 2, taking as an example the closed prices of last year's range of 67-102 euros/$mtCO_2e$, a ship emitting 65,000 $mtCO_2e$ could pay from 1.7 million euros in costs concerning 2024 emissions, and go up to 4.25 million euros for compliance costs in 2026 emissions for 65 euros/$mtCO_2e$.

If the $mtCO_2e$ price were €105/$mtCO_2e$, it could go from €2.7m in costs concerning 2024, up to €6.83m in 2026.

The implementation of tolls to reduce carbon emissions in the shipping industry will most likely lead to an increase in freight costs, resulting in higher prices. However, CEO of Lookout Maritime and Decarbonisation Lead of Baltic Exchange, Martin Crowford-Brunt, believes that the industry is not yet ready to handle this new system.

Although progress has been made in reducing the carbon footprint, there are still challenges to be faced. These challenges include a lack of regulatory support, insufficient fuel supply, and limited bunkering infrastructure.

The adoption of green fuels, such as green ammonia or green methanol, still faces technological and regulatory obstacles that need to be overcome to achieve decarbonization and meet the targets set by the IMO.

At CT Engineering Group's Ferrol site, we are conducting research to study the effects of the new generation of fuels on ship propulsion systems. This research aims to help the industry comply with the milestones set by the IMO, Europe, and the sector itself in reducing carbon emissions.

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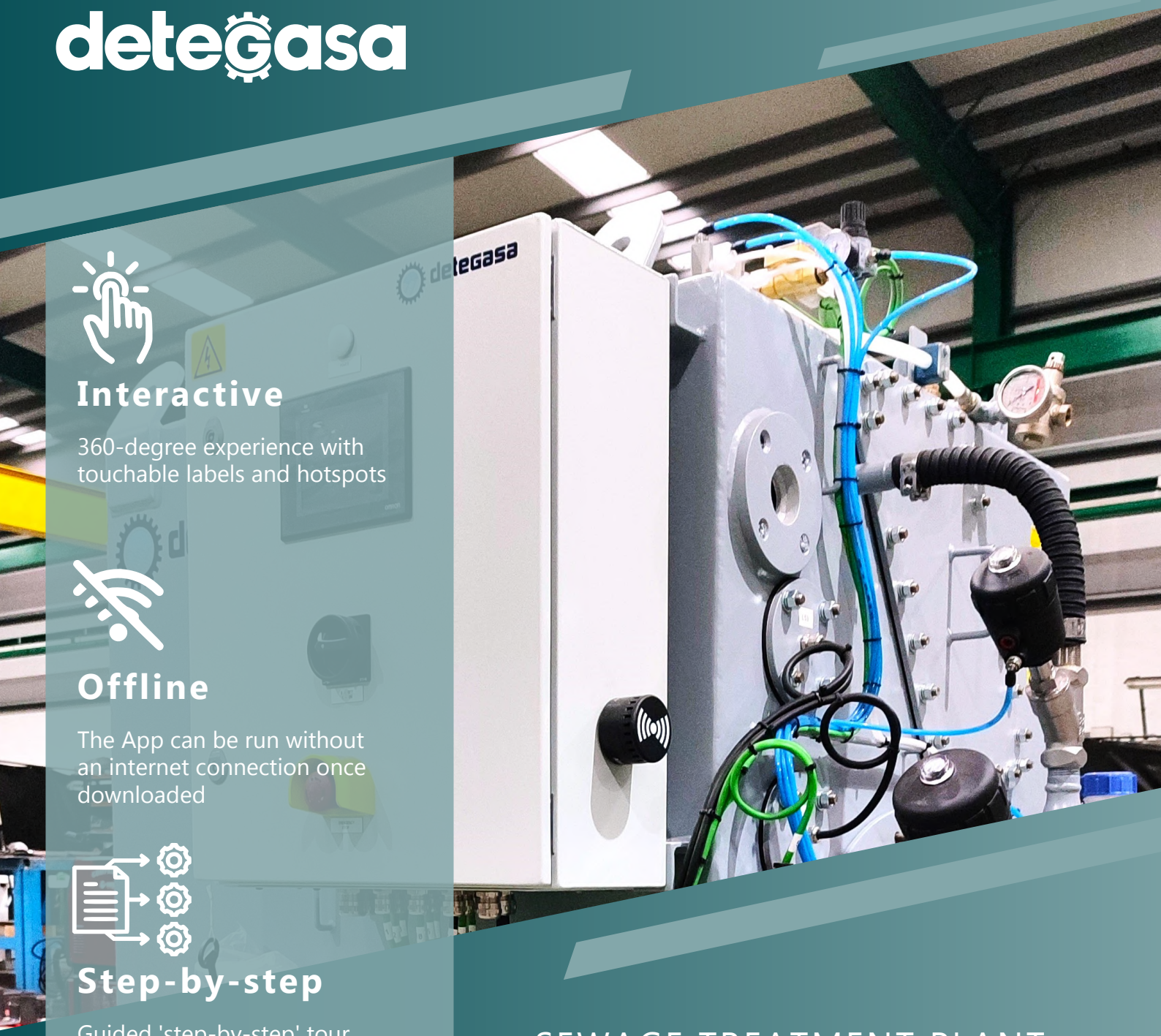

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Solutions to reduce Carbon Footprint at Sea

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Carbon dioxide, also known as CO_2, is a gas that is released during the extraction and burning of fossil fuels like coal, oil, and natural gas. It is also produced by natural processes such as forest fires and volcanic eruptions.

CO2 is one of the greenhouse gases (GHG) that trap heat and contribute to global warming. There are other GHGs such as methane, nitrous oxide, and fluorinated gases that also contribute to climate change.

The concentration of CO_2 in the atmosphere is monitored by the Mauna Loa Observatory in Hawaii, which is the global reference site for this purpose. **In January 2024**, the average concentration of CO_2 was recorded at **423 parts per million (ppm).**

Scientific consensus points to 350 ppm as the point at which the climate would begin to be unstable, something that was reached in 1990. Since then, the so-called Keeling Curve, which measures the levels of this greenhouse gas in the atmosphere, draws an upward line that, 28 United Nations Climate Change Conferences (COP) later, continues in the same trend. Official statistics confirm that CO_2 emissions have not fallen in recent years (except for the months of confinement and the drastic drop in activity in many countries due to the pandemic).

The 1.5 billion tons of CO_2 released by humans into the atmosphere since the beginning of the industrial era in the 18th century are to blame for this situation.

Transportation is the biggest contributor to GHG emissions, accounting for 29.6% of total emissions in 2021. Industrial activities (22.4%), agriculture and livestock (11.9%), electricity generation (10.8%), fuel consumption in the residential, commercial and institutional sectors (9.0%), and waste (5%) are the other major sources of emissions. CO_2 accounts for 79.7% of total GHG emissions, followed by methane (14.4%).

Maritime transport is often overlooked when it comes to CO_2 emissions. However, it has a significant impact on the environment, as 80% of global freight transport is by sea. Maritime transport accounts for 13.5% of European Union (EU) emissions and 3% of global GHG emissions).

REDUCE CO_2 EMISSIONS AT ALL COSTS

The Dubai Climate Summit of COP28 recently proposed the idea of eliminating the use of fossil fuels, such as coal, oil, and gas. This is a necessary step in achieving the goal of limiting the global warming to 1.5 °C maximum by 2050. Numerous options will need to be explored to reduce emissions in order to meet this challenge.

The COP agreement also includes a commitment to increase the use of renewable energy sources such as wind and sunlight, which are sustainable and do not deplete over time. This agreement sets short-term targets, such as tripling global renewable energy capacity and doubling energy efficiency. The agreement also emphasizes the need to eliminate inefficient fossil fuel subsidies that do not address

energy poverty and just transitions. Additionally, the agreement calls for the reduction of transport emissions through infrastructure and the rapid deployment of low- or zero-emission vehicles.

These targets have strict deadlines starting in 2030. Therefore, countries and industries that emit greenhouse gases will need to make decisions to meet these commitments.

IMPLICATIONS FOR MARITIME TRANSPORT

Maritime transport is a crucial part of the European Union's transport system and economy. It accounts for 75% of the EU's external trade and 31% of its internal trade in terms of volume. Every year, 400 million passengers arrive or depart at ports in the Member States, including around 14 million on cruise ships.

Marine exhaust emissions have been a concern in the maritime industry for decades. In 1973, the International Maritime Organization (IMO) introduced regulations to address ship-generated pollution known as MARPOL. However, these regulations did not include specific provisions for marine exhaust emissions. It was not until 1978 that amendments were made to these regulations. However, even then, marine exhaust emissions were not comprehensively addressed.

The turning point came in 1997 with the publication of MARPOL Annex VI, which finally covered a crucial subset of marine exhaust emissions, focusing particularly on emissions of nitrogen oxides (NOx) and sulfur oxides (SOx). The ratification of MARPOL Annex VI by Member States in 2005 was a significant milestone in the fight against marine pollution from these emissions.

This regulatory framework applied specifically to new internal combustion engines with a power output greater than 130 kW installed on ships on

or after January 1, 2000, as well as to ships undergoing repowering during a major conversion. This regulatory approach demonstrated an international effort to address the adverse environmental impacts associated with marine exhaust emissions by establishing clear standards and guidelines for their control and mitigation. Around the same time, the United States Environmental Protection Agency (EPA) established the TIER system, which led engine manufacturers to develop lower-emission designs to ensure that ship operators met the requirements.

In 2008, amendments were made to introduce fuel quality requirements and new TIER II and TIER III emission standards. These standards focused on reducing NOx, particulate matter, and CO_2 emissions. The TIER I requirements were also applied to pre-2000 engines. Additionally, a dual set of fuel requirements were introduced: one for global use and a more stringent one for ships operating in Emission Control Areas (ECAs).

In 2011, further amendments were made to Annex VI to reduce greenhouse gas (GHG) emissions. Chapter 4 added standards for the energy efficiency of ships, which in turn reduced fuel consumption, thereby reducing GHG emissions.

In 2013, two mandatory elements were added to ensure energy efficiency standards for ships: **the Energy Efficiency Design Index (EEDI) and the Ship Energy Efficiency Management Plan (SEEMP).**

According to the International Maritime Organization (IMO), these indicators represent the first legally binding treaty on climate change adopted since the Kyoto Protocol.

In 2018, IMO adopted an initial GHG emissions reduction strategy to eliminate GHG emissions from international shipping as soon as possible.

The strategy was based on the following three pillars:

1) Reduce carbon intensity (CO_2 per transport job [gCO_2/tonne-nautical mile]) by at least 40% by 2030 and work towards 70% by 2050, using 2008 as a baseline.

2) Reduce total annual GHG emissions by at least 50% by 2050, compared to 2008.

3) Reducing the carbon intensity of ships by implementing new phases of the energy efficiency design index (EEDI) for new ships.

These targets were established to be in line with the temperature targets of the Paris Climate Agreement.

Subsequent meetings of the IMO's Marine Environmental Protection Committee (MEPC) have led to the most recent MEPC 78, held in June 2022.

Notable advances related to energy efficiency and CO2 emissions were achieved in this MEPC78. Among them, the implementation of **EEXI (Energy Efficiency Index applicable to existing ships) classifications and the annual operational Carbon Intensity Indicator (CII)** obtained, in addition to an improved SEEMP.

These indices will provide carbon intensity assessments for vessels over 5,000 gross tons.

MEPC 80 approved the plan for the revision of the IIC rules and guidelines, to be finalized no later than January 1, 2026.

The plan foresees the following timetable for the review of the measure in the short term:

1) Data collection stage: from MEPC 80 to MEPC 82 (fall 2024);

2) Data analysis stage: working group at MEPC 82 to be succeeded by a correspondence working group; and

3) Convention and guideline review phase: an Inter-term working group between MEPC 82 and MEPC 83 (spring 2025), as well as a working group at MEPC 83.

Ongoing IMO directives require ships to improve their energy efficiency in the short term and thus reduce their greenhouse gas emissions, reaching net zero CHG emissions in 2050 and setting intermediate checkpoints in 2030 and 2040.

- **2030 Checkpoint:** Reduce GHG emissions by at least 20% and aim to achieve a 30% reduction compared to 2008.
- **2040 Checkpoint:** Reduce GHG emissions by at least 70% and aim to achieve an 80% reduction compared to 2008.

The levels of ambition guiding IMO's 2023 GHG Strategy are as follows:

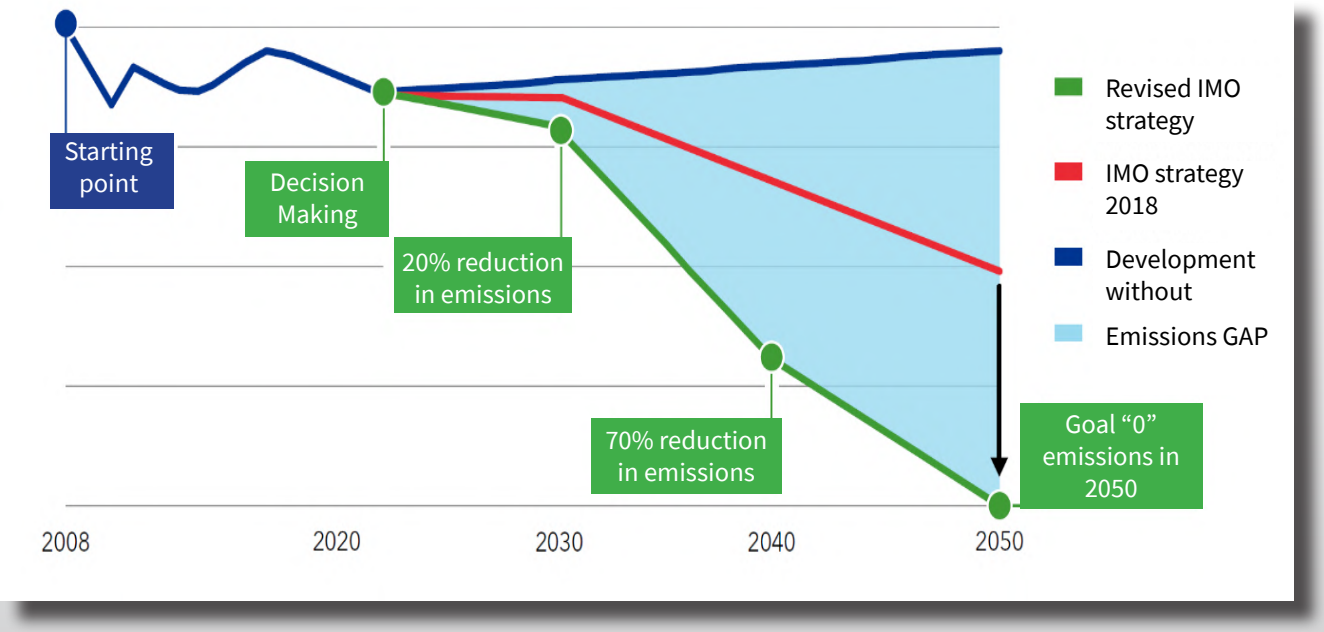

Illustration 1 - IMO's GHG reduction strategy objectives

1) The carbon intensity of ships will decrease by improving the energy efficiency of new vessels.

a) to examine with the purpose of strengthening the energy efficiency project requirements for ships;

2) The carbon intensity of international maritime transport will decline.

a) reduce CO_2 emissions per transport job, on average for all international maritime transport, by at least 40% by 2030, compared to 2008 levels;

3) Adoption of zero or near-zero GHG emission energy sources, fuels and/or technologies will increase.

a) the adoption of zero or near-zero GHG-emitting energy sources, fuels and/or technologies shall account for at least 5%, with a target of 10%, of the energy used by international shipping by 2030; and

4) GHG emissions from international shipping will reach net zero.

a) Peak GHG emissions from international shipping as soon as possible and reach zero net GHG emissions by 2050 at the latest or around 2050, i.e., close to 2050.

Meeting IMO's decarbonization ambition levels by 2050 will require significant changes in the shipping industry.

As of January 1, 2023, it is mandatory for all ships to calculate their energy efficiency index applicable to existing ships (EEXI) obtained to measure their energy efficiency and to report their obtained annual operational carbon intensity indicator (CII) and rating.

To meet the IMO's objectives, the maritime sector must quickly adapt and invest in modernizing and renewing its fleet, which has an average age of 20 years worldwide. However, the slow growth of the

fleet and the aging of ships mean that fuel alternatives and green technologies must be sought. Some ships are too old to be refurbished, while others are too new to be scrapped. Shipowners who are currently assessing new ships at the design stage should consider implementing measures towards achieving the 2050 emission reduction targets from the initial technical specifications.

WHAT IS EEXI?

The EEXI, which stands for Energy Efficiency Index Applicable to Existing Ships, is a set of regulations that is similar to its predecessor, the Energy Efficiency Design Index (EEDI), which has been in force since 2013. However, the EEXI is specifically designed for existing ships that are not covered by EEDI regulations. It applies to ships over 400 GT that are included in MARPOL Annex VI.

The EEXI uses the same methodology as the EEDI to establish CO_2 emission standards. Carbon emissions are measured per ton of cargo and mile, and the standard CO_2 emissions are determined based on the installed engine power, carrying capacity, and speed of the vessel. Standard emissions are calculated by taking into account the fuel consumption, installed power of the main and auxiliary engines, and a conversion factor between fuel and the corresponding CO_2 mass.

WHAT IS THE CII?

The CII stands for Carbon Intensity Indicator and it is a measure of a ship's pollution capacity. It compares a ship's carbon emissions with the benefits it brings to society by transporting goods by sea.

Larger ships tend to have higher emissions, but they

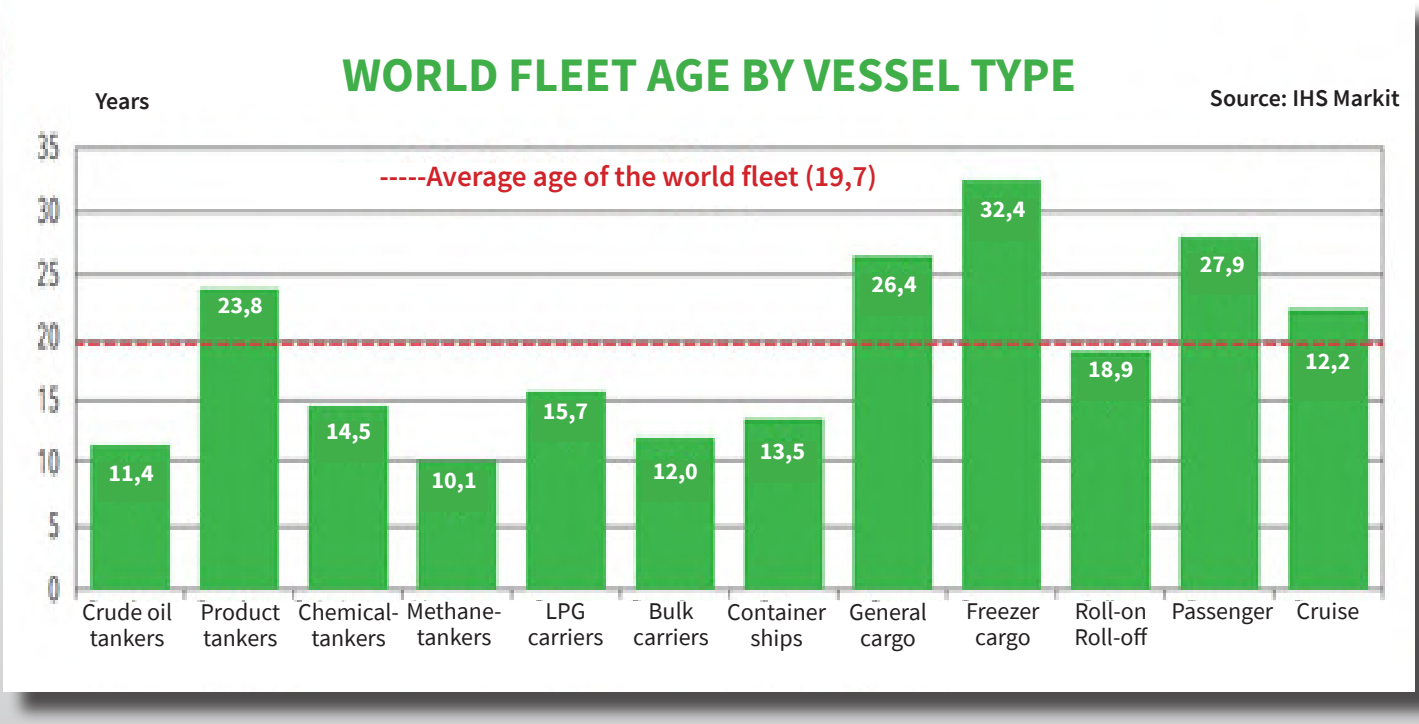

Illustration 2 - Age of the world fleet by vessel type

also carry more cargo. Therefore, the CII provides a fair assessment of a vessel's air pollution potential regardless of its size and propulsion type.

The CII classification has five main bands, namely A, B, C, D, and E, which represent the efficiency of the ship. The efficiency decreases as we move from A to E. Moreover, within each band, we have a range of CII classification values. For instance, a vessel may have a better or worse rating within its classification.

If a vessel is rated D or E for three years, it must improve its rating. This type of vessel must incorporate improvement actions that allow them to upgrade their classification annually.

According to data published by Clarksons in its latest weekly report, approximately two-thirds of the world's fleet capacity would be rated between A and C on the CII, and one-third as D or E.

THE CII CLASSIFICATION SYSTEM

The IIC provides a system for classifying ships according to the air pollution they cause. This classification of cargo and passenger ships can help us distinguish the most efficient ships from the less efficient ones.

The first year of verification of the annual operational IIC achieved is this 2024 for operation in calendar year 2023. Vessels, based on their performance, will receive an environmental rating of **A (higher superior performance level), B (lower superior)**, **C (moderated)**, **D (lower inferior)** or **E (lower performance level)**.

The rating thresholds will become increasingly stringent by 2030, with the rating criteria being reviewed annually.

All vessels should aim to obtain at least C classification. This allows us to establish incentives for the best performing vessels, thus encouraging more and more vessels to aspire to higher classifications. The administration, port facilities and other stakeholders are responsible for establishing these incentives for A- or B-rated vessels.

Any vessel receiving a D or E rating for three consecutive years must submit a corrective action plan, to show how the required rating (C or better) will be achieved. This plan must be approved by the flag State administration or by any Recognized Organization.

HOW WILL THE CII BE USED?

When classifications are published, vessels will be in one of five classification bands, A through E.

The bands indicate the vessel's operating efficiency during the previous 12 months and carry the following incentives and penalties for vessels classified in the corresponding band:

- **Band A-B** - Possible incentives, such as reduced port fees and green investments.
- **Band C** – No penalties, but no incentives.
- **Band D** for 3 years: Vessel to develop an approved carbon emission reduction plan. Possible imposition of fees or penalties.
- **Band E** for 1 year: Vessel must develop an approved carbon emission reduction plan. Possible imposition of fees or penalties.

Fuels, technologies and operational measures to decarbonize shipping and thus improve the EEXI and CII indices can be grouped into "packages" that represent possible ways to achieve the targets set by the IMO. As can be seen in the illustration 4, the intensity of CO_2 emission reductions varies considerably from one to another.

Year	Required reduction compared to 2019 benchmark
2023	5%
2024	7%
2025	9%
2026	11%
2027-2030	to be decided at a later stage

Table 1 - CII reduction targets approved at MEPEC 76

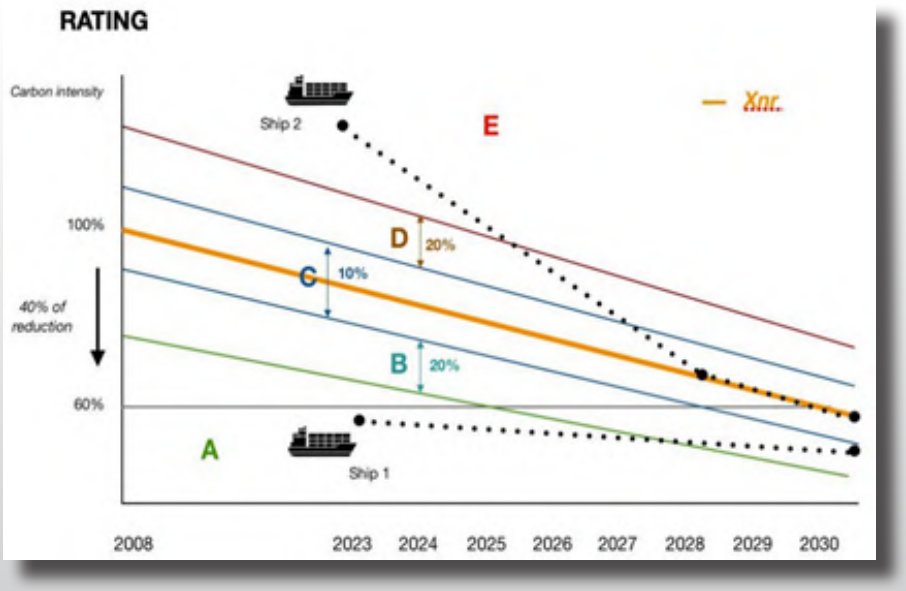

Illustration 3- CII reduction time scale

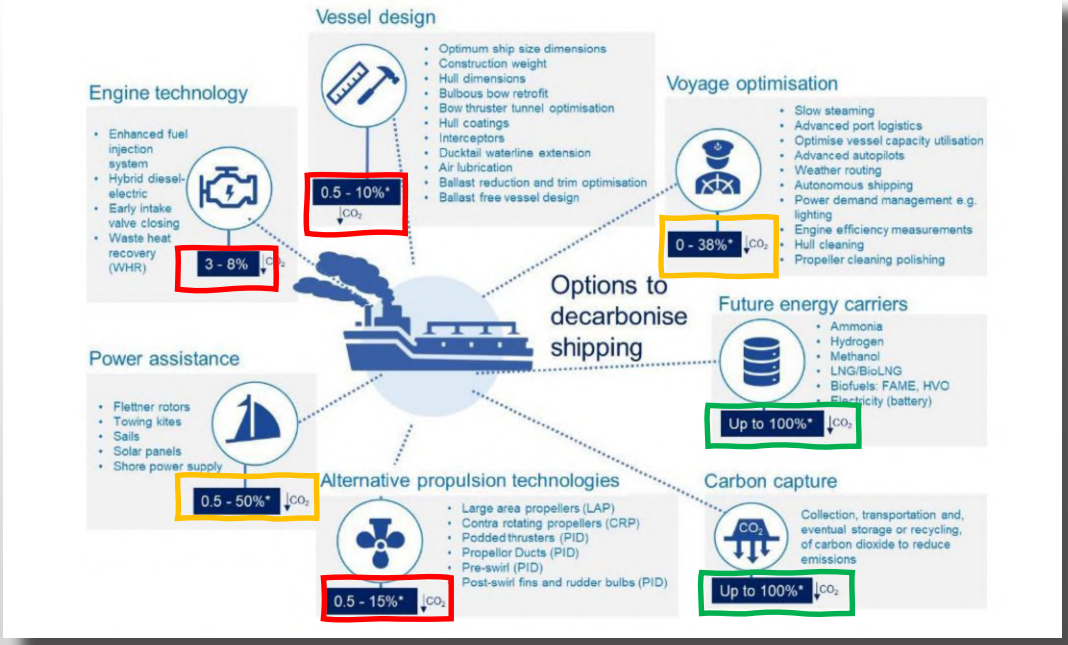

Illustration 4 - Possible solutions to reduce GHG emissions in shipping from a design and operational perspective

SPANISH VALUE PROPOSAL WITHIN THE PERTE FRAMEWORK FOR THE SHIPBUILDING INDUSTRY

WILLBÖ Engineering started analyzing potential solutions to improve the IIC (International Maritime Organization's Energy Efficiency Design Index) of existing ships in 2020. This was because many shipowners are under increasing pressure to reduce greenhouse gas emissions from new global regulations, customers, and shareholders. However, viable options for reducing emissions are currently limited.

While the fuels of the future hold promise, they are still decades away from being a definitive solution in the maritime sector. The industry must first watch how they develop technologically, and how production capacities can be expanded to meet potential demand. Energy efficiency solutions or the incorporation of auxiliary systems for propulsion alone are insufficient, and the progressive reduction of power, and consequently slow navigation, only delays the inevitable.

Several technologies can be used to significantly reduce GHG emissions, such as the use of zero-carbon fuels like hydrogen and ammonia, electrification, and Carbon Capture and Storage (CCS).

The deployment of low-carbon fuels will be necessary for the decarbonization of shipping. However, the low maturity of the technology and supporting infrastructure makes carbon-free fuels relevant mainly as long-term solutions.

Onboard CCS systems can play an important role in meeting the shipping emissions target before zero-carbon fuels become viable. This is because CCS systems are already highly matured for land-based applications. Considering the long lifetime of existing and planned hydrocarbon vessels, onboard CCS is also expected to be a long-term measure.

At this point in time and looking ahead to 2030-2050, carbon capture and storage offers an immediate opportunity to achieve sustainable shipping.

WILLBÖ Engineering is currently developing a ship carbon capture system that can reduce a ship's CO_2 emissions by up to 70%.

The CAPCO2 project, financed by the Ministry of Industry and Tourism of Spain, is being developed under the framework of PERTE NAVAL and aims to create cost-effective solutions for ship CCS while investigating different CO_2 capture methods for various ship types and transport applications. The project is led by a consortium of major companies in the maritime industry, including ERSHIP, ASTANDER, ASTICAN, SOERMAR, IDESA, and BUREAU VERITAS. The prototype of the system is expected to be ready by December 2024 and will be tested in Q1 of 2025.

The main objective of the CAPCO2 project is to develop cost-effective solutions for ship CCS, as well as to understand when CCS can be a more attractive technology than alternative solutions to reduce CO_2 emissions from ships. Within the project, different CO_2 capture solutions will be investigated to identify their potential (in terms of weight, empacho, integration, efficiency and cost) for different ship types and transport applications (size, fuel type, voyage distance), considering both new construction and retrofitting of ships.

Currently, the most reliable strategy for reducing carbon emissions is to capture the CO2 released during the combustion of exhaust gases. This CO2 must then be briefly stored on board until it can be offloaded at a port.

One significant advantage of the **CAPCO2 System** is that it requires minimal adjustments to the existing engine system and can be integrated into new constructions or retrofitted to existing vessels. Through networking and cooperation, the project will serve as an arena for sharing experiences and jointly advancing research in the field.

The CAPCO2 project is a significant contribution from the Spanish maritime sector to the development of new knowledge and technologies aiming to offer climate-friendly solutions for maritime transport. The project focuses on cost-effective CO_2 capture and storage applications for ships. CAPCO2 will generate knowledge on the critical factors that influence the potential of CO_2 capture on board, such as different engine systems, voyage distance, vessel type, size, and CO_2 capture rate. To develop solutions for short and long-term deployment, the project will investigate CO_2 capture from ships based on mature solvent-based technology and the potential of next-generation technologies that can significantly reduce the cost of deployment.

One of the key advantages of the CAPCO2 System is that it is scalable, which means that the shipowner can comply not only with the -40% compared to 2008 standard, but also directly with the -50% compared to 2008 standard.

The project aims not only to develop the system but also to carry out comprehensive case studies to determine where CCS can be cost-competitive with alternative solutions to reduce CO2 emissions from ships, such as ammonia, hydrogen, and batteries. This will provide shipowners with new tools to define the Life Cycle of their assets.

Based on other project activities, CAPCO2 will identify and establish a roadmap on key aspects, including technical, economic, incentives to facilitate implementation, legal, and regulatory. The goal is to enable the deployment of cost-effective CCS on ships.

In addition, the system offers a significant financial advantage when CO_2 taxes for shipping come into force. For European waters, this carbon tax will be introduced next year, by the "TARGET 55" or "FIT FOR 55" program. This means that for every ton of CO_2 emitted by a ship, there will be no carbon tax to pay. "*With expected taxes of more than 100 euros per ton, a carbon capture system on ships will quickly pay for itself,*" says Julian Fontela, Business Development Manager at WILLBÖ.

Types of Remote Control for Valves

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INTRODUCTION

Valves are essential elements in ships, used to control the flow of vital fluids for propulsion, stability, or safety on board. Remote valve control systems have revolutionized the way this equipment is operated, allowing for greater efficiency, safety, and flexibility. The number of actuated valves on ships has been increasing significantly in recent years, mainly due to factors such as the increase in process automation and the improvement of actuators available in the market. Historically, the valves that were actuated were primarily globe and gate valves, belonging to critical ship services such as ballast or fire-fighting systems. In these cases, the opening and closing operation times of the valves can be decisive, making remote operation necessary instead of local operation.

The recent increase in actuated valves implies that ships need to have one or more systems for remote control of them. Therefore, an important decision must be made to determine which system is preferable to select for each case. This article describes the existing possibilities (the fundamental and most frequent ones), presenting their characteristics, advantages, disadvantages, and main applications. Both in other industries and in the naval sector, one can mainly distinguish between three types of actuators, each of which presents a series of advantages and disadvantages, and there is no single model that is appropriate for all applications. Having a remote control system allows process automation and greatly facilitates valve handling, but it is very important to be clear about which method to use in each situation. It is very likely that, in the same project, where the scope is big and it is necessary to have many actuated valves in various services, it will be necessary to install two different systems, or even three. To select one or the other, it is necessary to take into consideration all factors, such as their performance, dimensions, or costs, among others.

ELECTRICALLY ACTUATED VALVE CONTROL

This type of actuator uses an electric motor to generate rotary motion, using electrical energy to actuate the valve. Technological improvements over the last 30 years have significantly increased the performance of these equipment and reduced costs.

Systems based on electric actuators typically consist of a control system, which manages communications with all actuators, and the motorized valves themselves. Installation only requires power and control wiring to power all components electrically and communicate the equipment with each other.

An electric control system can monitor complete processes, record data, and provide feedback. One of the main advantages of an electric control system is the variety of different possibilities it offers in communication network topologies. Four different communication topologies can be differentiated, without going into detail in complex cases, using fieldbus, each with its advantages and disadvantages: point-to-point, daisy chain, and loop.

The loop configuration between the actuators and the control system is the most advantageous, as it allows maintaining control of the valves even if the-

re is a failure in a section of the wiring. The current communication protocols available to actuators allow easy integration into the ship's platform control system.

Electric actuators are precise, allowing control and regulation of parameters such as speed and stroke, and their adjustment and configuration are becoming increasingly simple, with non-intrusive methods such as remote controls or Bluetooth devices. They also have very low consumption thanks to the optimization of electric motors. A very important advantage compared to other models is the availability of local controls. The electric actuator has a handwheel and, in most cases, a control panel on the actuator itself for manual operation. This is a very distinctive and favourable feature. Another important advantage is that there is no risk of leaks and contamination. For some time now, manufacturers have developed ranges and models of electric actuators focused on the naval sector, reducing their size and weight, meeting more stringent requirements (such as shock and electromagnetic compatibility), providing greater performance and functionality, greater robustness, greater reliability, and being conditioned to work in marine environment conditions.

Electric actuators are not as capable as hydraulic ones when it comes to working in heavy applica-

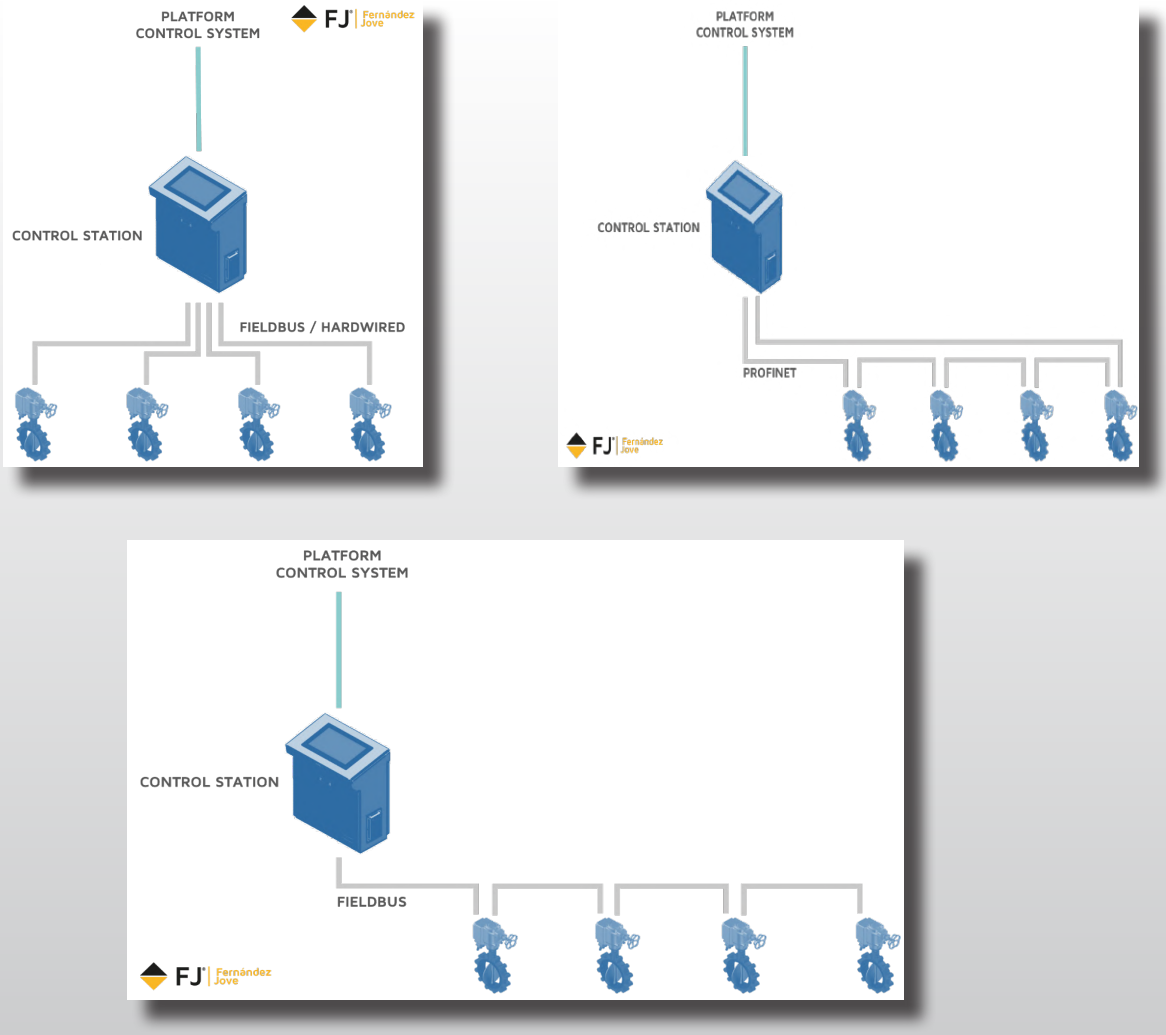


Figure 1. Communication network topologies

tions (large valves). This is a problem that does not affect ships as much as other industries, since naval valves are smaller in size and do not require excessive force for their operation. In the event that the electric actuator does not provide sufficient torque for valve operation, a solution is to install a gearbox between the valve and the actuator. The gear set of this reduction gearbox will allow obtaining a higher torque, with the detriment of reducing the operating speed to the same extent. Unlike hydraulic and pneumatic actuators, these actuators have limitations for fail-close or fail-open functions, often having to resort to solutions with batteries or capacitors. Another consideration to consider is that, in the case of being in an ATEX environment (Explosive Atmospheres), since they are electrical devices, the actuator design must be special.

HYDRAULICALLY ACTUATED VALVE CONTROL

Hydraulic actuators are frequently used, not only in the naval sector. These actuators use an incompressible fluid (oil) for their operation. The most common ones are those based on a linear cylinder-piston movement, which are used for quarter-turn valves (converting linear movement into a 90º rotation through a set of sliding pinions or a connecting rod) and linear valves (directly connecting the piston to the valve stem). As a general rule, two different types are used: single-acting and double-acting. The former is characterized by being actuated by introducing oil only on one side, while a spring on the other side moves the piston to the initial position when oil input is stopped. In the case of double-acting actuators, oil will be introduced on one side to move the

Figure 2. Electric actuator

piston and position the valve, and if it is desired to return to the previous position, it will be necessary to introduce oil on the second side of the actuator. There are also multi-turn hydraulic actuators, which are based on a hydraulic motor, although they are hardly used in the naval sector due to their high complexity and cost.

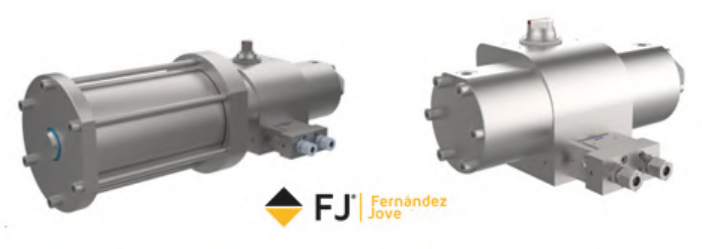


Figure 3. Single and double-acting hydraulic actuators

In general, systems based on hydraulic actuators consist of a hydraulic power unit (HPU), a set of solenoid valves with a control system (usually located in one or more control cabinets), and the actuators themselves, which are connected to the solenoid valves by small-diameter hydraulic piping. The HPU is responsible for providing the system with a constant oil pressure, usually between 100 and 200 bar, while the solenoid valves are activated or deactivated from the control system to control the flow of oil to the actuator chambers. In addition, it is common to install manual pumps (fixed or portable) for emergency operation of the valves, since the actuators do not include manual actuators and are often installed in difficult-to-access locations. Valve position detection is usually performed indirectly, using volumetric sensors in the lines leading to the actuators. The operation of hydraulic systems for valve control is safe and simple. The HPU can be installed at a great distance from the actuators, as the nature of the fluid allows for low power loss.

Hydraulic actuators are especially used in high-force applications, heavy tasks, thanks to the incompressible nature of the oil. A hydraulic cylinder can generate a force up to 25 times greater than a pneumatic cylinder of the same size. The main feature that distinguishes them from electric and pneumatic actuators is the great force they provide with considerably reduced size equipment. In addition, hydraulics can be submerged in tanks and installed in ATEX zones without any problem.

On the other hand, a hydraulic system has serious disadvantages. These systems require laborious maintenance tasks. They are composed of many equipment (pumps, motors, tanks, exchangers, etc.) that need to be kept in good condition for proper operation. The appearance of hydraulic oil leaks is a serious problem. The oil used is a very greasy, viscous, and adhesive substance, making it very difficult to clean, in addition to being able to damage or soil nearby equipment. To prevent leaks and ensure optimal system performance, proper preventive maintenance is important. The complexity of installing and commissioning a hydraulically actuated

Figure 4. Hydraulic actuator on butterfly valve

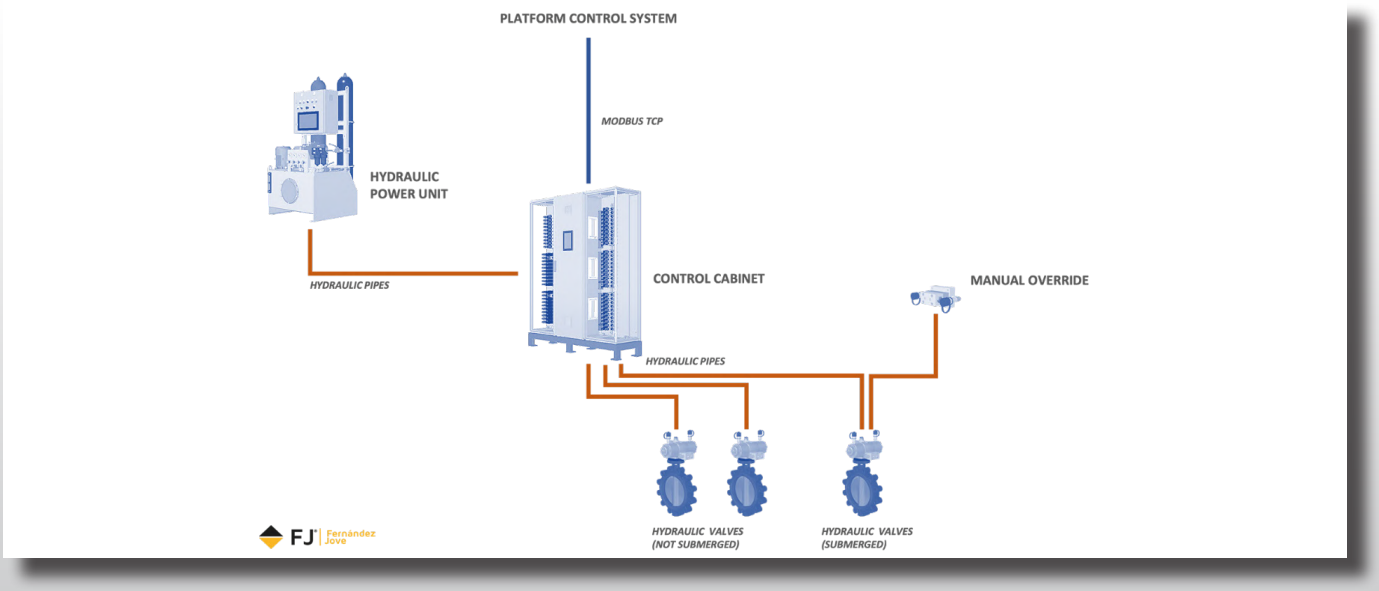


Figure 5. Hydraulic control system

valve system has a significant impact, both technically and economically. As mentioned earlier, the use of hydraulic systems is focused on quarter-turn and linear valves and is not a good option for multi-turn valves.

There is a special variant of the hydraulic actuators presented above, which are electro-hydraulic actuators. These combine in the same body the cylinder or piston and a small power unit. They operate using an electric motor that drives a hydraulic pump, which generates the necessary pressure to move the actuator piston, which transmits the movement to the valve stem.

This type of actuator combines the virtues and disadvantages of electric and hydraulic actuators. On the one hand, they provide high force and high speeds with small sizes, characteristics of hydraulic actuators, while allowing to design control architectures similar to electric actuators, since it is possible to include electronics that provide them with communication capability via fieldbus. In addition, the installation is less expensive than in hydraulic actuators, especially on large ships, by eliminating long hydraulic pipe runs. However, it loses what is probably the main advantage of hydraulic actuators, which is precisely the robustness that comes from the absence of electricity. Therefore, their use in submerged installations and in explosive or corrosive environments is very limited, requiring special configurations where electrical and hydraulic components are separated.

The use of these actuators in the naval sector is usually limited to large ships, where there are large distances between control units and actuators (which makes it more convenient to install cables rather than hydraulic piping), and large valves with high operating torques (which makes it more convenient to use hydraulic pistons instead of electric motors).

PNEUMATICALLY ACTUATED VALVE CONTROL

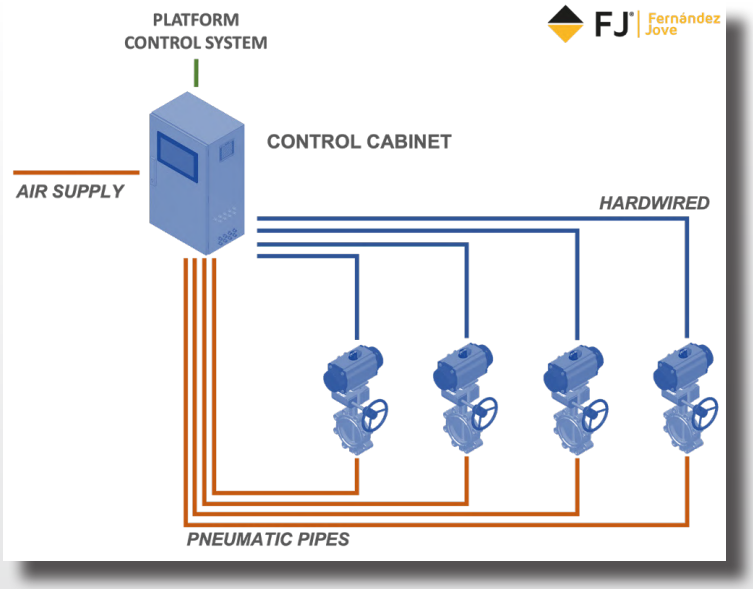
The pneumatic actuator transforms the energy of compressed air into mechanical energy. Like hydraulic actuators, depending on the nature of the actuator operation, we distinguish between single-acting and double-acting actuators. The operation is the same as that of hydraulic actuators, with the main difference being that in this case, the force is provided by air instead of oil.

A system based on pneumatic actuators typically consists of a source of compressed air (usually not dedicated specifically to the system itself, as in the case of the ship's compressors), a control system, solenoid valves (which allow pressurizing one or the other chambers of the actuators), and the actuated valves. These solenoid valves can be installed in the control system, in the actuator itself, or in any other location, providing some flexibility when

designing the pneumatic piping installation. Valve position detection is performed using position sensors (usually electromechanical or inductive), and it is transmitted to the control system via electrical signals. The elements necessary for the operation of a pneumatic control system (such as compressors) make it noisy.

The advantages of pneumatic actuators are very clear: they are simple and economical equipment. It is common to select this type of actuator in applications requiring fail-safe characteristics (in the case of the single-acting actuator, the valve automatically returns to its safety position when air input stops).

Although the design of this actuator is similar to that of the hydraulic one, the pneumatic one does not work as well in heavy applications due to the compressibility of air and possible pressure losses. For large volume valves, it is not appropriate to use a pneumatic actuator, as it would require one of a large size. In addition, although they are actuators with low operating times, they do not provide high precision.



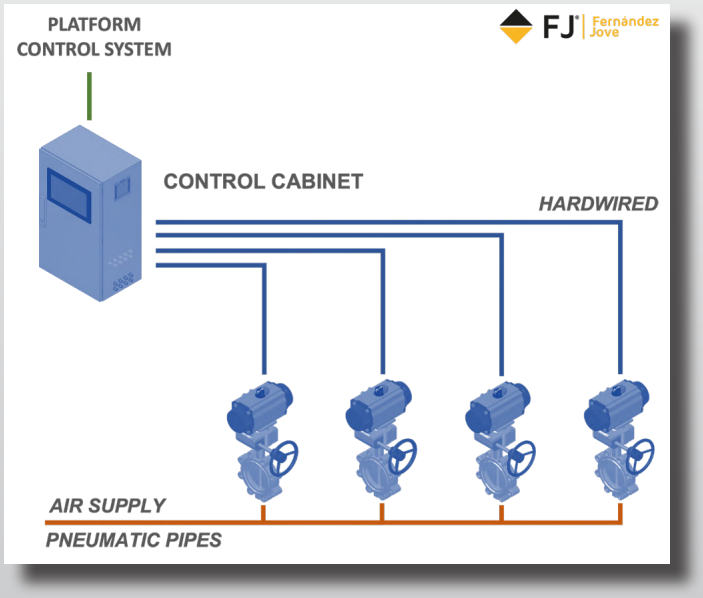


Figure 6. Pneumatic control systems

CONCLUSION

Each of the systems for remote valve control presents a series of advantages and disadvantages, which are summarized in the following table:

TYPE	ELECTRIC	HYDRAULIC	PNEUMATIC
Force generating movement	Electrical energy	Hydraulic pressure	Air pressure
Advantages	• High precision • Simple control • Easy installation • Low maintenance • Simple configuration • Wide variety of communication topologies • Provide a lot of operating and diagnostic information • No risk of leaks and contamination • Easy local operation	• Fast • High load capacity • Robust • Self-lubricating • Suitable for ATEX zone • Can be submerged	• Fast • Low cost • Simple • Robust • Suitable for ATEX zone
Disadvantages	• Medium-low load capacity • Limitations for *fail-close* o *fail-open* functions • Environmental limitations (ATEX zones and submerged valves)	• Complex installation • Expensive maintenance • Hydraulic oil leaks • Complex local operation • Low precision • Provide limited operation and diagnostic information	• Medium-low load capacity • Complex installation • Air leaks • Complex local operation • Low precision • Provide limited operation and diagnostic information
Main applications	Any type of system except for particular cases such as submerged valves.	Generally used for applications requiring high load capacity. In the naval sector, their main application is in systems where the valves are submerged in tanks.	Selected when the valves are small and high operating speed is required. Simplicity and cost are their main differentiation.

Table 1. Comparison of control systems

In conclusion, the choice of the appropriate type of actuator will depend on the specific needs of the application.

- Electric actuators are precise, easy to install, and offer much simpler local control. However, they are not as powerful as hydraulic ones.
- Hydraulic actuators are very powerful and compact, ideal for large valves or high-force applications. However, they require more complex installation, require regular preventive maintenance, and can be sensitive to leaks.
- Pneumatic actuators are economical, simple, and

offer fail-safe characteristics. However, they are less powerful than hydraulic actuators and not as precise.

It is important to take into account the environment, energy availability, safety, and necessary infrastructure when choosing a type of system. In any case, it is always recommended to consult with an engineer or specialist for assistance in selecting the appropriate actuator for your application.

- Environment: Electric actuators are the most versatile (suitable for wet or dry environments). Considerations such as ATEX environments or submerged installations must be considered.
- Energy availability: Electric actuators require an electrical power source. Hydraulic and pneumatic actuators require an air compressor or hydraulic pump.
- Safety: In case of damage, hydraulic actuators can cause dangerous oil leaks to the environment. Pneumatic actuators can be dangerous if an air leak occurs.
- Infrastructure: Installing an electric system is much simpler than that required for hydraulic and pneumatic systems.

Mainly due to the increase in process automation in ships, together with the reduction in the cost of electrical and electronic equipment thanks to technological advances, the electric system is the most demanded control system today. The range of actuators in recent decades has improved both economically and technically, and a turning point has been reached that makes them the first choice for a wide variety of systems found on ships.

THE 7P TAX EXEMPTION

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The 7P tax exemption is a benefit included in the Personal Income Tax Law that grants an exemption in IRPF taxation for income earned abroad, provided certain conditions are met. For instance, if a worker who is a resident of Spain travels to a foreign country to carry out a job, like providing technical assistance, training or commercial support to a local partner, they may be eligible for tax savings under this exemption.

The following should be met:

- To be eligible for tax exemption, the work must be carried out in a foreign country that has a tax system similar to personal income tax or has an agreement with Spain to avoid double taxation. However, this exemption does not apply if the work is done in a country that is considered a tax haven.

- In addition, the work must result in some sort of benefit or added value for a company or local entity.

- It's important to note that the maximum annual limit of exempt income is EUR 60,100 gross. Thus, if someone is taxed at the marginal rate of 45% for this amount, they could save 27,045 EUR net per year.

The 7P tax benefit can be applied to employees who travel abroad to work occasionally, those who reside abroad for work less than 183 days a year (to re-

tain their tax resident status in Spain), or those who commute daily from their home in Spain to work in an adjacent country (e.g. Portugal).

It is important to note that the 7P can only be applied when there is a face-to-face commute, not when working online. Additionally, the work carried out in the foreign country must result in a benefit for a local company, and it is also acceptable if the work carried out simultaneously produces a benefit for a Spanish company.

For instance, if the purpose of the trip is to attend a trade fair as exhibitors or visitors, or if it involves direct commercial action between our company and a potential local client, the 7P cannot be applied. However, it can be applied if, for example, we are accompanying our local distributor on a round of commercial visits and/or meetings, or if a technician is traveling to provide technical assistance, warranty, retrofit, installation, training, or other such tasks.

When a worker travels to a foreign country for work, and the company they are working for is located in a different third country, the criteria for taxation and benefits are applied to the country where the work is being performed physically.

Transit days are generally considered exempt and are calculated based on a calendar day basis. For instance, if a trip is taken from Monday to Thursday, then four days of salary are counted as exempt. Similarly, if the trip is made from Thursday to Sunday, then four days are also counted as exempt.

The application of the 7P can be done in two ways:

- the employee declares the exempt income when filing his/her income tax return or, alternatively,

- the company declares the exempt income in the employee's paycheck in the corresponding month/months. This is the ideal way to do it. On the one hand, it will save the employee from having to do complex formalities in his income tax return. In addition, the AEAT will be less likely to request additional justifications from the employee, or to question the requested exemption.

The 7P does not provide any tax or economic benefit to the company, nor does it pose any significant risk. Instead, it is the employee who benefits fiscally from its application, and also bears the tax risk if the AEAT considers that the exemption has been applied incorrectly. In such cases, the Tax Authorities may demand that the employee refund the IRPF amount, plus interest. In the worst-case scenario, the Tax Authorities may even request that the employer company refund the interest corresponding to the IRPF that was declared exempt. It is crucial to explain to the employee, preferably in writing, the risks involved in applying for the 7P and the potential implications in case of any error.

There are two alternative ways of calculating the exempt income 7p:

- for the difference between the salary received during the trip or stay, and the normal salary.

- for the proportional part of the gross annual salary. If it is not known with certainty what will be the gross annual salary that the employee will receive in that fiscal year, it is estimated that.

In each case, it is necessary to evaluate which is the most convenient for each worker.

Suppose an employee who belongs to the commercial team, is a manager, project engineer, etc., but does not receive any compensation for traveling or, if he/she receives it, it is very little. In this case, the second option would be preferable. However, if you are a technician who receives a bonus for occasional travel, the first option would be more suitable. It would be a good idea to conduct a simple simulation and choose the best option for each employee.

At the end of the year, a regularization of the exempt amounts can be made once the annual salary of the employee is known with certainty. It is important to note that this could impact those who fall under the second option mentioned above.

If the AEAT requires the employee to submit supporting documentation for the exemption, he or she must submit the invoices for the flights and hotel, and any receipts for expenses incurred in the destination country, such as cabs and meals. Additionally, it must be justified that the trip is for the benefit of a local company by providing some document that justifies it, such as an order issued by the local company, a supply or service contract, a warranty claim, or an agreement with the local company in which there is a commitment to provide face-to-face support. Both the company and the employee should have all the supporting documentation conveniently filed.

The 7p is a useful tool for companies to encourage and incentivize employees who travel or spend time abroad. It has no cost, except for the administrative work involved in the preparation of pay slips and the filing of supporting documents.

Taxation is not a mathematical rule, and tax regulations are usually not sufficiently clear. If you are currently applying the 7p in your company, there may be variations concerning what is set out here. As this is a very specialized matter, it is recommended that you turn to a first-class law firm with extensive experience in the matter, as we do in Detegasa. I hope you have found this information interesting.

Why simulation is the key to minimizing vessel noise pollution and protecting marine life

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Digital twin of a vessel. Having a digital ship allows engineers to use simulation tools to understand the vessel's performance. Hydroacoustics is an area where this technology will help address the vessel's noise signature.

Minimizing noise from vessels has become more important than ever as we understand its impact on a wide range of marine life that uses sound as a primary sensory mechanism.

As a major contributor to this noise pollution, commercial shipping is under much greater scrutiny and the International Maritime Organization (IMO) has issued new guidelines for noise targets. In some areas, incentives are offered, such as in Vancouver where significantly discounted port fees are available to vessels who comply with their noise standards. Insurance companies also offer discounts for vessels meeting the latest noise emission guidelines.

Reducing these noise emissions is a complex engineering challenge that demands a holistic approach from the early design stages. Simulation is crucial as it enables acoustic performance testing before anything has been built. But to take full advantage of it, engineers need the right tools and the expertise to apply them.

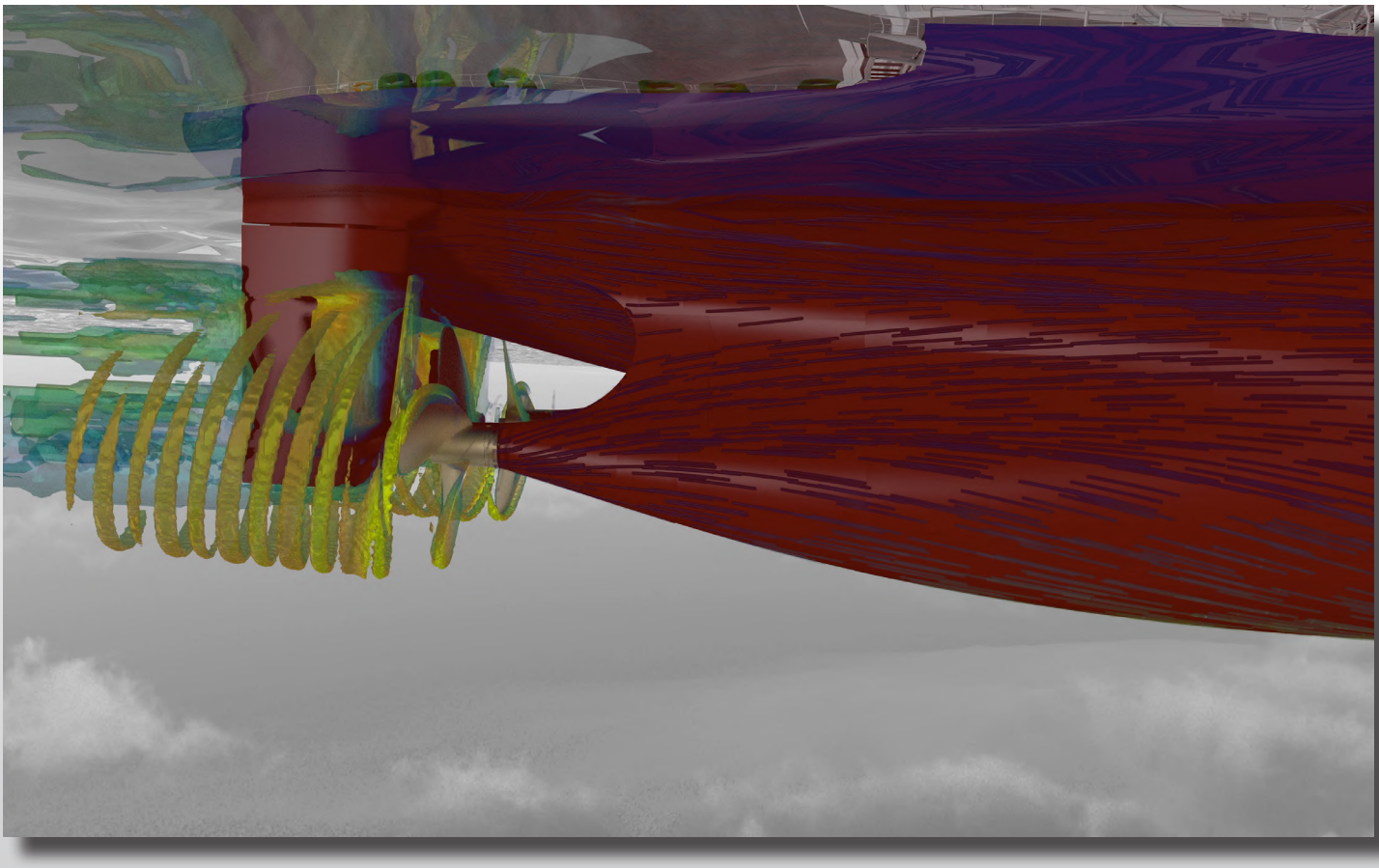
ACCURATE CAVITATION PREDICTION

Commercial vessels contain various noise sources, such as onboard machinery, powertrains, and propellers. These all need to be considered, but the most harmful to marine life is underwater radiated noise induced by cavitation which propagates four and a half times faster than through the air.

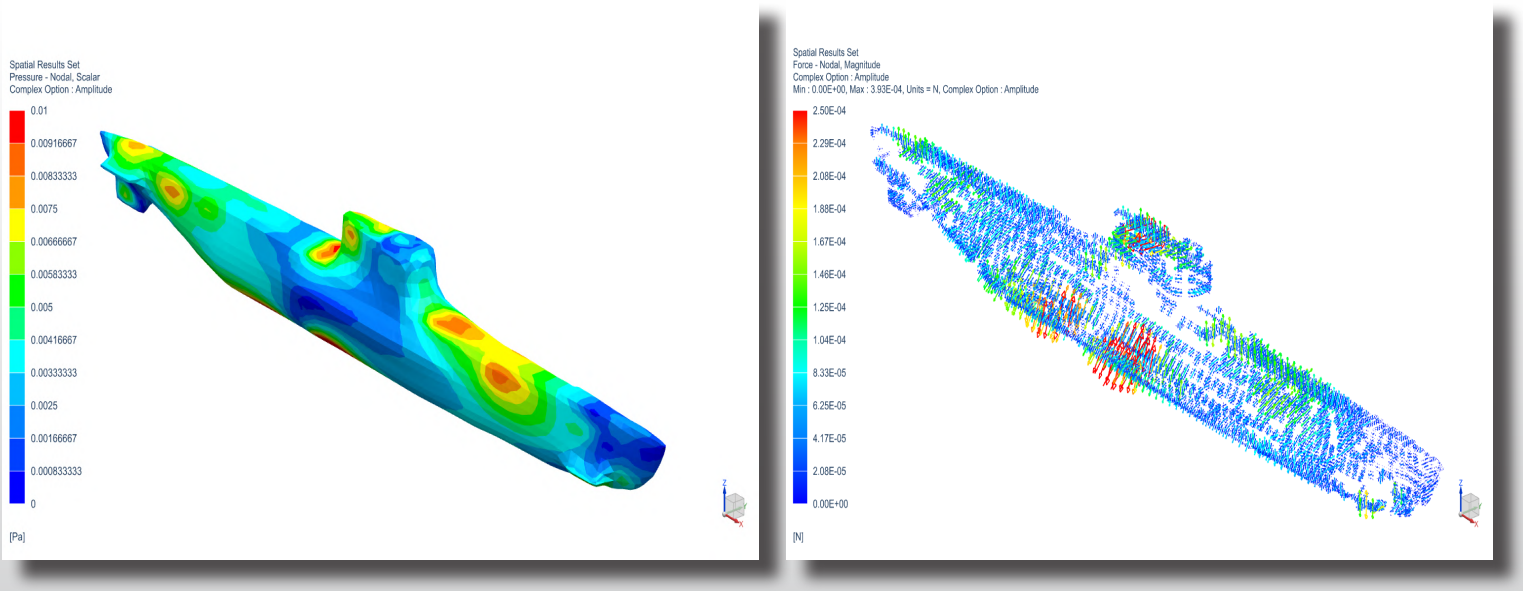
The latest CFD tools offer multiphysics simulations that can accurately predict cavitation, helping engineers refine models to minimize it.

Simcenter CFD solution uses the Ffowcs Williams Hawkings (FW-H) model to propagate the noise sources to various receivers. This is best employed when considering only hydrodynamically induced noise – the simulation specifies flow direction and uses mostly standardized practices for other types of ship problems and the physics setup. The software allows for the definition of impermeable surfaces – the whole of the propellor – and permeable surfaces which are flux boundaries around the noise sources. Receivers are placed anywhere in space and the far field noise is propagated and easily calculated.

These impermeable surfaces or walls of interest are vital as they include noise sources such as blade passing frequency effects. The permeable surfaces are also needed as these include all noise sources within the control volume, such as turbulent interactions and cavitation effects. Combining these shows good results until higher frequency ranges are reached, at which point other noise sources need to be considered.



Vorticity and cavitation around the propeller and interacting with the aft appendages are critical areas where noise is induced. Being able to simulate this and gain a fundamental understanding of the physics is greatly enhanced with simulation tools.



Simulation of acoustic pressure on coupled surface of fluid mesh (left) and of structural forces on coupled surface of structural mesh (right) with Simcenter 3D.

COUPLED SIMULATION

When more than hydrodynamic-induced noise needs to be evaluated, it's time to take advantage of full multiphysics simulations. In the past, simulation domains have been separated, but it has become clear that analyzing acoustics at the system level best requires the modeling of different types of noise sources and the structural dynamics together.

Simcenter STAR-CCM+, part of the Simcenter portfolio, is an ideal CFD tool for flow simulation and computing free field acoustics. However, Simcenter 3D, also part of the Simcenter portfolio, analyzes a wide range of factors such as installation effects, reflection absorption, and surface treatment. The simulations are made particularly efficient and fast by using adaptive order versions of the finite element method and the boundary element method. This means that when creating a mesh for the structure, instead of needing a large number of very small elements across the frequency range, adaptive elements that incorporate higher order shape functions and automatically adapt depending on the frequency are used. This leads to much less computational and memory load and, thus, a much faster simulation. Compared with standard methods, this speeds up simulations by as much as ten times.

Additionally, the calculated, propagated signals from the FW-H model are solved in the time domain and can be put through a Fourier Transform process to determine the frequencies and their associated sound pressure levels. According to IMO's MEPC.1/Circ.906, sound pressure level for underwater noise is defined as 10 times the base-ten logarithm of the square of the ratio of the underwater root-mean-square sound pressure (P) divided by the reference sound pressure of 1 micro-Pascal, ***SPL = 10 · log10(P/PREF) 2*** , where PREF = 1 micro-Pascal.

Once a full understanding of the different noise sources has been established, simulation can help determine the best way to mitigate them. For instance, by placing acoustic absorbers and anechoic tiles or applying surface treatment to reduce unwanted scattering and especially the directivity in sound radiation. All this can be done within simulation so it can be carried out early in the design phase to save costs and speed up development times

VALIDATION, VERIFICATION, AND REFINEMENT

Once a physical vessel has been built, it must be tested to verify that it meets the initial requirements set out at the beginning of the design phase. If it doesn't meet the acoustic performance required, then troubleshooting is needed to improve it.

Transfer path analysis looks at the noise sources and identifies how they are transferred to target locations such as the ship deck, cabins, or the surrounding water. First, it identifies the strength of each source, be it the powertrain, propeller, or other system and quantifies this in terms of acoustical load. This then shows how the noise measured at each location is made up of different noise sources and how much each one contributes. This quantifies it in terms of structural forces and volume velocities for airborne loads.

For example, an engine mounted on a vessel propagates noise and vibration through the structure and radiates airborne noise through the engine housing. Transfer path analysis calculates the sensitivity from the source to the target locations, enabling engineers to understand the measured pressures and accelerations.

Using various sensors, the displacement of the mount is measured, based on its stiffness, to determine the forces that the engine exerts on the body of the vessel. This leads to a contribution analysis path showing the different path locations and acoustical loads.

When it comes to underwater radiated noise, it's important to consider that the vessel is traveling through the water. This requires a microphone array where each microphone measures the sound wave at a different location with a certain delay. Depending on the frequency range being measured, more microphones and a larger array are required.

However, algorithms and software have been developed to keep the cost down by allowing for a small array to be just as effective at localizing noise sources from a moving vessel. This tracks the position of the vessel and measures the pressures and noise sources at each location. It then recalculates this at regular intervals as the vessel passes by and calculates an average of the measurements to produce an accurate image of all the noise sources from the hull.

DISCOVER MORE

The benefits of simulation in predicting acoustic performance are clear to see. And as regulations become stricter, it will become an even more essential tool for vessel designers.

Simcenter, part of Siemens Xcelerator, supports a multiphysics and integrated approach to acoustic performance evaluation with Simcenter STAR-CCM+ and Simcenter 3D. simulation solutions.

To learn more, watch the webinar featuring insights from industry experts.

Testing can be used, among other things, for troubleshooting. By placing accelerometers and microphones in the right locations, the most important transfer paths that contribute to noise and vibration problems can be determined.

The interview:

Francisco Vaquero

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Neuwalme is a global provider of value-added solutions based on oil-hydraulic, pneumatic, and mechatronic technologies. It was founded in 1982 as a privately held family business, and over the years, the company has continuously grown and expanded its portfolio of products and services to become a global supplier focused on professional customers in different areas. These areas include shipbuilding, automotive, energy, equipment manufacturers, food, steel, among others.

• What is the origin of Neuwalme, since its foundation, do you continue to maintain the same original lines of activity, or have you diversified your activity, what makes you different from your competitors?

In the 1980s, I founded Neuwalme with a partner and a leading Swedish supplier. We started with pneumatics, an area of expertise in which I had been trained. We had to promote ourselves through the contribution of specialized knowledge and with a prestigious and quality supplier brand as a backing. Later, we had to diversify and expand our line of activity as it was getting too small. So, we started with hydraulics, and the problem we saw was a lack of training, especially in mechanics.

This process coincided with the deep industrial reform of the naval sector in the 80s and 90s. A training fund was created for the retraining of naval workers, and I hired very experienced personnel who were trained to work in other sectors. With these hires and the training they received in Neuwalme, we managed to have a very important value and knowledge. They were very prestigious professionals, and we incorporated more people and reproduced this training system. Some of their children are still with us today. We did a great job of training, and it was a great boost for all of us.

What makes us different is that we work with quality suppliers and brands, which are present and are references all over the world. We have always had personnel training as a sign of identity, and that gives us a lot of value. We offer proximity within the current competition, more global, and we can always be called directly by a client. We give a closer, personalized service, both locally and with foreign clients. All this means that from the beginning of the project, we provide technical and specific value-added

solutions. Sometimes you have an idea, and we, through our engineering, provide options, analyze the need, and carry out the installation, after-sales service, and maintenance..

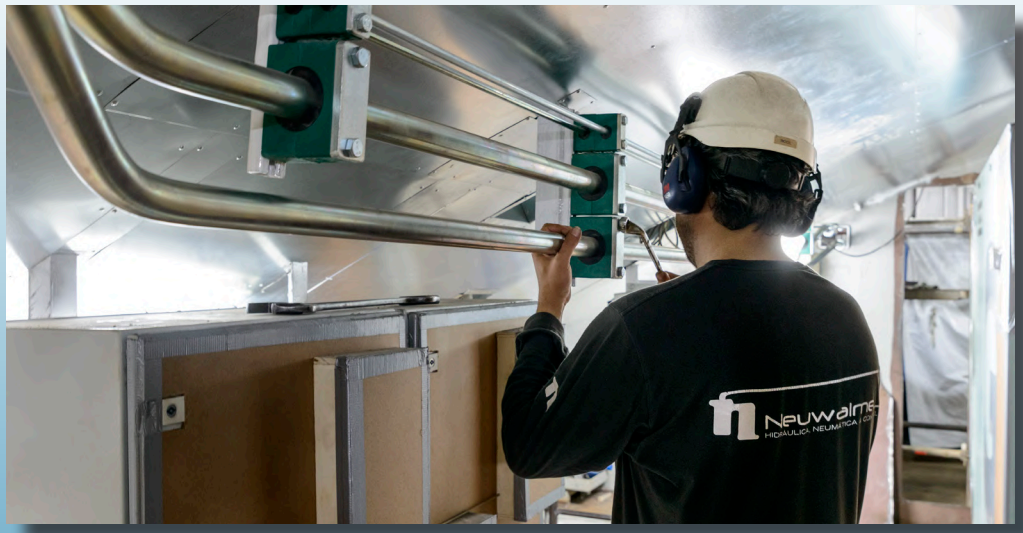
• You will have noticed many changes in all these years, how has this evolution been?

During the naval sector crisis in 2008, we faced a significant drop in turnover. We had a highly trained workforce, but the cost of keeping them was high. Hence, we had to look for other markets while retaining their value. Previously, we relied only on local demand for growth, but the crisis forced us to stop and create a plan. We began exploring other markets such as wind power and hydroelectric plants. We also expanded our reach beyond the Galician area and began working with engineering companies in the Basque Country. This opened up many doors for us, which we have since consolidated.

• Would you say that the way of competing today has changed, in what sense? In both the national and international markets, do you consider that there has been any significant change in the way of doing business, of winning contracts?

I believe that the most significant change occurred during the 2008 crisis. Previously, there was more margin at the business level, and to maintain the activity, we had to adjust and change our approach. This affected everyone, including customers and suppliers, particularly in terms of price adjustment. We had to lower prices significantly and analyze every product detail. This seemed to be a general trend across all sectors, along with the entry of Asian competition. Previously, we didn't pay much attention to this, and we didn't have time to keep up with the demand and market dynamics.

The crisis also impacted the level of competition, and we began to compete more at a local level. However, we soon noticed the entry of foreign and



national competition, including companies from Catalonia and the Basque Country

• What are the particularities and challenges of the marine sector from your point of view, what customers do we need to attract?

From my perspective, there has been a significant decline in activity in shipbuilding. Fewer shipyards are constructing vessels that incorporate high technology and require skilled labor, resulting in a reduced contribution of added value. Although companies are better equipped than ever before, there may not be as much demand for this type of vessel.

Previously, shipbuilding required an enormous number of working hours, as seen in the construction of the Vulcano chemical tankers or the Metalships seismic vessels. Today, fishing and oceanographic vessels are highly sophisticated and complex constructions, which are of great added value but require less workload.

The current business model has changed, and the contribution to technology and equipment has been minimized. Nowadays, the project is closed with the shipowner rather than the shipyard. The engineering companies work hand in hand with the shipowner to determine the type of ship needed and the required function. From there, the project is adjusted, and the technology to be incorporated is defined in a package to be built and assembled in the shipyard. The machinery is part of a package that is contracted separately with the selected supplier. This has been changing and evolving for years.

• Do you encounter difficulties for the development of your activity: infrastructures, transportation, logistics, environmental regulations, etc., could you tell us the advantages and disadvantages, strengths and weaknesses of our region?

I believe that our strength points to our weakness. I am referring to the lack of personnel. We have a highly qualified workforce with a lot of experience, but at the same time, it's very difficult to renew it. This limits us, especially when it comes to taking on larger projects.

This is probably one of the main obstacles to growth. While we have the technical and economic capacity, we don't always have the qualified personnel we need at all levels, such as engineers and assemblers.

The issue of the lack of personnel, especially for SMEs, is very complex today. From my point of view, there is another phenomenon that has evolved - the staff that joins now does not have a long-term vision of growth in the company. Perhaps their vision is more short-term. Society has changed, as have

their concerns. In the past, people used to live more for work, but now they do not work evening hours, when years ago they were even asked to do so. We have also been adapting to this by rationalizing schedules and offering work stability and conditions that are not only material, such as not working on Friday afternoons, for example.

We must make the naval, metal, and industrial sectors more attractive. Today, it's clear that it's not attractive for people leaving vocational training or universities. We need to be didactic about what the naval and industrial sector can bring to them. After all, everything is closely related. In addition to specific training and good conditions, we have to make our sector more attractive so that people with technical profiles want to work in it.

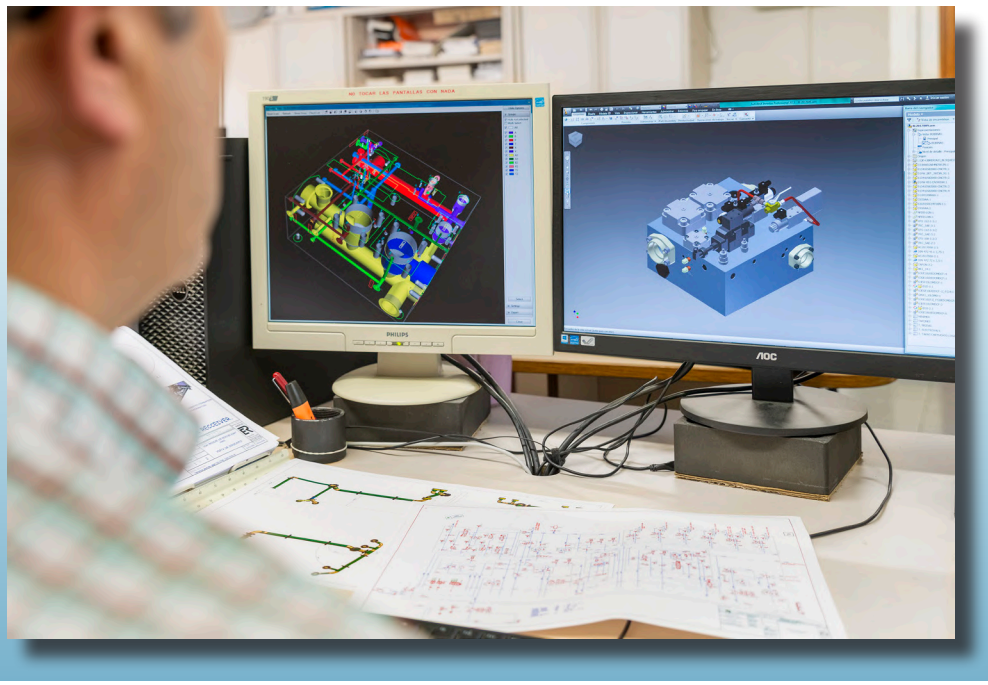
• Do you regret any of the business decisions you have made in recent years, and would you have changed any of them?

During the 2008 crisis, our company focused on expanding our domestic and international markets. We found success in North Africa, particularly in Morocco, where there was a high demand for our services. The automotive sector played a significant role in our success as most of the auxiliary companies were established there. However, we didn't see the same level of success in other countries where we had operations. Our venture in Brazil, for instance, didn't yield any significant results. It was a learning experience for us. If we had known what we know now, we wouldn't have pursued it.

• Neuwalme develops its activity for several productive sectors, including the naval sector. In what way do you plan to continue developing and expanding the business, what are your short and medium term objectives?

In the past, our focus was primarily on the naval sector and we were heavily dependent on it. However, for some time now, we have been exploring other sectors and markets. We follow a consistent strategy by adapting to technological advancements and investing in them. Our approach has always been to provide added value through cutting-edge technological solutions, supported by renowned brands that place us at the forefront.

Hydrogen is a prime example of our approach. We are actively involved in providing solutions and cutting-edge technology in this field. While we specialize in pneumatics and hydraulics, expanding our expertise to any fluid or gas is essential for Neuwalme.



• We talk about innovation as one of the pillars for the current development of companies, to what extent has R&D&I been important in Neuwalme's trajectory? And how far has it taken you, is a company like Neuwalme prepared to tackle this digital transformation?

We have a dedicated R&D department that is constantly studying and developing new solutions. For example, we have been investing in hydrogen-related technologies for several years now. Flushing has become a common topic of discussion, and we are well ahead of the curve in terms of resources, research, and knowledge acquisition. Neuwalme has developed high-flow and pressure equipment that is not commonly found elsewhere. In Spain, and even abroad, there are not many companies that can offer such specific requirements. This is the result of many years of research and development.

• Environmental protection is one of the challenges facing the industry, do you think measures are being taken, are they affecting you negatively, where could they be improved?

If I wasn't here supporting Neuwalme, I wouldn't have faith in their ability to provide industrial solutions for years to come. Based on my professional experience, the challenge for us is to adapt and prepare for upcoming technological and social changes, which are happening at a rapid pace. While we have no control over these changes, I believe small and medium-sized enterprises (SMEs) need more support beyond just financial assistance. There are many other ways to help, such as improving communication channels. SMEs make up more than 90% of our business fabric and are responsible for a significant portion of innovation and technological development. Large companies rely on us, and we must support them.

• The presence of women is scarce in the naval sector. Is their participation in the sector being encouraged?

The main issue is that the industry is heavily dominated by men. Unfortunately, this is a societal problem that extends beyond our sector and into the world of industry in general. Despite this, at Neuwalme, we strive to progress alongside society. We hire female engineers and welders when they are the best candidates for the job. Our priority is always to select the most qualified candidate. However, we acknowledge that this is still a very male-dominated sector.

• Does the naval sector work in a united way, how is it seen from an auxiliary company?

There is a perceived lack of confidence among the local small and medium-sized enterprises (SMEs) in Galicia. This may be due to the different business fabric of the region as compared to other areas, such as the Basque Country. In the Basque Country, when a large company contracts a wind farm in a foreign country, it brings along its entire distribution chain. However, this is not the case in Galicia, partly because there are no such large companies. The tractor companies in Galicia do not trust their local auxiliary industry as much as they should. Additionally, there is not enough support from the administration for the SMEs, despite their demonstrated preparedness.

In other regions, there is less local competition and more unity among businesses. Business meetings are constructive for everyone, and there is a sense of trust and support. However, in Galicia, if you meet with powerful companies from other regions and you are not at least 10% cheaper, they will not consider you because they prioritize their local auxiliary industry. This is a clear and direct message that Galician SMEs need to take into account.

• Given the challenges ahead, are you optimistic about the future?

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Thanks for your support:

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