SPIES | Interreg North Sea | Co-funded by the European Union

POLICY RECOMMENDATIONS for the deployment of ON-SHORE POWER SUPPLY for inland and coastal shipping in the NORTH SEA REGION

30 June 2025

MORE ON THE PROJECT

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Executive summary

Inland shipping, like many other sectors, must become more sustainable. European, national, and regional goals focus on cutting emissions, promoting green transport and mobility, and encouraging a shift to eco-friendlier transport modes.

To reach the ultimate goal, zero-emission inland shipping, both ship propulsion systems and power supply during mooring must become climate-neutral as well. Shore-based power helps by letting vessels use electricity while moored, greatly reducing emissions and noise, and improving onboard comfort.

Although some shore power facilities already exist, their development has faced barriers like limited competition, poor information, high costs, and lack of standardization. A coordinated and transparent policy across the North Sea Region is essential to overcome these issues and meet climate goals.

The "Shore Power in European Shipping" (SPIES) project, part of the Interreg North Sea program, aims to build a strong, sustainable shore power network for inland and small coastal ports. It also serves as a policy platform, drawing on practical experiences and best practices.

As a first step, SPIES launched a cross-border online survey to engage stakeholders and gather insights. The survey targeted inland shipping entrepreneurs, port and waterway managers, cabinet builders, hardware suppliers, software developers, government agencies and research institutes from the North Sea region. Its results fed into working groups, expert meetings, and interviews to further support the project. This survey, in combination with the various interviews and organized expert meetings, resulted in a number of recommendations, broadly supported by various stakeholders in the industry. These can be subdivided in five broad categories.

Regulations and policies

Many ports are insufficiently aware of the European obligations regarding shore-based power, as laid down in the AFIR Regulation. There must be more active communication about these obligations. In addition, the criteria for shore-based power obligation should not only be based on throughput volume, but also on minimum dwell time of ships. It is also important to explicitly link the benefits of shore-based power to sustainability reporting obligations (CSRD) so that companies are better supported in their reporting.

The current European standards for shore-based power are mainly aimed at large sea-going vessels and do not sufficiently take into account smaller power classes and ease of use. A standard must be developed for small seagoing vessels (87 kVA – 1 MVA). In addition, it is necessary to optimize the existing standards by differentiating power classes and supporting modern payment methods such as QR codes and apps. Connections and installations on board ships should also be harmonized in order to promote interoperability between ports.

Accessibility and availability

Inland shipping operators recognize the advantages of shore-based power, but experience bottlenecks such as limited infrastructure, disruptions, unclear cost structures and technical incompatibility. Investments must be made in targeted infrastructure in strategic locations, tailored to the energy needs of different types of ships. Reliability must be guaranteed through EU-wide Service Level Agreements (SLAs). Shore-side electricity installations need to be widely compatible with a variety of vessels and infrastructures. Finally, it is important to conduct targeted communication campaigns to dispel misconceptions about cost, reliability, and ease of use.

The location and accessibility of shore power cabinets are crucial for ease of use. The placement of shore-based power cabinets must be revised on the basis of ease of use, distance to ships and port-specific characteristics. There must be practical standards for placement and accessibility, such as maximum distance and energy loss. Locations must be determined on the basis of transshipment and minimum length of stay. Sufficient grid capacity must be guaranteed, with smart solutions such as grid control, local generation and storage.

Standardization and data management

An effective roll-out of shore-based power also requires technical standardization. Each shore power cabinet must be adapted to the power needs of the ships that usually moor at the location in question. Cabinets must meet strict safety standards and be equipped with new technologies such as real-time monitoring and automatic fault detection. A European central knowledge and management organization must be responsible for the management, updating and further development of standard technical designs.

Interoperability is essential for a scalable shore-based power infrastructure. European standardization must be pursued so that every ship can connect to any shore-based power supply without hindrance. This requires, among other things, standardized data communication protocols between cabinets, apps and platforms, a policy that encourages open networks and federated data sharing, and an independent governance structure.

Effective asset management is a critical success factor. Technical specifications must be standardized through one widely supported data model, uniform interfaces and strong cybersecurity. A European central ship database with verified identities, access rights and full data control according to GDPR must be developed.

Federated data sharing is essential for a secure and scalable rollout. A knowledge and management organization must develop and manage standards, APIs, specifications, security protocols and possibly certification. 'Security by design' must be applied to infrastructure, software and protocols.

Finance and tax

Financing is an important precondition. A transparent pricing strategy must be developed for shore-based power, so that inland shipping entrepreneurs gain insight into the structure of the costs. An EU-wide, permanent and automatic exemption from taxes on shore-based power should be introduced, including locations outside official port areas. AFIF funds should be allocated as a priority to (collaborative) shore-side power projects that follow the SPIES recommendations. In addition, subsidies must be available for the development of the federated data model.

Learning from existing research and innovation

The CLINSH (2019-2022) project's energy scan shows that many ships are experiencing technical problems with shore-based power. Important reasons for limited use are too few cabinets, high price, poor access and insufficient power. Inland shipping operators must be made more aware of their energy consumption on board in order to promote energy efficiency.

On top of that, innovation remains necessary. Shore-based power must be integrated into a broader electric charging concept that also serves port facilities and electric vehicles. Investments must be made in battery storage systems to absorb peak loads and improve grid stability. Mobile shore power cabins should be supported as a flexible solution for locations where fixed infrastructure is not feasible.

Conclusion

SPIES offers different levels of policy and decision makers useful insights on the deployment of shore-based power supply for inland navigation and small coastal shipping. Based on an extensive sounding of the various stakeholders in the sector, recommendations have been formulated in various domains. These recommendations, when taken up at the appropriate levels, will contribute to the uptake of shore-based power supply by the shipping and port communities and form a small but crucial step towards a sustainable, emission-free transport system in the North Sea Region and, by expansion, the whole of the EU.

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Introduction

In order to achieve emission-free inland shipping, it is crucial to make both the propulsion of ships and the power supply during mooring more sustainable. Shore-based power plays a key role in this. Allowing inland vessels to switch to electricity from the mainland instead of using their diesel engines when mooring can significantly reduce pollutant emissions. In addition, this leads to less noise pollution, which significantly improves the quality of life in port areas.

However, the introduction of shore-side electricity is currently fragmented and limited to national and local initiatives. This presents several challenges, such as a lack of competition, high transaction costs, and the risk of vendor lock-in, where users become dependent on specific vendors. Moreover, it lacks consistency and transparency in rates, applications, and technical platforms.

This fragmented approach hinders the broad acceptance and effective implementation of shore-based power in the North Sea Region (NSR). Although the technical specifications for shore-based power have largely been established, an NSR-wide roadmap that promotes interconnectivity and standardization of data protocols is lacking. Without this uniform approach, there is a risk that inland shipping operators will only make limited use of shore-based power facilities. To address these challenges, a coordinated and transparent shore-based power policy within the NSR is essential. With the deadlines approaching for the implementation of shore-side power on the TEN-T core grid in 2025 and the comprehensive grid in 2030, swift action is necessary.

A uniform policy aimed at cooperation within the NSR can not only accelerate the acceptance of shore-based power, but also significantly support the transition to emission-free inland shipping. It is crucial that this policy recommendation plan is elaborated and implemented in a timely manner to achieve the climate objectives and ensure a sustainable future for inland navigation.

Project "Shore Power in European Shipping"

The Shore Power in European Shipping (SPIES) project is a "small scale" project within the Interreg North Sea program. Various partners from the region are shaping the project:

- **Flanders:** Provinciale Ontwikkelingsmaatschappij (POM) Limburg (lead partner) and De Vlaamse Waterweg
- **France:** Chamber of Commerce and Industry of the Hauts-de-France Region, represented by Ports de Lille
- **Germany**: Hafen Hamburg Marketing Reg. Assoc.
- **The Netherlands**: Province of Limburg and MCA Brabant/HJ van Engelen Consulting
- **Denmark**: Port of Aalborg, Research and Development

SPIES acts as a platform that brings together stakeholders to work on a supported policy advice for the development of a robust and sustainable shore-based power network in the North Sea Region. This advisory plan addresses both technical and organizational challenges associated with the implementation of shore power and contains strategic recommendations, based on practical experiences and best practices from the project.

The project builds on insights and experiences from various stakeholders in the maritime sector, including policymakers, inland shipping entrepreneurs, port authorities, hardware and software manufacturers, infrastructure managers, research institutes and energy suppliers. To ensure broad involvement, an online survey was organized, working groups were set up and individual interviews were held. Thanks to this co-creative approach, a detailed picture of the bottlenecks and solutions for the roll-out of a coordinated shore-based power network emerged.

Limits of the project

SPIES focuses specifically on shore-based power for inland vessels mooring in inland ports and smaller coastal ports. In other words, SPIES does not deal with the development of shore power for sea and pleasure craft. Inland ports, strategically located inland, are crucial hubs for the transshipment and distribution of goods. They are accessible to inland vessels and smaller (sea) vessels and play a key role in intermodal transport by connecting the hinterland with international seaports and other transport networks. These ports have extensive infrastructure for loading, unloading, storage and cargo handling and provide strategic access to transport by rail, road and in some cases pipelines. Inland ports typically include multiple terminals, unloading docks, warehouses, and advanced logistics facilities that support efficient cargo management.

What is shore power?

Shore-based power is an electricity supply from the mainland that supplies moored ships with electricity. This allows ships to switch off their own diesel generators, leading to a reduction in emissions of harmful substances (such as CO_2, NO_x and particulate matter) and a decrease in noise pollution in port areas. Shore power is often supplied via special connection points on the quay (shore power cabinets). It is seen as an important (transitional) technology to promote the sustainability of the maritime sector.

What is shore power not?

Shore power is therefore not an alternative to charging batteries used for the propulsion of ships or the operation of cranes and loading and unloading equipment. The electricity supplied from the cabinet is only used to provide electricity for domestic applications when a ship is moored.

Why a coordinated roll-out of shore power?

Several factors underline the importance of a coordinated roll-out of shore-based power in the North Sea Region:

- **Environmental objectives and emission reduction**: The North Sea region is highly industrialized, with significant inland navigation activity. A uniform implementation of shore-side power in ports leads to a consistent reduction in air pollution, greenhouse gas emissions and noise pollution, which significantly reduces the ecological footprint of inland shipping.
- **Economic and operational efficiency**: A uniform roll-out and standardization of technical standards and infrastructure ensures that inland shipping operators and shipping companies can confidently invest in the necessary equipment on board, knowing that it will be compatible with the power supply in different European ports. Standardization prevents a fragmented system and operational complexity, leading to greater efficiency, lower costs, and faster adoption. In addition, with a uniform implementation, inland ports can benefit from economies of scale, reducing installation and operational costs.
- **Promoting fair competition**: When shore-based power is rolled out unevenly, a competitive imbalance can arise between ports. A uniform system ensures a level playing field for all ports and shipping companies, encouraging the widespread use of shore power.
- **Supporting international policy alignment**: Europe and international maritime organizations are pushing for the decarbonization of the shipping industry, including through initiatives such as the European Green Deal and Fit for 55. A unified rollout aligns with these broader policy objectives and demonstrates regional leadership in sustainable shipping practices.

Reading guide

This policy recommendation plan is based on experiences and insights from the maritime field. In order to increase the involvement of the professional field, the partners opted to organize an online survey, aimed at the various stakeholders in the inland shipping sector. In **Chapter 1**, this online survey is further specified, and some important results are presented. The following chapters highlight important facets in the roll-out of a shore-based power network.

Chapter 2 deals with the legal framework that affects the transition to sustainable mobility, with specific attention to shore-based power facilities for ships and inland vessels. It situates the current directives and regulations, as well as the technical requirements that are set for the shore-based power infrastructure. The chapter concludes with a number of important recommendations, strongly aimed at better communication about and interpretation of the rights and obligations of the parties involved.

The various standards applicable to electrical installations and shore-side power connections are discussed in **Chapter 3.** With a focus on safety and efficiency. In addition, it offers recommendations for improving current standards and optimizing working conditions for ship crews.

Chapter 4 discusses the experiences of inland shipping entrepreneurs with the use of shore-based power as a source of energy for their moored ships. It highlights both the benefits and the challenges experienced by these entrepreneurs. The chapter provides an insight into the practical implications of the use of shore-based power and highlights the need for improvement in various areas, such as infrastructure, billing and system compatibility. It shows the potential of shore-based power as a sustainable energy solution, but also the obstacles that still need to be overcome to optimize its use.

Chapter 5 discusses the problems experienced by inland shipping operators when connecting to shore-based power due to a lack of available or well-placed cabinets. Major bottlenecks are occupied connection places, insufficient cabinets in locks and ports, defective cabinets and excessive distances from ships. In addition, technical limitations and safety regulations can make it difficult to use. An energy scan confirms these obstacles. SPIES recommends an evaluation and repositioning of shore power cabinets, taking into account ship needs and port characteristics. Establishing a maximum distance between cabinets can improve handling and safety.

Chapter 6 provides insight into the hardware preconditions for an efficient and reliable shore-based power supply. The chapter discusses the importance of standardization and the preparation of a standard technical specification. The link is also made with the power requirements and the need for an offer per ship type. Finally, recommendations are made for standardization, reliability and further innovation of shore-based power infrastructure. It addresses safety standards, technical requirements and the need to integrate new technologies.

The following chapters highlight the underlying data structure. The first consideration is given to the promotion of interoperability (**Chapter 7**) within the shore-based power infrastructure and the possibilities for more freedom of choice for users. In addition to some good practices, the advantages of an open shore-based power system, such as flexible management and more efficient billing, as well as the challenges in terms of usage management and outages, are discussed. Attention is paid to user experiences in different regions, such as the Netherlands and France. Here too, a number of recommendations are made to promote interoperability.

The roll-out of a federated data model for shore-based power requires good asset management (**Chapter 8**) to ensure the efficiency and reliability of the infrastructure. This includes the management of physical assets throughout their lifecycle. Standardization of technical specifications and data communication is essential for interoperability and security. A common ship database with verified identities is recommended to ensure privacy and comply with the "General Data Protection Regulation (GDPR).

Federated data sharing (**Chapter 9**) forms the crucial link between asset management and interoperability in the roll-out of shore-based power in inland ports. It provides a secure and standardized exchange system, allowing for real-time information exchange. This stimulates the use of shore power, reduces costs and promotes sustainability. Interoperability allows different systems to work together seamlessly, leading to efficient asset management. This will improve the management and optimization of shore-side power facilities, ensuring the reliability and sustainability of the infrastructure.

Chapter 10 examines the cost price of shore-based power and compares it with alternative energy sources. For example, an overview is given of the current shore-based power rates in the EU, discussing differences in price and energy tax. It argues for a European harmonization of tariffs and a clear price mechanism. The impact of energy taxation and the changes to the Energy Taxation Directive will also be discussed, which could be a possible incentive for the transition to sustainable energy sources in inland shipping. This chapter provides insight into the current pricing and the need for a fair and sustainable price structure for shore-based power. The Alternative Fuels Infrastructure Facility (AFIF) is also discussed, suggesting that only projects that follow the SPIES recommendations should be financed. It is also requested to investigate the subsidy possibilities for setting up a federated data model.

Shore-based power is essential for the green transition in ports and helps to reduce the ecological footprint of shipping. At the same time, the inland shipping sector is working to reduce harmful emissions from biofuels and emission-free ships. Innovations such as electrically powered ships and ships with fuel cells are becoming more and more common. The question is whether shore power, given the rapid greening of inland vessels, is a finite story. **Chapter 11** "Innovation" and **Chapter 12** "Energy efficiency on board" therefore makes the link between shore power, green(er) vessels and port infrastructure.

Finally, **Chapter 13** presents a general conclusion of the report as well as a summary of the various recommendations to optimize the roll-out of the shore-based power network.

Chapter 1: Insights from the field

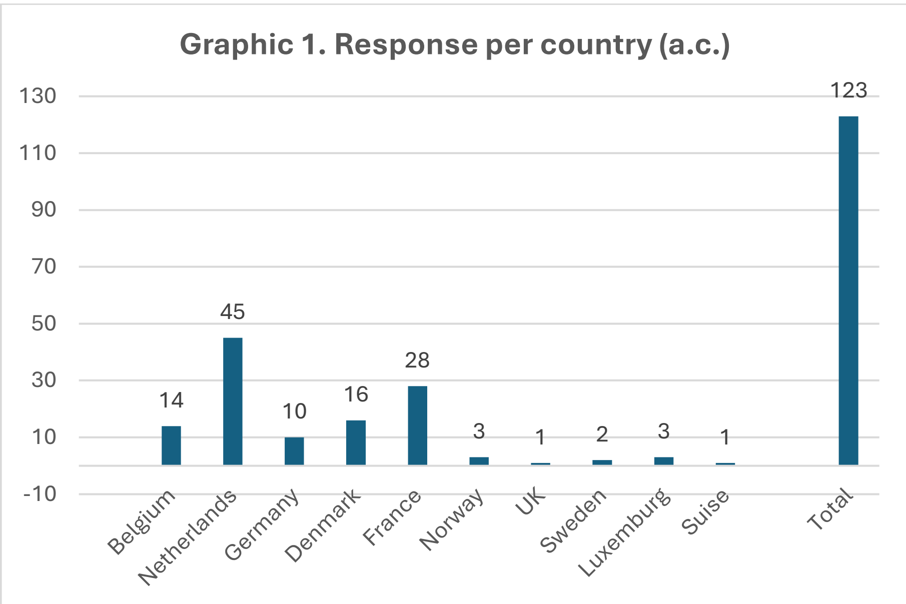
In order to increase the involvement of relevant stakeholders and various players in the shore-based power domain and to gather valuable insights, SPIES launched an extensive cross-border online survey. This focused on inland shipping entrepreneurs, port and waterway managers, cabinet builders, hardware suppliers, software developers, government agencies and research institutes from the North Sea region. The results of the survey formed the basis for in-depth working group discussions, expert meetings and interviews, which collected further valuable input for the project.

1.1 Survey design

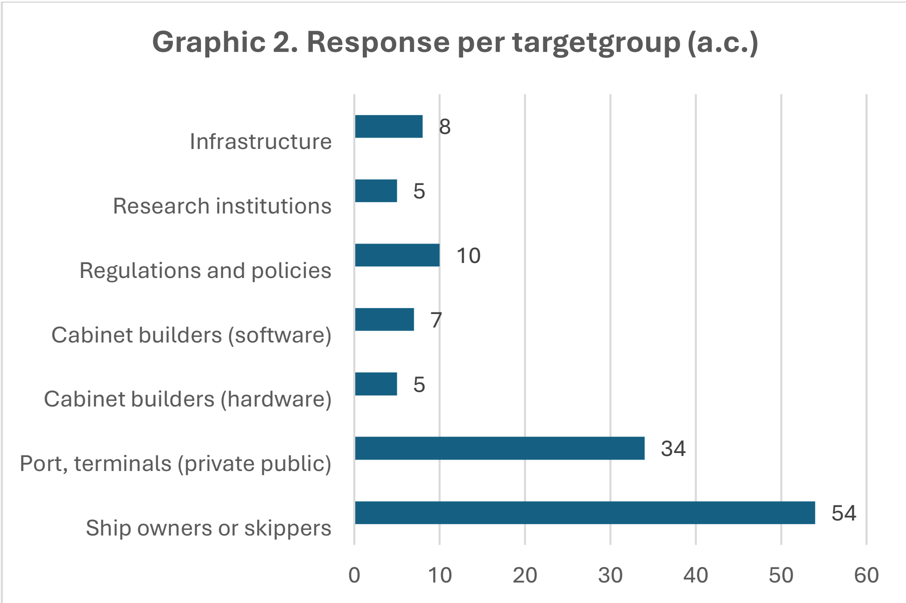
The online survey took place from September 2024 to January 2025. A specific questionnaire was drawn up for each target group (see Annex 2), which gauged experiences, challenges and obstacles in the use of shore-side power, as well as the needs within the sector. The dissemination took place through the project partners and member organizations within the maritime sector (inland ports as well as small seaports).

1.2 Response and results

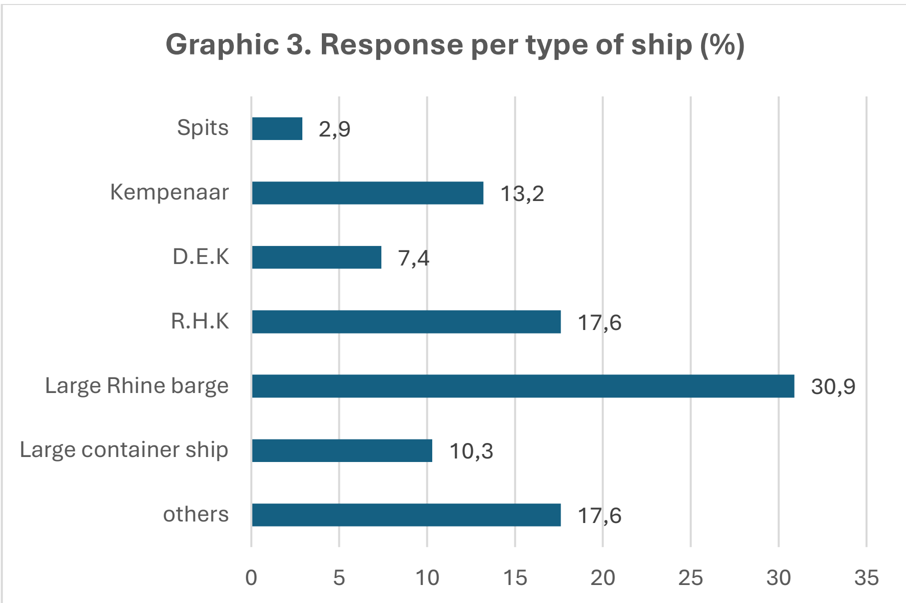
SPIES received 123 responses from no less than 11 countries (see Graphic 1). In general, the responses per target group can be considered representative of the entire group.

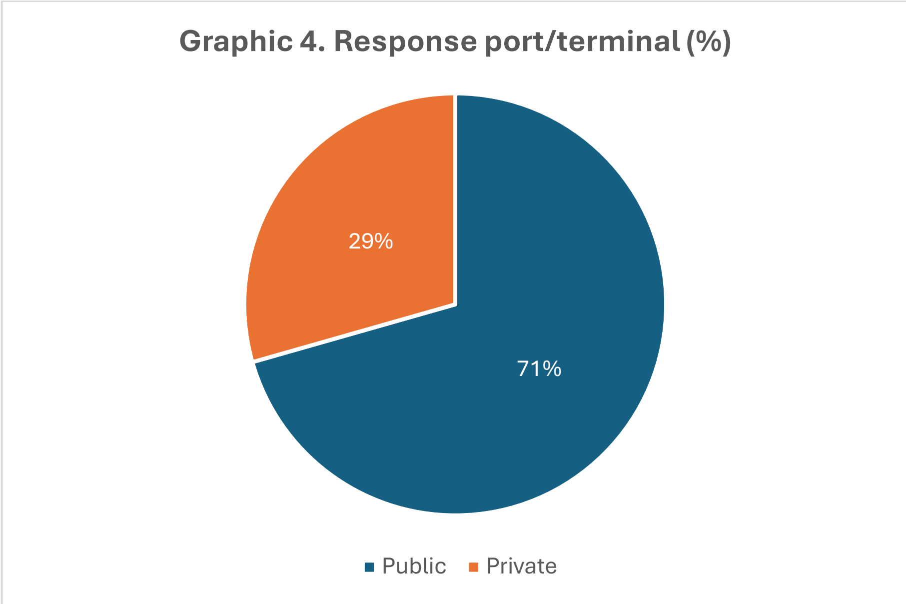


The strong representation of inland shipping entrepreneurs (see graph 2) and ports is striking, which indicates that these groups in particular benefit from a simple and functional roll-out of shore-based power, both in terms of installation and use. The response from cabinet builders and technology suppliers was more limited, but the current market is also quite limited. For these target groups, input was obtained from the major market players.



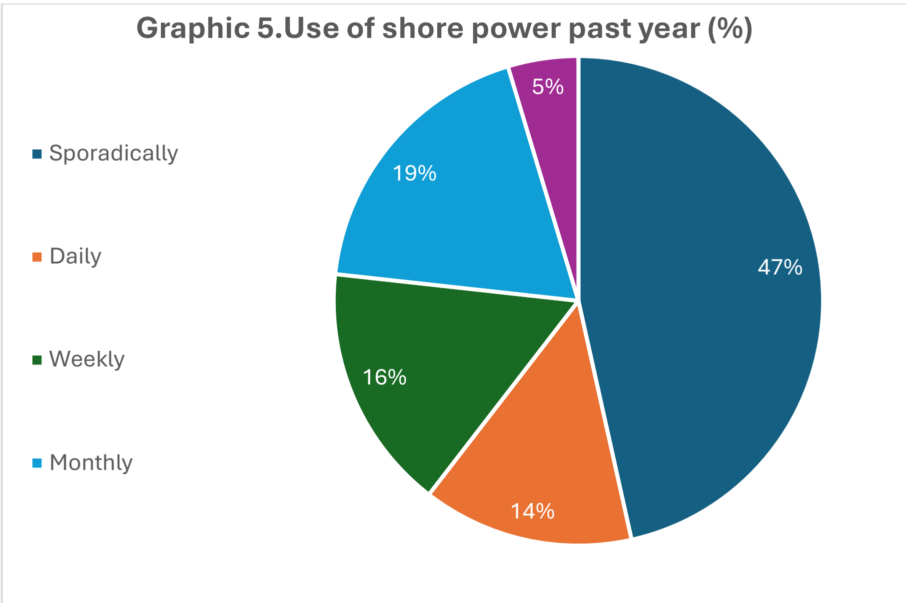
For inland shipping entrepreneurs, a balance is observed between the different types of vessels (see Graphic 3). A representative ratio between public and private ports is also noticeable in the ports (see Graphic 4).



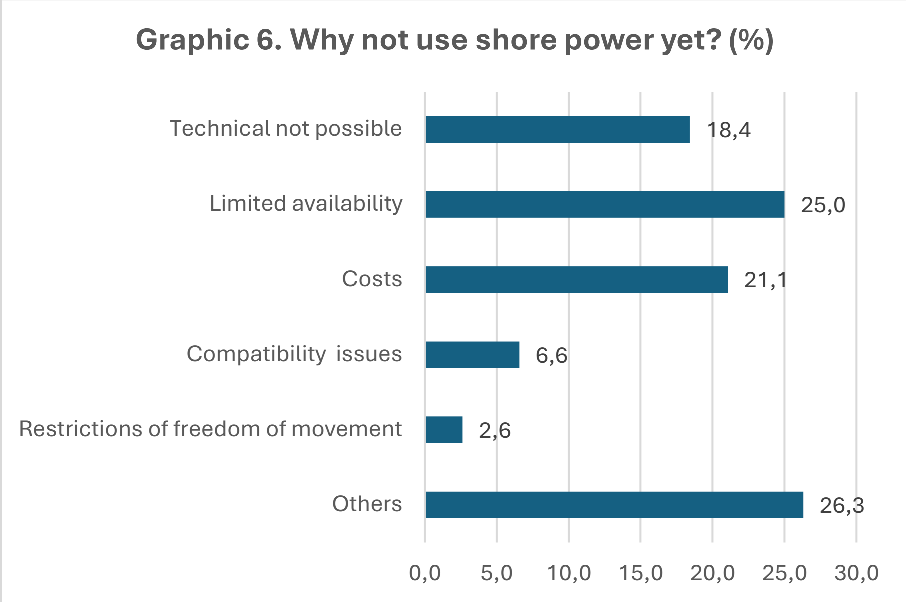


1.3 Some conclusions

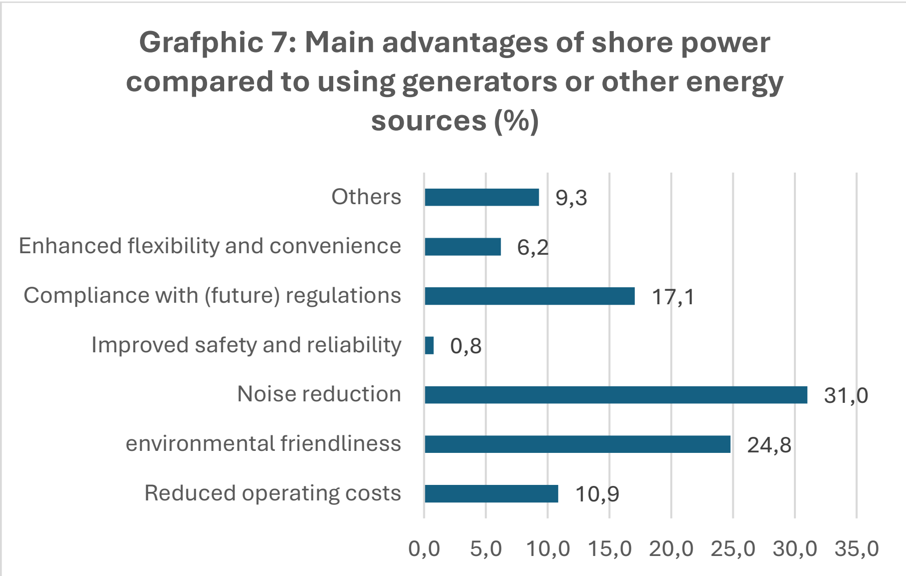
No less than 80% of inland shipping entrepreneurs indicate that they already use shore-based power, although this often happens only sporadically (47%) (see Graphic 5). Within this group, no less than 91% indicate that shore power should be made available at more locations.



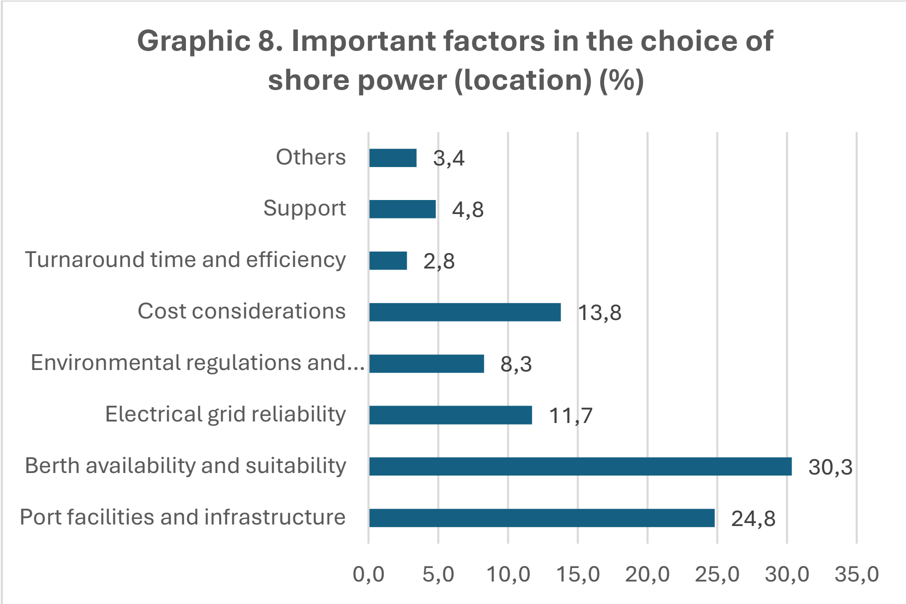
The reasons why some skippers do not (yet) use shore-based power are varied. For example, 25% cite limited availability as the main obstacle, followed by higher costs (21%) and lack of technical capabilities (18%) (see Graphic 6). Nevertheless, 91% of this group indicates that they would switch to shore-based power as soon as these obstacles are removed.



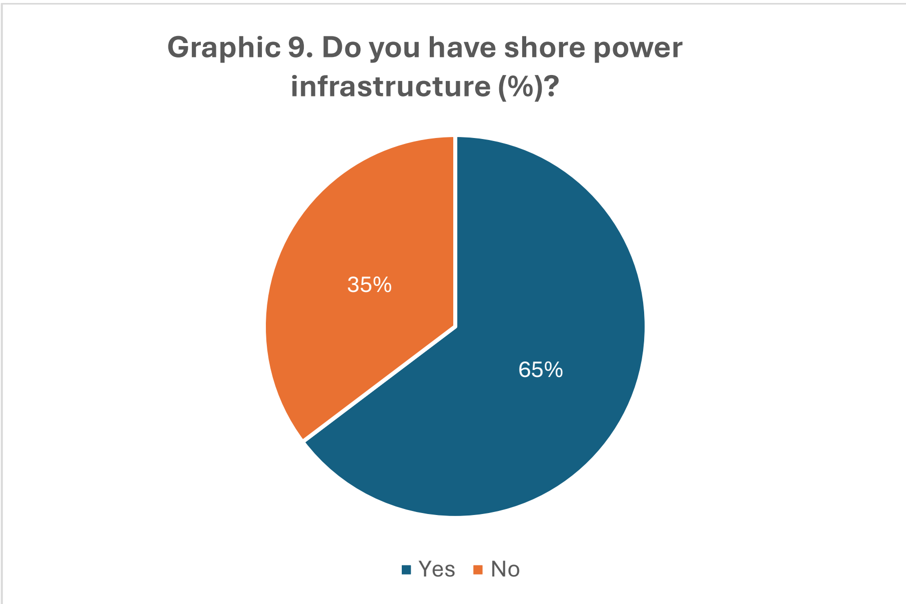
When asked what advantages skippers see in using shore power over a generator, the environmental and environmental aspects are particularly highlighted, with 55.8% of respondents citing this as the most important benefit (see Graphic 7).



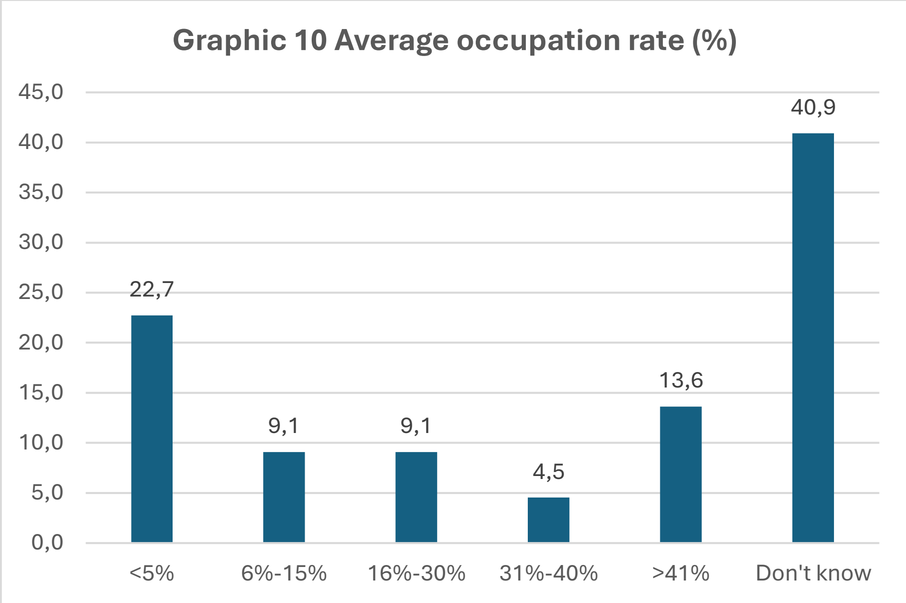
Finally, when asked about the main reason for an inland shipping entrepreneur to choose a port with a shore-based power supply, the mooring availability and possibilities appear to be an important factor (30%), followed by the facilities and infrastructure available (24.8%) (see Graphic 8).

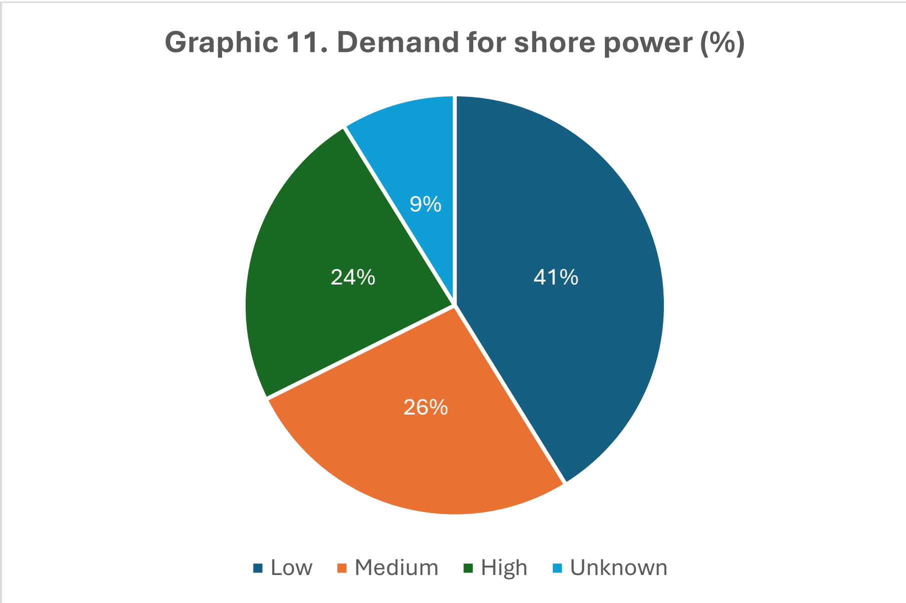


The survey of port authorities shows that 65% of the respondents have shore-based power infrastructure, ranging from basic cabinets (23%) and smart cabinets (32%) to a combination of both (45%) (see Graphic 9).

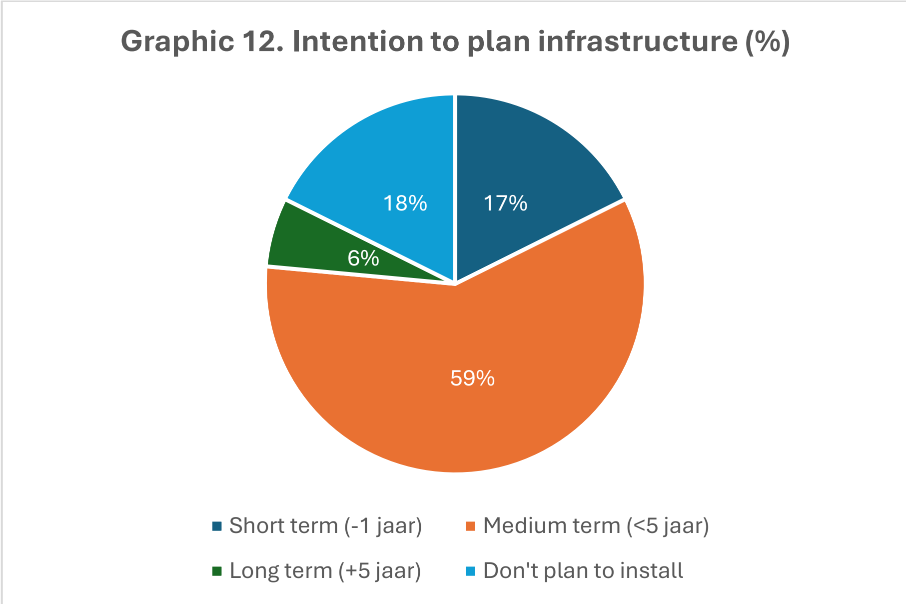


However, the current occupancy rate is indicated by the ports as low (less than 30%), although 41% also indicate that they have no insight into the use of the shore-based power cabinets. (see Graphic 10). The demand for shore-based power installations is therefore estimated by the ports to be mainly low (41%) (see Graphic 11).

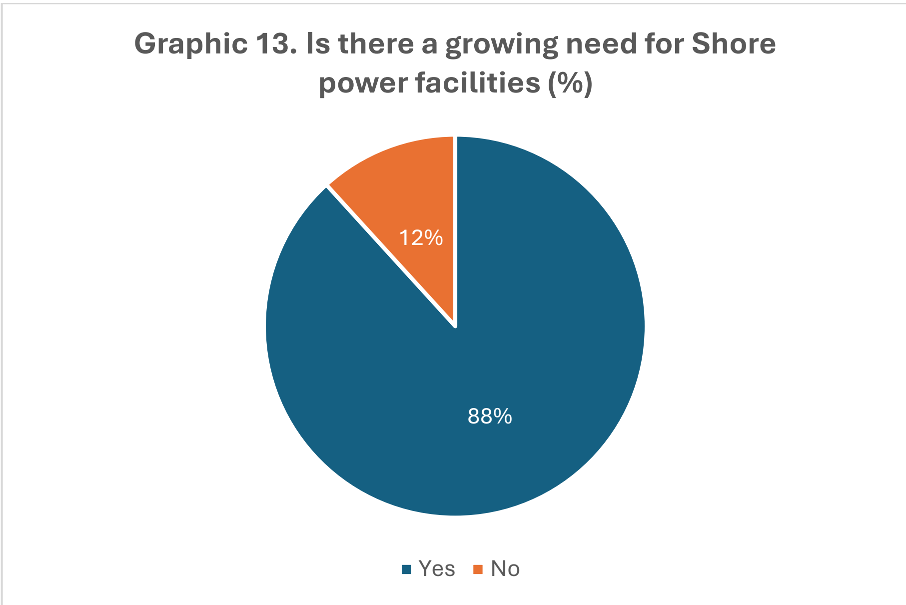




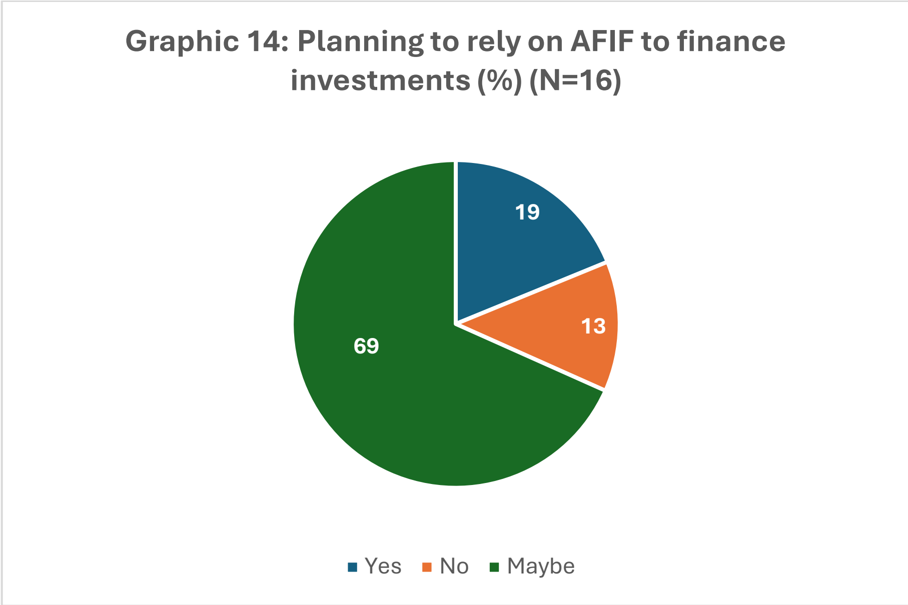
Nevertheless, there is a strong willingness to realize additional infrastructure within five years. 26 (of the 34) ports indicate that they want to invest in this, with the focus mainly on smart cabinets (68%). (see Graphic 12)



These investment plans are in line with the expectation that demand for shore-side electricity facilities will increase, a development endorsed by 88% of the ports (see Graphic 13).



Both ports and inland shipping companies were asked about the biggest challenges for a uniform roll-out of shore-based power and which elements they consider essential in a policy advice plan. The answers to these questions have been incorporated into this plan. The various chapters therefore explicitly refer to input from the field.



Of the ports surveyed, the majority (81.25%) indicated that they are not yet sure whether they will rely on AFIF for their investments in shore power. It was noted that the current procedure to obtain support is too complex and requires too much administration, or that there are insufficient internal resources (financial, personnel, etc.) available to respond to this call.

1.4 Recommendation

Make AFIF funds more accessible for shore power infrastructure

Many (inland) ports and private companies wish to install shore power infrastructure. AFIF could financially contribute to this. Many parties find the current administrative burdens within the framework of AFIF too heavy for the realization of shore power infrastructure. Consider a lighter version of AFIF for the realization of shore power infrastructure."

Chapter 2: Laws and regulations

2.1 Current legislative framework

The **European White Paper of 28 March 2011**[1] calls for a reduction in oil dependence in transport and a 60% reduction in greenhouse gas emissions in the transport sector between 1990 and 2050. The **Commission Communication (24 January 2013)**[2] identifies electricity, hydrogen, biofuels, natural gas and liquefied petroleum gas (LPG) as the main alternative fuels. A coordinated approach is needed to meet the long-term energy needs of all modes of transport. Therefore, the specific needs of the different modes of transport should be taken into account when drawing up national policy frameworks. To facilitate the development and implementation of Member States' national policy frameworks, the **European Parliament adopted Directive 2014/94/EU** on the deployment of alternative fuels infrastructure.

These guidelines also include the development of shore-based power by means of a standardized connection for seagoing vessels or inland vessels. Member States must ensure that shore-side electricity installations that are put into operation or renewed from 18 November 2017 comply with the technical specifications. Facilities for seagoing vessels must comply with the technical specifications of the IEC/ISO/IEEE 80005-1 standard. No further standard is defined for inland waterway vessels.

It also requires Member States to ensure in their national policy frameworks that the need for shore-side electricity supply in maritime and inland ports is assessed. Shore-side electricity supply will be installed as a priority in the ports of the TEN-T core network, and in the other ports before 31 December 2025, unless there is no demand and the costs are disproportionate to the benefits, including the environmental benefits.

In the **Communication of 9 December 2020**[3] on the Sustainable and Smart Mobility Strategy, the Commission highlights the uneven deployment of recharging and refueling infrastructure across the Union and the lack of interoperability and user-friendliness.

Furthermore, the committee points to the fact that the level of ambition in setting targets and supporting policies in the national policy frameworks required by **Directive 2014/94/EU** varies greatly between Member States. Those differences hamper the creation of a comprehensive and complete network of alternative fuels infrastructure across the Union. As a result, **Regulation (EU) 2023/1804**[4]**,** better known as **Clean Power for Transport (CPT),** will follow on 13 September 2023.

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1 European White Paper of 28 March 2011[1] 'Roadmap to a Single European Transport Area — Towards a competitive and resource efficient transport system

2 Communication from the Commission (24 January 2013) [2] 'Clean Energy for Transport: A European Strategy for Alternative Fuels

3 Communication of 9 December 2020 'Sustainable and Smart Mobility Strategy – putting European transport on track for the future'

4 13 September 2023 Regulation (EU) 2023/1804 on the deployment of alternative fuels infrastructure and repealing Directive 2014/94/EU,

Clean Power for Transport (CPT)

Clean Power for Transport sets binding national targets for the deployment of alternative fuels infrastructure, for different modes of transport, including vessels. In addition, common technical specifications and requirements are laid down with regard to user information, data provision and payment modalities, including those for shore-side electricity.

Article 4 (paragraph 5) on electricity supply for transport states that Member States must ensure that their national policy frameworks assess the need for shore-side electricity supply for seagoing vessels and inland waterway vessels in maritime and inland ports. These shore-side electricity facilities will be installed as a priority in the ports of the TEN-T core network and in the other ports before 31 December 2025. If there is no demand and the costs are not in proportion to the benefits (including the environmental benefits), this can be deviated from. Paragraph 6 requires Member States to ensure that installations commissioned or renewed from 18 November 2017 comply with the technical specifications.

The shore-based power facilities for seagoing vessels (including the design, installation and testing of the systems) must comply with the IEC/ISO/IEEE 80005-1 standard. For inland vessels, please refer to the technical specifications for hydrogen refueling points.

Alternative Fuels Infrastructure Regulation (AFIR)

The **Fit for 55 package**[5] provides for a new **Regulation (EU) 2023/1804** on the deployment of alternative fuels infrastructure. Directive 2014/94/EU is hereby repealed. This Regulation is better known as **the Alternative Fuels Infrastructure Regulation (AFIR).** AFIR aims to develop a minimum infrastructure to support all alternative fuels modes of transport, to ensure the full interoperability of this infrastructure and to develop comprehensive user information and adequate payment options.

The regulation also sets a number of mandatory national targets for the deployment of alternative fuels infrastructure. For the electricity supply of ships, the Regulation (Article 9) sets out objectives and targets for the deployment of shore-side electricity supply for larger sea container and passenger ships in maritime ports and for inland waterway vessels (Article 10) in the Trans European Transport Network (TEN-T)- core and comprehensive networks.

According to Article 10, at least one shore-side electricity supply must be available for inland vessels in all inland ports of the TEN-T core network by 2025. For inland ports in the extensive network, this must be done before 2030. Member States are responsible for the roll-out and reporting of the requirements included in AFIR. This means that they are also responsible for setting and imposing sanctions.

5 https://www.consilium.europa.eu/en/policies/fit-for-55/

AFIR also determines the technical specifications for the electricity supply for maritime transport and inland navigation. The most important in the context of shore-based power are the technical specifications for the electricity supply. For example, high-voltage shore-side power facilities for seagoing vessels (including the design, installation and testing of the systems) must comply with the technical specifications of standard IEC/IEEE 80005-1:2019/AMD1:2022. Plugs, sockets and marine coupling contact systems must at least comply with the technical specifications of standard IEC 62613-1:2019. Shore-side electricity supply for inland waterway vessels shall at least comply with standard EN 15869-2:2019 or standard EN 16840:2017, depending on the energy requirements.

According to AFIR, shore-side electricity supply shall be provided in inland ports of the TEN-T core network and of the TEN-T comprehensive network, as listed and categorized in Annex II to Regulation (EU) No 1315/2013. This Regulation was repealed by the European Parliament and the Council on 13 June 2024 and amended by Regulation (EU) 2024/1679[6] on the development of the TEN-T network.

Regulation (EU) 2024/1679 on Union guidelines for the development of the Trans European Transport network

The Regulation on guidelines for the development of the trans-European transport network defines the following nine European transport corridors listed: Atlantic; Baltic Sea-Black Sea-Aegean; Baltic Sea-Adriatic Sea; Mediterranean Sea; North Sea-Rhine-Mediterranean; North Sea-Baltic Sea; Rhine-Danube; Scandinavia-Mediterranean and Western Balkans-Eastern Mediterranean.

A distinction is made between the core network and the comprehensive network:

- The **core network (and the comprehensive core network)** consists of the parts of the comprehensive network with the greatest strategic importance for the achievement of the objectives of the trans-European transport network policy and reflects the evolution of transport demand and the need for multimodal transport. In particular, the core network contributes to accommodating the growing mobility and ensuring high safety standards and to the creation of a transport system with low CO2 emissions.
- The **comprehensive network** extends the network to ports where the total annual throughput volume of the inland port exceeds 500 000 tons according to the latest triennial Eurostat average.

The core network and the comprehensive core network should be developed as a matter of priority in accordance with this Regulation in order to achieve the policy objectives of the trans-European transport network. Member States are invited to take appropriate measures for the European transport corridors to be developed so that their infrastructure

6 Regulation (EU) 2024/1679 on Union guidelines for the development of the trans-European transport network.

within the core network complies with the Regulation by 31 December 2030 and within the comprehensive core network by 31 December 2040 at the latest, including: the equipment associated with inland waterways for the loading, unloading and storage of goods in inland ports and the associated equipment (in particular propulsion and control systems) that reduce, among other things, water and air pollution, energy consumption and carbon intensity. This may include waste reception facilities, shore-side electricity facilities and other alternative fuels infrastructure for production and supply.

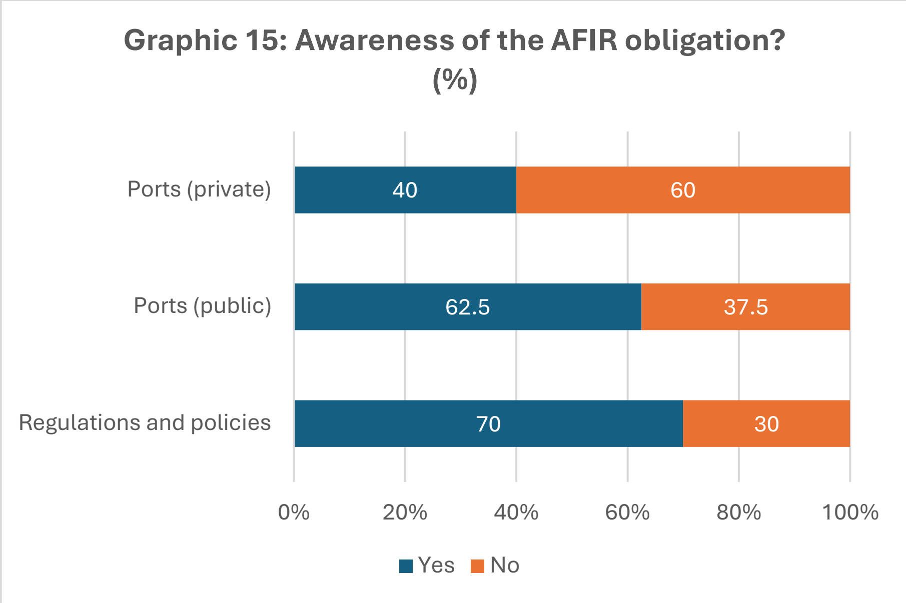
Corporate Sustainability Reporting Directive (CSRD)

In the context of the increasing emphasis on sustainability and environmental friendliness, companies are increasingly required to report their sustainability efforts. The Corporate Sustainability Reporting Directive (CSRD) mandates large companies to prepare detailed sustainability reports. The CSRD covers three areas: Environment, Social, and Governance, also known as ESG. The specific reporting requirements for these areas have been elaborated in the European Sustainability Reporting Standards (ESRS) to ensure that each company reports in the same manner.

Shore power significantly contributes to one of the aspects in the requested reporting especially CO_2 reduction. Therefore, it is important, in light of the CSRD, to highlight this to companies and provide support so that the deployment of shore power is not limited to the TEN-T network alone.

2.2 Findings of regulators, governments and ports

The online survey shows that private ports in particular are less familiar with the regulations. No less than 60% indicate that they do not know about them. The AFIR obligations are better known to public ports and policy bodies. However, it is striking that here too, 37% of the public ports and 30% of the policy bodies are not fully aware of the applicable rules.



2.3 Recommendations

Communicate more about AFIR

The majority of private ports (60%) and public ports (37.5%) and 30% of government institutions indicate that they are not aware of the AFIR regulations, despite the obligations arising from the regulation. This clearly indicates a lack of knowledge about the current legislation. When implementing new regulations, it is therefore important that policymakers, end users and operators are well informed. SPIES therefore advises to conduct the necessary communication about the AFIR regulations to (private and public) ports and government institutions.

Define mandatory shore power locations

According to current legislation, it is mandatory to make a shore-based power installation available along the TEN-T network. This network is determined on the basis of the total annual throughput volume exceeding 500,000 tons (based on the most recent three-year average from Eurostat). However, interviews with the ports and government services involved show that in practice the necessary infrastructure is not always available at the transshipment locations, such as in gravel extraction on the Meuse (the Netherlands). Unlike the CPT (Clean Power for Transport), the AFIR regulations do not contain any exceptions, except in cases where there is no demand and the costs are not proportional to the benefits (including the environmental benefits), for providing the necessary shore power infrastructure. However, barges are usually moored for long periods at locations where loading and unloading is not taking place (rest areas and overnight stops). It therefore seems more appropriate, in order to reduce the emission of CO2, NOx and

PM10 particulate matter, to make shore power facilities available at these locations instead of at transshipment installations.

In addition, berths are sometimes located in the vicinity of civilization. In these cases, too, it may be advisable to provide shore power to reduce noise nuisance from running generators.

SPIES therefore proposes to add a minimum stay time (mooring time) in addition to the tonnage as an additional parameter as a basis for the obligation to provide shore-based power infrastructure.

Highlight shore power in the context of the CSRD

Shore power makes a significant contribution to CO2 reduction. In light of the CSRD, it is therefore important to inform companies about this and support them so that the deployment of shore power is not limited to the TEN-T network and public ports and waterway authorities alone.

Chapter 3: European standardization

3.1 Current technical standards

Shore-based power standards

The maritime sector uses different standards to ensure the safety and efficiency of electrical installations. This article discusses the main obligations of four critical standards: **IEC 80005, NBN EN 15869, EN 16840 and HD 60364-7-709**. These standards focus on various aspects of shore power connections and electrical installations for ships and marinas and play a key role in ensuring safe and reliable connectivity.

The following standards are important for shore-based power in inland ports:

- The **IEC 80005 standard** focuses on high voltage shore power connections (HVSC) for ships and provides specifications for the design and installation of HVSC systems, including shore distribution systems, shore to ship connections, transformers and frequency converters. In addition, the standard sets requirements for safety systems, such as earth switches and safety circuits. The standards also include procedures for periodic testing of the systems to ensure reliability and safety. This standard is mainly applicable to ships that need a high-voltage connection, such as large commercial ships and cruise ships.
- The **NBN EN 15869 standard** relates to electrical shore-based power connections for inland vessels. The most important obligations are the requirements for three-phase current of 400 V, 50 Hz, with a nominal current of up to 125 A. Strict safety regulations apply on both the shore side and on the ship's side of the connection to ensure safety. In addition, the standard ensures compatibility between different ships and ports, contributing to a standardized and efficient infrastructure. This standard applies specifically to inland vessels used for commercial inland navigation.
- The **HD 60364-7-709 standard** is aimed at low-voltage installations in marinas and similar locations. The main obligations are the use of RCDs and other protective equipment to provide protection against electric shock. Electrical installations must be protected from flooding and other forms of water intrusion, which means that all equipment and cabling must be suitable for use in humid environments. The standard also sets requirements for the safety of electrical connections, including the proper installation and maintenance of connection points. In addition, all electrical installations must be clearly marked and identified to facilitate safety and maintenance. Finally, the standard requires regular inspections and maintenance of electrical installations to ensure that they are in good working order and comply with safety regulations. This standard applies specifically to marinas and similar locations.

Standards for plug connections

A specific standard also applies to plugs:

- **IEC 62613** is a standard that covers plugs, sockets and ship couplings for shore-based high-voltage connections (HVSC systems). It is divided into two main parts:
    - **IEC 62613-1:2019**: This section covers the general requirements for these accessories, including three phases and ground with pilot contacts and one pole for neutral. These accessories are designed for rated currents up to 500 A and rated operating voltages up to 12 kV at 50/60 Hz.
    - **IEC 62613-2:2016**: This section specifies the dimensional compatibility and interchangeability requirements for these accessories so that they can be used by different types of vessels. It includes standard sheets for various configurations of shore outlets, plugs, marine connectors, and ship inlets.
- **IEC 60309** is an international standard for industrial plugs, sockets and couplings. This standard is intended for applications where a higher current and voltage are required than household plugs
    - **IEC 60309-1**: This section describes the general functional and safety requirements for industrial plugs and sockets. These are plugs with a nominal operating voltage of up to 1000 V (AC or DC) and a nominal current of up to 800A.
    - **IEC 60309-2**: This part specifies the requirements for dimensional interchangeability for pin and contact tube accessories. This ensures that plugs and sockets from different manufacturers are compatible.
    - **IEC 60309-4**: This section deals with switched sockets and connectors, with or without interlocking. These products combine a socket or connector with a switching device in a single housing.
    - **IEC 60309-5**: This section focuses on the compatibility and interchangeability of plugs and sockets for low-voltage shore connections (LVSC systems) for ships.

The plugs and sockets according to this standard are often color-coded and have different configurations depending on the voltage and amperage. For example, blue plugs are commonly used for 230V applications, while red plugs for 400V applications are three-phase applications. The CEE (Commission Internationale de l'Éclairage) is an international organization that focuses on the standardization of light and color technology. However, in the context of plugs and sockets, CEE often refers to the IEC 60309 standard, which describes industrial plugs and sockets. These are often referred to as CEE plugs and sockets.

3.2 Shortcomings in the current standardization

Only a pre-standard for smaller ships

In the maritime sector, many shore power standards are in force, as shown in the overview below[7].

Power demand	Type of ship	Standard	Status	Voltage	Frequency	Cabel management system	Connector	Comments
>1 MVA	RoRos (Cargo or passenger)	IEC 80005-1 + Annex B	normative	6.6kV/11kV	50/60Hz (conversion ashore if needed)	on shore	in accordance with IEC 62613	There are suggestions for improving the standard, but in general the standard for this segment is well defined and working
>1 MVA	Cruise ships	IEC 80005-1 + Annex C	normative	6.6kV/11kV	50/60Hz (conversion ashore if needed)	not defined	in accordance with IEC 62613	
>1 MVA	Container ships	IEC 80005-1 + Annex D	normative	6.6kV/11kV	50/60Hz (conversion ashore if needed)	on vessel	in accordance with IEC 62613	
>1 MVA	Tankers	IEC 80005-1 + Annex E	informative	6.6kV	50/60Hz (conversion ashore if needed)	on shore	in accordance with IEC 62613	Standard needs to be further defined, especially how to deal with hazardous zones
>1 MVA	LNG carriers	IEC 80005-1 + Annex F	informative	6.6kV	60Hz (conversion ashore if needed)	not defined, has to be outside hazardous area	in accordance with IEC 62613	No additional development of the standard needed
87kVA - 1MVA	Offshore supply, service and working ships	IEC/PAS 80005-3 + Annex C	Pre-standard	400V/440V/690V	50/60Hz (conversion ashore if needed)	on shore	defined in Annex B; in accordance with IEC 60309	Pre-standard will likely change significantly before becoming a standard: no ship-specific annexes, but capacity classes instead, potentially with standard transmission voltage/frequency: 690V/60Hz
87kVA - 1MVA	Container ships	IEC/PAS 80005-3 + Annex C	Pre-standard	400V/440V/690V	50/60Hz (conversion ashore if needed)	on vessel	defined in Annex B; in accordance with IEC 60309	
87kVA - 1MVA	Tankers	IEC/PAS 80005-3 + Annex C	Pre-standard	440V	60Hz (conversion ashore if needed)	on shore	defined in Annex B; in accordance with IEC 60309	
87kVA - 1MVA	all others	IEC/PAS 80005-3	Pre-standard	400V/440V/690V	50/60Hz (conversion ashore if needed)	on shore or mobile	defined in Annex B; in accordance with IEC 60309	
<87kVA	inland shipping	EN 15869-1:2019	normative	400V	50Hz	cable on vessel	CEE plugs	No further improvements needed, uncopmlex and well-defined standards

Despite the different standards, it can be concluded that for smaller seagoing vessels (with a requested capacity between 87 kVA and 1 MVA) only a pre-standard is currently available. This pre-standard is expected to be significantly modified before it can be used as the final standard for this shipping segment.

Shortcomings of current standards

Not every (inland) vessel has the same data needs. The current standards do not make any differentiation in terms of power requirements. In addition, these standards do not pay sufficient attention to modern payment methods, such as payment via App or QR code.

7 Final report Movares: https://www.schonescheepvaart.nl/nieuwsitem/resultaten-iw-innovatieproject-versnelling-uitrol-walstroom

3.3 Recommendations

Set Shore-based power standard for smaller sea-going vessels (with a requested capacity between 87kVA and 1MVA)

No shore-based power standard has currently been set for small seagoing vessels. SPIES is therefore urging the establishment of a shore-based power standard for this ship segment in the short term as well.

Optimize current standards

Establish a differentiation in the current standards in terms of available capacities. After all, every type of ship does not require the same power. The CEMT class (Classification of European Inland Waterways) can be a guideline here. In addition, the possible payment methods (e.g. Annex A NBN EN 15869) should be expanded with the latest payment methods such as payment by App or QR code. However, as will be seen in the following chapters, these payment methods require a more uniform and standardized approach.

Establish Standardization of connections and electrical installations

As was mentioned by a number of inland shipping entrepreneurs in the online survey, it is important that there is standardization for the connections, but also for the electrical installations on board of the vessels. It is important to establish uniform standards for the connections of shore-side power cabinets and cables so that they are compatible with different types of vessels, barges and infrastructure. This promotes interoperability and prevents technical failures or delays when connecting ships to shore-side power.

Chapter 4: User experiences

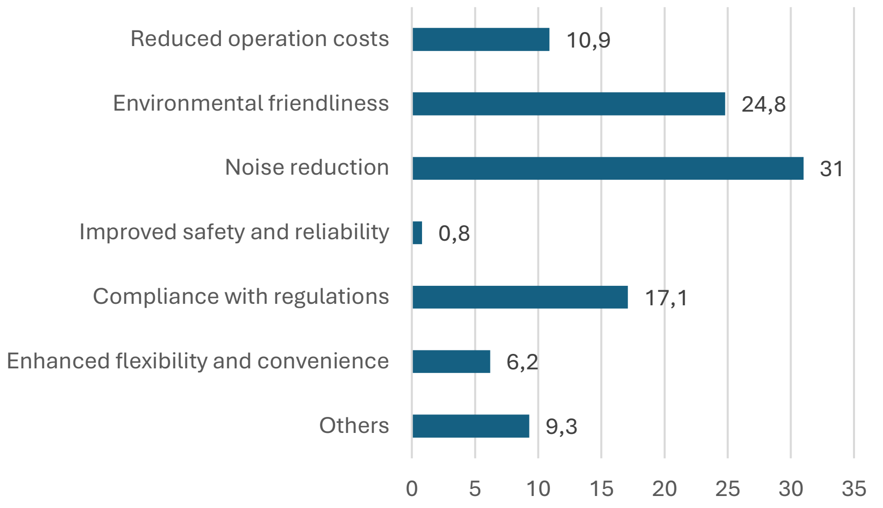
4.1 Current experiences

Advantages according to users

In recent years, inland shipping companies have been paying increasing attention to the use of shore-based power as an alternative to traditional energy sources such as diesel generators. This is due to the significant benefits that shore-based power offers in terms of cost savings, environmental friendliness, noise reduction, regulatory compliance and operational convenience. These advantages make shore-based power an attractive option for ships mooring in ports.

In the online survey, inland shipping entrepreneurs indicate cost savings as one of the most important advantages of shore-based power (see graphic 15). Generators require regular maintenance and fuel, which adds up to significant operational costs. Shore-based power, on the other hand, uses electricity from the grid, which is often cheaper and requires less maintenance. This leads to reduced operational costs for barge operators, which enables them to increase their profitability.

Graphic 16 Main advantages of shore power (%)



In addition, shore power is more environmentally friendly than the use of generators. Generators emit harmful substances, such as carbon dioxide, particulate matter and nitrogen oxides, which contribute to air pollution and climate change. Shore-based power significantly reduces these emissions, making it a more sustainable choice. This is especially important at a time when the shipping industry is under increasing pressure to reduce its carbon footprint and contribute to the fight against climate change.

Another important advantage of shore-based power, according to the sector, is noise reduction. Generators can be quite noisy, which can be disruptive to both the crew and the environment. This is particularly problematic in urban areas or ports in the vicinity of residential areas. Shore power provides a quieter and more comfortable environment, which contributes to the well-being of the crew and the quality of life in the area.

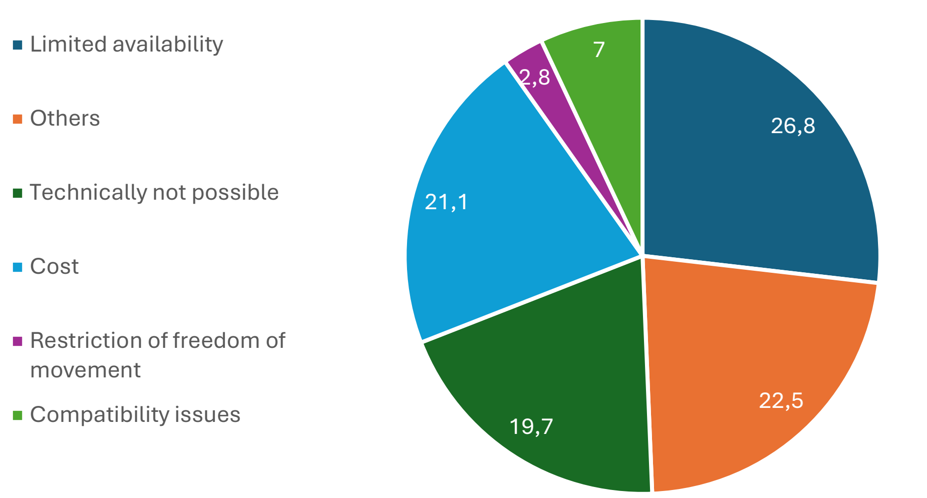
Shore-based power also helps with compliance with future regulations. Many countries and ports are introducing increasingly stringent environmental regulations to reduce emissions from ships. By switching to shore power, ships can comply with these regulations and avoid potential fines or restrictions. This makes shore-based power not only an environmentally friendly, but also a legally responsible choice.

Finally, shore power offers more flexibility and convenience. It eliminates the need to continuously monitor and maintain generators, increasing operational efficiency and giving the crew greater peace of mind. This convenience is further enhanced by the fact that shore power is often readily available in ports, making it easy for ships to connect and use a reliable source of energy.

Usage Determinants

Several crucial factors play a role in the installation of shore-based power infrastructure. First of all, the port facilities and infrastructure are of great importance. This includes the compatibility of the connection points and the capacity to meet the power requirements. A well-equipped port can handle the energy needs of docked ships more efficiently, contributing to smoother operations. However, according to the inland shipping entrepreneurs, this is not always the case.

Graphic 17: Why not use shore power yet (%)



In addition, inland shipping operators indicate that the availability and suitability of berths is essential in the implementation of shore-based power. Ports must have sufficient berths that are suitable for ships that need shore power. This prevents delays and ensures that ships can be connected to the shore power supply quickly and efficiently.

The reliability of the electricity grid is another important factor. A stable and reliable local electricity grid is necessary to ensure a constant power supply. Interruptions or instability in the network can lead to operational problems and additional costs for the ship.

The turnaround time and efficiency of port operations are also affected by the availability of shore power. An efficient shore-based power supply can reduce the turnaround time of ships, which contributes to higher productivity of the port.

Finally, the availability of technical and operational support is crucial. Ports must have sufficient support to solve any problems with the shore-side power supply quickly and effectively.

In the spotlight: payment – invoicing for the use of shore power

Experiences with invoicing vary among inland shipping entrepreneurs. Some users receive multiple bills monthly, while others receive only one bill or none at all, depending on their usage and the providers' billing systems. Opinions on billing are divided; some find the billing good and fast, while others report problems such as double payments, long repayment terms, and bills that don't always mention the cost per kWh.

Insight into annual consumption and costs depends on the availability of information and the systems used. Some users have access to detailed historical data, while others lack this insight due to technical limitations or because they are not yet fully utilizing the systems. Lack of insight is due to technical limitations, high costs, limited availability of shore power points and compatibility problems with the connections.

Finally

It is clear that there is still a lot of room for improvement, especially in terms of cost, availability and ease of use of shore-based power facilities. However, inland waterway operators see the added value of a collective approach and a common policy on shore-side power, as this can contribute to a more efficient and sustainable shipping sector.

4.2 Recommendations: Questions from inland shipping entrepreneurs

Ensure sufficient infrastructure in the right place with the necessary power requirements per type of vessel

It is essential that ports, terminals and waterway managers invest extra in shore-based power infrastructure. These investments are crucial to meet the growing demand from inland shipping entrepreneurs for sustainable energy solutions.

In addition, these shore-side electricity facilities must be tailored to the specific needs of the users. This means that the different types of ships and their power needs must be taken into account.

Ensure well-functioning shore-based power infrastructure

Inland shipping entrepreneurs emphasize the importance of a well-functioning shore-based power infrastructure. However, in order to guarantee the reliability and efficiency of shore-based power supplies, it is crucial that Service Level Agreements (SLAs) are established within the European Union. These SLAs should establish clear intervention times in case shore power cabinets fail to operate or exhibit reduced functionality. This ensures that malfunctions are resolved quickly and effectively, allowing inland shipping entrepreneurs to use shore power without interruptions. Setting such SLAs will not only increase the satisfaction of inland navigation operators, but also contribute to the overall sustainability and efficiency of the European inland navigation sector.

Promote interoperability

Ensuring interoperability in the use of shore-side power is crucial for the efficient and seamless operation of the infrastructure. This means that shore-side power systems must be compatible with different ship types and brands, and that they meet standardized technical and operational requirements (see also Chapter 3).

In addition to inland navigation operators, European regulations, such as the Alternative Fuels Infrastructure Regulation (AFIR), also emphasize the importance of full interoperability across the EU. This ensures that ships can use the same shore-based power facilities in every port without technical problems or adjustments. This accelerates the adoption of shore-based power and reduces the environmental impact of the maritime sector (See also Chapter 2).

Ensure good and clear communication about the benefits of shore power and the applicable regulations

Setting up a communication campaign to refute the prejudices about shore power is a strategic necessity to promote the acceptance and implementation of this sustainable technology. First of all, it is essential to identify the most common misconceptions about shore power, such as the alleged high cost, the reliability of the technology and the ease of use.

Sharing success stories of ports and ships that already use shore-based power can also contribute to refuting prejudices. These stories illustrate the practical benefits and feasibility and can serve as inspiring examples. Finally, it is important to collect feedback from inland shipping operators and to adjust the campaign based on this input to increase effectiveness.

This message must be spread through various shipping communication channels, including social media, newsletters, webinars and workshops, in order to reach a wide audience.

By following these steps, a communication campaign can effectively contribute to reducing prejudices and promoting the (further) use and acceptance of shore-based power.

Chapter 5: Positioning cabinets

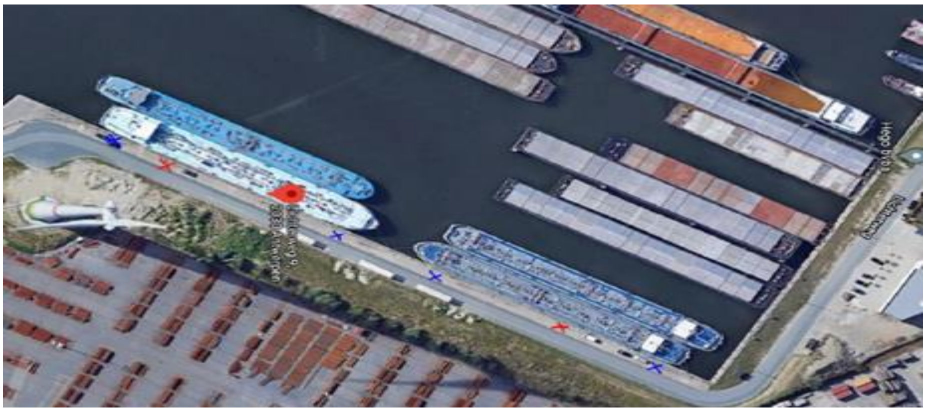
5.1 Current experiences

When asked whether there were ever situations in which they did not have the possibility to connect to a shore-based power cabinet, 39 inland shipping companies indicated that this was indeed the case. The main reasons are:

- No space in the port because the mooring places with a connection are occupied by recreational boats or ships without connection facilities on the ship;
- No connections in the outer ports of locks. These are often used as overnight accommodation;
- Faulty cabinets and cabinets with too many malfunctions;
- Insufficient (or no) cabinets in the port in relation to the number of berths;
- The distance from the cabinet to the ship is too long;
- Connections do not meet the technical requirements of the ship (amperage);
- The nature of the cargo (e.g. highly flammable liquids) does not allow a second ship to lay power cables over the cargo area (of the first ship);
- Sometimes there is no possibility to connect to the network because the terminals are in use.

The location of the current shore power cabinets is therefore often suboptimal. This unfavorable placement means that skippers have to bridge long distances with heavy cables to connect their ships to shore power. This not only hinders ease of use but can also lead to security risks and inefficiencies. These findings are also evident in an energy scan[8] to stimulate the use of shore-based power that was carried out on behalf of North Sea Port, Port of Antwerp and the Flemish government (De Vlaamse Waterweg and the Department of Mobility and Public Works).

Figure: practical example of "poor" accessibility of shore power cabinets. Red crosses represent current shore power cabinets, blue crosses represent suggested location of shore power cabinets.



The red crosses indicate the locations where the shore power cabinets are currently situated. The blue crosses indicate the locations where these would be best positioned from the ship's perspective.

8 These energy scans are part of the European research project Clean Inland Shipping (Clinsh). Learn more: www.clinsh.eu

To address these issues, SPIES proposes to carry out a thorough evaluation of the current locations of shore power cabinets and reposition them where necessary. The practical needs of skippers and the specific characteristics of the ports should also be taken into account in the case of new cabinets. Determining a maximum distance between the shore power cabinets can optimize the use of shore power.

5.2 Recommendations

Determine where shore power cabinets make sense

SPIES proposes to use a minimum mooring time as the basis for the obligation to provide shore-side electricity infrastructure instead of the average throughput volume (500,000 tons) now laid down in Regulation (EU) 2024/1679 on Union guidelines for the development of the trans-European transport network.

Ensure the correct location of shore-based power infrastructure

When properly installing shore-based power infrastructure, it is important to pay attention to practical bottlenecks, such as the influence of high tide and low tide on the shore-based power cabinets and the location in relation to the ship. If necessary, provide additional infrastructure so that the shore power cabinet can always be used safely.

Determine the distance between shore power cabinets

In the context of the manageability of connection cables for the shore power cabinet and the ship, a standard must be drawn up. The NIOSH (National Institute for Occupational Safety and Health) method, originally from the United States but also used in Europe, calculates how much a worker can safely lift. Under ideal conditions, the maximum lifting weight is 23 kilos. Depending on the circumstances such as the frequency of lifting, the distance the load has to be moved and the posture of the worker during lifting, this lifting weight can also be lower. It should also be noted that a loss of power occurs when the distances between the shore power box and the barge are too great.

Given the importance of safety and the maneuverability of the connection cables, SPIES recommends that the distance between the shore power cabinets and the moored vessels be set out in a general guideline.

5.3 Featured: Availability sufficient grid capacity

The increasing demand for shore-based power supplies also increases the risk of grid congestion because the capacity of the electricity grid is too limited. This possible grid congestion has a significant impact on the roll-out of a shore-based power network.

- Shore power requires a high-power supply, especially for larger vessels. In areas with grid congestion, there may be insufficient capacity to realize additional connections without expanding the electricity grid.
- Additional investments are needed in grid reinforcement or smart solutions (such as energy storage or load management). This can make the business case for shore-based power less attractive.
- Grid operators apply waiting times for new connections in areas with grid congestion, which can delay the implementation of shore power.

In the event of the risk of grid congestion, additional smart solutions must therefore be found. Examples include batteries, which can reduce peak loads, smart control of shore power, local generation through green power facilities (solar panels or wind energy combined with storage). Importantly, ports must work together with grid operators to find solutions, such as flexible grid tariffs or prioritization of shore-based power within grid capacity plans.

Chapter 6: Hardware

6.1 History

The discussions with the ports show that the first shore power cabinets were installed in the late 90s. These early models were often little more than simple sockets, with no possibilities for remote monitoring or technical assistance. This significantly limited functionality and ease of use, as it did not allow for direct control or support in the event of technical issues.

Ports and waterway authorities started installing more advanced shore power cabinets linked to management platforms in the mid-2010s. However, these systems were usually implemented on an individual basis. The different systems caused considerable inconveniences for users, who often have to have multiple identification systems in their possession, but also for maintenance parties who have to control the various systems technically.

If shore-based power is rolled out on a large scale, it is essential to further identify and solve these problems. To this end, the "Walstroomcollectief[9]" took a first step through a collaboration between Dutch and Flemish port companies, provinces, port municipalities and waterway managers. The shore power collective provides a basis for achieving the right facilities at the right location.

This collaboration led to the preparation of a standard technical specification for shore-based power cabinets. These specifications have already been used by "De Vlaamse Waterweg". On behalf of 30 (inland ports) and waterway authorities in the Netherlands and Belgium, a framework agreement for the supply of shore-based power cabinets was placed on the market and was officially presented at the expert meeting organized by SPIES at the Central Commission for the Navigation of the Rhine (CCNR) on 29 May 2024.

A shore power cabinet for inland shipping does not have to be identical at every location. In some places, the facility is used more intensively, while elsewhere specific requirements apply for remote control, for example. The technical specifications of the

[9] Walstroomcollectief: The Walstroomcollectief was founded in 2020. This collective aims to install the right shore-based power facilities in the right locations, with a strong focus on sustainability and cooperation. This collective approach offers substantial benefits, such as cost savings, improved efficiency, and a greater impact on environmental goals. Port Solutions Rotterdam B.V. (PSR) acts as the director of this collective and plays a crucial role in the coordination and implementation of the projects.
Products:
- At the end of 2020, the study 'Shore-based power, a feasibility study into clustering of needs' was completed.
- In September 2021, the handbook 'Ship types and need for shore power' followed.
- First two quarters of 2022: inventory of the power requirements per location
- In March 2023, the Multi-Year Shore-based Power Program and a market consultation carried out followed, which are a necessary and logical step in the preparation of a tender for new shore-based power facilities.

“Walstroomcollectief” therefore distinguish three types of shore-based power cabinets for inland shipping:

- Type 1 (Bronze): transaction, switching on and off and registering consumption.
- Type 2 (Silver): the functionalities of bronze + local reset functionality outside cabinet + remote by technical helpdesk.
- Type 3: (Gold): the functionalities of silver + temperature and humidity + voltage control / emergency power supply (UPS).

This is shown schematically in Figure below.

Platform shore power Service provider

Processing & communication Unit shorepower cabine

Output

Type	Relais	Fuse	Earth leakage	Other Comp*
Brons	In/out	-	-	-
Silver	In/out	In	In	-
Gold	In/out	In	In	In/out

Input

Type	Relais	Fuse	Earth leakage	Plug	KwH	Other Comp*
Brons	Status	-	-	Status	Kwh	-
Silver	Status	Status	Status	Status	Kwh	-
Gold	Status	Status	Status	Status	Status	Status

**Other components here include, for example: temperature and humidity, fans, cabinet lighting and heating. This allows for full remote control.*

In addition to the types mentioned, there are several other options available. However, this can make it difficult to achieve the desired one-to-one interchangeability of the controller, for example due to the number of inputs and outputs on the controller or the underlying local software. The technical specifications and components are also laid down in the standard technical specifications.

6.2 Ship types and need for shore power

As already mentioned in chapter 3, the NBN EN 15869 standard determines the required capacities for a shore power cabinet. For example, the electrical shore connection must be designed for three-phase 400 V, 16 A, 50 Hz, but can also be designed for three-phase 400 V, 32 A, 50 Hz, or for three-phase 400 V, 32 A and 63 A, 50 Hz. However, this standard does not take into account the specific location of the shore-based power cabinet and therefore also does not take into account the actual needs of the mooring vessels.

In addition to the technical specifications, the Walstroomcollectief drew up the handbook "Ship types and need for shore power". This handbook provides a detailed overview of the average shore-side power consumption and power requirement per ship type. This is essential to gain insight into the required shore-based power facilities for each location.

6.3 Recommendations

Provide standardization and harmonization

Each shore-side power cabinet should be designed for the specific power needs of the vessels that usually call at the berth. It is therefore not necessary to make all the capacities laid down in the standards available on each shore power cabinet. The right power in the right place should be the starting point.

In addition, shore power cabinets must comply with all relevant safety standards, such as the requirements for earth leakage circuit breakers, short-circuit protection and surge protection. They must also be robust and resistant to the specific environmental conditions of ports, including humidity, salt air (in marine applications), and temperature fluctuations. The reliability of the cabinet is essential to ensure uninterrupted power supply for the ships.

With advancing technological developments, new types of shore-based power cabinets may enter the market in the future that offer more advanced features such as real-time monitoring of power consumption or automatic fault detection. These innovations should be embraced and integrated, provided they improve the reliability and safety of the infrastructure.

Set up a specialized European knowledge and management organization

In view of the above, it seems essential to commission an independent European body to develop, manage and update a standard technical design in due time. This body should be in close consultation with the business community and European and international standards organizations.

Chapter 7: Interoperability

7.1 Problem definition

As mentioned in Chapter 6 *Hardware*, in the mid-2010s, ports and waterway authorities began installing more advanced shore power cabinets. These installations were typically based on individual needs, leading to limited coordination with other ports and authorities. In many cases, the chosen contractor implemented their own newly developed platform. This fragmented development illustrates the lack of a unified user system for current shore power cabinets—one that could serve all inland shipping operators. Even after all these years, different providers of shore power switchgear, payment systems, and apps unfortunately continue to use their own platforms, which often do not communicate with each other.

In addition, there is a 'vendor lock-in', where an organization becomes so dependent on a specific supplier that switching without major financial or operational consequences is virtually impossible. There is also a lack of a uniform link between the shore power cabinet and the user platform, which further complicates interoperability.

At the beginning of 2023, the report “Deel Actie 2: Open data communication protocol" was published on behalf of the Port of Amsterdam Authority, the Royal Association of Dutch Shipowners and Stena Line. The aim of the contract was to break down these barriers, so that every service provider and every user can communicate with each other on every shore-based power supply (interoperability).

Desk research and interviews revealed that data exchange, along with factors such as data ownership, reliability, and independence, is crucial for the development and successful implementation of an open data communication protocol.

In order to clearly map out the data flows within the process, an independent Enterprise Architect was called in. This architect drew up a customer journey and described the actors involved with their corresponding roles. Based on this, five possible scenarios were developed, which were evaluated for their contribution to solving the identified bottlenecks. This analysis is summarized in the table below.

Table: Scenarios and contribution to the solution direction

	Do nothing	Register	Platform	Federated	Different market
Standardized open market solution	-	-	+	++	+
Increasing the quality of the shore-based power chain	-	+	+	+	++***
Reduce/control port costs	-	+	+	+	++***

Unambiguous user system for shore power (such as in parking and e-charging)	-	-	+	+	+
Unambiguous use and payment	-	-	+**	-	-
Preventing vendor lock-in	-	-	+	++	+
Interoperability between (systems of) different providers	-*	+	+	++	+

**The current market forces do seem to lead to a voluntary improvement in interoperability at the moment.*
***In the platform scenario, this only applies if the payment process is handled through a platform.*
****There is an opportunity to introduce shore-based power as a use case in the draft of the new Energy Act 2025*

The table above shows that the federated scenario contributes the most to solving bottlenecks. This federated data-sharing solution still needs to be rolled out for shore-based power. This solution has already been implemented in other sectors.

7.2 Interoperability benefits

By ensuring interoperability between multiple providers in the chain, ports can respond more flexibly to the needs of their users. However, it is essential that usage is strictly monitored to ensure that, at any given time, only one user can access an inland navigation service through the app of their choice. Once a connection point is in use or reports a malfunction, it must be locked to prevent access by other users.

Opening up the shore-based power infrastructure to multiple apps responds to the wishes of the users. After all, current experiences with shore-based power are diverse. Some users find invoicing efficient and fast, although there are occasional issues with double payments and long refund times. Others experience the organization of shore-based power as complicated and expensive, especially in the port of Rotterdam and Dordrecht, where the shore-based power cabinets often function poorly. There are also complaints about the high kWh prices and the cumbersome invoicing method, which sometimes requires invoices to be downloaded manually.

Users who sail mainly in the north of France and the Moselle do not report any major problems with the existing operators, although the system of applications has not yet been fully implemented there. In the Netherlands, the method is heterogeneous, with both monthly collective accounts and monthly settlements per ship.

The survey shows that opinions are divided: some users find the service good, while others find it complicated and expensive. There is a clear need for improvement and standardization, especially with regard to invoicing and the availability of shore-based power.

7.3 Recommendation

Work on Interoperability

In 2010, the Commission gave a mandate to the European Standardization Organizations (M468) to develop new standards or revise existing standards in order to ensure interoperability and connectivity between recharging points and chargers of electric vehicles. CEN/CENELEC has set up a Focus Group, which published a report in October 2011. That report contains a number of recommendations, but no consensus was found on a standard interface. Further policy action is therefore needed to find a generic solution that ensures interoperability across the Union.

Given the possible similarity with recharging points and chargers of electric vehicles, interoperability of shore-side electricity within the TEN-T network would offer significant benefits.

The starting point should be that any ship with any system should be able to connect to any shore-based power supply within the EU without any problems. This requires standardized data traffic and protocols, so that ships can use the available shore power in the various ports without technical obstacles.

In the following chapters, we will go deeper into how we can achieve this interoperability for shore power.

Chapter 8: Asset management

8.1 Introduction

The roll-out of a federated data model for shore-based power requires a thorough approach to asset management to ensure the efficiency, reliability and lifespan of shore-based power infrastructure.

Asset management involves the systematic and coordinated management of physical assets throughout their entire lifecycle, from planning and design to operation and maintenance. In the context of shore power, effective asset management is essential to ensure that shore power installations function optimally.

Through asset management, ports and maritime companies can not only reduce operational costs and improve the reliability of their shore-based power facilities but also contribute to the sector's broader sustainability goals. This includes minimizing environmental impacts, promoting energy efficiency, and supporting the transition to a low-carbon economy. Additionally, a good asset management system can help identify potential risks and implement preventative measures to minimize failures and downtime.

Through a strategic and integrated approach to asset management, ports and maritime companies can not only comply with current and future regulations but also play a leading role in the transition to a more sustainable and efficient maritime industry.

8.2 Current development

Overview of shore-side electricity infrastructure

The Flemish website “Binnenvaartservices”[10] provides an overview of all public shore power cabinets in Flanders. For each cabinet, the location, cabinet number and available power are shown on a map. If we want to give multiple Apps access to the shore-based power infrastructure in the EU, a solution must be found to give the Apps access to each other's cabinets. In the previous chapter, a federative solution was proposed for this.

Within the Comex2/Eurisportal working group, making shore-based power data available to users will be made possible via the EuRISportal.eu in mid-2026, in accordance with the

10 https://www.vlaanderen.be/binnenvaart/binnenvaartservices

TEN-T and AFIR regulations and the IENC (Inland Electronic Navigational Charts) coding guide.

Version 2.5.1 of the IENC coding (for electronic inland navigation charts) contains all the requirements for shore power supplies, see screen dump below.

G.3.26 Power Supply Station (O)

A station, at which a vessel is able to obtain electric power supply (Inland ECDIS Standard)

Graphics	Encoding Instructions	Object Encoding
Real World  *Real World*  *Real World*  *IENC Symbolization*	A) Use INFORM attribute just in case important information, which is not already encoded, has to be provided to skippers. B) The attribute "Category of bunker vessel" (catbun) is of LIST type and hence more than one value may be chosen, if a bunker station (G.3.2) is at the same location. C) If the power supply station has a special time schedule or special operating hours apply, the object can be combined with a time schedule. For this purpose please refer to the time schedule (general) object 'tisdge' (T.1.1) D) If a structured external XML-file with more detailed communication information is available, the reference to the file has to be entered in the TXTDSC attribute. E) If the ISRS Location Code is available it has to be encoded (refer to General Guidance section H).	<u>**Object Encoding**</u> **Object Class =** bunsta(P) (M) catbun = [4 (power)] (O) OBJNAM = [name and/or operator/owner] (O) NOBJNM = (Refer to Section B, General Guidance) (M) catvol = [1 (230V), 2 (400V)] (M) catfrq = [1 (50Hz), 2 (60Hz)] (M) amoamp = [xxx] (amps), e.g. 300 (O) allcon = [allowed consumption], e.g. 2 hours or 1000 kWh (O) catplg = [type of plug], e.g. CEE, Powerlock, etc. (O) shrnum = [xx] (number of connections), e.g. 4 (O) TXTDSC = (Refer to letter D) (C) unlocd = [ISRS Location Code] (O) CONDTN = [1 (under construction), 2 (ruined), 3 (under reclamation), 5 (planned construction)] (M) SCAMIN = [22000] (C) SORDAT = [YYYYMMDD] (C) SORIND = (Refer to Section B, General Guidance)

By 2026, the Danube FIS portal[11] and vaarweginformatie.nl[12] will be expanded with shore-based power facilities, after which the data from the (existing) shore-based power infrastructure can be added. This data can then be exported to IEC production software and also to EuRIS.

In addition to the static information, the possibility to share information on the status of the shore-side power supply (available, occupied, failure, no data) should be provided for

11 https://www.danubeportal.com/

12 https://www.vaarweginformatie.nl/frp/main/#/home

the EuRISportal.eu to share information on the status of the shore-side power supply (available, occupied, failure, no data), as is the case for bridge and lock status in EuRIS.

Data communication on shore-side electricity infrastructure

In order to make the status of the cabinet visible, it is necessary to standardize the data communication between the shore power cabinet and the underlying platform.

In addition to laying down the technical specifications in the framework agreement of "De Vlaamse Waterweg", this assignment also defined the interface between the shore-based power cabinets and the technical management system for the three types of shore-based power cabinets (bronze, silver and gold), as included below.

Table Interface between shore-side power cabinets and the technical management system

	Cabine type brons	Cabine type Silver	Cabine type Gold
Commando's	Cabine in/out	Cabine in/out	Cabine in/out
		Reset kast	Reset Cabine
			Other
The status message	Plug attached	Plugs attached	Plugs attached
		Status relais	Status relais
		Overload error	Overload error
		Main voltage present	Main voltage present
			UPS + Battery Condition
			Status cabinet door
			Other
Measurements	Energy meter	Energy meter	Energy meter
			Temperature box
			Humidity cabinet
			Others

At least the following data points are sent to/from the technical management system per shore power cabinet:

Table : Cabinet-level data communication

Description	Type	ID
Main voltage switch	BOOL	1
Main voltage present	BOOL	2
Transformer security	BOOL	3
UPS status	INT	4
UPS Battery Status	INT	5
Circuit breaker / earth leakage circuit breaker Status	BOOL	6

Re-armament of Circuit Breaker / RCD	BOOL	7
Status of whether the cabinet is delivering	BOOL	8
Automatic Cabinet heating and lighting	BOOL	9
Cabinet temperature	INT	10
Cabinet humidity	INT	11
Cabinet Lighting	BOOL	12
Cabinet door open/closed	BOOL	13
Communication error LED	BOOL	14
LifeBit	BOOL	15
CabinetNr	STRING	16

At least the following data points are sent to/from the technical management system per charging point:

Table: Data communication at charge point level

Description	**Type**	**ID**
Idle	BOOL	100
Start	BOOL	101
Stop	BOOL	102
Alarm	BOOL	103
Status of the plug	BOOL	104
Order KWh consumption	INT	105
Totaal KWh verbruik	INT	106
Automatic socket	BOOL	107
Switching on main relay	BOOL	108
Circle rearming	BOOL	109
Authentication	BOOL	110
LED authorization error	BOOL	111
LED connection error	BOOL	112
Led error ship	BOOL	113

For each charging point within the same shore power cabinet, the data points are shifted by 100 each time, so:

Table: Data communication at multiple charging points

Description	**ID**
Charging point 1	1xx
Charging point 2	2xx
Charging point 3	3xx
Charging point 4	4xx

8.3 Recommendations

Standardize the technical specifications

The technical specifications of the "De Vlaamse Waterweg", together with the specifications of the other shore-based power providers, should lead to a widely supported and managed data model, which also provides sufficient room for future expansions, for example: charging or supplying power to/from batteries on board inland vessels; energy management across multiple shore power cabinets to manage overload/grid congestion; Remote management and maintenance functionality.

Standardize data communication on shore power infrastructure

Different vendors use proprietary communication protocols and software, which can lead to dependency and security risks if protocols are not secure. A harmonized and secure standard prevents vulnerabilities. Important additional elements are:

- Use of encrypted communication protocols to protect data and connections;
- Authentication and access controls for operators, service providers and users;
- Regular software updates and patches to close vulnerabilities;
- Network segmentation to separate critical systems and mitigate risk;
- Implementation of real-time monitoring and detection systems against cyber threats.

It is important to ensure the use of one or more standardized protocols that comply with the above elements. In this way, it is possible for several shore power cabinet suppliers to supply shore power cabinets that can be used immediately without additional customization.

Work on a general European ship database

However, granting access to different systems (Apps) creates some additional challenges. We are now seeing different solutions at different shore power providers. How do we ensure that the personal data of inland shipping entrepreneurs does not become widely distributed? After all, the General Data Protection Regulation (GDPR) strengthens the privacy rights of individuals and imposes strict rules on the collection, processing and storage of personal data. Failure to comply with the GDPR can result in significant fines.

In order to guarantee the privacy of users, it is recommended to develop a general ship database with verified identities that provides the necessary authorized access, so that inland shipping operators gain more insight into the ship data that is kept. This gives every inland shipping operator the free choice to give an App or organization (billing service) access to his or her data. This means separating authentication of the users in the identity registry and the rights to access data in the authorization registry.

The definitions of an identity registry and an authorization registry in a federated data system are:

- Identity Provider (ID Provider): The identity provider (IdP) is a service that stores and manages the digital identity of a participating party in the federated collaboration. This service is used so that a user can be identified to connect to the necessary resources. The role of IdP can be performed by a service provider within the system of federated data sharing.
- Authorization Register: This register records the current rights and status of a participating party of the federative cooperation. Authorizations make it possible to pass on the right to information to parties in the chain. For example, it can be tested whether a skipper is creditworthy and can be authorized to purchase shore power.

Provider Identities (Provider ID))	The identity provider (IdP) is a service that stores and manages the digital identity of a participating party in the federated collaboration. This service is used so that a user can be identified to connect to the necessary resources. The role of IdP can be performed by a service provider within the system of federated data sharing
Authorization Register	This register records the current rights and status of a participating party in the federative cooperation. Authorizations make it possible to pass on the right to information to parties in the chain. For example, it can be tested whether a skipper is creditworthy and can be authorized to purchase shore power.

Chapter 9: Federated data sharing

9.1 Introduction

Federated data sharing[13] is crucial for the efficient roll-out of shore-based power in inland ports, as it creates a secure, transparent and standardized exchange system for all parties involved.

By making data on shore-based power facilities, ship movements, power consumption and availability accessible in a shared network, ports, energy suppliers, operators and inland shipping entrepreneurs can better respond to the supply and demand of shore-based power. In any case, data sharing has many advantages when rolling out a shore-based power network:

- Optimal use of shore power
  - Real-time visibility into connection point availability prevents overloading and inefficient use.
  - Smart reservation systems help skippers to book a connection in advance, reducing waiting times and unused capacity.
- Cost savings and efficient management
  - Energy management based on data-driven insights prevents over-dimensioning of the infrastructure.
  - Smart fare structures can be dynamically adjusted based on supply and demand.
  - Data standardization means less customized investment, less required capacity, provides flexibility, so that the possibility arises to offer other services.
- Synergy benefits if federated data is linked to other processes in/from inland ports, such as the collection of port dues, waiting and berth management, waste processing, water supply, etc. stimulating sustainable shipping
  - By linking shore-based power data to emission reports, inland shipping companies can more easily demonstrate that they use sustainable energy sources.
  - Governments and port authorities can take targeted policy measures based on available data to stimulate the use of shore-based power.
- Secure and interoperable data sharing
  - A federated model allows parties to manage and share their own data with whomever they want, without central databases (platforms) that entail privacy risks.
  - Standardization makes integration and replacement with existing IT systems of ports and shipping companies easier and potentially cheaper.
  - Interoperability facilitates the connection of new markets and new services.

Federated data sharing enables the large-scale and efficient adoption of shore-based power in inland ports. Real-time information exchange can make smarter use of energy

[13] Federated data sharing represents a method where various parties can share data without centralizing it.

networks, reduce costs and promote sustainable inland shipping. This contributes directly to the sustainability and digitization of the inland shipping sector.

9.2 Data Protocols

The control unit (controller) can be considered the heart of the shore power cabinet, because it provides the connection between the cabinet and the interfaces.

Within network and industrial applications, different communication protocols are used, each with specific characteristics and areas of application. These protocols differ in complexity, efficiency, security, and suitability for certain scenarios.

In 2023, the Dutch so called “Walstroomcollectief” set the standard for communication between shore-based power cabinets and the technical management system. This standard includes the Operational Technology (OT), which refers to hardware and software that detect or influence industrial equipment and processes through direct monitoring and control of physical devices, processes, and events. OT is widely used in industrial environments such as factories, power plants, and transportation networks. For sharing data, such as on the internet or via the Internet of Things (IoT), IoT-like protocols are used.

In order to determine the most suitable protocol for data exchange, a separate consultation was set up within the “Walstroomcollectief”, in which market parties were also represented. In this working group, the three most obvious protocols were compared and discussed. These are the following:

- OPC-UA (OPC Unified Architecture) is a cross-platform protocol that enables secure and reliable data exchange in industrial automation. It supports complex data types and offers comprehensive security features, making it suitable for industrial automation and IoT applications. However, implementation can be complex and costly.
- MQTT (Message Queuing Telemetry Transport) is a lightweight messaging protocol that uses a publish/subscribe model, ideal for IoT applications with limited bandwidth and energy consumption. It is efficient and uses little bandwidth but is less suitable for large messages or complex data structures.
- DNP 3.0 (Distributed Network Protocol) is primarily used in Supervisory Control and Data Acquisition (SCADA) systems for utilities such as electricity and water. It is robust and efficient, suitable for real-time data transmission in challenging environments. Although more complex than older protocols such as Modbus, DNP 3.0 provides the reliability and efficiency that are essential for the utility industry.
- Open Charge Point Protocol (OCPP) 2.0.1 is used for the communication between charging stations for electric vehicles and the management platforms. It promotes standardization and interoperability within the EV charging infrastructure.

Because of the possible synergy in offering electricity, the OCPP 2.0.1 protocol from the market of charging stations was initially considered. However, this protocol was not recommended for the following reasons:

- Not sufficient in terms of messages/notifications (table);
- Not supported by controller manufacturers;
- No experience with cabinet builders in relation to shore power;
- Not supported by technical management system manufacturers;
- Ultimately, the charging station market cannot be compared to the shore-based power market by other customers. There is already a lot of diversity between the different ships, but ultimately the ship determines the varying current consumption. With cars, this is the other way around, and the systems of a large number of car manufacturers are built in the same way (in terms of receiving power, plug, etc.).

For this reason, the OCPP protocol was no longer retained and the remaining protocols were compared with each other.

Schematic representation of protocol comparison

	OPC UA	MQTT	DNP 3.0
Open standard	Yes	Yes	Yes
Present in the market	Approximately 10 years	Approximately 10 years	Approximately 25 years
Widespread	Yes	Yes	Yes
Knowledge among panel builders	Yes	No	Yes
Designed for wireless	No	No	Yes
Supports local buffering	No	Not really	Yes
Buffering built into the higher-level technical management system	No	No	Yes
Easy to configure	Yes	No, you need to develop your own framework	Yes
100% standardized	Yes	No, you need to develop your own framework	Yes

Based on the above assessment framework, the Walstroomcollectief recommended the DNP3.0 protocol. The following reasons are particularly important for this:

- Robust protocol;
- Designed for industrial installations;
- Supports local data buffering;
- Supported by many manufacturers.

However, the survey and the discussions in the context of SPIES show that (some) market parties are no longer so negative about OCPP. This is how "Borne & Eau[14]" of VNF (Voies Navigables de France) and Ports of Le Havre, Rouen and Paris (HAROPA) and a Dutch market party works. So, there is now experience with existing cabinet builders. We also see that MQTT and OPC-UA are preferred by commercial service providers. In short, we see different protocols that are used.

It is recommended to revise the previous study and arrive at 1 or more usable, managed protocols in the shore-based power market.

9.3 Cybersecurity

Cybersecurity is the practice of protecting computer systems, networks, devices, and data from unauthorized access, attacks, or damage. This should also be taken into account when developing a shore-based power network, as these systems play a crucial role in the energy supply for ships and are part of broader port and energy infrastructures. A cyberattack on shore-based power can not only cause financial and operational damage but also pose security risks. The aspect of data security and privacy is certainly important here. Shore-side power systems collect and process data on users, energy consumption and payments. Insufficient security can lead to data leaks, misuse of sensitive information or improper purchase of shorepower. A strong focus on cybersecurity keeps shore-side power a reliable and safe source of energy for inland and maritime shipping, while ensuring operational efficiency and sustainability.

There are several laws and directives that mandate the protection of critical infrastructure, such as the NIS (Network and Information systems) 2 and the DORA (Digital Operational Resilience Act) legislation. The NIS2 Directive focuses on sectors such as energy, transport, finance, healthcare, water management, digital infrastructure, public services, space, food supply, postal and courier services and industry. The DORA legislation is specifically aimed at the financial sector and includes banks, investment firms, insurance companies, reinsurance companies, payment institutions and electronic money institutions.

The introduction of this legislation has significant consequences for organizations. They must implement stricter security measures, conduct regular risk assessments, report

[14] https://www.borneeteau.fr/

cyber incidents promptly, and meet compliance requirements. Non-compliance can lead to heavy fines, increased scrutiny, reputational damage, and loss of customers.

To comply with the NIS2 Directive, companies must take steps such as conducting risk assessments, implementing technical measures, creating incident response plans, developing security policies and procedures, organizing training and awareness sessions, and continuously monitoring and evaluating their IT environment. The cost of compliance can be significant, including investments in security technology, staffing costs, compliance audits, incident management, and training.

9.4 Recommendations

Establishment of a knowledge and management organization for shore-based power

In order to optimize the implementation and management of shore-based power installations, it is recommended to set up a specialized knowledge and management organization. This organization will be responsible for establishing common protocols and Application Programming Interface (API) patterns within the shore-based power market. In addition, it is responsible for drawing up specification requirements, developing the necessary authentication and access controls for operators, service providers and users and, if necessary, acting as a certifying body.

Implementation of real-time monitoring and detection systems against cyber threats

Make use of 'Security by design' in which security is integrally included in the design of protocols, applications and infrastructures from the start. Instead of adding security after the fact as an extra layer, risks are proactively analyzed and minimized through secure architectures, encryption, access controls, and encryption best practices. This helps to reduce vulnerabilities, improve compliance, and increase resilience to cyber threats.

Chapter 10: Financing

"Shore power is too expensive". At least, this is the position of many inland shipping entrepreneurs in the survey conducted by SPIES. This was also mentioned by the sector in previous discussions, including on the introduction of a shore-based power obligation. The question that arises is whether this is actually the case.

10.1 Shore-based power tariffs

During one of our expert meetings, the question arose whether electricity (and therefore also shore power) can simply be resold. After all, in Europe, there are specific laws and regulations for the sale of electricity. An important directive is Directive (EU) 2019/944 on common rules for the internal market in electricity. This directive stipulates that only approved energy suppliers may sell electricity to end users. This classification has a number of far-reaching consequences that would make it considerably more difficult for ports/waterway authorities to offer this service as electricity suppliers. For example, electricity suppliers must in principle have a supply license and are bound by certain disclosure obligations.

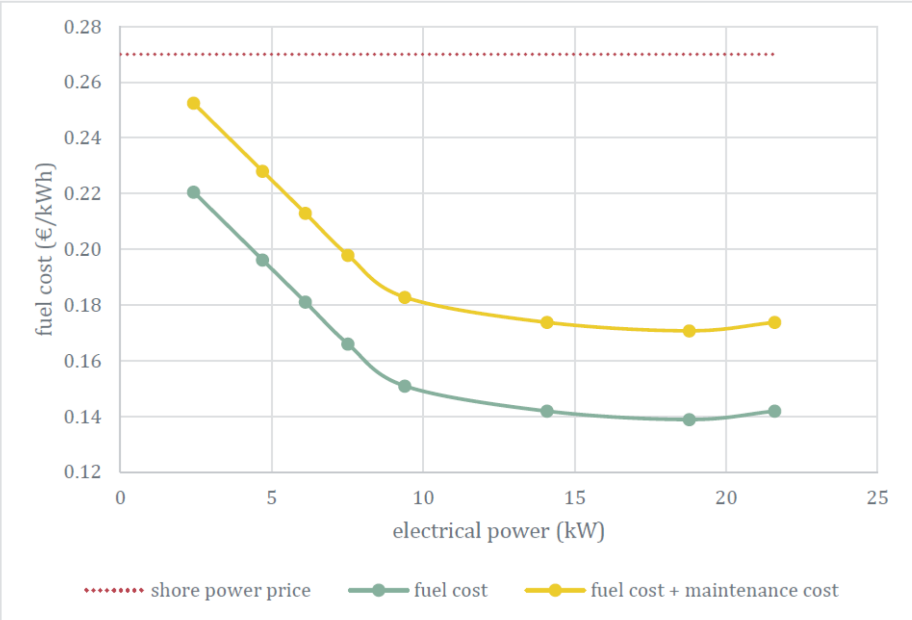
In an attempt not to be included in the status of supplier, it seems necessary to organize the shore-based electricity supplies in the form of a private distribution network.

In principle, however, there is a ban in principle on private distribution networks. There are only exceptions to this prohibition. In some cases, it is unavoidable or simply opportune that electricity is distributed to certain customers while these customers do not have their own access point to the 'public' distribution network or a closed distribution network. However, in the case of a private distribution network, the distribution of electricity or natural gas must be inherent and subordinate in relation to all the services provided by the operator of the private distribution system to the underlying customer (skippers). Until now, the supply of shore power is considered a private distribution, in which in principle the rule of freedom of contracting fully plays a role here. The price that one pays for energy as a user of a private distribution network is therefore a negotiated price.

In recent years (period 2015-2024), the price of shore-based power in the Netherlands and Flanders has been universally set at €0.27/kWh. It is difficult to find out how that 0.27 €/kWh was determined at the time. It is assumed that when determining the rate, a rate in line with gas oil was sought. Since the beginning of 2025, we have seen a change in the level of the rates. Most ports in the Netherlands no longer maintain the rate of €0.27/kWh. The current rates in the different countries can be found in Annex 3.

The Clinsh (CLean INland Shipping) project "Shore power and Energy scan program inland shipping" (see also Chapter 12) also investigated the level of the shore-based power tariff and compared it with the costs of using the generator. The study shows that effective fuel costs of the generator set are 0.23 €/kWh. In addition, the maintenance costs of the generators must also be taken into account. Typically, maintenance costs are assumed to be 0.17 €/operating hour (Shore power versus generator power, a cost study, 2011). When the maintenance costs are included in the fuel costs of the generator set, using the average consumed power of the ship (6.33 kW in this example), the total cost of generator power is equal to 0.25 €/kWh. This is shown in the figure below.

***Figure: Fuel cost of a typical inland shipping generator in function of its electrical power supplied (including maintenance cost of the generator set). The dotted horizontal line shows the average shore power price*.**



Moreover, the use of shore-based power is future-proof. With an increase in the share of renewable energy in the electricity grid, primary energy consumption for electricity generation and the associated CO2 emissions will logically also decrease sharply. So, there is still a lot of potential for improvement. On the other hand, few new innovations are possible in the field of combustion engines and the efficiency of electricity generation via the gas oil generators will improve little or not at all.

10.2 VAT exemption from shore-based power

In order to promote the use of shore-side electricity supply for ships at berth, it is essential to create a level playing field between two competing sources of electricity: on-board generation and shore-side electricity. Currently, the on-board electricity generation using auxiliary engines powered by conventional fuels enjoys a full tax exemption by the Mannheim Act, this includes both levies and taxis. Shore-side electricity, on the other hand, continues to be subject to different taxes and levies under Council Directive 2003/96/EC, commonly referred to as the Energy Taxation Directive. This imbalance creates a financial disadvantage for shore-side power, discouraging its deployment, despite its environmental benefits.

To encourage shore-based power, it is crucial that policymakers consider making use of the possibility of obtaining a tax exemption or reduction for duties and taxes on shore-side power used in shipping. The legal framework for this is provided by the European Energy Taxation Directive. On the basis of a proposal from the European Commission, the Council of the European Union can adopt such a measure. Once granted, the exemption or reduction is valid for a period of six years, with the possibility of extension. Under this regime, taxes on shore-based power can be reduced to just €0.50/MWh.

Several EU Member States, including the Netherlands, France, Germany, Denmark and Italy, have already obtained such exemptions in 2021 under Article 19(1) of the Energy Taxation Directive (ETD), successfully reducing the tax on shore-side electricity to 0.50 euro/MWh.

In addition to the current possibility for Member States to apply for exemptions or reductions under the existing Energy Taxation Directive (ETD), another important development is underway that could further support the expansion of shore-side electricity initiatives.

Energy taxation plays a key role in driving the energy transition by incentivizing investments in low greenhouse gas technologies and energy efficiency. It also contributes to reducing the health effects by helping to curb local pollution through more sustainable energy use.

The European Commission is currently preparing a major revision of Council Directive 2003/96/EC, which restructures the EU's framework for the taxation of energy products and electricity. This revision of the Energy Taxation Directive is ongoing and has the potential to reshape the way energy taxation supports clean technologies, including shore-side electricity.

However, the assessment of the Commission's proposal and the compromise text currently under discussion in the Council shows that the revised Directive may fall short in promoting shore-side electricity supply, despite its recognition as a key priority under the new Alternative Fuels Infrastructure Regulation (AFIR).

The latest Council compromise text (document 7234/25 of 21 March 2025), in particular Articles 14 and 16, does not provide for a clear exemption framework for shore-side electricity. The use of the term "charging" in the text leads to ambiguity as to whether shore-side power is covered by the text, potentially excluding it from tax benefits. This lack of clarity undermines the effectiveness of the Directive in encouraging the introduction of shore-side electricity.

10.3. AFIF

The Alternative Fuels Infrastructure Facility (AFIF) is a financing instrument to support the deployment of alternative fuels infrastructure. Under the second call of the program, there are three cut-off dates: 24 September 2024, 11 June 2025 and 17 December 2025.

A total of 780 million euros was available in the general envelope. After the selection of the first cut-off date, approximately 448.5 million euros of this will remain available.

- Two-thirds of this budget (299 million euros remaining) is earmarked for projects that work with a European or national financial institution accredited as an Implementing Partner (IP).
- 149.5 million euros is currently still earmarked for projects that work with another commercial financial institution (non-IP).

The aim is to target mature projects. Selected projects must be completed no later than 39 months after the cut-off date.

To obtain funding through AFIF, project promoters must work together with a financial institution. It is not possible to submit an application on the basis of your own resources alone; AFIF's objective is precisely too free up financial resources from banks or other institutions to finance the market roll-out of alternative fuels infrastructure. In summary, there are two options:

- At least 10% of the total project budget must consist of a loan granted by an Implementing Partner (IP) accredited European or national financial institution;
- At least 10% of the total project budget must consist of a loan granted by another financial institution or commercial bank.

If the financing is done through a capital contribution, this 10% requirement does not apply.

10.4 Recommendations

Have a transparent pricing strategy

Determine the factors that determine the shore-based power price instead of the rate itself. This can help to develop a more transparent and flexible pricing strategy. By understanding the costs, market influences and strategic choices that influence the price, inland shipping operators can better understand why prices for shore-based power vary and what its value is. This helps them to make informed decisions about the use of shore-based power and provides greater transparency and trust.

Provide a clear and consistent VAT exemption for Shore Power

The European Commission's new proposal for the revision of the Energy Taxation Directive (ETD) is a positive, albeit limited, step forward. It would allow EU Member States to abolish, in whole or in part, taxes on electricity supplied to ships while at berth in ports –

without the need for prior approval from the Commission, as is currently required. In the current system, such approvals are complex and limited in time, and only last six years.

While this simplification is a welcome improvement, the proposal is ultimately a missed opportunity. The exemption for shore-based power currently only seems to apply to ships that moor in ports. However, shore power points are also available for inland vessels at locations outside seaports or inland ports, such as locks. In the current wording, it does not seem possible to exempt the electricity consumption at these shore-side power points from taxes and levies.

The use of shore-side power for ships should be encouraged more strongly. For this reason, an EU-wide, full and permanent tax exemption is proposed. This demand is also in line with the objectives of AFIR and ReFuel EU Maritime. Moreover, it ensures a level playing field for ports within the EU.

Making such a tax benefit both mandatory and sustainable would remove the need for cumbersome and time-consuming procedures at the national, federal and regional levels, and would provide much-needed clarity and consistency to support the wider adoption of cleaner, port-based energy solutions.

Take into account the recommendations of SPIES when awarding AFIF

Shore-side power initiatives that follow the recommendations of the SPIES project in the AFIF call offer a sustainable solution to current shortcomings in the maritime sector. By reducing air and noise pollution, saving fuel costs, and promoting technological innovation, these projects will create a more robust and future-proof infrastructure. Adhering to environmental standards and encouraging collaboration between stakeholders makes these initiatives not only more effective, but also more sustainable in the long term.

Provide financial resources to start up the Federated Data Model

It is strongly recommended to make financial resources (subsidies) available for the development of the federated data model. This model provides an integrated and efficient way to manage and share data between different stakeholders in the maritime sector. By investing in the development of this data model, we can improve collaboration and data exchange, leading to better decision-making and optimization of shore-based power initiatives. In addition, a well-developed data model contributes to compliance with environmental standards and increases the transparency and reliability of data. Financial support for this crucial part of the infrastructure is therefore of great importance for a sustainable and efficient future of the maritime sector.

Chapter 11: Innovation

11.1 Shore power in the bigger story of E-charging

Shore-based power is widely considered to be an essential element in the green transition of ports and waterways, contributing to reducing the ecological impact of shipping. However, with the emergence of sustainable inland vessels, the question arises whether shore-based power is a permanent solution or just a temporary intermediate step.

While shore-based power is being rolled out further, the focus is also on making inland vessels more sustainable. The sector is committed to various measures to reduce the emission of harmful substances, such as the use of biofuels and the development of emission-free ships. Innovations such as electrically powered vessels and ships with fuel cells are becoming increasingly common.

Discussions with various players and stakeholders within the shore-based power market show that there are concerns about the future of shore-based power. The rapid sustainability of inland vessels raises the question of whether shore power is a permanent solution or will eventually become superfluous. On the one hand, shore-based power offers a direct and effective way to reduce emissions from moored ships. On the other hand, the need for it may decrease as ships become increasingly cleaner and more independent in their energy supply.

Although the sustainability of inland vessels is a positive development, shore-based power remains a valuable solution in the short to medium term. It provides a direct way to reduce emissions from ships ashore and contributes to broader sustainability goals within shipping. However, in the long term, as ships become increasingly cleaner and energy-independent, the role of shore-based power may shift. Therefore, it is essential to continue to invest in shore power facilities and preferably integrate them into a broader electric charging concept.

An important point of attention is the multifunctional deployment of shore-based power infrastructure. Ideally, it should be available not only for ships, but also for port installations such as unloading cranes and other port equipment. When there are no ships at the quay, these installations can use the available shore power. This ensures continuous and more efficient use of the infrastructure, making better use of the investment. Moreover, it contributes to a reduction in emissions and noise pollution, which benefits the environmental performance of the port as a whole.

In addition, shore-based power also offers opportunities for the broader charging infrastructure, especially in densely populated areas. By linking shore-side power supplies to charging stations for electric vehicles, the available energy can be used more efficiently and the pressure on the electricity grid can be further alleviated. In this way, shore-based power can not only make shipping more sustainable, but also play a broader role in the necessary energy transition of cities and ports.

11.2 Absorbing peak loads

Although the NBN EN 15869 standard (see chapter 3) defines specific powers from 16 A to 125 A at 400 V, literature review shows that such powers are not always necessary. In practice, the required energy requirement is often lower, as the standard is based on peak loads.

Worldwide, energy demand has increased sharply in recent decades. While this growth offers numerous benefits, it also comes with challenges. After all, energy is not an inexhaustible source. For a sustainable future, it is crucial to use energy wisely. This means focusing on energy-efficient technologies, limiting our consumption and continuing to invest in renewable energy sources.

A possible solution to reduce peak loads from ships is the use of batteries. By placing a battery between the shore power infrastructure and the electricity grid, stored energy can be used at times of increased demand. This reduces the load on the grid and reduces the need for a heavy grid connection. This can save costs and make it easier to meet grid requirements. In addition, batteries in areas with grid congestion can contribute to the stability of the electricity grid.

In addition, battery containers can play an important role in a more sustainable energy supply. By storing energy when it is abundant and cheap, for example from solar or wind energy, it can be used efficiently later. This not only reduces the pressure on the grid but also promotes the optimal use of renewable energy sources.

11.3 Mobile shore power cabinet

In many ports, it is not feasible to provide every berth with fixed shore-based power infrastructure, especially at smaller terminals. Mobile battery containers can offer a flexible and practical solution here.

The Floating Battery project[15] of the Flemish Institute for Logistics (VIL) investigates the technical feasibility of transporting mobile battery containers by water to inland vessels. One of the main advantages of this project is the flexibility it offers.

In addition, these battery containers can also be used for other applications within the port infrastructure, such as providing energy for port installations and equipment.

[15] With the 'Floating battery' project, VIL and Sirris want to develop a flexible and sustainable solution for inland shipping by using battery containers for power supply during mooring and as charging infrastructure for battery-electric vessels at berths where no fixed infrastructure is available.

11.4 Recommendation

Integrate shore-based power into the broader energy policy

Shore-based power does not stand alone. Research how shore-based power infrastructure can be part of the broader energy policy. Provide battery storage systems to handle peak loads and improve grid stability. Integrate flexible solutions (mobile shore power cabinets) into the current network, so that in the future every ship can be plugged in.

Chapter 12 Energy Efficiency on Board

12.1 CLINSH Results

In 2021, an energy scan was carried out on 26 inland vessels as part of the EU project CLINSH (CLean INland SHipping, 2019-2022), which focused on improving air quality in urban areas by reducing emissions in the inland navigation sector and removing barriers to switching to shore-side power.

The following conclusions were drawn from the various energy scans:

- About 31% of the vessels in the survey experienced technical problems when connecting to shore power.
- If the ship complies with the NEN-EN 15869-3:2019 standard, there are no problems with the use of shore power. This standard is a good tool for making ships electrically compatible with shore power.
- Only 31% of the ships complied with NEN-EN 15869-3:2019. The most common technical violations were:
  - no isolation transformer (54% of the ships),
  - no IP67 shore power cable/plug (42% of the ships), and
  - no soft start switch (peak current) (15% of the ships). This usually does not mean that the ship cannot use shore power.
- The most common reasons why skippers do not (often) use shore power were: (i) not enough shore power cabinets (54%), (ii) the price is too high (50%), (iii) no good accessibility of the cabinets (31%), (iv) technical problems on board (31%) and (v) insufficient power (23%).
- The average electricity consumption of inland vessels in this study was 6.33 kW. This is also the average power consumption at berth (e.g. when using shore power).
- The average fuel cost (incl. maintenance) for generator power of all vessels included in this study was €0.25/kWh. This is lower, but comparable to the then standardized shore-based power price in the Netherlands and Flanders (€0.27/kWh).
- When energy-saving measures are implemented (excluding maximizing the use of shore power), the average load on the generator set decreases, increasing the cost of generator power. In this way, the use of shore-based power is promoted.
- When all the cost-effective energy saving measures (payback period < 4 years) identified in the energy scans are implemented, the average primary energy savings per ship (only taking into account the electrical consumption on the ship) for different ship types are: 30% for a passenger ship, 48% for a tanker, 27% for a container ship and 19% for a dry cargo ship.
- The most common energy-saving measures with the highest energy saving potential at the lowest investment cost were:
  - adjusting the control of the sanitary boiler;
  - limiting the use of electric resistance heating;

    - maximizing the use of shore power;
    - replacing the lighting with LED;
    - residual heat recovery engines, and
    - energy monitoring.
- The total savings of all cost-effective measures (< 4 years) identified during these 26 energy scans amounted to 1,935,144 kWh/year of primary energy and 499 tons of CO_2-eq/year.

As can be seen from previous chapters, many of these conclusions are still valid. In addition to solving the technical issues on land (chapters 4 to 8), inland shipping entrepreneurs should also be more aware of their energy consumption on board. For this reason, SPIES wishes to include one final recommendation in its recommendation plan

12.2 Recommendation

Promote Energy Efficiency on Board

Provide the necessary means of communication to make the inland shipping sector (more) aware of its (domestic) energy consumption on board the ship.

Chapter 13: Overall conclusion

The Interreg SPIES project wishes to make a number of recommendations to optimize the implementation of shoreside power facilities and to reduce the environmental impact of the maritime sector. These recommendations can be combined into the following 15-point program for shore-based power.

15-point program Shore Power

This survey, in combination with the various interviews and organized expert meetings, has resulted in 15 recommendation clusters.

These 15 recommendations provide a detailed and structured approach to improve shore-side power infrastructure, adapt regulations and promote sustainability and efficiency in the maritime sector.

Cooperation is crucial for the development of shore-based power facilities within the European Union. By joining forces between ports, energy companies and governments, we can develop and implement the necessary infrastructure and technologies. These joint efforts not only contribute to a more efficient and sustainable energy supply for ships, but also to the reduction of emissions and the improvement of air quality in port areas. Fostering cooperation is therefore essential to achieve the EU's ambitious climate goals and ensure a greener future.

15-Point Program Shore Power					
Cluster	Recommendation	Chpt	Responsible		
			Europe	National (regional)	Local Ports/Waterway Managers
1. Increase AFIR awareness.					
	Communicate more about AFIR obligations. Conduct a comprehensive communication campaign about the AFIR regulations and obligations to ports and government institutions. *The majority of private ports (60%) and public ports (37.5%) and 30% of public institutions report that they are not aware of the AFIR regulations, despite the obligations arising from the regulation.*	2			
	Link the benefits of shore power to the Sustainable reporting obligations (CSDR). *Shore-based power contributes to CO_2 reduction. In view of the CSRD, it is important to inform and support companies so that the deployment takes place more widely than just on the TEN-T network and at public ports.*	2			
2. Adjust regulations.					
	Adjust the criteria for shore-based power obligation. These should not only be based on throughput volume, but also on minimum docking time of ships. *According to the law, shore-based power is mandatory along the TEN-T network, determined on the basis of a throughput volume of >500,000 tons. In practice, the infrastructure is often lacking at these locations. For effective reduction of CO_2, NOx and particulate matter, it makes more sense to provide shore power at berths where ships moor for a longer period of time, often near residential areas. This also reduces noise pollution from generators.*	2			
3. Set up a specialized European knowledge and management organization.					
	Set up a specialized European central knowledge and management organization to standardize and optimize the roll-out and management of shore-based power.	6,9			

	Set up a specialized (Independent) organization at European level for: - *establishing common protocols and Application Programming Interface (API) patterns;* - *developing, managing a standard technical design;* - *Establishing specification requirements, developing the necessary authentication and access controls for operators, service providers and users;* - *and, if necessary, acting as a certifying body.* *This body should consult closely with industry and European and international standardization bodies.*				
4. Determine safety standards for shore power cabinets and connection cables.					
	Cabinets must meet strict safety standards, withstand specific environmental conditions and be equipped with new technologies such as real-time monitoring and automatic fault detection. In addition, establish standards for the handling of connection cables between shore power cabinets and ships to ensure safety and efficiency.	3,8			
	Develop a power standard for smaller sea-going vessels (with a requested capacity between 87kVA and 1MVA). *No standard for shore-based power has yet been established for small sea-going vessels. SPIES is therefore urging the establishment of a shore-based power standard for this ship segment in the short term as well.*	3			
	Optimize the existing standards by differentiating power classes. Connections and installations on board ships should also be harmonized and standardized. *Provide a differentiation in the current standards in terms of available capacities. After all, not every type of ship needs the same power. The CEMT class (Classification of European Inland Waterways) can be a guideline in this regard*.	3			
	Determine the distance between the shore power cabinets. *Given the importance of safety and the manoeuvrability of the connecting cables, SPIES recommends that the distance between the shore-side power cabinets and the moored vessels be laid down in a general guideline.*	5			
5. Differentiate capabilities and Payment Methods.					
	Optimize current standards and support modern payment methods such as QR codes and apps.	3	Knowledge and mgnt.		

	Provide a differentiation in the current standards in terms of available capacities. After all, not every type of ship needs the same power. The CEMT class (Classification of European Inland Waterways) can be a guideline in this regard. In addition, the possible payment methods (e.g. Appendix A NBN EN 15869) must be expanded with the latest payment methods such as payment via App or QR code. However, as will be seen in the following chapters, these payment methods require a more uniform and standardized approach.		organization (see 3)		
6.Optimize and invest in shore-based power installations					
	Investments must be made in targeted infrastructure in strategic locations, tailored to the energy needs of different types of ships. *It is essential that ports, terminals and waterway managers invest extra in shore-based power infrastructure. These investments are crucial to meet the growing demand from inland shipping entrepreneurs for sustainable energy solutions. In addition, these shore-side electricity facilities must be tailored to the specific needs of the users. This means taking into account the different types of vessels and their power needs.*	3			
	Determine where shore power cabinets make sense. *SPIES proposes to use a minimum mooring time as the basis for the obligation to provide shore-side electricity infrastructure instead of the average flow volume (500 000 ton) currently laid down in Regulation (EU) 2024/1679 on Union guidelines for the development of the trans-European transport network*	5			
	Ensure the correct location of the shore power infrastructure. *When properly constructing shore-based power infrastructure, it is important to pay attention to bottlenecks in practice, such as the influence of high and low water on the shore-based power cabinets and the location in relation to the ship. If necessary, provide additional infrastructure so that the shore power cabinet can always be used safely.*	5			
	Sufficient grid capacity must be guaranteed, with smart solutions such as grid control, local generation and storage.	5			
7.Establish service level agreements.					
	Reliability must be guaranteed through EU-wide Service Level Agreements (SLAs). *Inland shipping operators demand reliable shore-based power. SPIES therefore advises EU-wide Service Level Agreements (SLAs) with clear intervention times in the event of malfunctions. This promotes continuous use, increases satisfaction and strengthens the sustainability of the sector.*	4			

8.Ensure interoperability. Standardize technical specifications and data communication protocols to ensure compatibility.					
	Work on interoperability and promote it. European standardization must be pursued so that every ship can connect to any shore-based power supply without hindrance. *Ensuring interoperability in the use of shore-side power is crucial for the efficient and seamless functioning of the infrastructure. This means that shore-side power systems must be compatible with different vessel types and brands, and that they must meet standardized technical and operational requirements*	4	Knowledge and mgnt. organization (see 3)		
	Standardized data communication protocols between cabinets, apps and platforms, a policy that encourages open networks and federated data sharing, and independent governance structure. *In 2010, the European Standardization Organizations (M468) were tasked with developing standards for the interoperability of charging points. The same applies to shore power: every ship must be able to connect to any network in the EU without any problems. This requires standardized data traffic and protocols. In the following chapters, we will discuss how to achieve this.*	7	Knowledge and mgnt. organization (see 3)		
9.Include shore power facilities in shipping chart(s).					
	In addition to static information, it should be possible to display information on the status of the shore-side power supply (available, busy, fault, no data) on an independent platform or on navigation charts. *In order to encourage inland shipping companies to use shore-based power, it is necessary to provide them with an overview of the shore-based power infrastructure available in ports and along the waterways. In addition, opening up the shore power facilities to multiple user apps means that it is not always clear which cabinet is in use or malfunctioning.*		Knowledge and mgnt. organization (see 3)		
10.Protect privacy and manage data.					
	Provide one widely supported data model, uniform interfaces and strong cybersecurity. *Make use of 'Security by design' in which security is integrally included in the design of protocols, applications and infrastructures from the start. Instead of adding security after the fact as an extra layer, risks are proactively analyzed and minimized through secure architectures, encryption, access controls, and*	9			

	encryption best practices. This helps to reduce vulnerabilities, improve compliance, and increase resilience to cyber threats.				
	A European central ship database with verified identities, access rights and full data control according to GDPR must be developed.	8			
11.Provide transparent pricing and taxes.					
	An EU-wide, permanent and automatic exemption from taxes on shore-based power should be introduced, including outside formal ports. *The new EU proposal for energy taxation is a limited, but positive step. Member States can abolish all or part of the electricity tax for ships in ports without the approval of the Commission. This simplifies procedures and provides clarity, which encourages the adoption of cleaner port energy.*	10			
	A transparent pricing strategy must be developed for shore-based power, so that inland shipping entrepreneurs gain insight into the structure of the costs. *Determine the factors behind the shore-based power price instead of the tariff itself. This ensures transparency and flexibility, helps inland shipping operators understand price variation and supports better decisions and trust.*	10	Knowledge and mgnt. organization (see 3)		
12. Support innovation and embrace and integrate new technologies such as real-time monitoring and automatic fault detection to improve the reliability and safety.					
	Integrate shore-based power into the broader energy policy. *Shore-based power must be integrated into a broader electric charging concept that also serves port facilities and electric vehicles. Investments must be made in battery storage systems to absorb peak loads and improve grid stability. Mobile shore power cabins should be supported as a flexible solution for locations where fixed infrastructure is not feasible.*	11			
	Promote energy efficiency on board. *Provide the necessary means of communication to make the inland shipping sector (more) aware of the (domestic) energy consumption on board the ship.*	12			
13.Set up a communication campaign against prejudice.					

	Conduct targeted communication campaigns to dispel misconceptions about cost, reliability, and ease of use. *Setting up a communication campaign to refute the prejudices about shore power is a strategic necessity to promote the acceptance and implementation of this sustainable technology*.	4			
14.Provide the necessary financial resources					
	Make AFIF funds more accessible for shore power infrastructure. *Many ports and companies want to install shore power, where AFIF can help financially. However, the current administrative burden of AFIF is too heavy. Consider a lighter AFIF scheme for shore power projects.*	1			
	AFIF funds should be allocated as a priority to shore-side power projects that follow the SPIES recommendations. *Shore-side power initiatives that follow the recommendations of the SPIES project in the AFIF call provide a sustainable solution to the current shortcomings in the maritime sector. By reducing air and noise pollution, saving fuel costs, and promoting technological innovation, these projects will create a more robust and future-proof infrastructure. Adhering to environmental standards and encouraging collaboration between stakeholders makes these initiatives not only more effective, but also more sustainable in the long run.*	10			
	Provide financial resources to support the development of the federated data model. *Financial support for the federated data model is essential. This model improves data exchange and collaboration in the maritime sector, which optimizes shore-side power initiatives, helps meet environmental standards and increases transparency.*				
15.Encourage collaboration between stakeholders so that shore-based power initiatives are not only more effective, but also more sustainable and robust in the long term.					

Appendix

1.Abbreviations

AFIF	Alternative Fuels Infrastructure Facility
AFIR	Alternative Fuels Infrastructure Regulation
API	Application Programming Interface.
CAPEX	Capital expenditure
CCNR	Central Commission for the Navigation of the Rhine
CEE	Commission Internationale de l'Éclairage
CEF	Connecting Europe Facility
CEMT	Conférence Européenne des Ministres de Transport
CEN	Comité Européen de Normalisation
CENELEC	Comité Européen de Normalisation Electrotechnique
CLINSH	CLean INland SHipping
CPT	Clean Power for Transport
CRSD	Corporate Sustainability Reporting Directive
D.E.K. vessel	Dortmund-Eemskanaalschip (Dortmunder)
DNP	Distributed Network Protocol
DORA	Digital Operational Resilience Act
ECDIS	Electronic Chart Display Information System
ETD	Energy Taxation Directive
EU	European Union
EURIS	European River Information Services
GDPR	General Data Protection Regulation
HVSC	High Voltage Shorepower Connection
IEC	International Electrotechnical Commission
IEEC	International Energy Efficiency Certificate
IENC	Inland Electronic Navigational Charts
ISO	International Standardization for Organization
IoT	Internet of things
kVA	Kilovolt ampere
LPG	liquefied petroleum gas
MQTT	Message Queuing Telemetry Transport
MVA	Megavolt ampere
NIOSH	National institute for Occupational Safety and Health
NIS	Network and Information Systems
NSR	North Sea region
OCPP	Open Charge Point Protocol
OPC -UA	Open platform communications unified architecture".
OPS	Onshore Power supply

R&D	Research and Development
R.H.K. vessel	Rhine – Herne Canal vessel
RORO	Roll-on- Roll off
SCADA	Supervisory control and data acquisition
SLA	Service Level Agreement
SPIES	Shore power in European Shipping
TEN-T	Trans European Transport Network
VNF	Vois navigable de France
VIL	Flemish Institute for Logistics
VWEU	Treaty on the Functioning of the European Union

2.Questionnaire

Regular information	
• Company / organisation	
• Country	
• Email general	
• Active in shore power within the domain:	• Schip owners or skippers (Users) • Ports, terminals private -public • Cabinet builders (hardware) • Technology providers (software) • Regulations and policies • Research Institutions • Infrastructure
Questionnaire for target group USERS	
• What type of vessel do you own?	• Spits • Kempenaar • D.E.K. • R.H.K. • Large Rhine barge • Large container ship • Large container ship • Coaster • Others
• Are you already using shore power?	• Yes • No
• How often have you used shore power in the past year?	• Sporadically • Daily • Weekly • Monthly • Only in certain periods (holidays, etc)
• Are there enough connection possibilities for shore power?	• Yes • No
• Has the situation already arisen that there was no possibility of affiliation? Explain.	
• Which ampere (A) do you need?	• 16A • 32A • 63A • 125A • 400A
• Which voltage (V) do you need?	• 220V

	• 400V
• Which frequency (HZ) do you need?	• 50 Hz • 60 Hz
• Do you use an App to connect to the shore power network? Which?	
• Is using/communicating with your current app user-friendly?	• Yes • No
• Is there a help function in the app?	• Yes • No
• Does it make sense if you can also use the same app for other applications (water/waste management)?	• Yes • No
• How many bills do you get each month for using shore power?	• 0 • 1 • 2 • 3 • 4 • 5 and >5
• What are your experiences with the current invoicing?	
• Do you have enough insight into annual consumption/cost for using shore power?	
• Why not?	• Technically not possible • Limited availability • Cost • Compatibility issues • Restrictions on freedom of movement • Others - explain
• Would you use shore power if the issues in the previous question were met?	• Yes • No – Why not?
• What do you think are the main advantages of shore power compared to using generators or other energy sources?	• Reduced operating costs • Environmental friendliness • Noise reduction • Improved safety and reliability • Compliance with (future) regulations • Enhanced flexibility and convenience • Others- explain
• What do you think are the most important factors that determine the choice of (a certain) shore power (location)?	• Port facilities and infrastructure (compatibility connection points, capacity to handle power requirements,… • Berth availability and suitability • Electrical grid reliability • Environmental regulations and incentives • Cost considerations • Turnaround time and efficiency • Support • Others - Explain
• How do you think the use of shore power can be promoted?	
• Do you see added value in a collective approach and a common policy on shore-based power?	
Questionnaire for target group ports/terminals	
• Private or public port/terminal?	• Private • Public
• The port/terminal is located in	• TEN-T core • TEN-T expansion • None of the above

• Are you aware of the AFIR obligation?	• Yes • No
• How would you describe the demand for shore power facilities in your port?	• Low • Medium • High • Unknown
• Do you think there is a growing need for these facilities?	• Yes • No • Explain Your answer
• Do you see added value in a collective approach and a common policy on shore-based power?	• Yes • No • Explain Your answer
• Do you have shore power infrastructure?	• Yes • No • Yes, What was/ is the motivation for this? • No, What was/ is the motivation for this?
• Which types of shore power connections in ampere (A) do you offer?	• 16A • 32A • 63A • 125A • 400A
• Which types of shore power connections in voltage (V) do you offer?	• 220V • 400V
• Which types of shore power connections frequency (Hz) do you offer?	• 50 Hz • 60 Hz
• Which infrastructure have you installed?	• Basic cabinets • Smart cabinets • Mix of both
• What was in the past year the average occupancy rate?	• < 5% • 6%-15% • 16%-30% • 31%-40% • 41% • I don't know it
• Is there a charge for using shore power? How much is this rate? And how was this pricing arrived at?	
• Who supplies the energy for the shore power connections?	
• How do you inform users about the availability, location and facilities of the shore power facilities in your port?	
• How do you measure the impact and effectiveness of shore power projects in terms of emission reduction, cost savings and operational efficiency?	
• Is (fast) charging infrastructure available for freight transport in the port or along the waterways?	• Yes • No
• Is it possible to provide more information about this (fast) charging infrastructure for freight transport?	
• If Your plan shore power infrastructure, in which time frame do you want to install this?	• Short term (- 1 year) • Medium term (<5 years) • Long term • We don't plan to install Shore power infrastructure
• Which infrastructure do you plan to install?	• Basic cabinets • Smart cabinets

	• Mix of both
• Are you installing this individually or in a group?	• Individually • in Group
• Are there any other comments or suggestions you would like to share regarding shore power facilities in your port?	
• Are you aware of the EU call that is currently running within Alternative Fuels Infrastructure Facility (AFIF)?	• Yes • No
• Are you planning to rely on AFIF to finance future investments in shore power?	• Yes • No • Maybe
• If no, why not?	• Too complex • Too much administration • No internal resources (financial, personnel, etc.) Available • Was previously not aware of • Others
• Have you an idea of expected investment to adhere the EU-legislation, the necessary capacity, necessary infrastructure, hardware etc.	
• What do you think are the biggest challenges in rolling out shore power in the North Sea region?	
• Which recommendations would you include in the recommendation report?	
Questionnaire for target group Cabinet builders (hardware)	
• Does your company currently offer shore power solutions for ports or other locations where ships need electricity supply?	• Yes • No
• What is currently stopping you from doing this?	
• Are your solutions suitable for inland or Sea ports?	• Only inland ports • Only Sea ports • Both ports
• Which types of shore power solutions does your company offer (e.g. fixed connections, mobile units, smart charging solutions, etc.)?	
• Which data protocol are you currently using?	• OPC-UA • REST • SOAP • DNP 3.0 • Other • If other, which protocol do you use?
• Why was this protocol chosen by you?	
• How are your company's shore power solutions powered?	• Regular electricity grid • Renewable energy sources • Others - which?
• Does your company also offer services for remote monitoring and management of shore power supplies?	• Yes • No - Explain
• What support does your company offer to customers when implementing shore power solutions, such as installation, maintenance, training, etc.?	
• Are there any specific technological innovations or developments within your company related to shore power that you would like to highlight?	

• How does your company see the future of shore power facilities in ports? Are there any plans for further improvements or expansions?	
• What collaboration opportunities does your company see with other stakeholders in the shore-based power sector, such as ports, government agencies, or technology partners?	
• Are there any other comments, suggestions, or information you'd like to share regarding shore power solutions and your company's role in them?	
• Which recommendations would you include in the SPIES recommendation report?	
Questionnaire for target group Technology suppliers (software)	
• Does your company currently offer shore power software solutions?	• Yes • No
• What types of software does your company offer?	
• Which data protocol are you currently using?	• OPC-UA • REST • SOAP • DNP 3.0 Other
• Why did you chose for this protocol?	
• Are there new technologies or innovations in development by your company?	• Yes • No
• Which types of software?	
• Are there any specific challenges or obstacles that your company has experienced when developing or implementing shore power projects?	• Yes • No • What are they?
• Is there a need for standardization in the further development of shore power?	• Yes • No • Explain
• How do you see the interoperability between the different providers?	
• What future trends or developments does your company see in the field of shore power and sustainability?	
• How would you describe the key benefits of shore power projects, both for the maritime sector and for the environment?	
• Are there any other comments, suggestions or insights you would like to share regarding shore power development and your company's role in it?	
• What do you think are the biggest challenges in rolling out shore power in the North Sea region?	
• Which recommendations would you include in the recommendation report?	
Questionnaire for target group Regulations and policies	
• How do you see the role of shore-based power in the context of sustainable development goals and climate change?	
• Are you aware of the AFIR obligation?	• Yes • No
• Do you have insight into the implementation of AFIR obligations in your country?	• Yes • No
• How is this followed up?	

• AFIR requires at least 1 shore power installation at each TEN-T core location. will this timing be met?	• Yes • No
• What are the obstacles to realizing this obligation in a timely manner?	
• What challenges do you see with regard to the implementation of shore power?	
• What structure do you see for the future development of shore power?	• Private initiative • Public initiative • Private – public partnership
• Which steps are you considering to promote the adoption of shore power?	
• What role do you envisage in regulating tariffs and access to shore-based power facilities?	
• Are there any other comments, suggestions or insights you would like to share regarding shore power development and your company's role in it?	
• What do you think are the biggest challenges in rolling out shore power in the North Sea region?	
• Which recommendations would you include in the recommendation report?	
Questionnaire for target group Research Institutions	
• Is research being conducted into shore power (applications) in your organization?	• Yes • No
• Which domains are investigated by your organization?	
• Are these research results already available?	• Yes • No
• Are there any other comments, suggestions, or information you'd like to share regarding shore power solutions and your company's role in them?	
• What do you think are the biggest challenges in rolling out shore power in the North Sea region?	
• Which elements would you like to see included in a policy recommendation plan for shore power within the North Sea region?	
Questionnaire for target group Infrastructure	
• Are you aware of the AFIR obligation?.	• Yes • No
• Is the additional need for shore power infrastructure taken into account when expanding/renewing the distribution network?	• Yes • No
• Who initiates the request for additional shore power infrastructure?	• Intern • Local authorities • The Port • Waterway manager • Private companies • The skippers
• What do you think are the biggest challenges in rolling out shore power in the North Sea region?	
• Which elements would you like to see included in a policy recommendation plan for shore power within the North Sea region?	

3.List of sources

- Alternative Fuel Infrastructure Regulation (AFIR): https://eur-lex.europa.eu/legal-content/NL/TXT/HTML/?uri=CELEX:32023R1804
- Clean Energy for Transport: A European Strategy for Alternative Fuels (24 January 2013): https://eur-lex.europa.eu/legal-content/EN/TXT/?uri=legissum:20010301_2
- Danube tool: https://www.danubeportal.com/
- European research project Clean Inland Shipping (Clinsh): www.clinsh.eu
- European Standards: https://osha.europa.eu/en/european-standards
- European White Paper of 28 March 2011 'Roadmap to a Single European Transport Area - Towards a competitive and resource efficient transport system: https://eur-lex.europa.eu/LexUriServ/LexUriServ.do?uri=COM:2011:0144:FIN:en:PDF
- Fit for 55 package: https://www.consilium.europa.eu/en/policies/fit-for-55/
- Floating battery: https://vil.be/project/floating-battery/
- Movares: https://www.schonescheepvaart.nl/nieuwsitem/resultaten-iw-innovatieproject-versnelling-uitrol-walstroom
- Regulation EU 2023/1804 of the european parliament and of the council on the deployment of alternative fuels infrastructure and repealing Directive 2014/94/EU (13 September 2023): https://eur-lex.europa.eu/eli/reg/2023/1804/oj/eng
- Regulation EU 2023/1804 on the deployment of alternative fuels infrastructure and repealing Directive 2014/94/EU (13 September 2023): https://eur-lex.europa.eu/eli/reg/2023/1804/oj/eng
- Regulation EU 1679/2024: https://eur-lex.europa.eu/eli/reg/2024/1679/oj/eng
- Regulation EU 1315/2013: https://eur-lex.europa.eu/eli/reg/2013/1315/oj/eng
- Sustainable and Smart Mobility Strategy – putting European transport on track for the future' (9 December 2020): https://eur-lex.europa.eu/legal-content/EN/TXT/?uri=celex:52020DC0789
- Vaarweg informatie tool: https://www.vaarweginformatie.nl/frp/main/#/home
- Walstroomcollectief: https://www.portsolutionsrotterdam.nl/walstroomcollectief

4.Current shore-based power rates (may 2025)

Land	Port/ Waterway		Comments
Netherlands	• Port of Rotterdam:	€0,35	• Rates are per kWh and include 21% VAT.
	• Dordrecht, Papendrecht en Zwijndrecht:	€0,35	
	• Port of Harlingen:	€0,484	
	• Kampen:	€0,35	
	• Provincie Zuid-Holland:	€0,35	
	• Gemeente Nieuwegein	€0,35	
	• Zaanstad binnenvaart:	€0,32	
	• Zaanstad riviercruises:	€0,65	
	• North Sea Port binnenvaart:	€0,35	
	• North Sea Port riviercruises:	€0,44	
	• Krimpen aan den IJssel	€0,35	
	• Overige havens:	€0,2745	
	• Alkmaar	€0,50	
	• Twente	€0,3872	
	• Amsterdam binnenvaart	€0,2745	
	• Amsterdam riviercruises	€0,65	
	• Den Haag	€0,27	
	• Scheveningen	€0,3025	
	• Den Helder	€0,4477	
	• Den Oever	€0,50	
	• Deventer	€0,3185	
	• Eindhoven	€0,363 (+€2,118 start)	
	• Enkhuizen	€0,35	
	• Geertruidenberg	€0,274	
	• Groningen	€0,30	
	• Haarlem	€0,828	
	• Harlingen	€0,48	
	• Hengelo	€0,2745	
	• Hoekse Waard	€0,63	
	• Hoorn	€0,45	
	• Huizen	€0,75	
	• Ijmuiden	€0,4477	
	• Kampen	€0,30	
	• Lauwersoog	€0,30	
	• Leiden	€0,50	
	• Lelystad	€0,45	
	• Maassluis	€0,1452	
	• Moerdijk	€0,2745	
	• Nijmegen	€0,35	
	• Oosterhout	€0,3267	
	• Oss	€0,30	
	• S-Hertogenbosch	€0,25	
	• Schiedam	€0,27	

	• Terschelling €0,45 • Veere cruiseterminal €0,6776 • Vlissingen €0,605 • Wageningen €0,22 • Zaltbommel €0 • Zwartsluis €0,30 • Zwolle €0,4646	
Belgium	• Port of Antwerp: €0,27 • De Vlaamse waterweg €0,27 • De Vlaamse waterweg €0 • North Sea Port: €0,2745	• Rates are per kWh and excl. 21% VAT. • Exception North Sea Port, this rate includes 21% VAT
France	• Sur le réseau fluvial du Nord – Pas-de-Calais €0,20 • Caudebec €0,516 • Villefranche-sur-Saône €0,45	
Germany	• Altenrheine €0,0003 • Bergeshovede €0.0003 • Bergkamen €0,0003 • Datteln €0 • Dorenthe €0,0003 • Dorsten €0 • Düsseldorf €0,46 • Emmerich an Rhein €0,003 • Engers €0,4598 • Lübeck €0,46 • Ludinghausen €0,003 • Münster €0,0003 • Radbod €0,003 • Riesenbeck €0,0003 • Schmedehausen €0,003 • Staubing €0,46 • Traben – Trarbach €0,46 • Voerde- Friederichsfeld €0 • Volkach €0,46	

5.Letters of support

The following organizations support the SPIES project:

Lead partner	
1	POM Limburg (BE)
Partners	
2	De Vlaamse Waterweg (BE)
3	Hafen Hamburg Marketing (DE)
4	MCA Brabant (NL)
5	Ports de Lille (FR)
6	Port of Aalborg (DK)
7	Province of Limburg (NL)
Supporting partners (through Letter of Support)	
8	Central Commission for the navigation of the Rhine (FR)
9	Port of Antwerp-Bruges (BE)
10	European Federation of Inland Ports (BE)
11	Inland Navigation Europe (BE)
12	Bundesverband Öffentliche Binnenhäfen (DE)
13	North Sea Ports (BE- NL)
14	Port of Groningen (NL)
15	City of Nijmegen (NL)
16	Senate chancellery of the free and Hanseatic city of Hamburg (DE)
17	Voies navigables de France (FR)
18	Panteia (NL)
19	Port of Limburg (NL)
20	Kenniscentrum Binnenvaart Vlaanderen (BE)
21	Port of Brussels (BE)
22	EU-IWT Platform (BE)
23	Port solutions Rotterdam (NL)
24	Expertise- en Innovatie Centrum Binnenvaart (NL)
25	Rijkswaterstaat Nederland (NL)

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Priority 4: Better governance