

Zero waste Heat vessel towards relevant Energy savings also thanks to IT technologies



D6.6 | First ZHENIT Stakeholder feedback report

WP6 – Dissemination, communication and exploitation

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Clean and competitive solutions for all transport modes -
Innovative on-board energy saving solutions



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Table of Content

Executive Summary	7
1 Introduction	8
2 Methodology.....	9
2.1 Identification of the Target Stakeholders and Tool used	9
2.2 WPs involvement and Partners’ contribution	11
2.3 Methodology and Structure	11
2.3.1 Adsorption cooling and desalination.....	12
2.3.2 ORC-ejector heat pump.....	12
2.3.3 Thermal energy storage	13
2.3.4 Isobaric expansion engine	13
3 Communication & Dissemination strategy and actions.....	15
3.1 Stakeholder list and partners engagement	15
3.2 Social Media engagement.....	16
4 First results.....	18
4.1 Adsorption cooling and desalination	18
4.2 ORC-ejector heat pump	20
4.3 Thermal energy storage.....	21
4.4 Isobaric Expansion Engine.....	23
5 Conclusions	25

List of Figures

Figure 1 - ZHENIT Survey Introduction	10
Figure 2 - ZHENIT Stakeholder feedback survey post on LinkedIn.....	16
Figure 3 - ENGIMMONIA post on LinkedIn.....	17
Figure 4 - Results of the first section of the survey.....	19
Figure 5 - Results of the second section of the survey	21
Figure 6 - Results of the third section of the survey	23

Executive Summary

The ZHENIT project, now in its 26th month, presents the "D6.6 First ZHENIT Stakeholder feedback report" deliverable as part of Work Package 6, which is dedicated to the dissemination, exploitation, and communication of the project's results. This deliverable is a crucial milestone, offering a preliminary yet profound analysis of the stakeholder survey conducted under Task 6.1. Focused on pivotal topics such as adsorption cooling and desalination, ORC-ejector heat pump, thermal energy storage and isobaric expansion engine, the survey captures the current pulse of the maritime industry's stance on innovative and sustainable technologies.

The survey has gathered a rich tapestry of insights from a diverse group of stakeholders, including shipowners, ship builders, regulatory bodies, and other industry experts. These insights are invaluable in shaping the future course of the ZHENIT project, ensuring that its direction is congruent with real-world industry dynamics and expectations. Looking ahead, this document will undergo a significant update in Month 42 with the release of D6.10 "Final Dissemination activities report also reporting Final event, stakeholders and sisters project interaction". This upcoming report will not only reflect the culmination of the dissemination activities but will also detail the final event, comprehensive stakeholder interactions, and synergies with sister projects, providing a holistic view of the project's outreach and impact.

1 Introduction

Within the framework of Work Package 6 of the ZHENIT project, "D6.6 first ZHENIT Stakeholder feedback report" emerges as a pivotal document, aligning with Task 6.1's focus on robust stakeholder engagement. As we navigate through Month 26 of the project, this deliverable offers an initial analysis of the feedback received from various maritime industry stakeholders. This analysis is instrumental in laying the groundwork for an informed and strategic approach towards the project's objectives.

This deliverable is a dynamic document, set to evolve with the project's progression. It will be updated in Month 42 with the "Final Dissemination activities report also reporting Final event, stakeholders and sisters project interaction" which will provide a comprehensive overview of the project's dissemination journey, encompassing the final event and extensive stakeholder and sister project interactions.

2 Methodology

In developing the ZHENIT project, a systematic approach was employed to gather stakeholder feedback, which was crucial for guiding the project's design activities. The methodology centred around a comprehensive online survey hosted on Microsoft Forms, chosen for its user-friendly interface and robust data collection capabilities. Target stakeholders were meticulously identified, focusing on key groups such as Shipowners, Shipbuilders, Regulatory Bodies, and Port Authorities due to their significant roles in the maritime industry and direct impact on the project outcomes. The survey covered four key areas: adsorption cooling and desalination, ORC-ejector heat pump, thermal energy storage, and isobaric expansion engine. Each topic was addressed through a series of thoughtfully crafted questions using a Likert scale, which enabled a detailed measurement of stakeholder opinions. In addition to the Likert scale questions, the survey included a few yes-or-no questions and open-ended questions to capture a broader range of responses and insights. Partners involved in various WPs collaborated to ensure a well-rounded questionnaire, each contributing specialized questions related to their respective areas of expertise. This collaborative effort ensured that the survey comprehensively covered all critical aspects of the project, facilitating a deep understanding of stakeholder perspectives and expectations.

2.1 Identification of the Target Stakeholders and Tool used

The stakeholder consultation for Deliverable 6.6 is strategically conducted through an online survey implemented on Microsoft Forms (Figure 1). This platform has been selected for its accessibility, intuitive interface, and sophisticated data analysis features, facilitating the efficient collection and interpretation of stakeholder feedback.

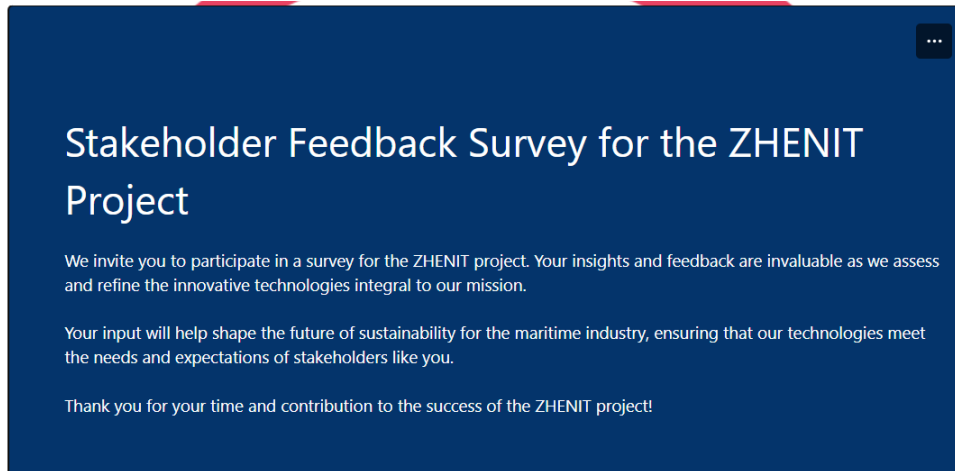


Figure 1 - ZHENIT Survey Introduction

The survey is available at the following [link](#).

The identification of stakeholders was a comprehensive process, guided by insights from the consortium partners and findings from Task 6.1 activities. We compiled a list of relevant stakeholders, ensuring a diverse representation from various sectors of the maritime industry. This list included but was not limited to:

- **Shipowners:** Their insights are crucial for understanding operational impacts of our project on the maritime industry.
- **Shipbuilders:** They provide a perspective on the practicalities of incorporating new technologies in vessel design and construction.
- **Regulatory Bodies:** Their involvement is key in understanding the regulatory landscape and ensuring compliance with industry standards.
- **Port Authorities:** They offer insights into the infrastructural challenges and opportunities in port operations.

In addition to these groups, our stakeholder range also encompassed researchers, equipment manufactures, designers, and service companies, each providing unique insights into different aspects of the maritime industry. This multi-faceted approach in stakeholder identification and engagement was pivotal for capturing a wide range of perspectives, thereby enriching the ZHENIT project's development and ensuring its alignment with industry needs and challenges.

2.2 WPs involvement and Partners' contribution

The structure of the ZHENIT project survey has been developed in close collaboration with various partners involved in different Work Packages (WPs), each contributing their unique expertise and insights.

Each WP contributed their expertise in specific areas of the project, ensuring that the survey comprehensively addressed the diverse aspects of maritime decarbonization from technological innovations to legislative and non-technical challenges. By involving multiple WPs, the survey was enriched with diverse, specialized questions, reflecting the multifaceted nature of the ZHENIT project.

2.3 Methodology and Structure

The survey extensively utilizes the Likert scale format, where respondents express their level of agreement or disagreement with statements. The questionnaire is composed by statements that the respondent is asked to evaluate by giving it a quantitative value following the format of a typical five-level Likert item:

- Strongly disagree
- Disagree
- Neither agree nor disagree
- Agree
- Strongly agree

This format is chosen for its effectiveness in quantifying subjective opinions and attitudes, making it easier to analyse and interpret data. Moreover, for some specific questions has been decided to utilise multiple choice questions.

The survey begins by collecting basic information about the respondents, precisely the role in the maritime industry. The survey allowed four types of answers:

- Shipowner
- Shipbuilder
- Regulatory bodies
- Port authorities

- Other (open answer)

This information is vital to contextualize responses and understand the perspectives of different stakeholder groups.

After a brief introduction to the survey and the initial section to collect information about the respondents, the survey dives into specific technologies, seeking stakeholder feedback on various aspects of their implementation. It has been divided into 4 sections correspondent to the topics on which the project works:

- 1) Adsorption cooling and desalination
- 2) ORC-ejector heat pump
- 3) Thermal energy storage
- 4) Isobaric expansion engine

The following subparagraphs will dive into the five topics with an overview of each question

2.3.1 Adsorption cooling and desalination

We have created four questions posed according to the Likert scale format:

- 1) *“The possibility of exploiting waste heat to produce cooling and fresh water on board is attractive”*
- 2) *“The adsorption cooling and freshwater production could be beneficial especially in cruise ships”*
- 3) *“The validation of this technology, even in small scale, on board of a real vessel is important to demonstrate its technical feasibility”*
- 4) *“If this technology will demonstrate techno-economic performance comparable to standard vapor compression unit, I would consider it for future installation on board”*

2.3.2 ORC-ejector heat pump

We have created six questions posed according to the Likert scale format:

- 1) *“The possibility of exploiting waste heat to produce electricity is attractive”*
- 2) *“The electricity production could be beneficial especially in cruise ships”*
- 3) *“Using waste heat for electricity production seems more attractive than using it for cooling production”*
- 4) *“Using waste heat for cooling production seems more attractive than using it for electricity production”*

- 5) *"The validation of this technology, even on a small scale, on board a real vessel is important to demonstrate its technical feasibility"*
- 6) *"If this technology will demonstrate techno-economic performance, I would consider it for future installation on board"*

2.3.3 Thermal energy storage

We have created six questions posed according to the Likert scale format:

- 1) *"The possibility of storing waste heat to reduce fuel consumption is attractive"*
- 2) *"The stored thermal energy could be beneficial for ships with intermittent demand of heating & cooling"*
- 3) *"Using thermal energy storage seems particularly attractive for provision heat at ~50-150 degC"*
- 4) *"Thermal energy storage enables to extend the operating hours of other waste heat conversion technologies"*
- 5) *"Compact thermal energy storage, using phase change materials, is more attractive for on-board applications due to reduced footprint"*
- 6) *"Scale up demonstration of thermo-economic performance and full-scale installation on board are essential"*

2.3.4 Isobaric expansion engine

We have developed 8 questions: one is an open-ended question, while the other seven are multiple-choice questions:

- 1) *"What are the temperature levels of your waste heat on board?" – Open answer*
- 2) *"Does your vessel operation have compression needs on board?"*
 - a. Yes
 - b. No
- 3) *"Is the energy demand from compression process on board significant in your daily operation?"*
 - a. Yes
 - b. No
- 4) *"Is the energy demand intermittent or with prolonged compression running hours?"*
 - a. Intermittent
 - b. With prolonged compression running hours
- 5) *"Is the energy demand from pumping process on board significant in your daily operation?"*
 - a. Yes
 - b. No
- 6) *"Is the energy demand from pumping process on board intermittent or with prolonged pumping running hours?"*

- a. *Intermittent*
 - b. *With prolonged pumping running hours*
- 7) *“Is your waste heat availability very intermittent?”*
 - a. *Yes*
 - b. *No*
- 8) *“Does your waste heat availability combine periods of constant load with intermittent load?”*
 - a. *Yes*
 - b. *No*

3 Communication & Dissemination strategy and actions

In alignment with Task 6.1 of the ZHENIT project, this section of D6.6 is dedicated to detailing the comprehensive communication strategy employed for the effective dissemination of our stakeholder consultation survey. The strategy encompasses a series of coordinated efforts, leveraging various communication channels and platforms to ensure widespread awareness and participation in the stakeholder consultation process.

The objective was to create an inclusive and interactive dialogue with stakeholders, encompassing shipowners, shipbuilders, regulatory bodies, port authorities, and other key figures in the maritime sector. By doing so, we aimed to gather rich, diverse insights and foster a collaborative environment where stakeholders feel valued and heard. This section outlines the strategic steps taken to compile a comprehensive stakeholder list and the execution of a multiplatform social media campaign, all of which were integral to the success of the stakeholder engagement in Task 6.1.

In the following subsections, we will explore each aspect of this communication strategy in detail, highlighting how they collectively contributed to achieving the objectives set forth in Task 6.1 of the ZHENIT project.

3.1 Stakeholder list and partners engagement

The process of compiling the stakeholder list has been a collaborative and structured endeavour. We developed a detailed Excel file, categorizing potential stakeholders into 4 key groups: Shipowners, Shipbuilders, Regulatory Bodies, and Port Authorities. This categorization has been aligned with the diverse interests and influences within the maritime industry, ensuring that all relevant perspectives were included.

Moreover, partners' involvement has been prominent in the initial phases of outreach. In crafting our approach for stakeholder engagement, we embraced a highly collaborative method. Upon finalizing this list, we included the survey into the July's project newsletter. This communication was designed to effectively disseminate the survey link directly to each identified contact. Emphasizing accessibility and inclusivity, the stakeholder consultation was made available through an open link. We encouraged each stakeholder to further share the survey within their networks. This strategy aimed to amplify our reach, leveraging the interconnected nature of the maritime industry to gather a breadth of perspectives and insights.

3.2 Social Media engagement

The dissemination of the ZHENIT stakeholder survey was strategically amplified through an extensive social media campaign, leveraging both the project's and partners' channels. The campaign was designed to maximize the survey's visibility and encourage widespread participation from a diverse range of stakeholders. The survey was actively promoted on ZHENIT's official social media pages, specifically on LinkedIn and X (Figure 2). More emphasis has been made on LinkedIn for its nature and scope. This platform has been chosen for its wide reach and popularity among professionals: by using this platform, we aimed to tap into a network of industry experts, researchers, and practitioners who are active on social media.



Figure 2 - ZHENIT Stakeholder feedback survey post on LinkedIn

In addition to our own channels, we ask to all consortium partners to repost the survey on their personal LinkedIn pages. This approach was instrumental in extending our reach beyond the ZHENIT network, tapping into the individual networks of each partner. Partners' reposts served to endorse the survey, adding credibility and a personal touch, which likely encouraged higher engagement rates.

Our promotional strategy also included collaboration with sister projects, particularly ENGIMMONIA project, which shared the survey on its LinkedIn page (Figure 3). This collaboration allowed us to reach stakeholders who are involved in similar projects and have an interest in maritime decarbonization, thereby enriching the diversity of our respondents.

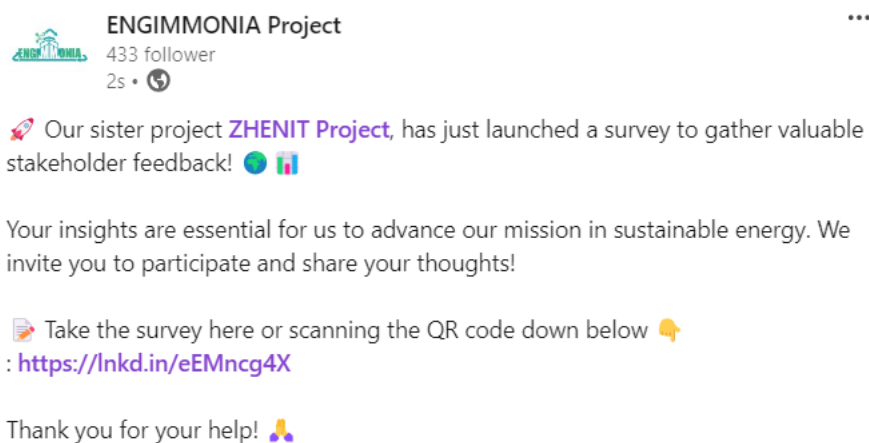


Figure 3 - ENGIMMONIA post on LinkedIn

To maintain momentum, the survey was posted multiple times across these platforms. Each post was strategically timed to optimize visibility and engagement. The repetitive posting helped in keeping the survey in the public eye over an extended period, increasing the likelihood of it being seen and completed by a broad audience. Additionally, we tagged the official LinkedIn profile of CINEA - European Climate, Infrastructure, and Environment Executive Agency when sharing the survey. This was done to achieve broader coverage and increase the visibility of the post, thereby encouraging more responses to the survey.

4 First results

The ZHENIT stakeholder survey attracted a diverse range of participants, highlighting the sector's multifaceted interest in sustainable technological advancements. Among the respondents, 18% were shipowners, 18% were shipbuilders, 18% represented regulatory bodies and port authorities, and 45% comprised various other stakeholders, including equipment manufacturer, designers, supplier of enamels and paints and service companies.

Despite significant efforts in promoting the release of the ZHENIT project's survey on social media and repeatedly requesting partners to share it with potential stakeholders, only 11 responses have been received so far. However, it should be noted that the survey is intended to remain active over time, and the communication strategy will continue to be pursued to increase responses. The final deliverable D6.10 "Final Dissemination activities report also reporting Final event, stakeholders and sisters project interaction", will aim to provide a more comprehensive and in-depth analysis of stakeholder feedback on the ZHENIT project technologies, offering important insights.

In the following sections, we will delve into the survey data, categorized into 4 key areas. Each category offers a unique lens through which to view the industry's readiness and attitudes towards sustainable practices and technologies.

4.1 Adsorption cooling and desalination

The analysis of the survey data on adsorption cooling and desalination technologies indicates a highly favorable attitude among respondents, with several key insights emerging. Firstly, the idea of exploiting waste heat for producing cooling and fresh water on board is seen as attractive among respondents, with 63.3% of respondents agreeing and 36.4% strongly agreeing. This suggests a strong consensus on the value of utilizing otherwise wasted thermal energy for dual purposes, which could enhance both environmental sustainability and operational efficiency.

When considering the specific application of this technology on cruise ships, the responses are more mixed, yet still positive overall. A combined 63.7% of respondents (36.4% agreeing and 27.3% strongly agreeing) recognize the potential benefits, though 27.3% neither agree nor disagree and 9.1% disagree. This distribution implies that while the majority see clear advantages, there is a significant portion of respondents who are either uncertain or skeptical, possibly due to concerns about the practical implementation or specific operational challenges in the cruise ship context.

The importance of validating adsorption cooling and desalination technology on a real vessel, even at a small scale, is highly endorsed. An equal split of 63.6% agreeing and 36.4% strongly agreeing reflects a near-universal acknowledgment of the need for empirical evidence to demonstrate technical feasibility. This strong support highlights the industry's preference for tested and proven technologies before large-scale adoption, emphasizing the importance of pilot projects and real-world trials.

Regarding the future consideration of this technology, if it demonstrates techno-economic performance comparable to standard vapor compression units, the responses are notably optimistic. A significant 54.5% agree and 36.4% strongly agree that they would consider it for future installation on board, while only 9.1% neither agree nor disagree. This indicates a high level of confidence in the potential of adsorption cooling and desalination technologies to meet or exceed current standards, provided they can deliver on both technical and economic fronts. The minimal neutrality suggests that most respondents have already formed a strong opinion on the matter, favoring innovation and improvement in maritime technology.

In summary, the data reveals a strong endorsement for the concept of using waste heat for cooling and desalination, particularly if validated in real-world settings and proven to be competitive with existing technologies. The positive responses highlight a readiness within the industry to embrace new, efficient, and sustainable solutions, with particular enthusiasm for technologies that offer dual benefits and align with environmental goals.

2. Please rate each statement using the following scale:

[More Details](#)

■ Strongly disagree
 ■ Disagree
 ■ Neither agree nor disagree
 ■ Agree
 ■ Strongly agree

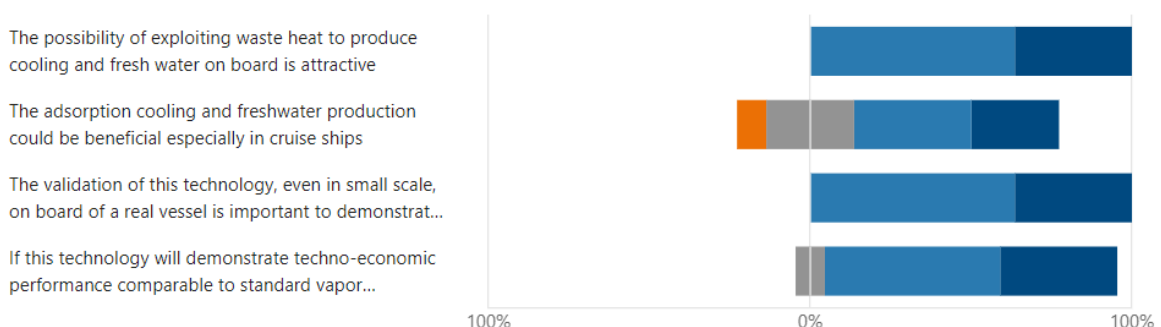


Figure 4 - Results of the first section of the survey

4.2 ORC-ejector heat pump

The survey data on the ORC-ejector heat pump technology reveals a broadly favorable perspective, with nuanced insights into its potential applications and comparative advantages. Respondents show a strong enthusiasm for the concept of using waste heat to produce electricity. Specifically, 54.5% strongly agree and 36.4% agree that this application is attractive, indicating a clear recognition of the value in converting waste heat into electrical power. This sentiment reflects an understanding of the potential benefits such as improved energy efficiency and reduced waste.

When it comes to the potential benefits of electricity production on cruise ships, opinions are more mixed. While 36.4% of respondents agree and another 36.4% strongly agree that this technology could be advantageous for cruise ships, there is notable dissent with 18.2% disagreeing and 9.1% remaining neutral. This variance suggests that while there is significant support for the technology's benefits in maritime applications, there are also concerns or uncertainties regarding its specific implementation and impact in the cruise ship context.

Comparing the attractiveness of using waste heat for electricity production versus cooling, the responses highlight a lack of strong consensus. A substantial 45.5% strongly agree that electricity production is more attractive, while 54.5% neither agree nor disagree, indicating a divided view on which application might be preferable. Conversely, when evaluating the attractiveness of using waste heat for cooling production, 45.5% agree that it is more appealing than electricity production, while 45.5% remain neutral, and only 9.1% disagree. This balanced distribution suggests that the preference between cooling and electricity generation may depend heavily on specific operational requirements and contexts.

The importance of validating this technology through real-world trials on board vessels is overwhelmingly supported, with 90.9% agreeing and 9.1% strongly agreeing on its necessity. This indicates a strong consensus on the need for empirical testing to demonstrate the technology's technical feasibility and operational reliability, emphasizing the industry's preference for validated and proven solutions before widespread adoption.

Looking ahead, there is a clear inclination towards considering the ORC-ejector heat pump technology for future installations if it demonstrates satisfactory techno-economic performance. A combined 63.6% agree and 36.4% strongly agree that they would consider its adoption, provided it meets the expected performance and cost-effectiveness standards. This positive outlook reflects an openness to integrating innovative technologies that offer both efficiency and economic benefits, signaling a readiness within

the industry to embrace advancements that align with performance benchmarks and financial feasibility.

3. Please rate each statement using the following scale:

[More Details](#)

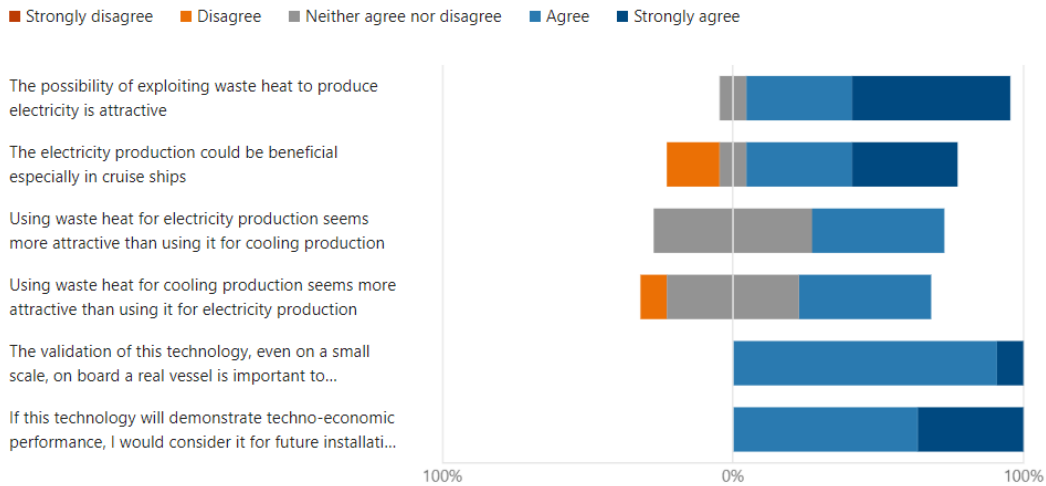


Figure 5 - Results of the second section of the survey

4.3 Thermal energy storage

The survey data on thermal energy storage reflects a generally favorable view of its potential benefits and applications, although there are varying degrees of enthusiasm and some areas of uncertainty. The concept of storing waste heat to reduce fuel consumption is seen as attractive by a substantial majority, with 54.5% agreeing and 18.2% strongly agreeing. This indicates a solid recognition of the potential cost and efficiency benefits of utilizing stored thermal energy to minimize fuel use, despite 9.1% disagreeing and 18.2% remaining neutral on the matter.

The application of stored thermal energy for ships with intermittent heating and cooling demands is also viewed positively, with 63.6% agreeing and 9.1% strongly agreeing on its benefits. However, 27.3% of respondents are neutral, suggesting some uncertainty about how effectively this technology might address fluctuating energy needs in maritime settings.

When evaluating the attractiveness of thermal energy storage for providing heat at temperatures around 50-150 degrees Celsius, responses are more divided. While 45.5% agree that it is an appealing

option, an equal percentage (45.5%) are neutral, and 9.1% disagree. This distribution highlights that while there is interest in this application, there is also a significant portion of respondents who remain unsure about its advantages in this specific temperature range.

The ability of thermal energy storage to extend the operating hours of other waste heat conversion technologies is seen as beneficial by a majority, with 63.6% agreeing and 9.1% strongly agreeing. This shows recognition of the value in enhancing the operational flexibility and efficiency of waste heat systems. Nonetheless, 18.2% are neutral, and 9.1% disagree, indicating some varying opinions on the practical impact of this capability.

Compact thermal energy storage systems, particularly those utilizing phase change materials, are considered more attractive for onboard applications due to their reduced footprint. A significant 63.6% agree and 18.2% strongly agree, suggesting a strong preference for solutions that conserve space in the constrained environments of maritime vessels. Despite this, 9.1% disagree and another 9.1% remain neutral, which points to some differing views on the importance of compactness in thermal storage solutions.

Finally, the necessity of scaling up demonstrations of thermo-economic performance and implementing full-scale installations on board is widely acknowledged. With 72.7% agreeing and 18.2% strongly agreeing, there is clear support for the need to validate the technology's performance and feasibility in real-world conditions. Only 9.1% remain neutral, reflecting a general consensus on the importance of thorough testing and practical application before broader adoption.

Overall, the data indicates a positive outlook on thermal energy storage, with particular emphasis on its potential to enhance fuel efficiency, support intermittent energy needs, and benefit from compact designs. However, there is also recognition of the need for further validation and demonstration to fully establish its viability in practical maritime applications.

4. Please rate each statement using the following scale:

[More Details](#)

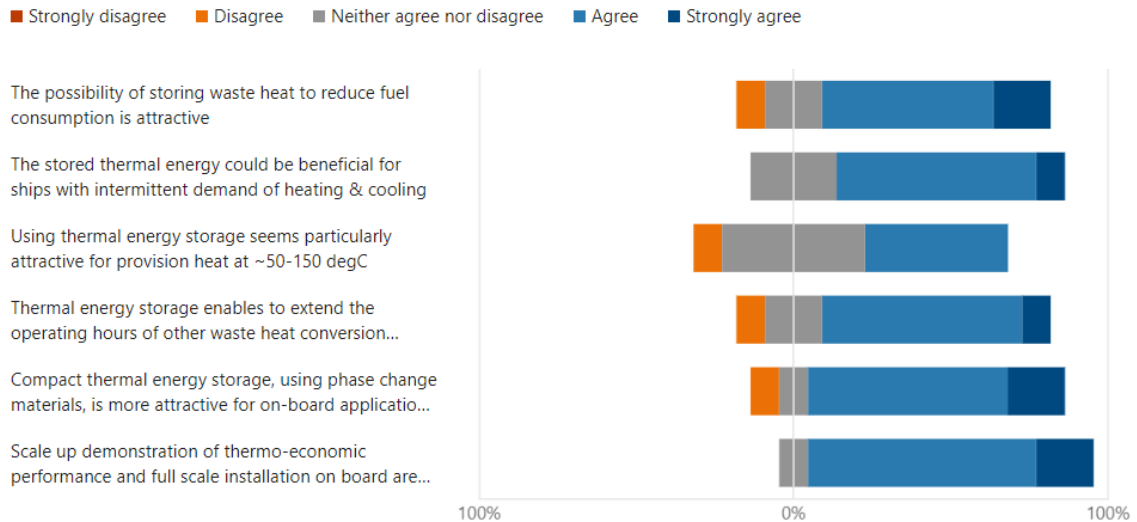


Figure 6 - Results of the third section of the survey

4.4 Isobaric Expansion Engine

The survey data on the Isobaric Expansion Engine reveals a complex and varied landscape of onboard waste heat management and energy requirements. The reported temperature levels of waste heat range widely, from as low as 60°C to as high as 600°C, with several intermediate values like 75-85°C and 400°C. This diversity in temperature levels suggests that different vessels operate under a broad range of thermal conditions, which could significantly influence the effectiveness and suitability of the Isobaric Expansion Engine for different applications. The presence of extreme temperatures, such as 600°C, indicates that some vessels may generate very high-temperature waste heat, which could be particularly relevant for high-efficiency thermal systems.

In terms of compression needs, there is a noticeable split among respondents: 4 vessels require compression, while 7 do not. This distinction points to a disparity in operational requirements across different types of vessels. Furthermore, when asked about the significance of energy demand from the compression process, 9 respondents reported it as not significant, contrasting with only 2 who indicated that it is a major factor in their daily operations. This discrepancy highlights that for the majority of

vessels, compression energy demands are relatively minor, potentially reducing the immediate need for advanced compression technologies.

The nature of compression energy demand shows some variation. Among those with compression needs, 7 vessels experience intermittent demand, while 4 face prolonged compression running hours. This split suggests that while some operations require consistent compression over extended periods, others only have sporadic needs, which could affect how energy solutions are designed and managed onboard.

Regarding the pumping process, 5 respondents indicate that the energy demand is significant, whereas 6 find it to be of little importance. This distinction underscores that energy requirements for pumping can vary, influencing the overall energy management strategy. When it comes to the nature of pumping energy demand, 4 vessels report intermittent needs, while 7 experience prolonged running hours. This distribution highlights the need for solutions that can handle both sporadic and continuous energy demands efficiently.

Waste heat availability also varies significantly among respondents. While 3 vessels report that their waste heat availability is very intermittent, 8 indicate that it is not. Additionally, a majority of 7 vessels experience a combination of periods with constant load and intermittent load, as opposed to 4 vessels that do not. This variability in waste heat availability suggests that solutions must be adaptable to handle both stable and fluctuating thermal inputs effectively.

Overall, the survey data illustrates a diverse set of conditions and needs related to waste heat management and energy demands. The significant variation in waste heat temperatures, compression and pumping energy demands, and the nature of heat availability underscores the necessity for customized and flexible energy solutions that can accommodate the wide range of operational scenarios encountered in maritime environments.

5 Conclusions

As the ZHENIT project progresses into its 26th month, the "D6.6 First ZHENIT Stakeholder Feedback Report" reflects the project's dedication to understanding and aligning with the maritime industry's needs. This initial survey offers valuable insights into the industry's readiness for technological innovation and prevailing attitudes towards sustainable maritime practices. These findings are instrumental in guiding the project's future course, ensuring it aligns with stakeholder expectations and addresses relevant challenges and opportunities.

Despite the current responses being limited, efforts to disseminate the survey will continue to increase participation. By Month 42, the D6.10 "Final Dissemination activities report also reporting Final event, stakeholders and sisters project interaction" which will also include details on the final event, stakeholder interactions, and collaborations with sister projects, will provide a more comprehensive and representative overview. This final report will incorporate an expanded set of survey results, offering a richer and more detailed understanding of stakeholder feedback on ZHENIT's technologies and demonstrating the project's impact within the maritime industry.



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