



FLEXSHIP

***FLEXIBLE AND MODULAR LARGE BATTERY SYSTEMS FOR SAFE ON-BOARD
INTEGRATION AND OPERATION OF ELECTRIC POWER, DEMONSTRATED IN MULTIPLE
TYPE OF SHIPS.***

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LIST OF ABBREVIATIONS, ACRONYMS AND DEFINITIONS

Table 1. List of Abbreviations, Acronyms and Definitions

Acronym	Name
BES / BESS	Battery Energy Storage System
BMS	Battery Management System
CO ₂	Carbon Dioxide
EMS	Energy Management System
EU	The European Union
EU ETS	EU's Emissions Trading System
EUWT – SE	European Union Waterborne Transport – Synergies Ecosystem
EV / Electric V	Electric Vessel
FLEXSHIP	Flexible and modular large battery systems for safe on-board integration and operation of electric power, demonstrated in multiple type of ships.
GHG	Greenhouse Gases
HYPOBATT	Hyper-Powered Vessel Battery Charging System
ID	Identifier
IMO	International Maritime Organization
IRR	Internal Rate of Return
Li-ion SSB	Lithium-Ion Solid State Battery
MW	Megawatt
nm	Nautical Miles
No. / No	Number
NPV	Net Product Value

PESTEL (PESTLE)	Political, Economic, Social, Technological, Legal and Environmental business analytical tool
PMS	Power Management System
SEABAT	Solutions for Large Batteries for Waterborne Transport Project
SWOT	Strengths, Weaknesses, Opportunities and Threats analytical tool
TMS	Transportation Management System
WP	Work Package

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1. EXECUTIVE SUMMARY

This document is a deliverable of the FLEXSHIP Projects' **Work Package (WP) 6, Skills development, business models and stakeholders**, showing the approach to and results obtained to date in **Task 6.1 Evaluating stakeholders' requirements and expectations incorporating the technical feasibility (digital twin and demonstrator)**. WP6 addresses the main aspects of the strategic vision from the perspective of key stakeholders. Other tasks in the work package will factor stakeholders' current and future requirements and economic opportunities and risks into business models for electrically powered marine vessels in the European and Global shipping industries. Business models need to cover different sub-categories of stakeholder groups, as initial analysis has shown that use cases vary significantly, depending on shipping type. A SWOT analysis will be conducted to give better insight into relevant internal and external stakeholder influence. Analyses are being used to identify the project's key stakeholders, carry out assessments of their interests and relationships and how they affect the project and its viability.

Keywords:

- Keyword 1, Vessel
- Keyword 2, Electrification
- Keyword 3, Stakeholder
- Keyword 4, Opportunity
- Keyword 5, Risk

2. OBJECTIVES

The overall goal of FLEXSHIP is to develop and validate safe and reliable, flexible, modular, and scalable solutions for electrification of the waterborne sector [\[1\]](#). Technical objectives of the project cover on-board grid architectures, modular battery systems, on-board system integration and full-scale demonstration of all technologies on 2 vessels. For stakeholder engagement the objective of **Task 6.1 Evaluating stakeholders' requirements and expectations incorporating the technical feasibility** is to create a sound strategic foundation for the overall work package **WP6, Skills development, business models and stakeholders**. This objective underpins the overall FLEXSHIP project objectives and in particular Objective 6, relating to stakeholder management and communication and business model development.

INTRODUCTION

Maritime transport emits around 940 million tons of CO₂ annually and is responsible for around 3 to 4% of global greenhouse gas (GHG) emissions in the EU [2]. In line with the internationally agreed temperature goals in Article 2 of the Paris Agreement, in 2023 the International Maritime Organization (IMO) set goals, including:

- reduce CO₂ emissions per transport work, as an average across international shipping, by at least 40% by 2030, compared to 2008
- uptake of zero or near-zero GHG emission technologies, fuels and/or energy sources to represent at least 5%, striving for 10% of the energy used by international shipping by 2030 [3].

To help achieve the established environmental vision, FLEXSHIP focuses on electrification of fleets, replacing the conventional technologies, which use fossil fuels, with battery systems. It is expected that modular multi-MW battery systems will be needed.

For an ambitious project like FLEXSHIP, which aims to create sustainable business models and commercially viable solutions, it is important to understand the environment into which solutions are intended to be introduced. Influences on the success of the project may be from prospective customers, prospective suppliers, external institutions or elsewhere. Only by engagement with stakeholders can project assumptions be verified or be better aligned with the real-world situation. It is therefore crucial to the success of the project that all relevant stakeholder groups are firstly identified and then evaluated. It is appropriate to start identifying specific stakeholder contacts early in the project, so the project team can engage with the key stakeholder groups.

The scope of stakeholder groups being considered includes those within the European Union, those related to the European Union and those relevant to the European Union. Not all stakeholders are expected to belong to the EU, as, for example, EU stakeholders may need to source technology from outside the EU and some key maritime organisations are global. To ensure a holistic approach, various tools are available, including PESTEL Analysis.

The main objectives of the stakeholder analysis are:

- To understand the interests of stakeholder groups relative to the project's objectives. Groups which would be directly affected by, or which could directly

affect the project, are clearly of greater importance than those which are only indirectly affected.

- To promote FLEXSHIP in the maritime field, regarding the forthcoming electrification of the European fleet.
- To identify actual and potential conflicts of interest: A stakeholder, who is vital to the project, may have other priorities and the project consortium needs to understand this, in order to plan how to engage with them.
- To help identify relationships between different stakeholders, to identify opportunities for collaboration.
- To help provide an overall picture of the types of stakeholders that will influence or be influenced by the results of FLEXSHIP.
- To identify potential candidates to complete the list of stakeholders for business exploitation.

The relationship with stakeholders has the following four steps:

- Identify the stakeholders
- Create a Stakeholder Map
- Identify Stakeholders Allegiance
- Create a Stakeholder Management Strategy

DESCRIPTION OF WORK

2.1. Introduction

As well as by using the expertise of the consortium partners and consulting sister projects to apply established methods to identify and categorise stakeholders in the field of shipping electrification, the project team used two main approaches to gather data information on external stakeholders' views. Questionnaires were sent to stakeholders from different stakeholder groups and a webinar workshop was held, attended by a cross-section of stakeholders. Results from the questionnaires and workshop were cross-referred with project stakeholder analysis and work carried out in other work packages, including WP1 'Definition of KPIs, use case vessel requirements, and transferable technology'.

The Consortium

The FLEXSHIP Consortium is all the partner organisations contractually working on the project). The full consortium includes 16 organisations from 9 countries. The partners specifically involved in the output of this report are listed below (see [Table 1](#)).

Table 1 – FLEXSHIP Project Partners

Index	Organisation	Country	D6.1 Role
1	BRING	BE	Overall FLEXSHIP Project Management. Provided Stakeholder Contacts. External reviewer
2	SOERMAR	ES	Provided Stakeholder Contacts. Designed and implemented Stakeholder Questionnaire. Internal reviewer.
3	RINA	IT	Provided Stakeholder Contacts. External reviewer
4	SIVAS CUMHURİYET UNIVERSİTESİ (SCU)	TR	Internal reviewer. Seeking Stakeholder Contacts for more Questionnaire responses.
5	WEGEMT	NL	Provided Stakeholder Contacts. External reviewer
6	ISSNOVA	IT	Provided Stakeholder Contacts. Designed and implemented Stakeholder Workshop. Analysed Workshop results. Internal reviewer.
7	OTASKI ENERGY SOLUTIONS LTD	UK	Task and deliverable lead. Provided Stakeholder Contacts. Stakeholder Group definition and analysis. Analysed Questionnaire results. Authored document.

2.2. Stakeholder Grouping

For the higher-level analysis required for an EU-wide long-term project, organisations must be categorised into Stakeholder Groups. For more information on the approach to stakeholder grouping, please see [Stakeholder Management Strategy](#) below. Initial Groups identified in the '[FLEXSHIP] Stakeholder segmentation & contact list' were -

- Port Authorities
- Large Scale Batteries Companies
- EMS (Energy Management Systems) Companies
- Ferries (20-30km)
- Ferries EV (20-30km)
- Digital Twin Companies

Cross-reference with the preceding sister project, HYPOBATT, identified the following relevant GROUPS:

- Standards and Classifications Agencies
- Governments
- Engineering companies
- Shipping companies (apart from ferries)
- Electronics and Battery Recycling Companies
- Society in general
- Electricity Providers
- Universities & Research Companies

Environmental interest groups These groupings were used in the stakeholder group mapping and PESTEL Analysis.

2.3. Stakeholder Groups Mapping

For each of the Stakeholder Groups relationship to and stake in the project, attitudes and risk of no engagement were considered and mapped into a table (see [Table 2](#) below).

Table 2. Stakeholder Stake Analysis

Stakeholder Group	Stake in the project	Needs and Contributions	Perceived attitudes / risks	Risk if they are not engaged	Mitigation
Port Authorities	Indirect partner	Must provide berths with chargers	Interested. Need business case.	High risk if EVs cannot be charged anywhere	HYPOBATT Project addressing this risk
Large Scale Batteries Companies	Supplier	Marine market could be a significant market for them. Technology may restrict options.	Positive	Constraints of capacity and speed of charging	FLEXSHIP Project helping explore technical possibilities in this area.
EMS Companies	Supplier	Provide software and user interface to use hardware	Positive	Failure of EMS to keep up with technology could constrain adoption	FLEXSHIP Project helping explore technical possibilities in this area.
Ferries (20-30km)	Potential Customer	Potential buyers and users of vessel batteries	Positive	No further demand	FLEXSHIP Project helping promoting technology in this area.
Ferries EV (20-30km)	Customer	Buyers and users of vessel batteries	Interested. Need business case.	Already engaged. Share data and learnings from	

				project operations	
Digital Twin Companies	Supplier	Enable modelling required engineering	Positive	Slower development of solutions	FLEXSHIP Project developing its own digital twin.
Ship Builders	Supplier	Can build EVs	Depends on demand	Slower introduction of EVs	
Standards and Classifications Agencies	Influencer	Provide regulations and guidelines for manufacturers and users	Positive	Non-compliance	Focus on compliance in FLEXSHIP technical work packages
Governments	Influencer	Provide laws for manufacturers and users	Positive	Non-compliance	
Engineering companies	Supplier	Manufacturers and maintainers of batteries	Depends on their relationship to the supply and service. May support or may oppose	Sustainability of solution	
Shipping companies (apart from ferries)	Potential Customer	Potential buyers and users of vessel batteries	Largely positive but need a business case	Not critical if ferry companies support project	FLEXSHIP Project helping promoting technology in this area.
Electronics and Battery Recycling Companies	Indirect Vendor	Late but essential part of the product cycle of batteries	Positive	Need their help to address concerns about battery pollution	FLEXSHIP Project helping promoting technology in this area.
Society in general	Influencer	Set the context for many of other stakeholder groups.	Positive	No engagement not applicable, as public omnipresent. Risk is that public opinion could turn against electrification. Seems unlikely.	FLEXSHIP Project dissemination helping promote relevant technology.
Universities & Research Companies	Indirect Vendor	Would help further developing shipping battery products	Positive	Help may be required for future development	FLEXSHIP Project includes academic partners
Environmental interest groups	Influencer	Could support of oppose electrification of shipping	Positive but negative about waste batteries?	Could become opponents?	
Electricity Providers	Supplier	Must provide enough capacity	Positive	Can't supply enough energy	

		for ports to supply ships		to meet demand	
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The above output was used to mapping Stakeholder Groups influence and interests (see [Figure 7](#) below).

2.4. Stakeholder Management Strategy

It is clear from the initial stakeholder analysis, that the key stakeholder group relates shipping companies / organisations, including ferry operators. On the FLEXSHIP Project, it is from a shipping company's perspective that key variables need to be considered. Within the group Shipping Organisations, there are many subdivisions. One of the main subdivisions is vessel type and vessel type is the categorisation used for FLEXSHIP use cases. Other subdivisions of shipping groups include organisational departments, such as operational and maintenance, and different roles, including crew member. Where appropriate all subdivisions of this key stakeholder group should be considered. There are many other groups who will be influential in the electrification of shipping, whose views and needs must be taken into account.

Other groups, particularly shipyards, port authorities and battery manufacturers are key stakeholders and their interests must also be appropriately managed. Communication with all groups and contacts will be aligned with FLEXSHIP Work Package 7 communication strategy [7]

The intention is to form a Stakeholder Group or more precisely a dedicated FLEXSHIP Stakeholder Contact Group, including key people external to the project team, to work with on the rest of the project. Communication with the group will be coordinated with the FLEXSHIP dissemination and communication work, led from Work Package 7.

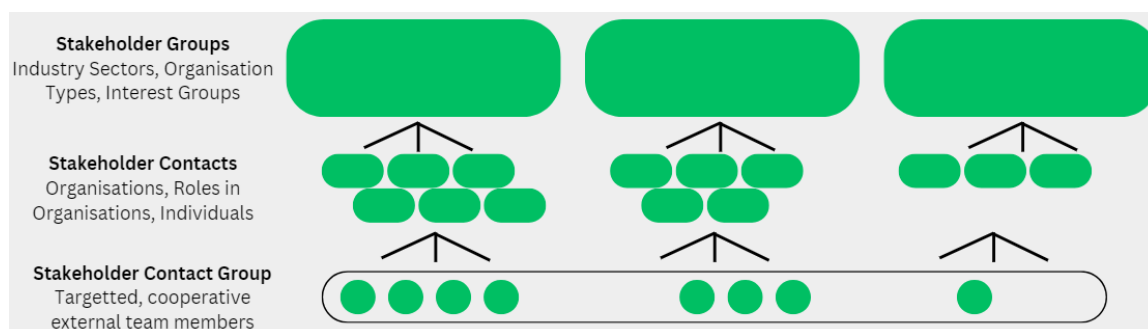


Figure 1. Stakeholder Analysis Terminology

With this report the first phase of FLEXSHIP stakeholder management closes. In the second phase, over the next 18 months, focus is going to be on current constraints for the stakeholders that prevent them adopting electrified marine technologies and factors for wide adoption of E-Vessels. In the final and third phase of the project it is expected to showcase the potential of FLEXSHIP-related technology.

PESTEL Analysis

PESTEL (or PESTLE) Analysis is an established method to appraise stakeholder groups from multiple perspectives and for ensuring a holistic approach to identifying stakeholder groups. It can be used to assess groups' roles on a project and does not restrict analysis from multiple time dimensions.

The categories it uses are -

- Political / Regulatory
- Economic
- Social
- Technological
- Environmental
- Legal

PESTEL Analysis was approached from both the bottom up and the top down. Firstly, each of the Stakeholder Groups already identified (see [Stakeholder Grouping](#) above) were assigned to relevant PESTEL categories (see above). One Stakeholder Group could apply to one or more than one PESTEL category. Then each PESTEL Category was checked to see that it had assigned Stakeholder Groups. The list of Stakeholder Groups was checked to ensure all relevant areas were covered. The approach was similar to that used earlier on the HYPOBATT Project [4] Results can be found below (see [Stakeholder Groups Analysis](#)).

2.5. Stakeholder Contacts

Unlike Stakeholder Groups, Stakeholder Contacts may relate to individual organisations or individual roles in organisations. From early in the FLEXSHIP Project, team members from different projects have populated a central file, '[FLEXSHIP] Stakeholder segmentation & contact list', with information about Stakeholder Contacts. Over 50 Stakeholder Contacts from many Stakeholder Groups and many countries inside and outside the EU have been identified (see [Figures 2 and 3](#) below).

2.6. Stakeholder Questionnaire

A set of stakeholder questionnaires were created, targeting different stakeholder groups but structured similarly. Each questionnaire had 27 questions, split into 9 groups. Question groups used are listed in [Table 4](#) below.

Table 3. Questionnaire Framework

Index	Question Groups
1.	Value Propositions
2.	Customer Segments
3.	Channels
4.	Customer Relationships
5.	Revenue Streams
6.	Key Resources
7.	Key Partnerships
8.	Key Activities
9.	Cost Structure

Four external stakeholders completed the questionnaires. They were from the Stakeholder Groups of -

- Battery Companies
- Port Authorities
- Ferry Companies (x 2)

FLEXSHIP partner SOERMAR also completed a questionnaire from the perspective of Shipping Companies, with whom they have much experience.

2.7. Stakeholder Workshop

The FLEXSHIP Stakeholder Workshop, held on Thursday, March 21st, 2024, from 10:00 AM to 12:00 PM CET introduced many stakeholders to the project.

Preparation for the workshop included requesting invitees to complete a registration form. The first part of the form featured an exhaustive description of the project and explained the purposes and specific objectives of the workshop. The intention was to capture the interest of the recipients and to stimulate their active and conscious participation in the event. The second part of the registration forms aimed to collect stakeholder contact information from participants. This was to facilitate follow-up communication with before and after the workshop and to acquire information relating to the professional background of the individual registrants and their motivation for taking

part in the event. As FLEXSHIP progresses, the partners need to stay in touch with stakeholders' attitudes to the project and to the related technical solutions.

The main objectives of the workshop are outlined in the table below showing its desired outcomes -

Table 4. Stakeholder Workshop Objectives

Outcome	Description
Stakeholder Understanding	Gain a clear understanding of current concerns, constraints, and key drivers for deploying cutting-edge clean marine technology according to the project's stakeholder ecosystem.
Optimal Energy Management	Design an optimal Energy Management System (EMS) for the most efficient operation of batteries in vessels.
Market Trends & Innovation	Identify trends in the market and discover emerging innovations.
Flexship Project Knowledge	Acquire and maintain knowledge about the Flexship project.
Electrification Technologies	Deepen understanding of new and scalable electrification technologies within the waterborne sector.
Stakeholder Connections	Establish connections with key stakeholders relevant to the themes of the FLEXSHIP project.

Other Stakeholder Input

Specific interest of the impact of marine vessel electrification on the crew appeared in surveys and is being addressed in more detail in Task 6.2 'Long term skills needs and strategies for a green shipping value chain.'

3. DISSEMINATION, EXPLOITATION AND STANDARDISATION

3.1. Introduction

WP7 'Dissemination, communication, and exploitation' focuses on the overall dissemination and exploitation of the project. Elements of T6.1 are significant for project dissemination and should complement and be aligned with WP7.

3.2. Stakeholder Contacts

The FLEXSHIP team identified over 50 stakeholder contacts. Specific contact details were found for most contacts. Ones with email addresses successfully added come from many countries across and beyond the European Union and from many relevant Stakeholder Groups (see [Figures 2 and 3](#) below respectively.)

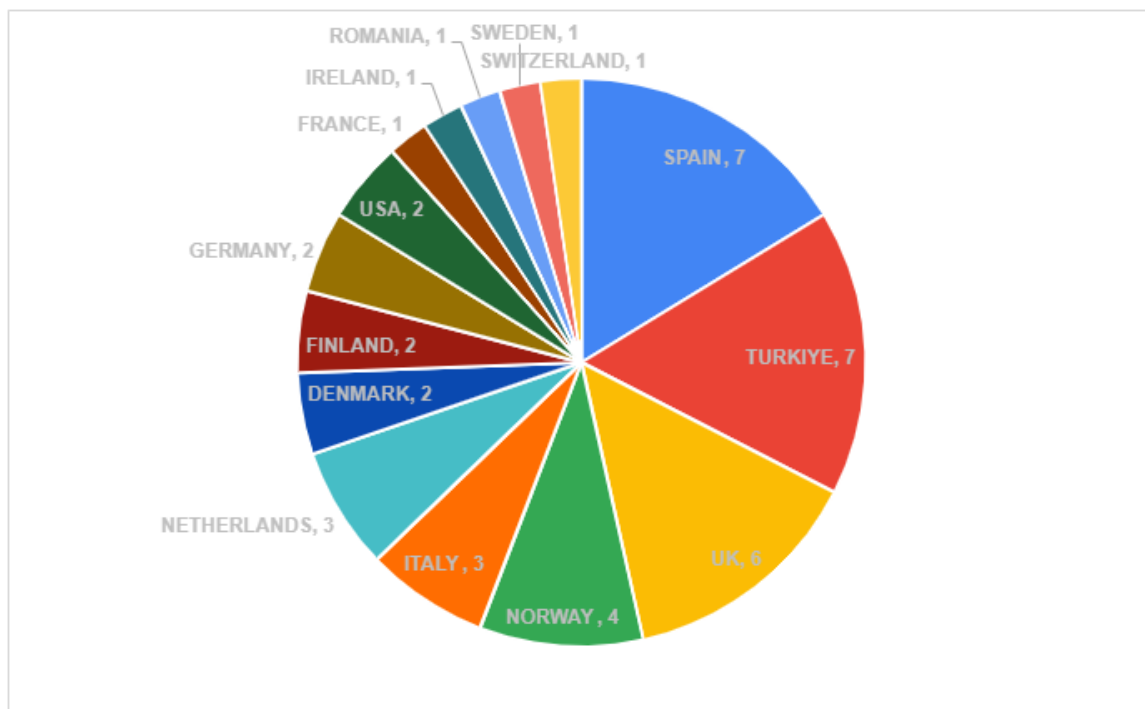


Figure 2. Stakeholder Contacts' Country

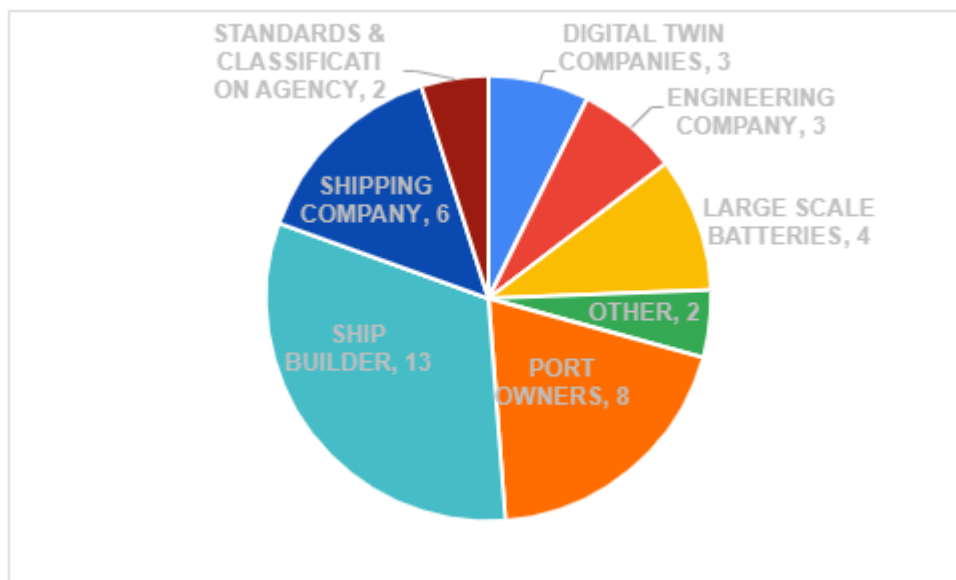


Figure 3. Named Stakeholder Contacts by Stakeholder Group

3.3. Stakeholder Questionnaire

In order to capture as much input as possible, questionnaires were not only sent to Stakeholder Contacts identified in the FLEXSHIP project stakeholder list but also to contacts for the HYPOBATT and SEABAT projects.

3.4. Stakeholder Workshop

71 participants from diverse sectors registered for the event. [Figure 4](#) shows a pie chart depicting the various fields of the workshop participants. The project generated significant academic interest, attracting many students. Consequently 66% of participants were aged less than 30. 75% of participants were male. Attendees were from a range of EU and non-EU countries (see [Figure 5](#)).

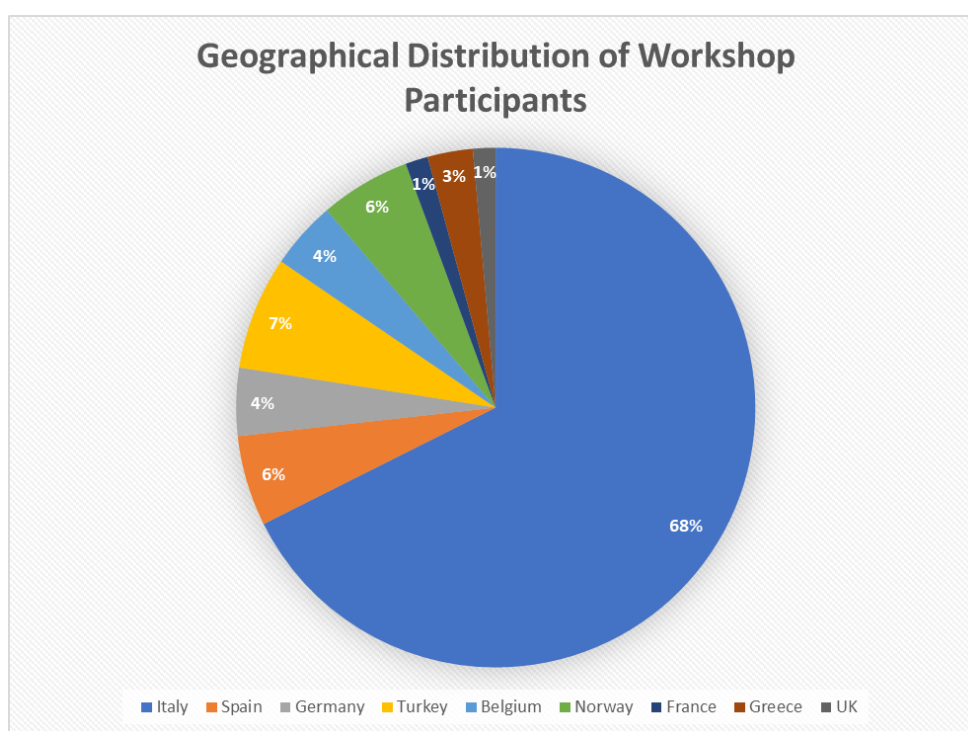


Figure 4. Geographical Distribution of Workshop Participants

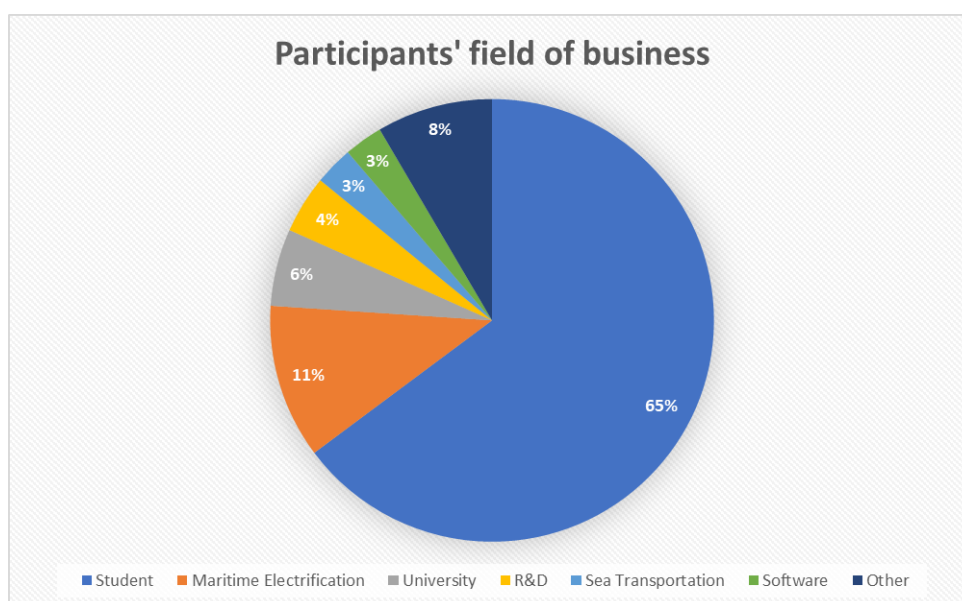


Figure 5. Workshop Participants' Field of Business

Through the registration form, these students have expressed their motivation for participating, indicating that their expected outcome is to acquire training relevant to the development of the maritime sector.

After the workshop a survey was distributed among the external stakeholders containing five questions, illustrated below ([Tables 6, 7 and 8](#)), to gather feedback and perspectives from participants representing a range of professional and educational backgrounds. Eight responses were received.

Table 5. Workshop Multiple Choice Questions

No.	Multiple Choice Question
1	Which are the general types of vessel that should undergo through the most urgent and accelerated re-electrification till 2040?
2	Which are the general types of vessel that would go through a higher realistic rate of electrification, driven by feasibility and potential GHG abatement? (Select 1 or more than 1 type if required)

Table 6. Questionnaire Vessel Types

Index	Vessel Type Choice
A	Fully cellular containers
B	General Cargo Vessels
C	Tugs
D	Bulk Carriers

E	Fishing Vessels
F	Pass/Car Ferries
G	Cruise
H	Crude Oil Tankers

Table 7. Questionnaire Open Questions

No.	Open Question
4	What are your current main concerns that are potentially blocking a wide deployment of vessel fleets' electrification?
5	Which are the main technologically based drivers, that you expect to be into the market to boost a sustainable waterborne sector from 2030 onwards?
6	Which are the key economically based drivers, that can financially support a successful vessel fleet modernisation from 2030 onwards?

4. RESULTS AND DISCUSSION

4.1. Stakeholder Groups Analysis

PESTEL Analysis identified roles of Stakeholder Groups related to FLEXSHIP and helped ensure fully broad identification of relevant Stakeholder Groups and how they relate to the project (see [Figure 6](#)). Mapping and Stakeholder Impact Analysis pointed to which of the Stakeholder Groups are key to the project (see [Figure 7](#)). Ferry Operators and Other Shipping Companies / organisations were identified as the most key Stakeholder Groups. This aligns with output from WP1, 'Definition of KPIs, use case vessel requirements, and transferable technology', where key use cases for the project are identified as types of shipping.

FLEXSHIP Stakeholder Groups PESTEL Analysis					
Political / Regulatory	Economic	Social	Technological	Environmental	Legal
Port Authorities	Port Authorities	Port Authorities	Digital Twin Companies	Environmental interest groups	Governments
Standards and Classifications Agencies	Shipbuilders	Shipbuilders	EMS Companies	Electronics and Battery Recycling Companies	
Governments	Ferries (20-30km)	Society in general	Large Scale Battery Companies		
	Ferries EV (20-30km)		Shipbuilders		
	Large Scale Battery Companies		Universities & Research Companies		
	Engineering companies		Electricity Providers		
	Shipping companies (apart from ferries)				
	Electronics and Battery Recycling Companies				

Key Values in bold, appear in multiple categories

Figure 6. Stakeholder Groups PESTEL Analysis

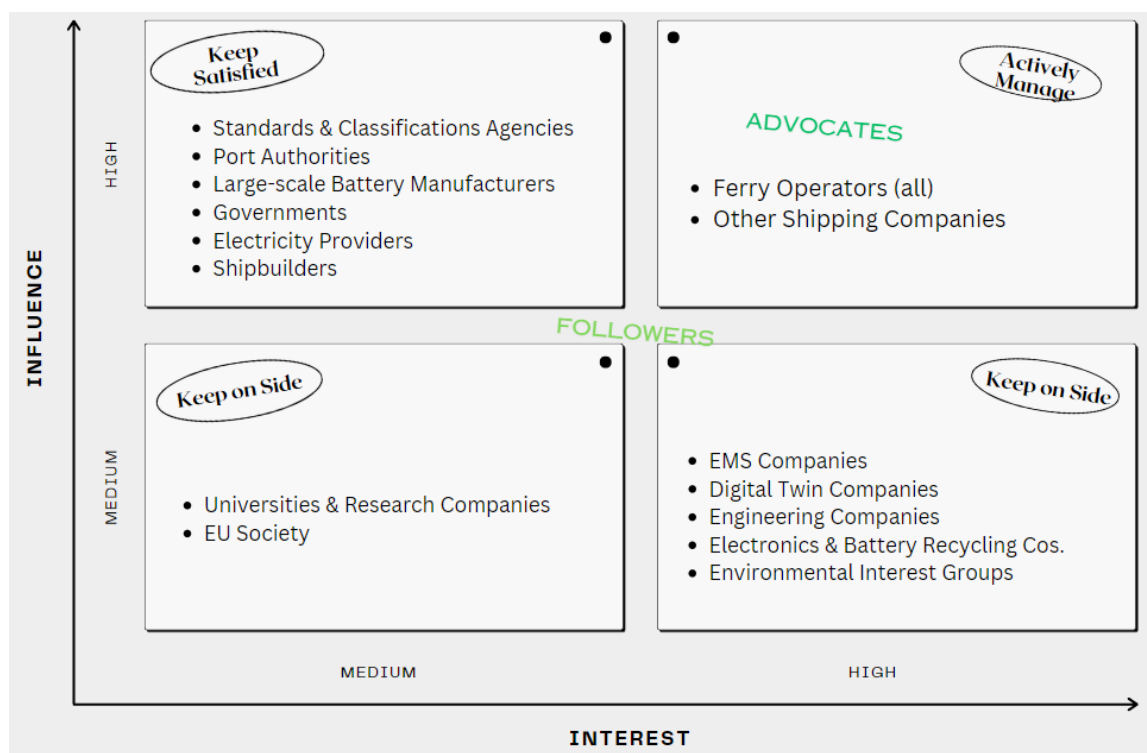


Figure 7. Stakeholder Groups Mapping

4.2. Stakeholder Contact List

A wide range of FLEXSHIP Stakeholder Contacts with details was identified, covering many Stakeholder Groups and many countries inside and outside the EU. 61 potential stakeholder contacts were listed, of which 41 have contact names. (See [Figures 2 and 3](#) above for further breakdowns of Stakeholder Contacts). Going forward in the project, a higher percentage of shipping organisation and other key stakeholder groups engagement is required, in order to add focus and quality to results.

4.3. Stakeholder Questionnaire Results

Results were collected from the stakeholders' responses. The responses were compared. The Shipowners responses created by SOERMAR fitted with responses already gathered from other stakeholders but SOERMAR added the opportunity to avoid CO₂ emission fines. EU legislation is being rolled out in this area, including the extension of the Emissions Trading System (ETS) to cover CO₂ emissions from large ships [\[2\]](#). Overall answers gathered in the questionnaire were rich in information, if not in quantifiable information.

4.3.1. Vessel Electrification Factors

Each stakeholder answer was reviewed and the following key parameters were extracted from the answers:

- Factors which could encourage adoption of electric vessels
- Factors which could discourage adoption of electric vessels
- Factors which could encourage or discourage adoption of electric vessels, depending on how they are realised

See [Appendix 3](#) for an example of how answers were classified. Stakeholder responses were normalised. Similar points made in the questionnaire answers were grouped as one. The output of this exercise was a list of vessel electrification factors.

Encouraging factors constituted 'Strengths/Opportunities'. Discouraging factors constituted 'Risks/Threats'. Other factors could belong to either group in the future. All factors were then plotted on a diagram (see [Figure 8](#) below). To add structure to the diagram strengths / opportunities were listed on a 'Commercial / Environmental' scale and risks / threats were listed on a 'Technological / Procedural' scale.

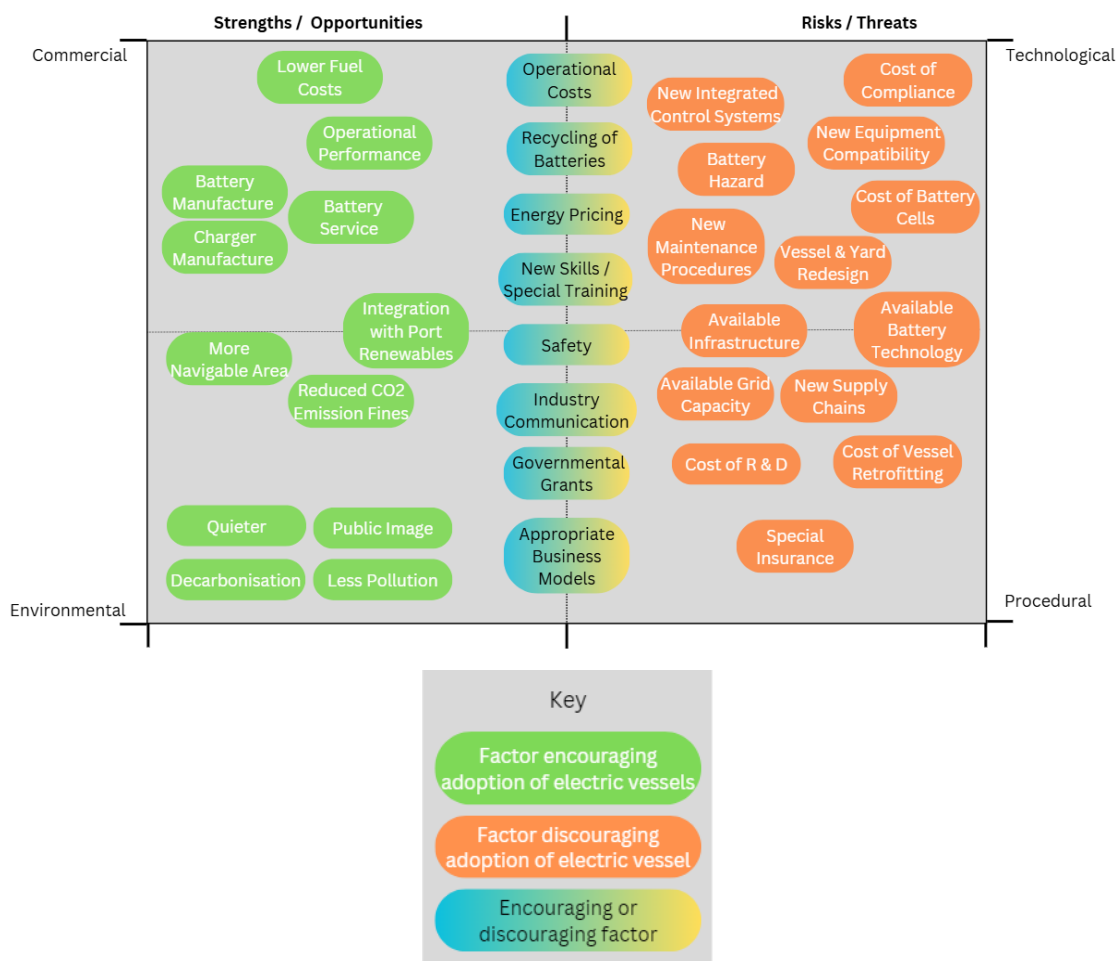


Figure 8. Key Parameters from Stakeholder Questionnaire Response Analysis

Further analysis, using normalisation techniques again, clustered the above parameters from the questionnaire into groups.

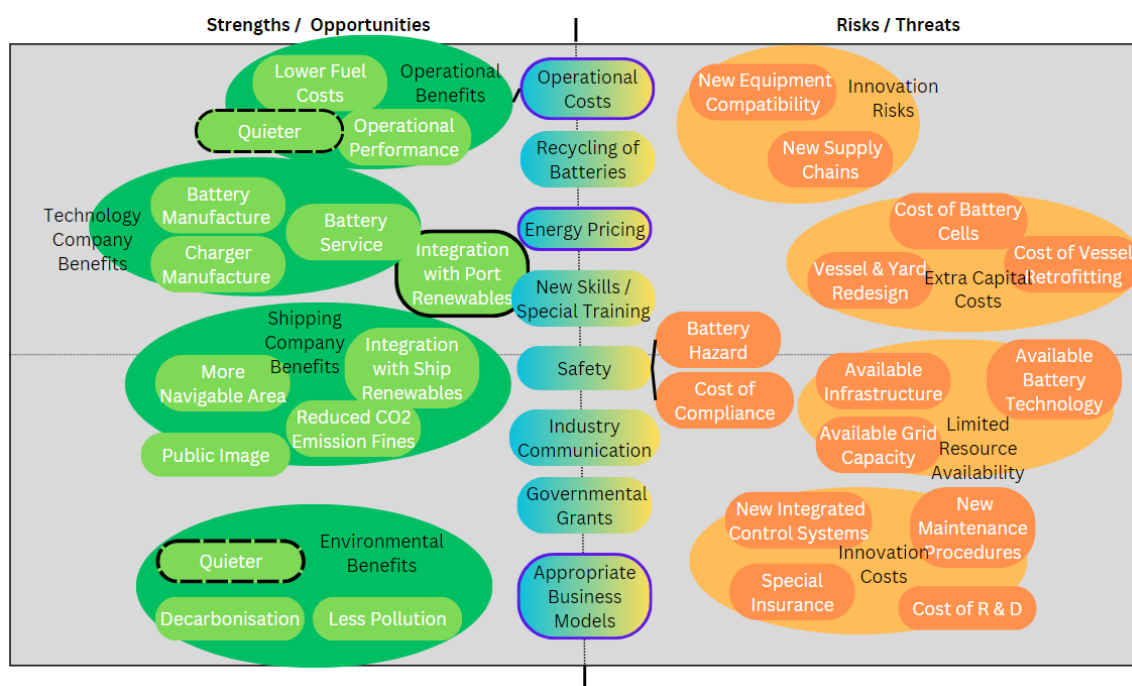


Figure 9. Key Parameter Clusters from Stakeholder Questionnaire Response Analysis

Below is an explanation of how factor groups, displayed in Figure 9 above, were created.

4.3.1.1. Encouraging Factor Groups

- Operational Benefits
 - Potential operational benefits for shipping companies include:
 - Lower fuel costs with less dependence on oil and gas supplies
 - Improved operational performance with direct drive from batteries
 - Quieter operation and other improvements to the working environment for employees
- Shipping Company Benefits
 - Some of the other benefits for shipping companies would be:
 - Access to marine areas, where combustion engine vessels are prohibited
 - Lower risk of fines for carbon emissions in the future

- Integration with renewable energy sources on vessels, such as wind and solar energy generation, to optimise energy management
- An improved public image
- Technology Company Benefits
 - Widespread adoption of electrification of vessels would generate opportunities for companies working on the relevant technologies, including:
 - Large-scale battery manufacturers
 - Vessel charger manufacturers
 - Battery servicing organisations
- Environmental Benefits
 - Environmental benefits of electrification of vessels would include:
 - Lower carbon / GHG emissions into the atmosphere.
 - Less risk of marine pollution from fossil fuels.
 - Quieter environment for the public and for wildlife.

4.3.1.2. Discouraging Factor Groups

- Extra Capital Costs
 - Vessel electrification could lead to extra capital costs compared to using conventional vessels, especially initially. Examples could be –
 - The cost of battery cells
 - The cost of redesigning vessels and the shipyards to build them
 - The cost of retrofitting in-service vessels to electrify them
- Innovation Costs
 - In introducing innovative marine technology, new supporting procedures, systems and processes will need to be developed and implemented, adding to overall costs. Stakeholders referred to the following expected areas of innovation costs:
 - Required research and development

- Integrated control systems.
 - FLEXSHIP Work Package 1 has identified required Flexible Management Systems, including for battery (BMS), energy (EMS), power (PMS) and transportation (TMS) [5].
- Revised maintenance procedures
- Special insurance for vessels modified for electrification
- Innovation Risks
 - As well as the anticipated innovation costs above, stakeholders identified further indirect costs from introducing new technology:
 - New suppliers need to be found and new supply chains established.
 - Electrification equipment may be incompatible with other marine equipment and tools. Inter-operability solutions will need to be found.
- Limited Resource Availability
 - Stakeholders are aware that if technical solutions are found for electric vessels, there remain questions about availability of the required resources.
 - Would the necessary infrastructure, such as chargers at ports, be available?
 - Would enough batteries of the required type be available?
 - With the other demands on them, would national power grids be able to provide capacity where marine vessels need it?

4.3.1.3. Mixed Factor Groups

As mentioned above, some factors stakeholders identified in the questionnaire responses have the potential to encourage vessel electrification or to discourage it. These were further normalised into six higher level groups,

- Business model, including potential operational costs and energy pricing
- Safety
- Industry community communication

- New skills and training
- Battery recycling
- Government grants and incentives

4.3.1.4. Mapping Process

In the process of analysing the stakeholders' responses other observations made by the author were that Noise could be considered as both an operational and environmental factor. Battery hazards and the cost of safety compliance was considered as part of Safety. Energy usage optimisation opportunities would be greater if ports' and vessels' capacity and renewable generation were considered together. This is possible where ports and vessels have common owners / operators.

4.3.2. SWOT Analysis

The normalised clusters of factors distilled from the Stakeholder Questionnaires (see Vessel Electrification Factors in [Figure 9](#) above) were assigned to SWOT Analysis categories. Encouraging Factors became Strengths. Discouraging Factors became Weaknesses and Mixed Factors each became an Opportunity and a Threat. See Figure 10 below for the representation of this analysis.

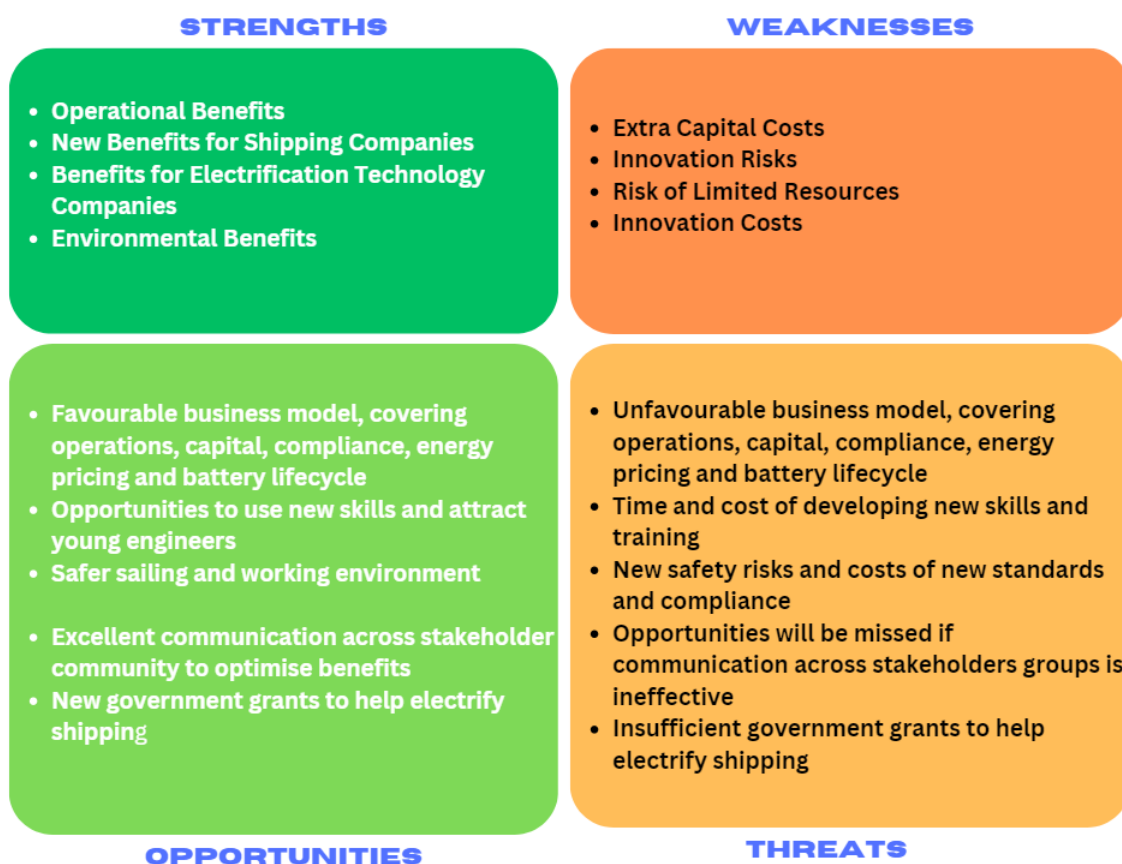


Figure 10. SWOT Analysis based on Stakeholder Questionnaire Response

Although views from any of the key Stakeholder Groups may be critical to the success of marine vessel electrification, it is established from other Stakeholder Group Analysis (see [Figure 7](#)), that for the FLEXSHIP Project business model the central perspective is that of Shipping Organisations.

In the questionnaires stakeholders identified many factors, which would need to be considered by shipping organisations in any economic decisions to move to electric vessels. Where factors could have quantifiable financial values, they should be included in the FLEXSHIP Business Model, which is a key deliverable of the project. Capital costs and Operational costs and benefits need to be covered in the model. They should include factors such as safety compliance and implementation of new supporting systems. The model could be used to calculate Net Present Value (NPV) and Internal Rate of Return (IRR).

Reduction in carbon emissions and GHGs is a key driver of the FLEXSHIP Projects and other projects in the European Union Waterborne Transport – Synergies Ecosystem (EUWT – SE) programme. In order to assess the environmental benefit of vessel

electrification, its potential impact on emissions must be calculated. This data could help governments understand the implications of any associated grants or incentives and thereby could also influence the business model.

In their responses to the questionnaire, stakeholders have revealed insight into how electrification will have a major on their systems, supply chain and their stakeholders. It is essential for the success of vessel electrification, that the many stakeholder groups involved work together achieve progress is this vital area.

4.3.3. Use Case Analysis from Questionnaire Responses

Answers given in the questionnaires expressed views on the suitability of different types of shipping for early electrification. Stakeholders felt the vessels which make shorter voyages and which return to home ports nightly are the use cases best suited for FLEXSHIP. (See Figure 11 below).

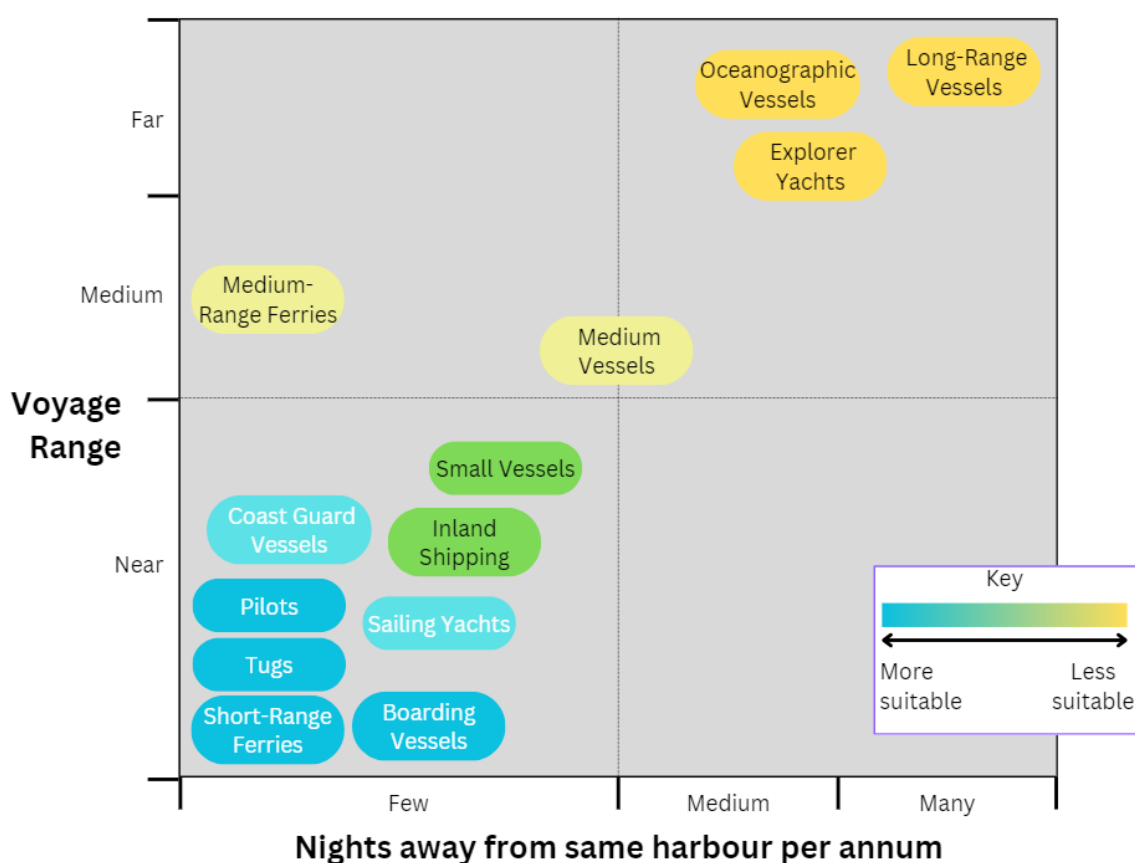


Figure 11. Use Case Mapping from Stakeholder Questionnaire Response Analysis

For FLEXSHIP use cases are effectively vessel types. In the questionnaire some stakeholders' views on vessel types suitable for electrification could be discerned.

Although long distance cargo ships are the type of vessel which emits the most GHGs [6], these were not considered to be the ideal use case for initial electrification. The costs and risks of starting with such types would be much higher. Although these types might be the longer-term target, other vessel types were considered more suitable for early electrification. At this stage even medium-sized vessels travelling medium distances would not be considered ideal candidates.

More suitable vessel types would be those which do not travel long distances and which return to the same berth or harbour every night. The vessel types identified which fit these criteria closest are Pilots, Tugs, Short-Range Ferries and Boarding Vessels.

Incidentally vessels such as Sailing Yachts, which have sustainable energy generation and which seldom stray far from their home harbour could be strong candidates for beneficial bi-directional charging. Bi-directional charging potentially optimises energy costs and could smooth demand on the grid. There are many innovations and considerations to realise vessel charging before bi-directional vessel charging needs to be considered further in the FLEXSHIP business model.

4.4. Stakeholder Workshop Results

4.4.1. Result Question 1 Priority Vessel Types for Accelerated Electrification

The initial survey question inquired: "Which are the general types of vessels that should undergo through the most urgent and accelerated re-electrification till 2040?".

This question was structured as a multiple-choice format, allowing respondents to select one or more options from the available alternatives.

The data derived from these responses (Figure 12) did not reveal a significant predominance among the various types of vessels, as illustrated in the figure, ranging from a minimum of 4% (attributed to Crude Oil Tankers) to a maximum of 18% (attributed to General Cargo Vessels and Pass/Car Ferries). This result is not as marked as other research, such as the Questionnaire results above and earlier FLEXSHIP use case analysis [5], maybe due to the question wording or the mix of attendees.

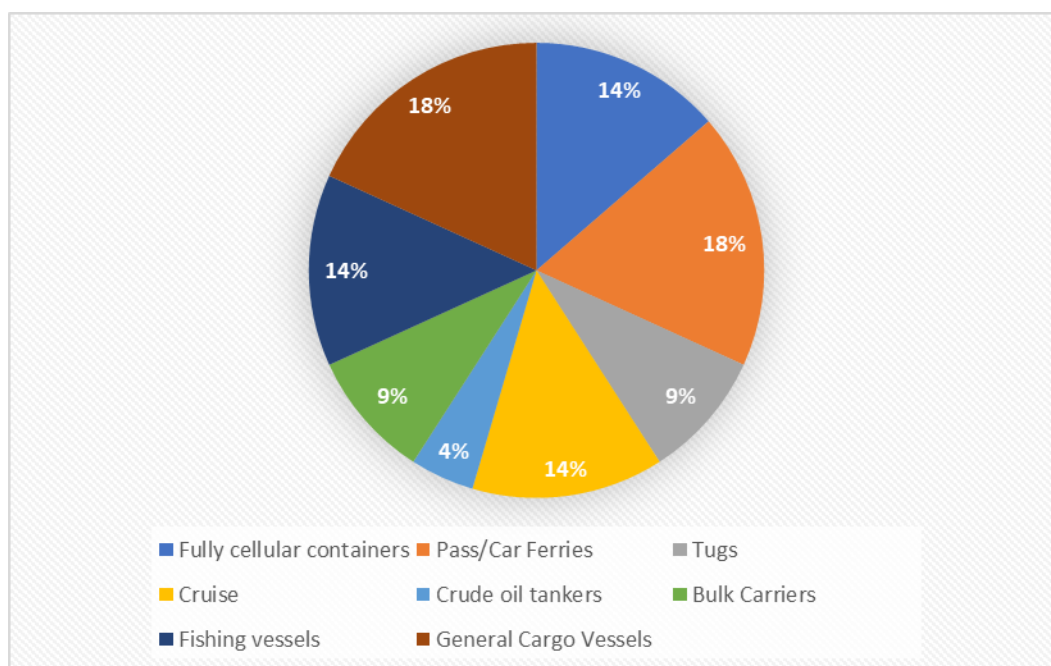


Figure 12. Workshop Poll Results - Q1. Priority Vessel Types for Accelerated Electrification

4.4.2. Result Question 2 Vessel Types Feasible for High Rates of Electrification and GHG Abatement

The second question inquired: "According to you, which are the type of vessels that would go through a higher realistic rate of electrification driven by feasibility and potential of GHG abatement? Select more than one type, if considered".

This question was structured as a multiple-choice format, allowing respondents to select one or more options from the available alternatives.

The data obtained from the responses (Figure 13) highlighted a greater presence for tugs, cruise and fishing vessels, each with a percentage of 21%, while the Fully Cellular Containers vessel type received a score of 0%. It's difficult to conclude too much from the answers to this question, as the vessel types which are feasible for electrification are probably different to the vessel types which offer greatest GHG emission abatement.

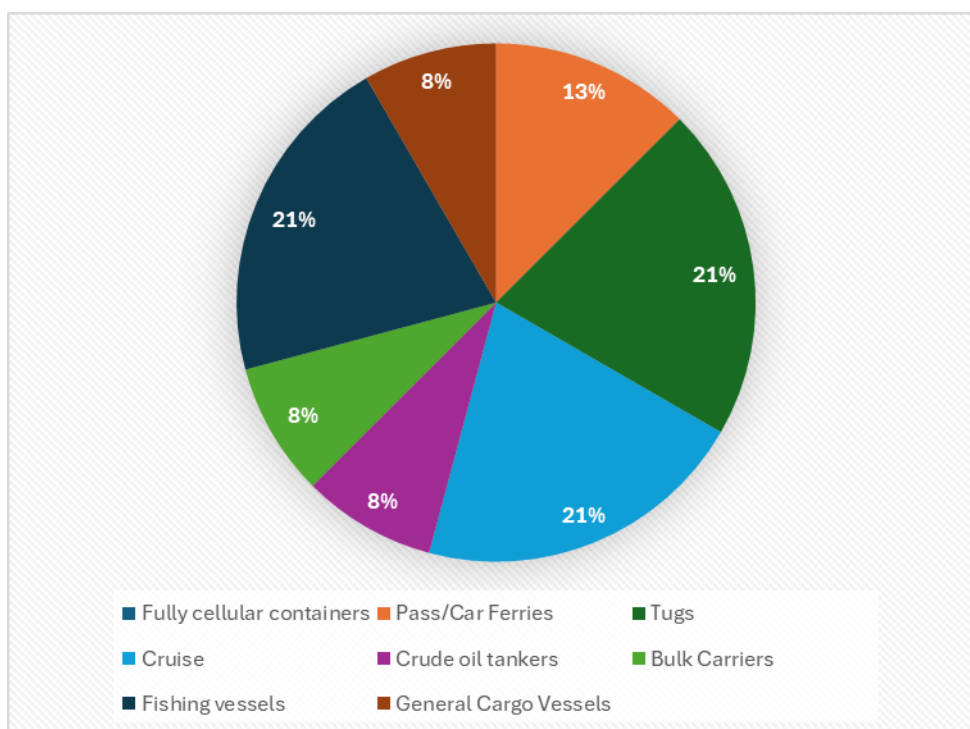


Figure 13. Workshop Poll Results - Q2. Vessel Types Feasible for High Rates of Electrification and GHG Abatement

4.4.3. Result question 3 Main Concerns Hindering the Widespread Adoption of Vessel Fleet Electrification

The third survey question posed was: "What are your current main concerns that are potentially hindering the widespread adoption of vessel fleet electrification?" This question was structured as an open-ended inquiry, thereby enabling respondents to provide detailed and nuanced responses that reflected their individual perspectives and expertise.

A summary of answers obtained is shown Table 9 below:

Table 8. Workshop Poll Results – Q3. Main Concerns Hindering the Widespread Adoption of Vessel Fleet Electrification

No.	Answer
1	Conversion cost to Electric
2	Batteries and charging facilities
3	Cost and lack of standards.
4	Jobs
5	Mostly technological barriers concerning the infrastructure set in ports for charging fully electric ships (i.e. cold ironing infrastructure) and the

	electricity distribution network condition. Plus, it is very important to strategically select ports to assign charging infrastructure to accommodate fully electric ships.
6	Fire safety (fire integration/insulation and Fire extinguishing system) regarding retrofitting and also new buildings, flag states different approach
7	System reliability and autonomy

The responses garnered have furnished a multifaceted understanding, encompassing a broad range of viewpoints from diverse sectors, of the challenges that are potentially impeding the widespread implementation of electrification across the naval fleet.

4.4.4. Result question 4 Key Technological Drivers

The fourth survey question posed was: "Which are the main technologically based key drivers that you expect to be into the market to boost a sustainable waterborne sector from 2030 onwards?" This question was structured as an open-ended inquiry, thereby enabling respondents to provide detailed and nuanced responses that reflected their individual perspectives and expertise.

A summary of the answers obtained is shown in Table 10 below:

Table 9. Workshop Poll Results – Q 4 Key Technological Drivers

No.	Answer
1	Proven and most widespread system
2	Tested and widespread systems
3	Maritime approved batteries; Efficient system integration.
4	Building a resilient infrastructure, promoting inclusive and sustainable industrialization and supporting innovation
5	Innovation in BES technologies to offer lighter battery solutions or new engines with higher energy efficiency. Plus, the newly established global market for carbon-neutral energy carriers will be important to ease availability of energy carriers and provide flexibility to the maritime sector.
6	founding of development of new technologies
7	DC protection device, Li-Ion SSB

These responses underscore the importance of technological advancements in driving the transition towards a sustainable waterborne sector. The emphasis on proven

systems, maritime-approved batteries, and efficient system integration reflects the need for reliable and efficient technologies to support the electrification of vessels. Additionally, the mention of innovation in BES technologies and the establishment of a global market for carbon-neutral energy carriers highlights the role of technological innovation in facilitating the widespread adoption of sustainable energy sources in the maritime sector.

4.4.5. Result question 5 Key Economic Drivers

The fifth survey question posed was: "Which are the key economically based key drivers that can financially support a successful vessel fleet modernization from 2030 onwards?" This question was structured as an open-ended inquiry, thereby enabling respondents to provide detailed and nuanced responses that reflected their individual perspectives and expertise.

A summary of the answers obtained is shown in Table 11 below:

Table 10. Workshop Poll Results – Q 5 Key Economic Drivers

No.	Answer
1	Targeted safety and environmental regulations with economic advantages for shipowners Who comply to them.
2	Economic benefits for ship-owners
3	Municipal and governmental support
4	The production of sustainable fuels would need to increase significantly to meet the growing demand.
5	GHG taxation, vessel renewal financial incentives (subsidization)from EU or national funding mechanisms
6	fee/duty relief for vessels with low emissions
7	Recharging infrastructure development, tax reduction for electrified vessels

These responses underscore the importance of economic incentives in driving the transition towards a sustainable waterborne sector. The emphasis on targeted regulations, economic benefits for shipowners, and governmental support reflects the need for a supportive policy environment to encourage the adoption of sustainable technologies. Additionally, the mention of sustainable fuel production, GHG taxation, and fee/duty relief for low-emission vessels highlights the role of economic instruments in promoting the modernization of vessel fleets.

5. CRITICAL RISKS

Table 11. Critical Risks

ID	WP/Task	Risk item	Effect	Proba- bility ¹	Severity ²	Counter measures	Risk owner
43	WP6	Task 6.1 Delay in updating the Contacts lists and Low stakeholder engagement that can lead to closely linked with other relevant projects and actions.	Moderate	Moderate	Moderate	Mitigation - More effort and more resourcefulness from partners needed going forward, to get more input from more Stakeholder Contacts from more Stakeholder Groups.	OTASKI

¹ Severity / Contribution to the failure of the project: Negligible, minor, serious, critical, catastrophic

² Probability of occurrence: improbable, remote probable, medium, probable, definite

6. CONCLUSIONS

The overall goal of FLEXSHIP is to develop and validate safe and reliable, flexible, modular, and scalable solutions for electrification of the waterborne sector. The 'Skills development, business models and stakeholders' work package helps by analysing stakeholders' helps by evaluating stakeholders' requirements for and expectations of safe, efficient, flexible and modular battery systems for ships.

Analysis of stakeholder groups gave initial structure to stakeholder analysis and prioritised the roles of different groups. The findings here were in line with use case analysis done earlier in the project.

The FLEXSHIP Stakeholder Questionnaire responses in early 2024 yielded much information about perceived opportunities and risks in electrification of marine fleets. Although the number of respondents was limited, the depth of the information indicated that key stakeholders have already given much consideration to the prospect of electrification of their vessels. The FLEXSHIP workshop conducted on March 21st, 2024 had a larger response and provided supporting, if less emphatic feedback. Participants emphasised the importance of proven systems, maritime-approved batteries, resilient infrastructure and innovation in battery energy storage technologies. Targeted regulations, financial incentives for shipowners and operators and governmental support were identified as crucial economic factors for successful vessel fleet modernisation post-2030.

All the stakeholder analysis pointed to use cases which may be the best candidates for early electrification, namely smaller vessels which travel limited distances and use the same port(s) repeatedly. As well as many opportunities from electrification, key stakeholders also pointed to many risks. These findings strengthen the value of research projects like FLEXSHIP to address arising concerns among stakeholder groups. In particular, work is required on a comprehensive business model, to help key stakeholder groups to embrace the electrification of shipping.

The findings and learnings from the initial stakeholder analysis make it clearer who the key stakeholders are. It is clearer that in the next phases of the project, it will be important to use a focussed Stakeholder Contact Group, aligning the project with the EU's most important stakeholders for the electrification of marine vessels (see [Appendix 2](#)).

7. REFERENCES

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- [7] Nikoleta Dozic, WEGEMT "FLEXSHIP: Flexible and modular large battery systems for safe on-board integration and operation of electric power, demonstrated in multiple type of ships." 2023 [Online] www.flexship-project.eu/wp-content/uploads/2024/01/D7.1-Dissemination-and-Communication-Roadmap.pdf

APPENDICES

Appendix 1 – WP6 Outline

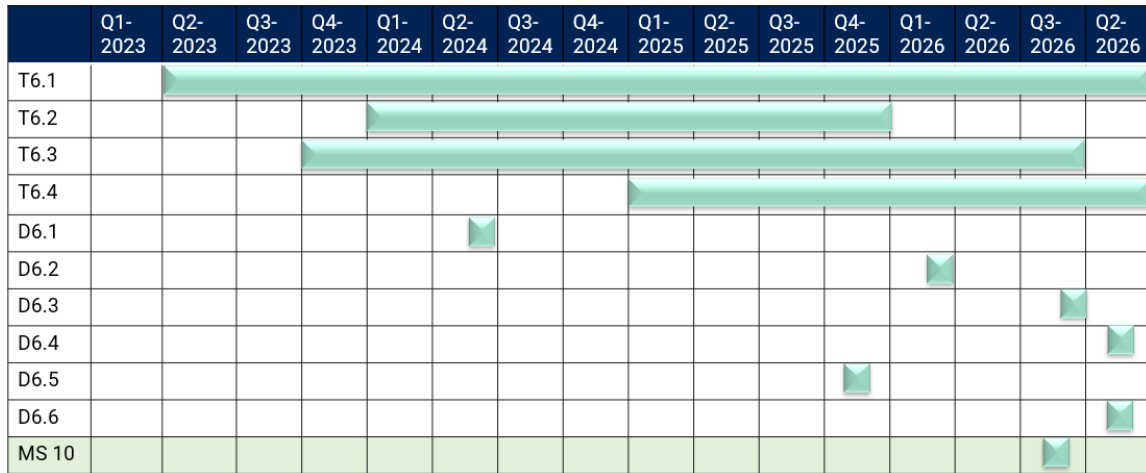


Figure 14. WP6 Timescale

Table 12. WP6 Project Elements

ID	Description
Task 6.1	Evaluating stakeholders' requirements and expectations, incorporating the technical feasibility
Task 6.2	Long-term skills needs and strategies for a green shipping value chain
Task 6.3	Development of business models for achieving 300nm by 2027, battery life cycle cost analysis, sustainability, social acceptance and environmental impact of vessel green transition and commercial strategies for technology transfer
Task 6.4	Development of business plan, commercial scalability, and economic strategy for operation for battery operated hybrid and full-electric ships
Deliverable 6.1	Report on Stakeholders' Engagement
Deliverable 6.2	FLEXSHIP Long-Term Skills Strategy
Deliverable 6.3	FLEXSHIP Scalability Plan
Deliverable 6.4	FLEXSHIP Business Plan
Deliverable 6.5	Report on Stakeholders' Engagement
Deliverable 6.6	Report on Stakeholders' Engagement M36
Milestone 10	Initial alignment and final validation of FLEXSHIP strategy by stakeholders

Appendix 2 – WP6 Focus

Future actions for FLEXSHIP stakeholder engagement,

Phase 2 (next 18 months), supporting sea trial design and manufacturing of solution

- Fuller alignment of internal (WP1) and external (WP6) stakeholder findings.
- High proportion of Stakeholder Contacts from key Stakeholder Groups in the Stakeholder Contact Group
- Close coordination between the Stakeholder team and the Communication Team
- Deeper analysis of current constraints for the stakeholders that prevent them adopting electrified marine technologies and factors for wide adoption of E-Vessels.

Phase 3, supporting testing, certification, integration and validation of solution and full business model.

- Showcase the potential of FLEXSHIP-related technology to key stakeholders.

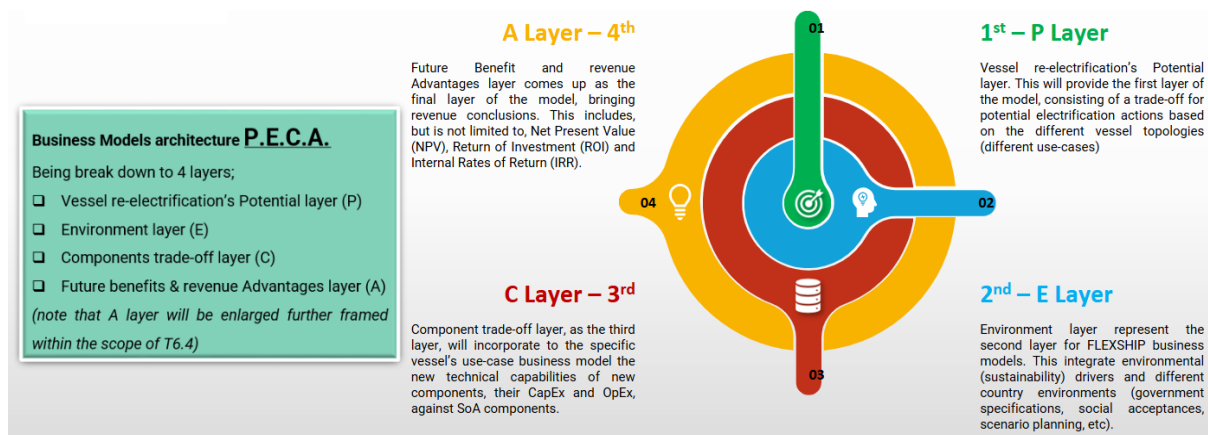


Figure 15. FLEXSHIP Business Architecture Model Approach

Appendix 3 – Questionnaire Analysis Sample

	Response Ship Owners	Response Ferry A	Response Ferry M
What value do you see in participating in the FlexShip project as a ship owner?	Be able to be updated and informed of the latest advances in technologies that allow me to decarbonize my fleet of ships		
How can the project benefit you in terms of cost savings, environmental impact, or convenience? Would you be able to quantify it?	The benefits are several, from the point of view of environmental impact it will allow us to meet the environmental objectives established for at least 2030.		
Are there any specific features or services offered by the FlexShip project that appeal to you as a ship owner?	The modular battery system, which could be adaptable to several ships in the fleet		
How do battery systems offer value in the context of ferry operations within the maritime and waterborne transport sectors? And for FlexShip project?		See below:	Many more possibilities of accessing the port, by achieving few emissions (ECA Zones). Possibility of obtaining cheaper energy (own electrical energy production plant) without having to buy them.
What specific benefits and advantages do batteries provide, such as reduced emissions, improved efficiency, or enhanced operational flexibility? Please name a few, highlighting from most to least importance.		* Reduced emissions: Ferries would contribute to the greenhouse gas emissions reduction running on electricity produced from renewable energy. * Fuel savings: reduction of costs as electricity production is normally cheaper than Fuel production, thus a lower operational cost would be enhanced. * Lower maintenance costs: Electric equipment usually has fewer moving parts. * Reduction of noise: Electric run vessels are less noisy than the equivalent run by fuel. This is important for the passenger/crew comfort and for transiting through noise sensitive areas. * More areas for navigation: greenhouse gas sensitive areas can now be covered by battery run ferries. * Financial benefits: benefits from governmental grants to promote electrification of sea transport. * Efficiency: Electric powered units are often More efficient than their Fuel run counterparts. * Public image: Society demands greener solutions.	Serious firefighting problems. Repair problems for shipyards. Special insurance for batteries. Special crew training.

Figure 16. Questionnaire Response Analysis Sample

Key for Figure 16

- Green text = Marine electrification opportunity
- Orange text = Marine electrification risk
- Orange text on green background = Neither or both opportunity and threat