

CASE STUDY IDENTIFICATION SHEET

SAILING TOWARD SUSTAINABILITY: GREEN PORT OF VARNA

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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 analyzing case studies that exemplify best practices for behavioral change among operators aimed at reducing the environmental impact of port operations.

The primary objective of this activity is to collect, document, and analyze concrete examples of technological, managerial, or behavioral 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

“SAILING TOWARD SUSTAINABILITY: GREEN PORT OF VARNA”

B. Green practice implemented

Real-time Navigation Route Optimisation

1. Practice 14: Real-time navigation route optimization

In recent decades, the reduction of emissions has become a global priority, with Europe leading efforts to implement sustainable policies. As part of the European Union, Bulgaria is committed to reducing emissions, particularly in its maritime sector, which is a key player in industrial emissions savings. The Port of Varna has been chosen for this case study due to its size, versatility, and strategic importance within the European transport network. Located on the Black Sea, Varna plays a crucial role in Bulgaria's trade and logistics, necessitating efforts to reduce emissions from port operations. The study highlights two primary methods of emission reduction: upgrading tugboats and pilot boats to more fuel-efficient models and optimizing operational logistics to minimize fuel consumption. Through coordinated planning among tug companies and port authorities, unnecessary vessel movements have been reduced, leading to lower fuel consumption and emissions. Additionally, Varna's pilot station has transitioned from steel boats to lighter fibre-reinforced constructions, resulting in a 25% fuel savings over the past 15 years. This case study explores the environmental and economic impact of these initiatives, emphasizing the importance of collaboration and regulatory support in achieving sustainable maritime operations.

C. Specific goals

Reducing Maritime Emissions – Analyse and implement strategies to lower CO₂ emissions from port operations, focusing on tugboats, pilot boats, and auxiliary vessels.

Fleet Modernization – Assess the impact of replacing older, high-emission tugboats and pilot boats with fuel-efficient or environmentally friendly alternatives.

Operational Optimization – Improve coordination between pilot stations, tug companies, and port authorities to minimize unnecessary vessel movements, thereby reducing fuel consumption and emissions.

Fuel Efficiency Improvement – Evaluate fuel consumption patterns and explore the benefits of sourcing high-quality fuel directly from local refineries to reduce environmental impact.

Stakeholder Collaboration – Encourage cooperation between key maritime players, including port operators, tug companies, and logistics planners, to enhance sustainability efforts.

Economic and Environmental Impact Assessment – Quantify fuel savings, cost reductions, and emission decreases resulting from modernization and optimization efforts.

Policy and Regulatory Support – Identify regulatory measures and financial incentives that could further support the adoption of green maritime technologies and practices.

D. Direct impact of the practice

By replacing older, less efficient tugs and pilot boats with modern, fuel-efficient vessels, consumption has been significantly reduced. Additionally, optimizing vessel movements has led to fewer idle passages, saving fuel. The introduction of newer, environmentally friendly vessels and improved operational planning has directly contributed to decreased greenhouse gas emissions, benefiting both air quality and the broader climate. Reduced fuel usage and optimized port operations have led to lower operational costs for tug companies, pilot stations, and port authorities. Since ports are located near major cities, reducing emissions from port operations directly improves air quality for residents in Varna and the areas nearby. Better coordination between pilot stations, tug operators, and port authorities has led to a smoother, more efficient workflow, reducing unnecessary delays and increasing overall port efficiency. Optimizing operational efficiency reduces wear and tear on port equipment, tugs, and pilot boats, prolonging their service life and lowering long-term maintenance costs. The implementation of emission reduction strategies ensures that the Port of Varna aligns with European and international environmental regulations, helping Bulgaria meet its sustainability commitments.

E. Place of implementation

Port of Varna, Black Sea Coast, BULGARIA

F. Start and end date or duration of the pilot project

3rd of February 2025

2. CONTEXT AND DESCRIPTION

A. Description of the practice

The practice implemented at the Port of Varna focuses on reducing emissions and fuel consumption through fleet modernization and operational optimization. By integrating these two approaches, the Port of Varna has successfully lowered its harmful emissions while maintaining efficient port operations. The coordinated efforts ensure that vessels use the most direct and efficient routes, limiting fuel waste and reducing environmental impact.

Operational Context

The Port of Varna is a key maritime hub on the Black Sea, consisting of multiple terminals, shipyards, and quays spread over a vast area. The operational complexity arises from the need to move ships between these locations using tugboats and pilot boats. On a typical day, multiple vessel manoeuvres occur, requiring precise coordination to avoid delays and unnecessary fuel consumption. This geographical spread makes efficient planning essential to avoid redundant tug movements. Enhanced coordination between the pilot station, tug companies, and port traffic control led to strategic task-sharing among tug operators. Instead of moving boats over long distances for individual assignments, companies collaborated to utilize the nearest available tugs, reducing unnecessary fuel consumption and emissions. This practice demonstrates how logistical planning and inter-company cooperation can significantly improve port efficiency while contributing to environmental sustainability. The results include lower operational costs, reduced CO₂ emissions, and an overall improvement in green maritime practices.

B. Driving factor behind the adoption of the green practice

1. Environmental Responsibility and Emission Reduction. The primary motivation behind implementing green practices at the Port of Varna is the major need to reduce maritime emissions, which contribute to both local air pollution and global climate change. Bulgarian Ports are high-traffic areas with significant fuel consumption from tugboats, pilot boats, and other auxiliary vessels. Since Varna's port is located near a major city, reducing emissions directly benefits urban air quality and public health. <https://aqicn.org/station/@96565/>

2. Compliance with European and International Regulations. As part of the EU, Bulgaria complies with stringent environmental policies, including EU emission reduction targets and International Maritime Organization (IMO) regulations. These rules encourage ports to adopt cleaner technologies and optimize operations to lower CO₂, NO_x, and SO_x emissions. Implementing greener practices helps the Port of Varna align with EU Green Deal objectives and maintain regulatory compliance.

3. Economic Efficiency and Cost Savings. Reducing fuel consumption is not only environmentally beneficial but also economically advantageous. Fuel is a major operating cost for tug and pilot boat companies. By optimizing vessel movements and replacing outdated, fuel-inefficient boats, companies lower operational expenses. The savings in fuel and maintenance costs provide a strong financial incentive to adopt green practices.

4. Industry Competitiveness and Reputation. Leading European ports are actively adopting sustainability initiatives, and the Port of Varna aims to stay competitive by following best practices in green maritime operations. Implementing fuel-saving and emission-reduction measures enhances the port's reputation as an eco-friendly logistics hub, attracting businesses and investors that prioritize sustainability.

5. Stakeholder Collaboration and Operational Optimization. The initiative is driven by a collaborative effort between tug operators, pilot stations, and port authorities to improve efficiency. By better planning vessel movements, these stakeholders reduce idle passages and unnecessary fuel consumption, demonstrating how operational coordination can achieve both economic and environmental benefits.

6. Future-Proofing Against Environmental Challenges. As stricter carbon regulations and emission limits emerge globally, ports must adapt to sustainable practices to avoid potential penalties or restrictions on operations. By proactively implementing these green initiatives now, the Port of Varna is positioning itself for a more sustainable and resilient future.

c. Stakeholders involved

- 1. Port Fleet 99 AD:** With over 50 years of experience, Port Fleet 99 operates a versatile fleet of seven tugboats, offering 24-hour manoeuvring and towing services within the port's waters. <https://portfleet99.com/en>
- 2. Navigation Maritime Bulgare (Navibulgar):** As Bulgaria's largest shipping company, Navibulgar offers comprehensive tug services for all vessel types, including port manoeuvring in Varna, salvage operations, and supply services. <http://www.navbul.com/>
- 3. Varna Towage Company Ltd.:** The company was founded in 2003 as Varna Towage Company Ltd. Varna Towage Company Ltd. began its operations with three brand new tugboats that

were acquired from the leading tugboat builder Sanmar Shipyards. <https://www.vtc-bg.com/services.html>

4. **Varna Pilot Station:** The primary organisation providing deep-sea and port pilotage from the approaches to the ports along the Northern Bulgarian Black Sea region - from cape Emine to the Romanian border. https://varnapilots.com/aboutus_en.html

3. IMPLEMENTATION

A. Description of the adopted practice

The importance of emission reduction from ships and port operations comes mainly from the general importance of the world economy reductions but also from the proximity of ports near major cities. Both ports – Varna and Bourgas, are situated close to the two of the biggest cities in Bulgaria and the quality of the air in those cities depends upon the emissions from port operations. The proposed reduction of emissions near ports could be achieved in two main ways. The first one considers the use of more efficient tugs, pilot boats and other equipment which are sources of emissions. The second one is the proper organization of the port operations and adequate coordination in order to reduce the operational time of tugs, pilot boats and other equipment.

The port of Varna utilizes both ways depending upon the existing financing and state economic situation. During the last several years, the old tugs had been decommissioned and replaced by new ones with significantly less emissions. One of the existing tug companies replaced its three more than thirty years old tugs with newly built ones. The pilot station replaced the old steel pilot boats with second hand plastic ones thus reducing the consumption of fuel. Table one below shows the constructions in use by Varna Pilot Station Co.Ltd.

Table. 1

Pilot boat	Year build	Year of commencement of use	Year of decommissioning	Material
Nereida	1969	1969	2023	Steel
Fobos	1968	2011	2021	Steel
Pilot 2	1980	1995	2018	Steel
Pilot 1	2013	2013		Steel
Pilot 2 new	1996	2021		Fibre
Pilot 3	2003	2022		Fibre

Compared to ships, the consumption of pilot boats is significantly less and in that way the savings of fuel and emissions are disdainfully small. In polluted areas these are something in the big basket. For the last 15 years, change from steel to plastic boats reduced the consumption of fuel in Varna Pilot Station from 23 *mt* per year to 18 tons per year (25%). That is a good example how small size companies contribute to the green economy. The operational optimisation is more important at the moment as the other measures concern huge investments. The operational ones depend only upon better arrangement and management of the day-to-day work.

On 03rd of February 2025 there were more than usual moves in the port. There are three tug companies each of them having four tug boats. The port area includes more than 60 berths consisting Varna East, terminals and shipyard quays along the old and the new canal, terminals in the lake of Varna, lake of Beloslav and Varna West and also Port of Balchik. The distance between

quays is sometimes up to 12 miles. In addition, town port of Balchik is 17 miles from the other terminals. Since early morning it was clear that manoeuvres were expected in all the areas. The duty operator in Varna Pilot Station discussed with the tug companies the forthcoming moves. So, the tug companies agreed between themselves to exchange part of the tasks in order not to move their tugs from one area to the other. M/v “Tundra” was supposed to move from Shiprepair yard Odessos, quay 1 to the floating dock 3. For that manoeuvre four tugs are compulsory but the tug company in contract with the ship owner of “Tundra” had three available in the area. Instead of transferring the fourth one from Varna Port West (12 miles distance) they took the available tug from other tug company in the area. The same took place with the other manoeuvre in shiprepair yard “TEREM”. M/v “Westford” was supposed to exit the floating dock with three tugs from one company but only two were available in that area. The third tug was arranged by the other tug operator which was in the vicinity thus saving move of one tug - 6 miles away.

All that was possible because of the proper planning between the duty operators of the pilot station, the three tug-company management and Varna Vessel Traffic Service duty operator. In most cases the commercial reasons are stronger than ecological ones but all companies try to reduce the costs of operations. Reducing the idle passages of tugboats, tug companies save fuel consumption which is less emissions as well. During the manoeuvres mentioned above a total of 16 miles of idle passages had been saved. Bearing in mind the power of the tugs of 1500 HP that means about 235 KG of DO fuel saved and PM, NO_x, CO₂, HCs emissions are reduced accordingly.

Another important issue is the quality of fuel used by the auxiliary ships, tugs and boats operating in the port area. In the pilot station comprehensive study was made about suppliers of fuel. As per the company’s quality management system the review of suppliers is done annually and the company approved as main supplier the local refinery thus receiving the fuel directly from the producer and eliminating the possibility to worsen the quality of fuel due to storage and transportation.

B. Technologies used (if applicable)

By replacing older, high-emission tugboats and pilot boats with newer, fuel-efficient models, including lighter fibre-reinforced boats, the port has significantly lowered fuel consumption. Improved tugboat deployment planning through better coordination between pilots, tug companies, and port traffic operators has minimized unnecessary vessel movements, saving fuel and cutting emissions. The direct procurement of high-quality fuel from a local refinery ensures cleaner combustion, further reducing environmental impact. These combined efforts demonstrate how strategic fleet upgrades, smarter operational planning, and fuel management can make maritime operations more sustainable while maintaining efficiency and cost-effectiveness.

c. Competencies required

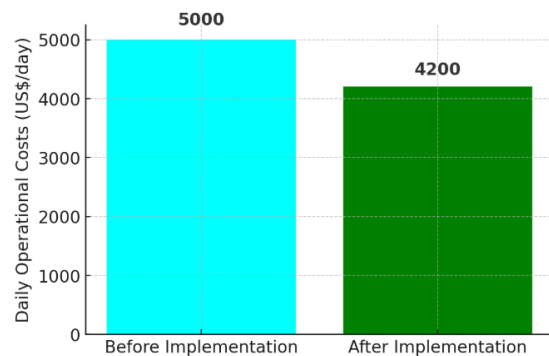
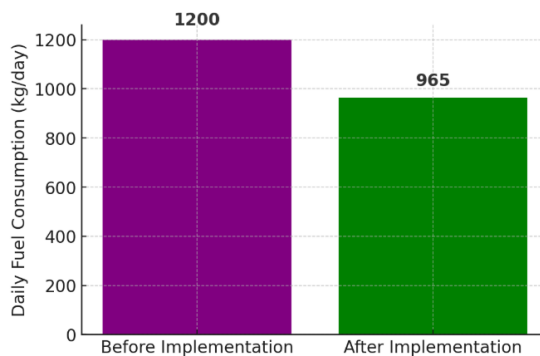
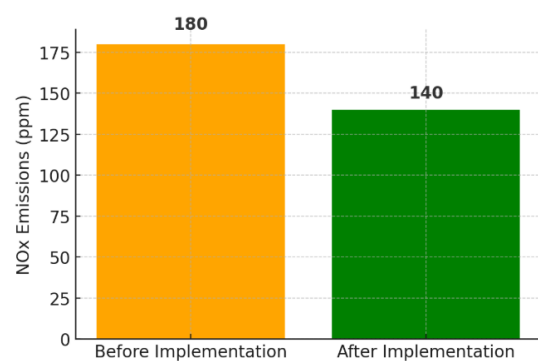
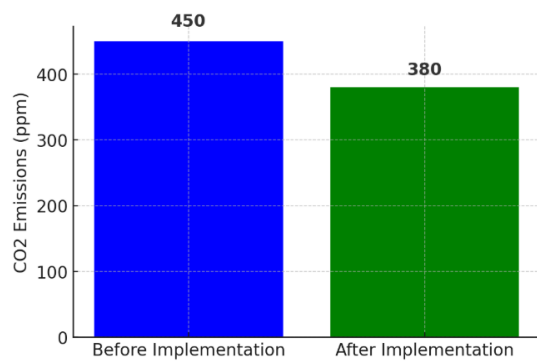
Implementing such green practice requires a multidisciplinary approach, integrating technical knowledge, operational efficiency, regulatory compliance, financial planning, and stakeholder collaboration. The combination of these competencies ensures that sustainability initiatives are both practical and effective in reducing emissions while maintaining smooth port operations.

4. COLLECTED DATA

Before implementation and after implementation

Port Of Varna Emission & Fuel Data

	Metric	Before Implementation	After Implementation
1	CO2 Emissions (ppm)	450	380
2	NOx Emissions (ppm)	180	140
3	Daily Fuel Consumption (kg/day)	1200	965
4	Daily Operational Costs (US\$/day)	5000	4200
5	Engine Running Time (hours)	12	10



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

A. Initial investment required

B. Key savings or economic impact

The most significant saving from the initiative at the Port of Varna was the reduction in fuel consumption. This reduction cut costs for port operators but also contributed to lower fume emissions, aligning with sustainability targets. Operational efficiency improvements have led to a 16% reduction in daily operational costs, decreasing from \$5,000 to \$4,200 per day. This drop is primarily due to better coordination among tug companies, which minimizes unnecessary vessel movements and reduces energy expenditure. The introduction of better task-sharing among tug companies has significantly decreased idle movements, saving an average of 16 miles for that day. This has lowered fuel consumption and has reduced the strain on tugboat engines, leading to lower maintenance and repair costs. Beyond economic gains, the initiative delivers notable environmental advantages, with CO₂ emissions dropping by 15.56% and NO_x emissions by 22.22%.

C. Contribution to environmental goals

Sustainability efforts at the Port of Varna provide a significant competitive edge, attracting more shipping companies seeking eco-friendly port services. As global environmental regulations tighten, ports that adopt green initiatives will be more appealing to businesses aiming to reduce their carbon footprint.

6. CONCLUSIONS

A. Success of the green practices

The Port of Varna's green maritime initiative has successfully demonstrated how fleet modernization and operational optimization can lead to measurable reductions in fuel consumption and emissions. By replacing outdated tugboats and pilot boats with more fuel-efficient models, including lighter fibre-reinforced boats, the port has achieved a 25% reduction in fuel consumption at the pilot station over the past 15 years. Additionally, enhanced coordination between tug companies, pilot stations, and port operators has significantly reduced unnecessary vessel movements, saving miles of idle tugboat passages in just one busy operational day. The adoption of higher-quality fuel sourced directly from a local refinery has further contributed to cleaner port operations. These improvements not only enhance the port's environmental sustainability but also reduce operational costs for maritime stakeholders, proving that eco-friendly practices can be both economically and environmentally beneficial.

B. Lessons learned

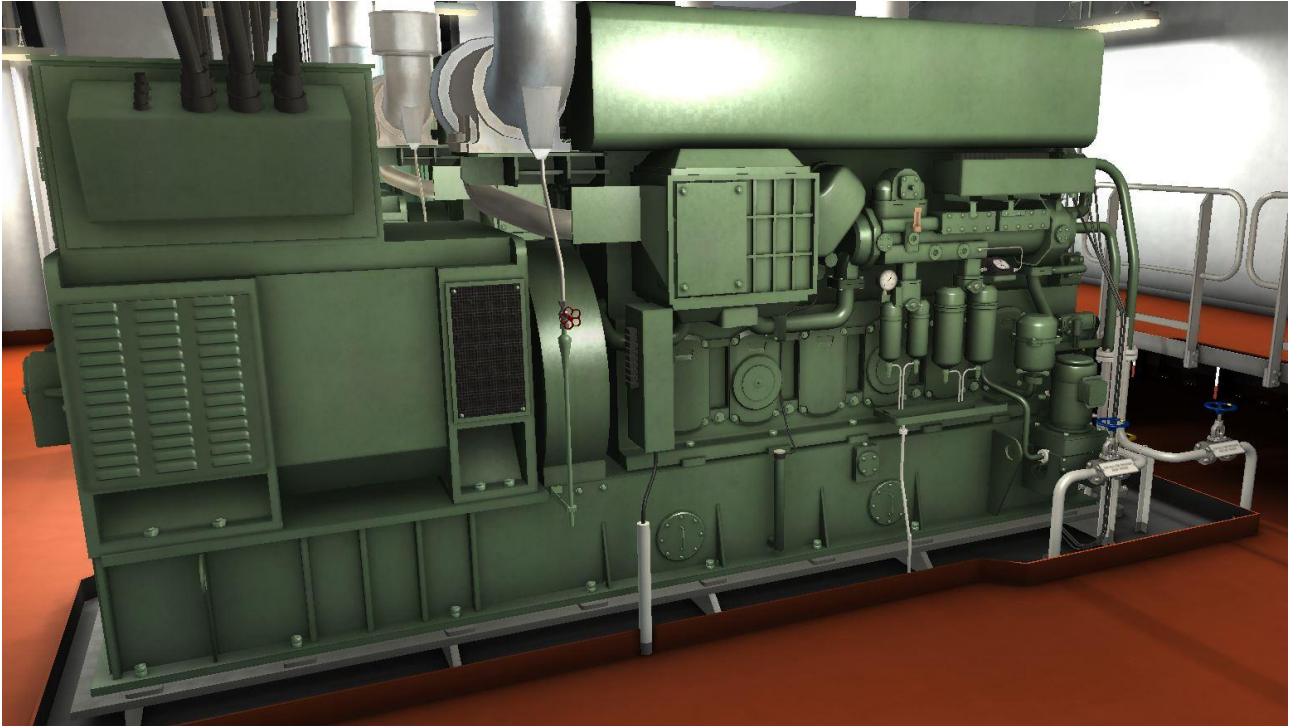
The success of the Port of Varna's green initiative highlights the importance of collaboration, efficiency, and innovation in reducing emissions. Effective communication between tug companies, pilot stations, and port authorities has proven essential for optimizing vessel movements and cutting fuel consumption.

C. Next steps

- **Introduce Hybrid or Electric Tugboats** – Investing in hybrid or fully electric tugboats could further reduce emissions and align with EU Green Deal targets.
- **Expand Shore Power (Cold Ironing) Infrastructure** – Implementing shore power systems would allow docked vessels to switch to electricity instead of burning fuel, cutting emissions significantly.
- **Enhance Training on Sustainable Operations** – Providing training for tugboat crews and port staff on fuel-efficient operations could further reduce unnecessary energy use.
- **Seek Financial and Policy Support for Green Initiatives** – Engaging with EU sustainability programs and exploring green funding opportunities could accelerate the transition to low-emission maritime technologies.

7. ANNEXES

D. The simulated engine



E. The Parameters of the simulated engine

