

CASE STUDY IDENTIFICATION SHEET

This document has been developed as part of the activities under Task 3.2 of the “GREENPORT Alliances” project, for which MAR.TE. S.c.ar.l. serves as the responsible entity. Task 3.2 focuses on identifying and analysing case studies that exemplify best practices for behavioural change among operators aimed at reducing the environmental impact of port operations.

The primary objective of this activity is to collect, document, and analyse concrete examples of technological, managerial, or behavioural innovation that have proven effective in contributing to the environmental, economic, and social sustainability of the port services sector. Through a structured selection and evaluation process, the document highlights the specific features of each case study and assesses their performance against key environmental and economic impact indicators.

The information gathered will be integrated into the overall framework of the GREENPORT Alliances project to promote the dissemination of sustainable solutions and the development of curricula for: a. higher education students (future personnel); b. current professionals (professional training); c. educators (train-the-trainer courses).

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1. GENERAL INFORMATION

A. Case study title

Implementing a Training Program for Sustainable Navigation in the Port of Aveiro: Promoting Slow Steaming for Environmental and Economic Benefits

B. Green practice implemented

1. Practice 3: Behavioural change through training and awareness

Description: A proposal for training programs to promote behavioural change by raising awareness among operators about the environmental impact of their actions. These programs include ongoing training, visual reminders, and incentives to adopt sustainable behaviours.

C. Specific goals

The primary objective of this case study is to demonstrate how a change in the behaviour of skippers operating pilot boats and tugs in the Port of Aveiro can lead to fuel consumption savings and a consequent reduction in CO_{2eq} emissions. To achieve this, a structured training and awareness program will be implemented, encouraging port pilots to adopt more sustainable navigation practices, particularly slow steaming. The initiative focuses on educating skippers about the environmental and economic benefits of reducing vessel speed, including fuel savings, lower greenhouse gas (GHG) emissions, and a reduced carbon footprint, through these specific targets:

- Develop and implement a structured training and awareness program for skippers of pilot boats and tugs.
- Encourage behavioural changes towards more sustainable navigation practices.
- Promote the adoption of slow steaming as a key for fuel efficiency strategy.
- Quantify the impact of reduced vessel speed on fuel consumption and CO_{2eq} emissions.
- Enhance awareness of the economic and environmental benefits of fuel-efficient navigation.

D. Direct impact of the practice

The implementation of a structured training and awareness program for skippers of pilot boats, tugs, and harbour pilots in the Port of Aveiro has a direct impact on multiple key areas. The initiative, integrated into the WP5 piloting phase of the GREENPORT project, aims to enhance energy-efficient navigation through behavioural change, particularly promoting slow steaming. By reducing vessel speed, fuel consumption decreases significantly, leading to lower CO₂ and greenhouse gas emissions, directly contributing to maritime decarbonization. This transition not only results in economic benefits for shipping operators through cost savings but also reduces dependency on fossil fuels. In addition, the training will promote greater awareness of sustainable shipping practices among maritime personnel, ensuring compliance with environmental regulations and reinforcing the Port of Aveiro's commitment to sustainability. The long-term goal is to cultivate a culture of environmental responsibility within the port services sector, while supporting international sustainability objectives, as reflected in the following key results:

- Reduction in CO₂ and other greenhouse gas emissions through energy-efficient navigation practices.

- Lower fuel consumption, leading to cost savings for shipping operators and increased economic sustainability.
- Enhanced air quality in the port area due to reduced emissions, benefiting both the environment and public health.
- Improved compliance with environmental regulations and international sustainability goals.
- Raise awareness of sustainable maritime practices among pilots, skippers and crew members and encourage a shift towards environmentally responsible behaviour.

E. Place of implementation



- **Port of Aveiro, Portugal** (initial pilot project).
- **Potential expansion to other ports**, fostering cross-port cooperation.

• Start and end date or duration of the pilot project

Start Date: [09/2025-10/2026]

Duration: This use case will be developed as part of WP5, which will run from September 2025 to October 2026. However, the training program is designed to be an ongoing initiative, with regular refresher courses and awareness campaigns to ensure continued engagement and long-term impact.

2. CONTEXT AND DESCRIPTION

A. Description of the practice

The initiative involves the implementation of a structured training and awareness program for skippers of pilot boats and tugs in the Port of Aveiro, also extending to port pilots who play a crucial role in assisting and communicating with vessels arriving in the port, guiding them through safe and efficient navigation practices. The primary focus of the program is to promote slow steaming, demonstrating how controlled speed reductions can significantly decrease fuel consumption and emissions without compromising operational

efficiency. The training aims to raise awareness of the environmental and economic benefits of adopting more sustainable navigation practices, and to align port operations with wider sustainability goals.

The program consists of theoretical training sessions on the environmental impact of vessel speed and emission reduction strategies, complemented by practical workshops where pilots and skippers engage in simulations of fuel-efficient navigation techniques. Visual reminders and digital tools will be used to reinforce sustainable behaviour in daily operations. In addition, performance tracking mechanisms will be introduced to assess the long-term impact of the practice, ensuring continuous improvement and adaptation. By integrating education, practical application, and ongoing evaluation, this initiative seeks to enhance operational efficiency while reducing the environmental footprint of port activities.

B. Driving factor behind the adoption of the green practice

The adoption of this green practice is driven by environmental compliance, economic efficiency, market demand, and operational benefits. Alignment with EU and IMO sustainability goals is essential to reduce the environmental footprint of port operations, especially as alternative propulsion technologies are not yet widely available. This initiative supports immediate efforts to reduce emissions through behavioural and operational changes, complementing long-term technological advances.

From an economic perspective, reducing fuel consumption through optimized navigation practices reduces operating costs for ship operators, offering an efficient and cost-effective solution without requiring major technological investments. In addition, stakeholder pressure from industry organizations and regulatory bodies is driving the adoption of greener maritime operations, reinforcing the need for sustainable practices.

Finally, enhancing the long-term sustainability of port operations is crucial. With many vessels expected to remain in service until 2050, improved training, awareness, and collaboration will enable ports to significantly reduce emissions, optimize resources, and ensure a more resilient and sustainable maritime industry.

C. Stakeholders involved

The successful implementation of this initiative relies on the active participation and collaboration of key stakeholders across the maritime sector. Each plays a crucial role in ensuring that sustainability goals are met, operational efficiency is maintained, and environmental impact is minimized. From regulatory bodies to operational entities, their collective engagement is essential for achieving long-term improvements in energy efficiency and emission reductions, as reflected in the following stakeholders:

- **Administration of the Port of Aveiro (APA)** – Oversees and coordinates the initiative, ensuring alignment with sustainability objectives. As the regulatory authority for the tugboat concession, APA facilitates cooperation with the concessionaire company.
- **Pilot Boat Skippers** – Employed by APA, they are directly responsible for implementing slow steaming and other energy-efficient navigation strategies within the port.
- **Harbour Pilots** – Also employees of APA, they are licensed navigational experts who guide vessels in and out of the port, ensuring compliance with safe and sustainable navigation practices.
- **Tugboat Operators** – Operate under the APA's concession and play a key role in aligning operational practices with environmental objectives.
- **Shipping Companies** – Benefit from reduced fuel consumption, lower emissions, and cost savings, aligning with industry-wide sustainability targets and regulatory demands.

- **Regulatory Agencies** – Monitor compliance and assess progress toward sustainability goals, ensuring compliance with environmental regulations.
- **European Maritime Pilots' Association (EMPA)** – Supports training programs and initiatives focused on reducing greenhouse gas emissions in maritime operations.

By fostering cooperation among these stakeholders, the initiative enhances both environmental responsibility and economic sustainability, contributing to a greener and more efficient port ecosystem.

3. IMPLEMENTATION

A. Description of the adopted practice

The implementation of this green practice follows a structured approach that combines training, awareness programs, and operational adjustments. The main objective is to promote behavioural change among skippers of pilot boats, tugs, and port pilots through education on fuel-efficient navigation practices, particularly the adoption of slow steaming.

The first step involves developing a tailored training curriculum that addresses the specific operational environment of the Port of Aveiro. This curriculum includes theoretical training sessions to raise awareness about the environmental and economic benefits of optimizing vessel speed and fuel consumption. It also provides practical guidance on energy-efficient navigation techniques, considering the need for compliance with EU and IMO sustainability goals.

In addition, the initiative includes workshops and digital training sessions, offering hands-on experience in fuel-saving navigation strategies. Performance tracking mechanisms are introduced, enabling pilots to receive real-time feedback on fuel savings and emission reductions. This data-driven approach encourages informed decision-making and reinforces the long-term sustainability of port operations.

The program also fosters continuous learning by organizing knowledge-sharing forums and periodic refresher courses. This ensures that skippers, pilots, and tug operators remain engaged with best practices in sustainable navigation and are equipped to adapt to evolving environmental regulations and industry expectations.

By integrating education, practical application, and ongoing evaluation, this initiative aims to reduce emissions, improve fuel efficiency, and enhance compliance with sustainability standards, ultimately contributing to a greener and more resilient maritime sector.

B. Technologies used (if applicable)

The implementation of this green practice relies on a combination of technologies and tools aimed at improving fuel efficiency, monitoring emissions, and promoting sustainable navigation behaviours.

A key technological component of the initiative is the use of real-time performance monitoring systems, which provide pilots and skippers with instant feedback on fuel consumption and emission levels. These tools enable data-driven decision-making, allowing operators to adjust their navigation practices in response to fuel efficiency insights.

Additionally, digital training platforms and simulation-based workshops will be used to reinforce best practices in slow steaming and energy-efficient manoeuvring. These training tools will incorporate interactive

learning materials and case studies to ensure that pilots, skippers, and tug operators develop practical skills that can be applied in real-world operations.

Given the increasing emphasis on alternative fuels, the project will also explore the feasibility of retrofitting existing vessels to accommodate new advanced fuels. However, due to the high costs and slow adoption of alternative fuel infrastructure, the focus remains on optimizing current technologies and navigation practices to achieve immediate emissions reductions.

By integrating real-time monitoring, digital training solutions, and sustainable fuel strategies, the initiative aims to create a scalable and cost-effective approach to reducing emissions and improving the environmental performance of port service vessels.

c. Competencies required

The successful implementation of this green practice requires a combination of technical, operational, and environmental competencies among the stakeholders involved.

Firstly, technical knowledge is essential, particularly in understanding the dynamics of vessel speed control and fuel consumption. Skippers of pilot boats, tug operators, and port pilots must be proficient in navigating vessels efficiently while ensuring optimum fuel consumption. This includes applying best practice in slow steaming and other fuel-efficient navigation techniques.

Operational skills are also critical, as pilots and vessel masters need to execute sustainable navigation strategies without compromising port efficiency and maritime safety. This requires an ability to balance environmental objectives with operational demands, ensuring that emission reductions are achieved without causing delays or disruptions.

Environmental awareness plays a crucial role, as all personnel involved must understand the impact of emissions on air quality and climate change. Training programs will reinforce knowledge of EU and IMO sustainability goals, fostering a commitment to reducing the carbon footprint of port operations.

Finally, training must be adaptable in order to integrate sustainability practices into daily operations. Continuous professional development, refresher courses, and digital learning tools will be used to ensure that pilots, skippers, and tug operators stay abreast of evolving regulations and industry best practices.

By equipping maritime personnel with these skills, the initiative aims to improve fuel efficiency, reduce emissions, and promote long-term sustainability within the Port of Aveiro's maritime operations.

4. COLLECTED DATA

To assess the effectiveness of the training program, a structured data collection process must be conducted before and after the training sessions. This will allow for a comprehensive evaluation of the impact on pilot boat skippers, port pilots, and tugboat operators, measuring changes in navigation behaviour, fuel consumption, and environmental awareness. The collected data will help refine future training strategies and ensure continuous improvement in energy-efficient navigation practices.

A. Before implementation

- Average fuel consumption per operation [liters per hour and per nautical mile].
- Average engine running time [h/day or h/month].
- Average and maximum speeds of the pilot boats and tugs in different operational scenarios (e.g., approaching/departing of ships, escorting, idling).
- Typical daily operating acceleration and deceleration rates.
- Estimated CO₂ and other greenhouse gas emissions (based on fuel consumption and engine efficiency).
- Air quality measurements in the port area, where applicable.
- Initial understanding of energy-efficient navigation concepts (measured through a pre-training questionnaire).
- Awareness of the environmental and economic impact of slow steaming.
- Perception of potential challenges and barriers to adopting fuel-saving navigation practices.

B. After implementation:

- Comparison of pre- and post-training fuel consumption under similar operational conditions [liters per hour and per nautical mile].
- Average engine running time [h/day or h/month].
- Reduction in average and peak navigation speeds where appropriate.
- Improvement in controlled acceleration and deceleration techniques.
- Reduction in CO₂ and greenhouse gas emissions due to optimized navigation behaviour.
- Improvement in local air quality indicators, if monitored.
- Post-training questionnaire to measure increased understanding of sustainable navigation strategies.
- Self-reported changes in behaviour and attitudes toward slow steaming.
- Feedback from skippers, pilots, and tug operators on the training's applicability and areas for further improvement.

By systematically analysing these key indicators, the training's effectiveness can be quantified, ensuring that its objectives align with sustainability goals while fostering lasting behavioural changes in port operations.

5. ECONOMIC AND ENVIRONMENTAL ANALYSIS (*IF THE INFORMATION IS ACCESSIBLE*)

A. Initial investment required

Since the training program within WP5 is yet to be implemented, specific investment details are not available at this stage. However, it is anticipated that the future implementation will require financial resources for several key components, including the development of the training curriculum, hiring expert trainers, and procuring necessary materials. Additional costs may arise from the establishment of monitoring systems to assess training effectiveness, as well as operational cost for the organisation of workshops and awareness sessions. Expected investment areas include:

- Training development costs (curriculum, trainers, materials).
- Implementation of monitoring and evaluation systems.

- Operational costs for conducting workshops and awareness programs.
- Digital infrastructure for potential e-learning components.

B. Key savings or economic impact

The economic impact of the training program will be evaluated once it is implemented. However, as highlighted in Graph 1, which refers to the pilot boat *Espinheiro* from the Port of Aveiro, there is a significant disparity between the increase in RPM and the corresponding rise in fuel consumption. The fuel consumption curve shows a much sharper increase compared to RPM, indicating that higher speeds lead to disproportionately higher fuel usage. This reinforces the importance of avoiding excessive RPM levels, as even small reductions in speed can result in substantial fuel savings. Through slow steaming practices, the expected benefits include:

- Fuel cost reduction due to slow steaming practices.
- Lower maintenance costs due to reduced engine strain.
- Improved operational efficiency for the Port of Aveiro.
- Potential for increased competitiveness and service reliability.

c. Contribution to environmental goals

The full extent of the environmental impact will be determined post-implementation, but preliminary observations indicate significant potential benefits. As seen in Picture 1, which represents a recent track of the pilot boat *Espinheiro* from the Port of Aveiro, the vessel exhibits varying speed levels along the route, with the darkest green sections indicating higher speeds. To maximize environmental benefits, the goal is to reduce speed fluctuations and lower the overall average speed of the vessel. This can be achieved through better pre-planning of port operations and increased awareness of slow steaming practices. The expected contributions to environmental sustainability include:

- Direct reduction in GHG emissions through energy-efficient navigation.
- Enhancement of local air quality, benefiting port workers and nearby communities.
- Promotion of sustainable maritime transport practices across the industry.
- Compliance with evolving environmental regulations and international sustainability commitments

6. CONCLUSIONS

A. Success of the green practices

As the training program within WP5 has not yet been implemented, a full assessment of its success will only be possible after its execution and evaluation. However, based on current projections and insights from similar initiatives, the case study is expected to demonstrate a **significant reduction in fuel consumption and CO₂ emissions** through the adoption of slow steaming practices. By adjusting navigation behaviours, particularly avoiding excessive speeds/RPMs as evidenced in Graph 1, substantial operational cost savings and environmental benefits can be achieved. Additionally, the structured training and awareness campaign will likely contribute to **improved adherence to sustainability goals**, fostering a long-term cultural shift towards fuel-efficient navigation.

Expected outcomes include:

- Reduced fuel consumption and operational costs.
- Lower CO₂ and greenhouse gas emissions, improving environmental performance.
- Enhanced knowledge and awareness of sustainable navigation among pilots and skippers.
- Greater predictability and efficiency in port operations through better voyage planning.

B. Lessons learned:

Since the case study is still in its preparatory phase, key lessons will be identified after implementation. However, potential **challenges and solutions** can already be anticipated:

Challenges Faced and Solutions Found

- **Resistance to Behavioural Change** - Emphasizing economic benefits and long-term sustainability through targeted awareness campaigns and real-time performance feedback.
- **Operational Constraints** - Improving port scheduling to reduce pressure on harbour pilots and skippers, allowing for smoother transitions to slow steaming practices.
- **Monitoring and Compliance** - Implementing fuel and speed tracking systems to assess adherence to training principles.

Training Needs Identified

- Focus on **real-world application** of slow steaming in daily operations.
- **Interactive training modules** to simulate fuel savings at different RPM levels.
- Emphasizing **data-driven decision-making** using case studies from vessels like the *Espinheiro* (See table 1).

Recommendations for Future Applications or Curriculum Development

- Integrate **real-time tracking tools** into the training to provide immediate feedback on navigation behaviours.
- Establish a **mentorship program** where experienced pilots guide new trainees in fuel-efficient navigation.
- Develop a **digital learning platform** for ongoing education and performance tracking.

C. Next steps

The next steps for this initiative involve expanding the training program to include other vessels operating in the Port of Aveiro, such as tugboats and cargo ships, ensuring a broader adoption of energy-efficient navigation practices. By promoting slow steaming, the initiative is expected to significantly reduce CO₂ and other greenhouse gas emissions, contributing to the decarbonization of maritime operations while improving air quality in the port area. Lower fuel consumption will lead to cost savings for shipping operators, making maritime activities more financially sustainable and reducing dependency on fossil fuels. Additionally, integrating automated fuel monitoring systems would provide real-time data to optimize vessel performance, while an improved scheduling system could help minimize idle time and unnecessary speed fluctuations.

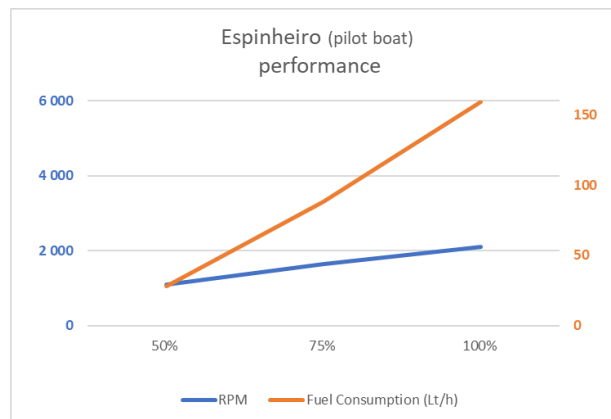
Beyond these environmental and economic benefits, the program aims to foster a culture of environmental responsibility among harbour pilots, skippers, and crew members, increasing awareness of sustainable maritime practices. Compliance with environmental regulations and international sustainability goals will also be reinforced, strengthening the Port of Aveiro's commitment to eco-friendly navigation strategies. Continuous refinement of the training content, based on feedback from the case studies and operational data, will be essential to maintaining its effectiveness. Regular audits and performance evaluations should be conducted to assess long-term impacts, and further research partnerships with academic institutions could enhance data-driven policy-making in maritime sustainability.

7. ANNEXES

d. Include relevant supporting materials

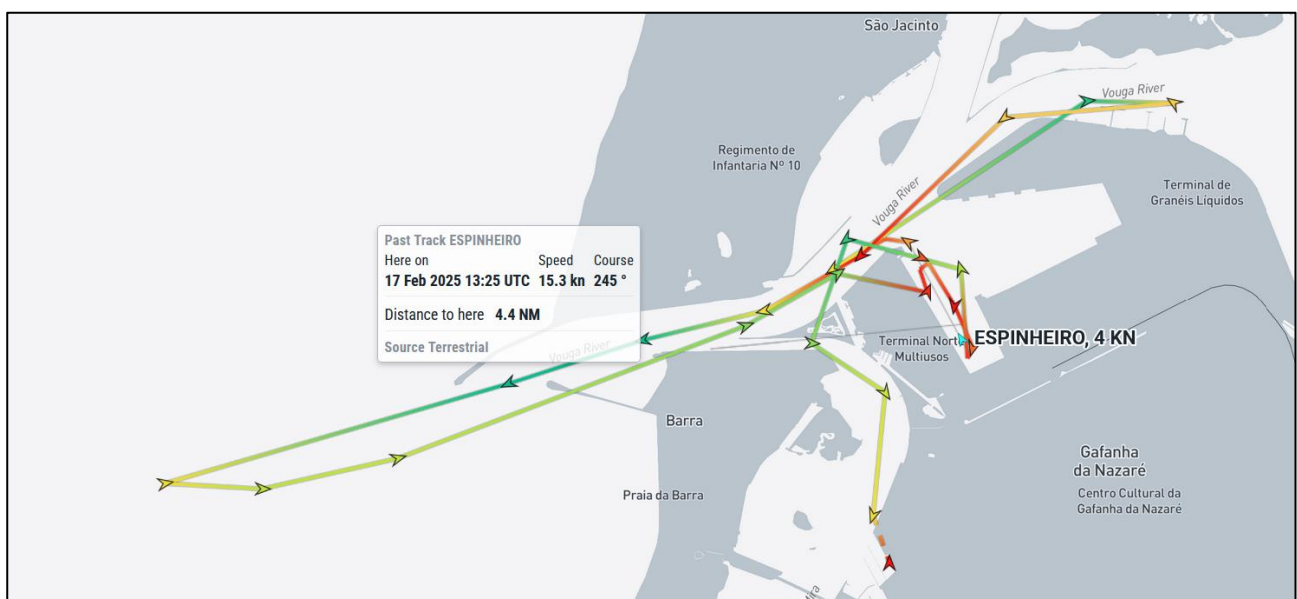
For example:

- Graphs and tables of results (e.g., emissions before and after, energy consumption)



Graph 1 - Espinheiro (pilot boat) performance at different power capacities

- Photos or diagrams of the implemented system



Picture 1 - Route and speed of a recent trip by the pilot boat Espinheiro of the Port of Aveiro

Table 1 - Pilot Boats of the Port of Aveiro

Pilot Boats		Engines
Triângulo		2 x VOLVO PENTA TAMD31P-A 150HP- 3900 RPM
Mó do Meio		2 x YANMAR 6LYA-STE 350 HP- 3300 RPM
Espinheiro		2 x VOLVO PENTA D9-425 425 HP- 2200 RPM