Horizon Europe Energy - HORIZON-CL5-2021-D3-02

EUROPEAN CLIMATE, INFRASTRUCTURE AND ENVIRONMENT EXECUTIVE AGENCY (CINEA)

D2.3: Report of recommendations on social, financial and technological barriers

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Date: 16 Feb 2024

This document is the SEANERGY project **"Report of recommendations on social, financial and technological barriers"** (contract no. 101075710) corresponding to **D2.3 (Month 17)** led by **"RINA Consulting S.p.A."**.

This project has received funding from the European Union's Horizon Europe research and innovation program under grant agreement number 101075710. This visual support reflects only the author's view. The Commission is not responsible for any use that may be made of the information it contains.

Project details			
Project name	Sustainability EducationAl programme for greeNEr fuels and enerGY on ports		
Project acronym	SEANERGY	**Start/Duration**	October 1st, 2022 (30 months)
Topic	HORIZON-CL5-2021-D3-02-02	**Call identifier**	HORIZON-CL5-2021-D3-02
Type of Action	HORIZON-CSA	**Coordinator**	Magellan Circle
Contact person	Beatrice Dauria (Project Coordinator) - dauria@circletouch.eu		
Project website	www.seanergyproject.eu		

Deliverable details			
Deliverable name	Report of recommendations on social, financial and technological barriers		
Number	D2.3	**Work package**	WP 2
Dissemination level	Public	**Nature**	Report
Due date (M)	12	**Submission date (M)**	17
Partner responsible	Rina Consulting	**Contact person**	Roberta Montesano

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Document History			
Date	**Version**	**Name**	**Changes**
24/03/2023	0	Table of content	
10/01/2024	1	First draft	
09/02/2024	2	Full report	Completion of the report
15/02/2024	3	Full report	Revised based on received reviews

TABLE OF CONTENT

List of Tables

List of Figures

List of Acronyms

Abbreviation / Acronym	Description
ABP	Associated British Ports
AET	Antwerp Euroterminal
AFIR	Alternative Fuels Infrastructure Directive
APEC	Antwerp and Flanders Port Training Center
CEAP	Circular Economy Action Plan
CEF	Connecting Europe Facility
CHP	Combined Heat and Power
CH_3OH	Methanol
CII	Carbon Intensity Indicator
CST	Concentrated Solar Thermal Energy
DG	Directorate-General for Mobility and Transport
ECSA	European Community Shipowners' Association
EDI	Electronic Data Interchange
EED	Energy Efficiency Directive
EEXI	Energy Efficiency Existing Ship Index
EMP	Energy Management Plan
EPI	Environmental Port Index
ESPO	European Sea Ports Organisation
ETD	Energy Taxation Directive
ETF	European Transport Workers' Federation
ETS	Emissions Trading System
GoO	Guarantee of Origin
HRS	Hydrogen Supply Station
HVO	Hydro-treated Vegetable Oil
LOHC	Liquid organic hydrogen carrier
IAPH	International Association of Ports and Harbors
ILO	International Labour Organisation
IMO	International Maritime Organization

Abbreviation / Acronym	Description
IoT	Internet of Things
LEP	Local Enterprise Partnership
LH_2	Liquid Hydrogen
MLC	Maritime Labour Convention
MoU	Memorandum of Understanding
NAP	National Action Plan
NECP	National energy and climate plan
NH_3	Ammonia
OPS	Onshore Power Supply
PA	Port Authorities
PIF	Border Inspection Point
PPE	Personal Protective Equipment
PV	Photovoltaic
RED	Renewable Energy Directive
SSE	Short-Side Electricity
SSP	Shore-to-ship power
STS	Ship-to-ship
TEN-T	Trans-European Transport Network
TTS	Truck-to-ship
VPF	Fundación Valenciaport
WEC	Wave Energy Converter
WPCAP	World Ports Climate Action Program

Executive Summary

The main goal of Deliverable 2.3 is to develop recommendations on social, financial and technological barriers and potentialities in order to enable the uptake of renewables and alternative fuels within the green port transition. The recommendations have been structured based on the review of best practices from current green ports (success cases) and in literature, on regional workshops (T2.2) results and through 25 interviews with key port stakeholders. Also based on the analysis carried out within this document, a batch of 4 customised regional factsheets of recommendations are provided.

This report provides a comprehensive summary of the main measures contributing to low-carbon energy transition/alternative fuel technologies and the best practices from current green ports, focusing on the review of 34 success cases of clean energy ports (European and not) and providing a clear analysis of the policy measures aiming at port decarbonisation, also including a view of the current level of social innovation and inclusiveness in Green Ports and a description of the key findings from interviews with Port Stakeholders. Key discussions include the implementation of renewable energy sources, electrification, and smart-efficiency solutions aimed at decarbonization and enhancing port operations' environmental sustainability. Stakeholders from various sectors shared insights on challenges and opportunities in achieving greener ports, emphasizing the importance of collaboration, innovation, and supportive policies to foster a sustainable transition. The interviews contribute to a broader understanding of best practices and recommendations for integrating renewables and alternative fuels in European ports, aligning with global efforts to combat climate change and promote sustainable development.

Considering the desk research, the literature and best practices reviews, the results from the workshops and from the stakeholders' interviews, main recommendations related to regulatory and social measures, corporate responsibility, education and training programs and technological innovations approaches, including safety aspects, have been identified and used to create regional factsheet dedicated to the four EU regions:

- North Atlantic and Baltic Region:

- East-Mediterranean Region;
- Inland waterways – The Danube Region;
- West-Mediterranean Region.

1. Introduction

To reach the European Green Deal objectives and Europe 2050's goals established by the European Commission, the SEANERGY Project aims to provide a solution for exploiting the untapped potential of the EU-ports energy system by implementing the SEANERGY Master Plan, which assesses stakeholders to execute the necessary activities towards transforming ports, regardless of their geographical context, into active members of the clean energy and fuel generation grid of EEZ. Activities such as training, reskilling, awareness spreading and communication channels creation, will set the basis of the green port transitioning, creating spaces of dialogue and teaching among all agents of the industry (private and public), which will, in turn, boost the development and integration of these technologies, along with prepared professionals that will be able to manage and implement them promptly, securely and efficiently.

The Sustainability Educational Programme for Greener Fuels and Energy (SEANERGY) on ports aims to go towards zero-emission ports, becoming clean energy hubs for integrated electricity systems, hydrogen, and other low-carbon fuels, as well as testbeds for waste reuse and the circular economy through the creation of the SEANERGY Master Plan. This Master Plan will be the main reference for all port institutions approaching the preparation of environmental and energy planning documents. The Master Plan is designed to help a community create a vision of how their operations will look in the future.

Port's role in climate change mitigation and specifically reducing maritime emissions has received significant attention. Ports are responsible for a variety of direct and indirect carbon emissions within logistic activities from shore-side infrastructure, non-renewable electricity consumption used to power buildings, lighting and various machinery, and other indirect emissions from the vehicles and vessels that use the ports to deliver and load cargo, and their associated warehouses. All these activities present opportunities for decarbonizing. For ports to remain relevant and be well-placed to compete in a changing world, they will need to make the most of these opportunities. Various operational and technological solutions are available to assist ports in reducing their direct and indirect emissions.[1] Often, economics and

[1] https://eit.europa.eu/sites/default/files/decarbonising_ports-catalogue_of_innovative_solutions_f.pdf

regulations are the main drivers of uptake of solutions, the key drivers of decarbonization are the policy regulations and customer demand. Several regulations and requirements directly affecting ports have been set in recent years to help tackle emissions and curb the growing climate crisis.[2,3,4] Therefore, the transition of ports requires a robust policy guiding and supporting[5] the communication of the various dimensions, consequent proposals, priorities, and subsequent actions.[6]

1.1 Purpose of the document

The main goal of this deliverable is to develop recommendations on social, financial and technological barriers and potentialities to enable the uptake of renewables and alternative fuels within the green port transition. The recommendations have been structured based on the review of best practices from current green ports (success cases) and in literature, on regional workshops (T2.2) results and through 25 interviews with key port stakeholders.

As the Task leader, RINA-C has led the best practices review and collected all the results reported in this document with the support of the partners. By analysing this information, RINA-C has elaborate recommendations for the port environment to foster the uptake of renewables and alternative fuels to enable the transition towards socially and environmentally responsible behaviour within all ranges (e.g. regulatory measures, corporate responsibility initiatives, education), ensuring inclusiveness of all actors and building on social and technological innovation approaches.

In addition, the scope of this document is also to provide a batch of 4 customised regional factsheets of recommendations.

[2] European Green Deal https://commission.europa.eu/strategy-and-policy/priorities-2019-2024/european-green-deal_en

[3] Initial IMO GHG Strategy https://www.imo.org/en/MediaCentre/HotTopics/Pages/Reducing-greenhouse-gas-emissions-from-ships.aspx

[4] 'Fit for 55' package: The FuelEU Maritime proposal https://www.europarl.europa.eu/RegData/etudes/BRIE/2021/698808/EPRS_BRI(2021)698808_EN.pdf

[5] Circular Economy in Europe: Developing the Knowledge Base https://op.europa.eu/en/publication-detail/-/publication/0cc8128f-d6d3-11e5-8fea-01aa75ed71a1/language-en

[6] (Miedziński, 2018)

1.2 Structure of the document

This document is organized into seven main sections. After this introduction, the document outlines, in Section 2, the methodologies utilized in literature review and desk research, stakeholders' interviews, analysis of regional workshops results and in developing of recommendations.

Following this, in Section 3 are reported the main measures contributing to low-carbon energy transition/alternative fuel technologies and the best practices from current green ports. This section focuses on the review of 34 success cases of clean energy ports (European and not) and provides a clear analysis of the policy measures aiming at port decarbonisation, from T1.4.1, also including a view of the current level of social innovation and inclusiveness in Green Ports. This section ends with a description of the key findings from interviews with Port Stakeholders. Annex I contains the list of Interviewees and main Contact information reported and structured as in the table below. Annex II contains the Interview Transcriptions elaborated by ATPERSON, while the video interviews with stakeholders will be published on the SEANERGY website.

Section 4 covers the Pan-EU workshop and its findings, from T2.2, identifying the social, economic, and technological barriers and potentialities. Section 5 reports the main recommendations related to regulatory measures, corporate responsibility, education and training programs and technological innovations approaches, also including safety aspects for alternative fuel use.

Section 6 presents the structure of the customized regional factsheets of recommendations reported in detail in Annex IV.

The document concludes with Section 7, providing a summary of the findings and recommendations for future action.

1.3 Relation to other project deliverables

The main goal of Deliverable 2.3 is to represent the summary of WP1 and WP2 and to provide useful information and the baseline for WP3 and WP4. In order to reach this goal, the present document considers and collect all the main results from the previous activities carried out within the SEANERGY Project, that support the creation of recommendations. This document includes results from T1.4, considering T1.4.1 “Desk Research on EU Strategy” and T1.4.2 “Initial Tech-Port Matchmaking” (Annex III). The Tech-Port Matchmaking provides a solid structure for identifying the port typologies and defining regional recommendations. Also, D2.3 includes a review of 34 success cases of clean energy ports analysed for the recommendations and improving the dissemination of success cases by considering the previously developed T1.2. Finally, the results of regional workshops organized during the WP2 and analysed in D2.2 are included in the present document, focusing on the economical, technological and social aspects, highlighting the barriers/potentialities and supporting the creation of the regional recommendation in the customized factsheets.

Equipped with these insights, the SEANERGY project is poised to tackle the identified challenges through the Work Package 3 (WP3) by developing the SEANERGY Master Plan (MP). This comprehensive guide will equip port industry stakeholders, irrespective of their geographical context, with the knowledge and tools necessary to transform ports into clean energy hubs. Complementing this effort, Work Package 4 (WP4) will focus on training, reskilling, and the creation of awareness and communication channels, ensuring a holistic and integrated approach to the green energy transition in the maritime sector.

2. Methodology

2.1 Literature review and Desk Research

Starting from a review, with the support of FPS, of the measures contributing to low-carbon energy transition/alternative fuel technologies, a summary of the main five solutions has been reported in Section 3, including Energy efficiency, Transition to Green energy for port facilities (solar, etc. for port offices); Digitalization of the Port, Alternative fuels infrastructure and automation.

The Best Practices review from Current Green Ports, reported in Section 3, has been carried out based on the available information on the project websites, Trans-European Transport Network (TEN-T) Core Network Corridor studies, European Sea Ports Organisation (ESPO), and International Association of Ports and Harbors (IAPH) studies. In addition, WMU has conducted desktop research on the existing Initial IMO GHG strategy and EU policy measures aimed at port decarbonization within the activity of Subtask 1.4.1 of the project and reported in Section 3 of this report. This preparatory research includes exploring deeper into secondary data sources to understand their context, perceptions, conflicts, and interplays. Digging deeper also helps identify the challenges and opportunities offered. It also highlights the action for stakeholders to align their vision and understanding of the problem.

This literature review and desk research offer a strong foundation for elaborating the recommendations reported in Section 5, for the port environment to improve energy and environmental sustainability and to enable the transition towards socially and environmentally responsible behaviour within all ranges.

2.2 Stakeholders Interviews and key findings

All stakeholder interviews took place between M10 and M15 of the project. Annex I contain the list of Interviewees and main Contact information reported and structured as in the table below. Annex II contains the Interview Transcriptions elaborated by ATPERSON, while the video interviews with stakeholders have been published on the SEANERGY website: https://seanergyproject.eu/interviews/.

Table 1: Interviewed Stakeholders Contact information structure

INTERVIEWEES/STAKEHOLDERS			
Name	Role	Sector	Nationality

As mentioned above, the interviews and the main information were analysed and transcribed. The most relevant findings are reported in section 3.5, summarized by ATP and CIRCLE.

To facilitate the identification of keyfindings, different thematic groups, among the stakeholders, have been set. This progression from a broad overview to specific thematic explorations ensures a comprehensive understanding of the SEANERGY project's scope and objectives, its alignment with European sustainability goals, and the collaborative effort required to foster a successful transition towards greener European port profiles.

By addressing the need for adoption of greener fuels, integration of innovative technologies, and the creation of supportive regulatory frameworks, the thematic groups segment further emphasizes the SEANERGY project's commitment to facilitating a holistic green transition in European ports. Moreover, the emphasis on stakeholder collaboration highlights the project's acknowledgment of the diverse perspectives and expertise required to achieve its ambitious goals. This structured approach provides a clear view for stakeholders to understand the ports' challenges, and potential impacts on the future of European ports and their role in the global effort to combat climate change and promote sustainable development.

2.3 Analysis of Regional Workshop Results

Within WP2, four regional workshops were conducted relating to the North Atlantic and Baltic Region, East-Mediterranean Region, Inland waterways: Danube Region and West-Mediterranean Region. Each workshop focused on a European region with the aim of analysing the social, economic, and technological barriers and potentialities perceived by the maritime sector to carry out the energy transition and decarbonization. Each regional workshop was structured as follows:

West-Mediterranean Region

The workshop focused on the southwest Mediterranean countries along with Portugal. The workshop was conducted online and there were around 50 attendees from East-

Mediterranean Europe's port ecosystem, including port authority members, technology industry employees, university researchers and others.

The workshop's title was "*Port Decarbonization Technologies*", and the agenda was the following:

- institutional welcome;
- introduction to the SEANERGY project;
- presentation of the Catalogue of Technologies;
- roundtable discussions on economic/business models, social/legal, technological barriers and solutions to achieve the energy transition and decarbonization in the maritime sector.

East-Mediterranean Region

The East Mediterranean workshop took place in a hybrid format, in Athens and online via zoom meetings. The region considered includes Greece, Cyprus, Croatia and countries from the Black Sea.

The event was divided into two main parts. In the first part, policy developments and economic incentives were elaborated. Representatives from academia, industry, the regulatory authority and the Greek DSO, HEDNO joined the panel and provided their views and activities in the direction of port decarbonisation. The second part, Best Practices of Port Decarbonization and Innovations, took place with the presentation of examples from ongoing projects and port operations by stakeholders from Piraeus Port Authority, academia and industry. All major port decarbonisation projects carried out in Greece so far (ELEMED, ALFION, CENTAVROS) were discussed.

Inland waterways - The Danube Region

The Inland Ports workshop focused on the Danube Region. The workshop was conducted online, and the agenda was the following:

- presentation of the SEANERGY project;
- perspectives of Danube Ports;
- regulatory framework, what ports have to expect;

- interactive discussion, reflections and next steps, followed by interviews

North Atlantic and Baltic Region

The North Atlantic and Baltic Region workshop aimed to bring together representatives from the IMO and the EU. The audience and the stakeholders that participated in the workshop were mainly divided into the following groups: port managing body and terminal operators, regulators, international organizations and trade associations, technology developers and manufacturers, research and education, energy providers, energy transition facilitators and third parties (designers, architects, contractors, construction workers, port project managers, consultants, other service providers).

During the first day, relevant stakeholders shared their perspectives on the role of green technologies and global cooperation towards maritime decarbonization. They highlighted important topics such as current progress, challenges, best practices, capacity building, life cycle assessment and cost-benefit analysis. On the second day, roundtables were carried out allowing the identification of the main benefits and barriers in four broad topics: technologies, business models, policies and regulations, and global cooperation towards the decarbonization of the port sector, from an international and regional perspective.

In Section 4, the results obtained from each workshop, relating social, economic and technological aspects, have been summarized by Fundación Valenciaport (VPF). The subsections of Section 4 analyse the results obtained in the different workshops.

2.4 Development of Recommendations

Through the in-depth analysis by European region of barriers and opportunities carried out through desk research, workshops and face-to-face interviews with port stakeholders has been possible to identify which are the key findings and the implication for EU Port Environment.
The analysis through three main types of barriers (social, economic and technological) interconnected with each other, has provided the base to identify recommendations that can be applied in EU ports to overcome the barriers. Starting from general recommendations, summarized in section 7, customize regional factsheet of recommendations have been prepared, described in section 6 and reported in Annex IV.

3. Best Practices from Current Green Ports

This section reports the main measures contributing to low-carbon energy transition/alternative fuel technologies and best practices from current green ports. This literature review and desk research offer a strong foundation for elaborating the recommendations reported in Section 5, for the port environment to improve energy and environmental sustainability and to enable the transition towards socially and environmentally responsible behaviour within all ranges.

In the following paragraphs, 5 main categories of measures are described, and 34 successful cases of existing ports within EU regions and not are analysed, describing the port type and the solutions adopted by the ports to reduce GHG emissions and improve their energy and environmental sustainability. Also, from sub-task 1.4.1 activity are reported the main policy measures aimed at port decarbonization such as: IMO action on Maritime and port decarbonization, EU action on Energy use and Climate Change, Ports 2030 agenda, European Green Deal and Horizon Europe's agenda, Ports Green Deal Master Plan.

Also, to complete the review, social innovation and inclusiveness in Green Ports have been analysed with the key findings from interviews conducted among the Port Stakeholders during the workshops.

3.1 Measures contributing to low-carbon Energy Transition/Alternative Fuel Technologies

In this section are reported 5 main categories of measures to contribute to low-carbon energy transition and to improve the utilization of alternative fuel technologies.

3.1.1 Energy efficiency of existing industry and infrastructure

Ports can improve energy efficiency and reduce energy usage by implementing this management practice. The International Standards Organization (ISO) introduced the ISO 5001 in 2011 as an effective instrument for assisting energy managers in attaining energy consumption reduction targets. The ISO 5001 follows the traditional Plan-Do-Check-Act (PDCA) approach. First, the port conducts an energy evaluation, focusing on consumption and efficiency. Then, a general approach with specific energy-saving targets and objectives can be established. Afterwards, a plan of action can be developed. The port selects some technical or operational measurements that are defined in the overall strategy. This allows the port to establish an inventory of its industry and infrastructure, which can then be linked to energy efficiency. There are various criteria by which the port's energy efficiency can be measured:

- Port management and policies, such as the port environmental plan, energy management strategy, monitoring systems, and green agreements, are being taken into consideration;
- Which type of fuel and power and how much are used in ports;
- Definition of the sea activities, including the number and the typology of vessels, the waiting time in the port and the level of efficiency on board each vessel in the port;
- Assessment of the efficiency of the equipment used on land at the port and of the trucks used during the loading and unloading vessel phases;
- Identification of alternative energy sources for this equipment.

3.1.2 Transition to Green energy for port facilities (solar, etc., for port offices)

The topic above explained how to measure the current phase of the port as reflected in its energy efficiency. This is a first step for the port management to see what categories must improve. There are numerous options to transition the port facilities to using green energy. The possible options are first divided into four categories: operations, equipment and vehicles, buildings, and other infrastructure and facilities. By knowing these options, the transition to green energy can be measured.

- Operations are not equally involved with green energy. It is more focused on energy-efficient operational processes. Studying this process in combination with management could potentially save energy on this. Besides, there are some measurements which can be taken to see if the port has a transition to green energy, for example:
    - Full or Semi-Automation of relevant port equipment;
    - Truck appointment system;
    - Dynamic (smart) lighting system;

- Equipment and vehicles: Multiple changes can be made for the port to develop a green transition. Most of the relevant changes that can be made are to new available engine technologies. The equipment and vehicles can be driven by hybrid, electric, or alternative fuels in order to reduce emissions and stimulate the green transition. This is mainly for terminal transport and stacking equipment at the port;
- Buildings: the transition to a green port has also impacted the buildings in the port. Renovating existing buildings or rebuilding new ones can lead to better energy efficiency. At the port, there are different types of buildings: warehouses, terminal buildings, administration offices, and maintenance and repair workshops. Solutions like energy-saving systems or sustainable construction implemented on buildings can help develop a greener port through improving of bioclimatic design. Focusing on the more energy-intensive port buildings and warehouses can lead to reduced energy consumption;
- Infrastructure & Facilities: a list below describes multiple energy savings that can be implemented at the port, to develop green energy for facilities & infrastructure and other consumers:
    - wind turbines onshore or offshore, generating renewable energy and covering the energy needs of the port;
    - solar panels onshore or floating are installed in different areas of the port. Often rooftops of buildings and warehouses.
    - wave energy converters, devices which convert the kinetic energy associated with a moving wave into useful mechanical or electrical energy;
    - biomass production plants, Biomass production, involves using waste or other renewable sources;
    - energy monitoring system, system monitoring the energy consumption of port equipment, buildings and other facilities;
    - smart grid and storage, the electricity network based on digital technology that can cost-efficiently integrate the behaviour and actions of all generators and consumers connected to it.

3.1.3 Digitalization of the Port

A key aspect of the digitalization of ports is the gains in operational efficiency, information transparency, and optimal allocation of limited existing and upcoming infrastructure. To this end, many ports have adopted the idea of developing a digital twin or digital 'doppelganger', which runs on data, laptops and mobile phones that can track in real-time current demand of port resources (energy, berth space, crane capacity, bunkering) as well as simulate expected demanded optimal planning.

A port made of 'apps', in which algorithms continuously track the movements of sea-going vessels, containers, inland vessels, trains and trucks. A port where everything is interconnected and objects independently exchange information using open-source data.

3.1.4 Alternative fuels infrastructure

Decarbonizing shipping requires the adoption of new alternative low-carbon fuels such as Hydrogen, Methanol, Batteries, Shore-Side Power, among other energy carriers. A key aspect of the adoption of alternative is the availability of alternative fuel infrastructure at ports to enable bunkering for vessels that berth at port as well as port operation vehicles.

Plans for the development of fuel infrastructure in the ports of the future are being continuously created and updated as market signals from shipowners shape the regulations and fuel demand. One common theme in alternative fuel infrastructure plans is that the bunkering and storage infrastructure for alternative fuels differ from traditional fossil fuel infrastructure. Green electricity carriers such as swappable battery containers, green hydrogen carriers such as swappable hydrogen containers, and Liquid hydrogen or methanol bunkering have different criteria than our current energy infrastructure. This involved close collaboration with alternative fuel providers, regional governments, and grid operators to build this infrastructure. The form of fuel storage onboard vessels can typically categorize alternative fuel infrastructure:

- <u>Swapping/filling infrastructure for Containerized storage solutions</u>: the two key alternative fuel sources for future vessels that are currently being demonstrated on the pilot and early adopter vessels are battery solutions and compressed hydrogen containers:

- Swappable ISO Compressed Hydrogen Containers: several pilot vessels in operation today use swappable Compressed H_2 containers for fuel storage. These are typically swapped out when empty for filled containers of hydrogen. While the containers may hold compressed H_2 at pressures ranging from 300bar to 500bar, these containers are developed according to the ISO standards for weight and dimensions of a typical ISO container with the exception that they are also classified as dangerous goods containers. It is specified that only hydrogen storage tanks up to a pressure rating of 500 bar may be transported filled in accordance with European Directive 2010/35/EU (Transportable Pressure Equipment Directive - TPED) ;
- In order to service vessels using such a storage solution, port terminals will need to have crane operators and certifications for handling, storage, swapping of dangerous goods containers (ADR certified);
- Swappable battery containers: similarly, vessels using swappable battery container systems swap out depleted battery containers for fully charged containers at a port terminal that is certified for handling dangerous goods containers.

- <u>Liquid or Cryogenic liquid fuels:</u> while several liquid energy carriers are being demonstrated in pilot vessels today and many being developed for future use, there are 4 main liquid or cryogenic liquid carriers that have been identified as frontrunners for shipping. These are Liquid Hydrogen (LH_2), Ammonia (NH_3), Methanol (CH_3OH), and LOHCs (Liquid organic Hydrogen carriers):
  - Cryogenic Liquid carriers (LH_2, NH_3): cryogenic liquid fuels such as liquid hydrogen and liquid ammonia will require specialized equipment and active cooling systems that ensure the fuels are maintained at the correct temperatures and pressures for safe storage and bunkering technologies that are in development for use in filling vessels;
  - Liquid carriers (LOHCs, Methanol): non-cryogenic liquid carriers such as LOHCs and Methanol have a simpler process for storage and bunkering as they do not need to be actively cooled to cryogenic temperatures and can be bunkered at room temperature. However, these fuels also require the development of

specialized infrastructure for storage and handling as they have specific requirements for safe operations that differ from traditional fossil fuels.

3.1.5 Automation

Port automation refers to the use of advanced technologies and robotics to automate various aspects of port operations. These technologies include automatic container handlers, cranes and intelligent conveyor systems. Replacing the manual work with automated systems, ports can significantly increase their efficiency and reduce the risk of accidents.

Another important aspect of port automation is the implementation of smart systems that enable real-time monitoring of container movements. This can create better cargo flows through the port. By using automation, electric-powered equipment can be really interesting for the development of a green port. Furthermore, automated systems enable better energy management and optimisation for the ports.

3.2 Overview of 34 Success Cases of Clean Energy Ports (European and not)

In this section, several successful cases of clean energy ports are described; most of them relate to innovations, technologies, or solutions used at different European ports. The figure below shows the selected European ports that provide an overview of clean technologies and solutions to enhance environmental sustainability and energy efficiency, which are described in the following subsections.

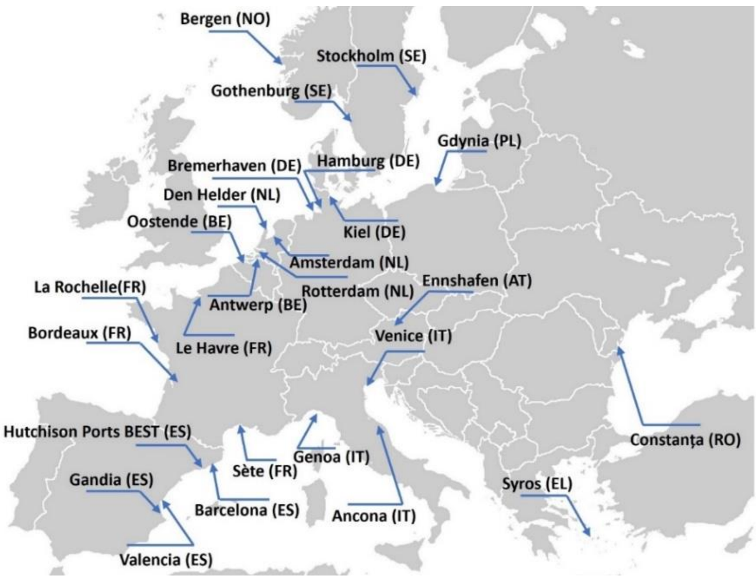

Figure 1: Success Cases from current European green ports

3.2.1 Port of Valencia

Port of Valencia (Spain) is the busiest port in the Mediterranean and the sixth busiest seaport in all of Europe. Regarding the best practices adopted in the port to foster the transition to clean energy, the first relates to the use of solar photovoltaic panels to generate electricity. A solar park is being installed on the Principe Felipe dock. This plant is one of two plants being placed in the port to generate green energy. This solar plant will supply the port with 3% of its power needs. This project will begin functioning at the end of 2023 and will produce 2,353 MWh/year. To benefit more from the solar energy, the solar panels have a surface area of 6,420 m^2 and a 30% slope, as shown in Figure 2[7].

Figure 2: Installation of the photovoltaic power plant located on the Principe Felipe dock

Additionally, the port authority has started construction on a new solar park that will be located on top of Valencia Terminal's vehicle silo (Figure 3) on the East Dock of the Port. The terminal, which is operated by the Grimaldi company, has a roof with a surface area of 27,700 m^2, where the solar station will be situated. 10,773 solar modules will be installed on a metal building that is four degrees inclined and facing the south. Two transformation centers will be installed, each one including two transformers of 1,250 kVA and 1,600 kVA. This facility will provide around 9,000 MWh/year or about 11% of the electrical energy used by the Port of Valencia[8].

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[7] https://www.porttechnology.org/news/port-of-valencia-set-to-be-powered-by-solar-energy/
[8] https://safety4sea.com/port-of-valencia-solar-plant-to-generate-11-of-its-electrical-energy-consumption/

Figure 3: Solar energy plant to be located on the roof of the vehicle silo of Valencia Terminal

The port of Valencia has another successful practice based on Hydrogen as the port received the first consignment of hydrogen (H_2) for the refuelling station on the Xità quay. With this significant accomplishment, it became the first port in Europe to have an operational hydrogen installation. This hydrogen supply station (HRS) is made up of two parts: a stationary portion used for receiving, storing, and compressing hydrogen up to delivery pressure, where today's test was conducted, and a portable portion with a dispenser for refuelling port equipment.

The hydrogen-powered ReachStacker, created as part of the European H2PORTS project, has been delivered to the Port of Valencia. This ReachStacker (**Error! Reference source not found.**) w as created by Hyster, a renowned forklift truck manufacturer with over 90 years of expertise. The machine will be given its initial hydrogen charge.

Figure 4: Hydrogen-powered ReachStacker arrived at the Port of Valencia

There are other activities connected to the utilization of renewable energy sources, such as wind, biomass, biogas, wave, and tidal energy, in addition to the solar and hydrogen projects.

Valenciaport intends to install a wave energy converter (WEC) to provide environmentally friendly power to port operations. The WEC in Valencia, which is being supported by the EU-funded project MAtchUP [9]and the Valencia City Council, will harness wave energy and convert it into electricity for the seaside, which is one of the city's most energy-intensive areas. In Marina's Hammerhead, the unit will be situated where waves may easily flow. It cost around €495,000. The WEC is anticipated to be operational by 2023 and will have a total surface area of 105 m^2, which equates to 77 m^2 of land and 28 m^2 of water surface. With its yearly output of 130,000 kW, the new gadget will cut the city's CO_2 emissions by 16 tons[10].

3.2.2 Port of Gandia

The port of Gandia is one of the Mediterranean Sea ports located on Spain's southeastern coast, approx. 35 nm of Valencia. A 4,500 square meter solar energy plant with a 990 MWh/year power production is being built in Shed 4 of the Port of Gandia. This project will make the Gandia port the first to be energy independent European port. Equipment for storing electrical energy will also be installed. The solar power plant's construction is anticipated to be completed in 2024, and maintenance will last for 52 months. Funding from both the Spanish government and the European Union is used to support this project. The project is worth $1.71 million (€1.7 million)[11].

Figure 5: The solar energy plant located in shed 4 of the Port of Gandia

9 https://www.matchup-project.eu/news/energy-is-the-force-of-nature-in-valencia/
10 https://www.espo.be/practices/valencias-port-authority-and-city-council-to-insta
11 https://www.valenciaport.com/en/valenciaport-adjudicates-the-photovoltaic-plant-for-the-port-of-gandia/

3.2.3 Port of Barcelona

As part of the CREATORS program, the Port is working on a project to put solar panels on Fisherman's Wharf and provide energy storage facilities (batteries) to encourage self-consumption. The port' building has flexible special panels that can conform to the rounded shape of the roofs like a carpet, as shown below. This facility will provide around 7 MW of solar energy [12].

Figure 6: The Port of Barcelona plant (7 MW of solar energy)

A solar power plant has been erected in the Border Inspection Point (PIF) Area of the Port of Barcelona, which provides around 50% of the building's energy needs. The project's price, including added equipment, was €361,504. 700 panels were put on the building's roof as well as the pergolas in the parking lot by the business Citelum Ibérica.

Moreover, by expanding its solar arrays by 1,210 m^2, APM Terminals Barcelona will produce up to 7.5% of its power from the sun by 2023. In 2022, the company's 980 solar panels, which cover the staff parking lot, produced 565,000 kWh of electricity, or 5.12% of the electricity used by the terminal, and enough to power 160 households for a year [13].

By September 2024, the port will have two berths within the ferry terminal equipped with shore-to-ship power (SSP) systems that are totally powered by renewable energy. As a result, ships will be able to shut off their engines and stop emitting pollutants when berthed. The method provides an emission reduction per ship of 96% in nitrogen oxides, 8% in sulphur

[12] https://piernext.portdebarcelona.cat/en/environment/ports-turn-to-the-sun-towards-energy-independence-with-solar-panels/

[13] https://www.apmterminals.com/en/barcelona/practical-information/news/2023/230308-apm-terminals-barcelona-to-increase-solar-array-installation

oxides, 94% in particulate matter, and 64% in carbon dioxide, according to calculations made by Puertos del Estado, the Spanish state ports agency [14].

152,000m^3 of LNG have been supplied through 544 LNG supply operations at the Port of Barcelona Since 2017, which include both truck-to-ship (TTS) and ship-to-ship (STS) operations. Of these, 498 TTS LNG operations have been conducted on Balearia ferries, and 46 STS LNG supply operations have been conducted on cruise ships owned by the Carnival Group[15].

3.2.4 Port of Rotterdam

The Port of Rotterdam, which is situated in and around the city of Rotterdam in the Dutch province of South Holland, is the biggest seaport in Europe and the largest seaport outside of East Asia.

The Port of Rotterdam is on a mission to use renewable energy, particularly for hydrogen generation, to decarbonize its operations and advance the energy transition. Up to 60,000 kg of renewable hydrogen can be produced each day by the 200 MW electrolyzer, which will be built on the Tweede Maasvlakte in the port. The offshore wind farm Hollandse Kust (Noord), which is partially owned by Shell, will provide the electrolyzer with its renewable energy needs. In 2025, Holland Hydrogen I is anticipated to begin operations[16].

On the Maasvlakte, the Port of Rotterdam Authority is developing an 11-hectare site (Figure 7) that might house a green hydrogen factory with a 1GW capacity[17]. This location is close to the area where Tennet will construct the Amaliahaven (380 kV) high-voltage substation. The 2GW DC connection from the IJmuiden Ver Wind Farm Zone Beta is intended for this location. The energy grid is not used at all when green electricity is transformed directly into hydrogen, reducing grid load. The Maasvlakte hydrogen plants may be linked to local heat networks,

[14] https://www.vinci-energies.com/en/news/onshore-power-supply-system-to-be-installed-at-port-of-barcelona/
[15] https://www.espo.be/practices/use-of-lng-at-the-port-of-barcelona
[16] https://safety4sea.com/cm-port-of-rotterdam-energy-transition-can-be-successful-only-with-scalable-and-affordable-alternatives/
[17] https://www.espo.be/practices/rotterdam-port-authority-offers-green-hydrogen-sit

according to the Port Authority. According to the port authority, ultimately, they will be able to use "green" heat in their workplaces[18].

Figure 7: Port of Rotterdam plans 1GW green hydrogen site

As part of the sustainability plan, multinational shipping company “Samskip” worked with its subsidiary “frigoCare” to create a solar panel system in the port of Rotterdam. The equipment was put in place on the roof of the 14,000-pallet cold storage facility owned by frigoCare in Rotterdam as shown in Figure 8. Around 3,100 solar panels were installed in all, covering a surface area of 7,500 m^2 and producing 750,000 kWh of power annually. ZEN owns the new solar panel installation, while frigoCare oversees the roof's surface. As a result, frigoCare gains access to a more affordable and environmentally friendly energy source. About 2.7 GWh of energy is used by the cold store each year. The solar panels will approximately produce 30% of this required need in accordance with the agreement between frigoCare and ZEN. Any surplus energy will be sent back into the regional grid[19].

18 https://renews.biz/85132/port-of-rotterdam-plans-1gw-green-hydrogen-site/
19 https://oevz.com/en/largest-solar-panel-system-in-the-rotterdam-port/#:~:text=The%20system%20was%20installed%20on,kWh%20of%20electricity%20a%20year.

Figure 8: Largest solar panel system in the Rotterdam port

Moreover, a solar park atop the Patrizia buildings along Witte Zeeweg 3-21 on the Maasvlakte (Figure 9) was inaugurated on July 6, 2023. Sunrock erected the solar roof. The 120,000 m^2 rooftop solar park can provide enough energy to power about 8,000 families for a whole year. With the addition of this 25 MWp park, the port buildings' roofs now have a total installed solar capacity of about 89 MWp.

Figure 9: solar park on Patrizia buildings along Witte Zeeweg 3-21 on the Maasvlakte[20].

3.2.5 Port of Amsterdam

The port of Amsterdam is in the Dutch province of North Holland. It is the second-largest port in the Netherlands in terms of transshipment and the fourth-busiest port in Europe in terms of metric tons of cargo. The goal of installing 100,000 m^2 (17MW) of solar panels on port buildings in Amsterdam was accomplished in 2020. The port had 120,000 square meters of

[20] https://www.portofrotterdam.com/en/news-and-press-releases/significant-increase-in-the-use-of-solar-power-on-port-building-roofs

solar panels by mid-2020. Around 260,000 square meters of solar panels will be installed at the port overall by the end of 2023.

Figure 10: Solar installations in the port of Amsterdam[21]

The environmental effect on communities close to ports, particularly in densely inhabited areas, is reduced by using SSP technologies. An excellent illustration of how SSP has been effectively done utilizing locally generated power is the Port of Amsterdam. There are several shore-based power stations for both inland ships and river cruisers in the Amsterdam area, as shown below.

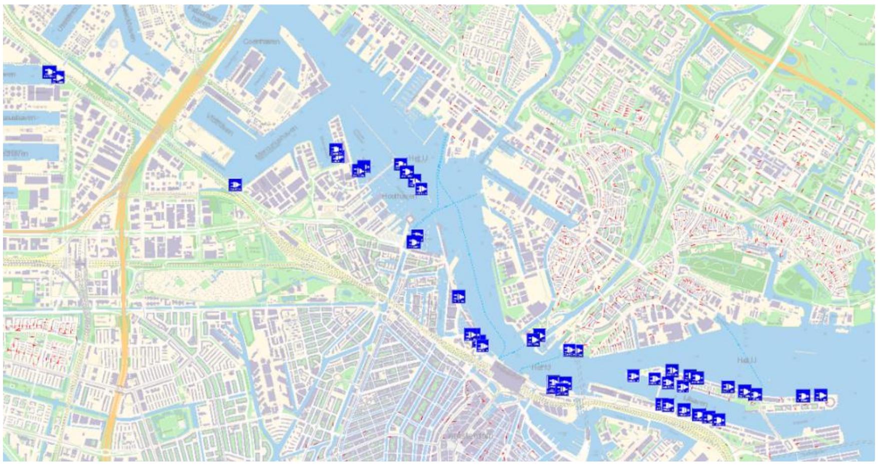

Figure 11: Map of shore power cabinets in the port of Amsterdam[22].

The Port of Amsterdam sees the implementation of new quayside electricity units for inland navigation and river cruises as well as the realization of a quayside electricity connection for

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[21] https://www.portofamsterdam.com/en/discover/sustainable-port/sun-port#:~:text=One%20year%20earlier%20than%20expected,electricity%20for%20around%206%2C000%20households.

[22] https://www.portofamsterdam.com/en/shore-power

sea cruise at the Passenger Terminal Amsterdam as crucial components of the port emission reduction technologies pillars in the new "Clean Shipping Vision."

The port collaborates with Tata Steel and HyCC to build H2ermes, a 100 MW hydrogen plant in IJmuiden on the Tata Steel site. This facility can produce up to 15,000 tons of green hydrogen annually using renewable power. Along with HyCC, the port also started the H2era project. They are investigating the possibility of building a 500 MW green hydrogen plant at the port with H2era. The Netherlands' biggest hydrogen plant to date. The goal is to complete this facility by 2027.

Pipelines beneath and storage tanks above ground make up the hydrogen infrastructure. For instance, the Port of Amsterdam is establishing a regional hydrogen infrastructure that will connect IJmuiden to the port area of Amsterdam through a national hydrogen network (Figure 12), in collaboration with Hynetwork Services (a Gasunie subsidiary), the national government, and governments in the North Sea Canal region. The new network will be built on top of the 12,000 kilometres of pipes already used for natural gas, some of which will be made accessible for the transfer of hydrogen. In the end, current pipes will make up around 85% of the hydrogen network, while newly built pipelines will make up the remaining 15%[23].

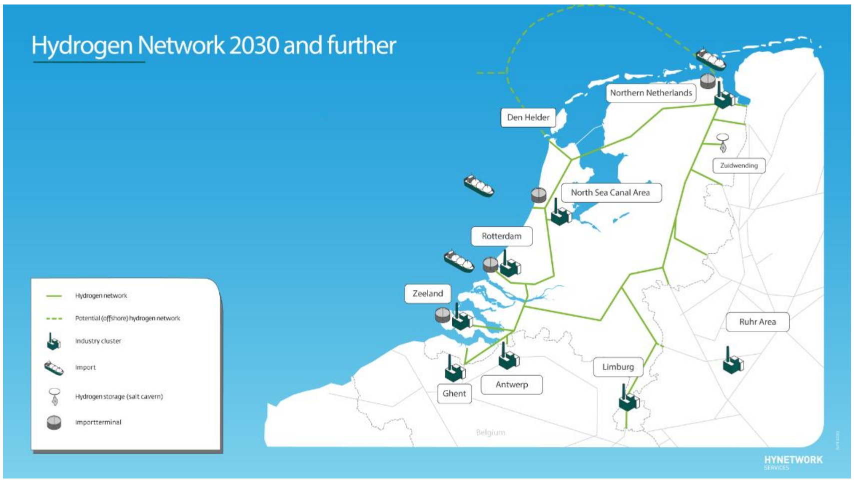

Figure 12: Hydrogen network Netherlands in 2030[24]

The Port of Amsterdam will be the location for the new biofuel plant Advanced Methanol Amsterdam (AMA) of GIDARA Energy. The plant will produce around 87,5 kilotons per annum

[23] https://www.hynetwork.nl/en/about-hynetwork-services/hydrogen-network-netherlands
[24] https://www.portofamsterdam.com/en/shore-power

of renewable methanol each year, which amounts to the waste produced by 290,000 households. This renewable methanol, which is a sustainable alternative to methanol produced from fossil fuels, will contribute to reducing carbon emissions. The plant, which should be operational in 2023, will be in BioPark, a development site in the Port of Amsterdam for producers of renewable fuels[25].

3.2.6 Port of Antwerp and Bruges

One of Europe's largest ports and one of the most sustainable ports in the world is the combined port of Antwerp and Bruges. The port already has a significant number of wind turbines, which contribute significantly to green energy. The wind turbines are distributed in two locations, the first is in Zeebrugge, which consists of 50 wind turbines and has a capacity of 130 MW; the other is in Antwerp, which contains 80 wind turbines and has a capacity of 200 MW (Figure 13).

Figure 13: Wind turbines in Port of Antwerp [26]

LED lighting, rooftops covered with solar panels, and rainwater are all utilized by the Antwerp Euroterminal (AET). The Concentrated Solar Thermal Energy (CST) farm with 1100 m^2 of parabolic reflectors was installed on the site of the logistics company ADPO (Antwerp

[25] https://www.gidara-energy.com/advanced-methanol-amsterdam
[26] https://www.portofantwerpbruges.com/en/our-port/climate-and-energy-transition

Distribution and Products Operations) in Beveren to create the solar park in Kallo, a unique solar-powered technology to generate 1.14MW of solar power. It uses two rows of 120 parabolic mirrors, each measuring 5 meters, to create three times as much energy as photovoltaic solar panels by converting sunlight into heat.

The mirrors follow the sun and direct incident sunlight onto collecting tubes. To be used at night, the heat might be kept in insulated containers. Based on focused sunlight, the mirrors produce green heat. The CST farm, which will replace 500 MWh of yearly gas use, is situated over the company's parking lot, above a railroad, and below a high-voltage line, serving as a perfect example of how to use the same piece of land twice.

Figure 14: Concentrated Solar Thermal Energy (CST) farm in the port of Antwerp [27]

The terminal makes use of new battery storage as a part of the PIONEERS project[28], which the European Union supports. Yves De Larivière, the managing director, reports that 86% of the terminal's energy now originates from green sources[29].

The port hopes to establish itself as a global centre for "green hydrogen," which may take the place of fossil fuels in several industrial applications. To support the domestic production of green and blue hydrogen, the Port is investing in importing renewable energy. To test a hybrid propulsion system that reduces emissions, the container terminal experimented with several

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[27] https://newsroom.portofantwerpbruges.com/pioneering-eco-friendly-project-for-solar-heat-in-the-port-of-antwerp

[28] https://pioneers-ports.eu/

[29] https://blue-economy-observatory.ec.europa.eu/news/antwerp-bruges-aims-become-worlds-greenest-port-2023-03-10_en#:~:text=The%20merged%20port%20of%20Antwerp,to%20wash%20containers%20and%20cars.

fuel types, such as a dual hydrogen-diesel fuel system, as shown in Figure 15. Dual-fuel technology can replace 70% of diesel consumption with hydrogen on new straddle carriers, with the goal of 100% hydrogen injection[30].

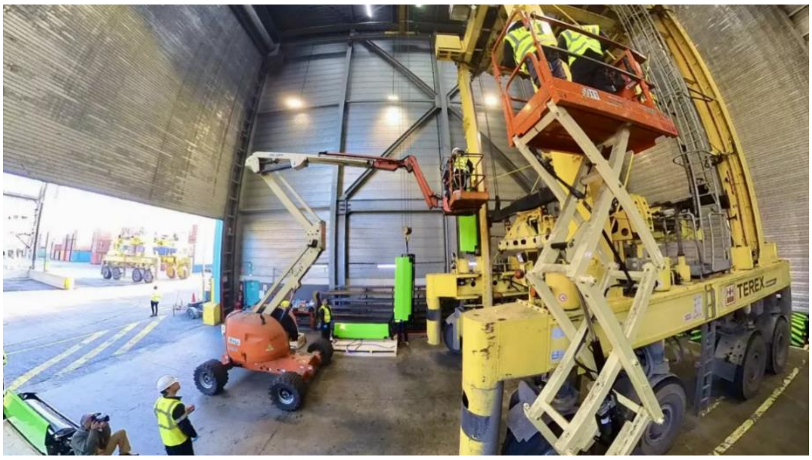

Figure 15: A straddle carrier is being equipped with dual hydrogen-diesel fuel system

3.2.7 Port of Ostend

Ostend, West Flanders, is where the Port of Ostend is in Belgium's Flemish Region. The port facilitates the movement of freight between Ostend and Ramsgate, as well as between Ipswich and North Killingholme Haven.

A floating solar power plant was constructed and set up on the sea as part of a unique initiative in which 12 companies from seven different nations collaborated. This floating plant is a significant component of the DUAL Ports EU-funded program. This plant produces 10kWp by using a 130 m^2 floating solar plant, as shown in Figure 16. The system is built to withstand winds of 44 m/s and waves of 2 m. Placing a floating solar power plant using a crane on the sea was a first for the world. Greenpipes's Customized cable protectors made from recycled plastic were used to protect the DC wires connecting the floating solar power plant to the PV equipment:

[30] https://www.espo.be/practices/port-of-antwerp-launches-worlds-first-dual-fuel-hy

Figure 16: Floating solar power plant in Port Oostende, Belgium[31]

3.2.8 Port of Genoa

The Port of Genoa is one of Italy's most important seaports. The Port of Genoa has already led several projects to promote the Green Port, including the following:

- the launch of a new service that will collect and handle garbage generated by land and ship separately in the port region;
- the use of alternative fuels for heating and cooling buildings, such as LNG and biomass;
- involvement in European initiatives and working groups with public and local authorities to reduce the impact of port activities on noise levels;
- the setting up of a 120 kW photovoltaic system on the roof of Savona's Palacrociere Cruise Terminal's West Terminal;
- building a structure to house Palacrociere's first LNG-powered passenger ship;
- the installation of energy-efficient lighting (LEDs) in place of conventional lighting;
- the provision of shoreside electrical power to the Genoa Prà basin to reduce noise and pollutant emissions;
- the implementation of an SSP system that provides shoreside electrical power to berthed vessels while the main and auxiliary engines are turned off, reducing CO_2 emissions in the Vado Ligure basin[32].

[31] https://greenpipegroup.com/project/floating-solar-power-plant-in-port-oostende-belgium/#:~:text=The%2010kWp%20(130%20m2)%20floating,the%20water%20with%20a%20crane.
[32] https://www.espo.be/practices/onshore-electricity-at-ports-of-genoa

Due to the proximity of dry docks to Genoa City and the fact that ships spend more time there, the Port Authority began its electrification effort there. 2010 saw the opening of the integrated tender for the executive design and implementation of the works, and 2011 saw the awarding of the contract. The project was finished in 2017. For all ships at dry docks, SSP has been available from the beginning of 2018. The Liguria Region (via POR FESR Liguria 2007-2013 grants) and the Ministry of the Environment have each contributed Euro 9,800,000 to the construction of these works.

Figure 17: The stations and sub-stations of OPS facilities for ship repair areas in Genova

Figure 18: Mobile structure for ships SSP in the port of Genoa [33]

3.2.9 Port of Ancona

Ancona's port is a major passenger hub on the Adriatic Sea, with frequent service to Split and Zadar in Croatia, Durres in Albania, and Igoumenitsa and Patras in Greece.

[33] https://sustainableworldports.org/project/port-of-genoa-onshore-power-supply-to-vessels/ .

To power all of the ship plants and the plants needed for shipbuilding and outfitting, the Ancona port's Fincantieri shipyard invested in the introduction of electrification at the quay. This will enable the engines to remain off during the productive process, decreasing polluting emissions.

The Central Adriatic Ports Authority and the Harbour Master of the port of Ancona promoted the voluntary "Ancona blue agreement," which addressed the issue of air quality in port environments, as a step toward the implementation of the new IMO 2020 worldwide regulation on ship emissions, which took effect on January 1, 2020. The representatives of four firms, Adria Ferries, Jadrolinija, Superfast Ferries-Blue Star Ferries, and Snav, signed the "Ancona Blue Agreement" on November 30, 2018, and it was effective until December 31, 2019.

In accordance with the agreement, instead of the 1.5% required at the time by law, the shipowners and ferry companies agreed to operate the main and auxiliary engines of the ships using fuel for marine use with a sulphur content not exceeding 0.1% from the completion of the mooring manoeuvre in port up until departure and exit from the port.

Ancona Blue Agreement serves as an illustration of an effective local framework for collaboration between public entities and marine operators to work together to accomplish significant outcomes in the area of environmental sustainability of port operations.

3.2.10 Port of Venice

Port of Venice is a port serving Venice, northeastern Italy. It is the eighth-busiest commercial port in Italy. There are many initiatives for environmental sustainability. The development of the LNG logistics chain must be mentioned among these initiatives; it received an overall EU grant of 28 million euros. Construction work for the LNG terminal was done by the Venice LNG company (VENICE LNG, GAINN4SEA, and GAINN IT projects), and the Rimorchiatori Riuniti Panfido company designed and built a barge prototype for transporting and LNG refuelling to ships (POSEIDON MED II). Moreover, there are many Onshore Power Supply (OPS) points to serve the ships, as shown in Figure 19.

Port	OPS point	Main type of traffic in the facility	Type of OPS Interface	Power (in kW)	Voltage (in V)	Frequency (in Hz)	standard followed
Venice	OPS point Nº1	Yachts /Boats/Tug/Pilots	OPS LV	less than 100 kW	400V	50 Hz	others
Venice	OPS point Nº2	Yachts /Boats/Tug/Pilots	OPS LV	less than 100 kW	400V	50 Hz	others
Venice	OPS point Nº3	Yachts /Boats/Tug/Pilots	OPS LV	less than 100 kW	400V	50 Hz	others
Venice	OPS point Nº4	Yachts /Boats/Tug/Pilots	OPS LV	less than 100 kW	400V	50 Hz	others
Venice	OPS point Nº5	Yachts /Boats/Tug/Pilots	OPS LV	less than 100 kW	400V	50 Hz	others

Figure 19: OPS points in port of Venice

3.2.11 La Rochelle port

The city of La Rochelle, which is also the prefecture of the Charente-Maritime department in the Nouvelle-Aquitaine region, is situated in the southwest of France. 7,580 solar panels were installed on the submarine base's roof in the La Rochelle port as shown in Figure 20 to produce 7 MW in 2018[34]. This photovoltaic plant was accomplished as a result of the Atlantic Port of La Rochelle's solarization project, which was started in 2014. Seven photovoltaic rooftops were first installed as the beginning. In 2016, they were installed on hangars. Therefore, the Port acts as a true energy source with sustainable development for local towns' self-consumption[35].

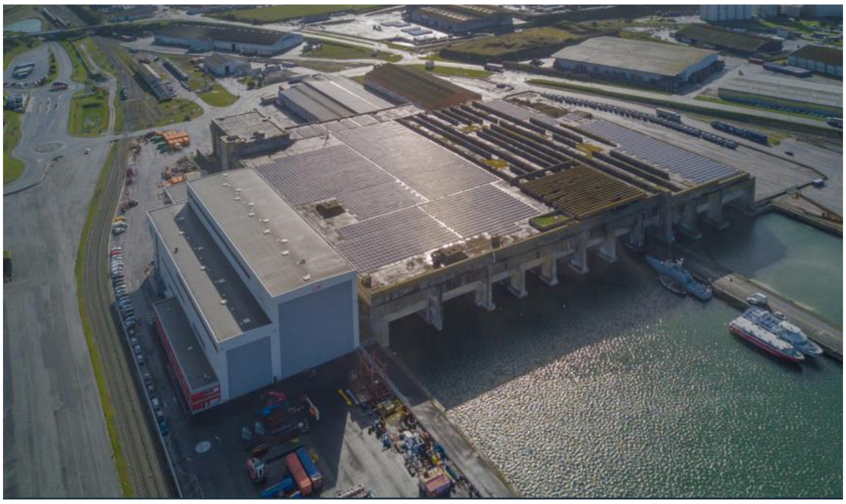

Figure 20: The roof of the submarine base in the La Rochelle port

[34] https://theconversation.com/how-shipping-ports-are-being-reinvented-for-the-green-energy-transition-162907

[35] https://www.talesun-solar.com/portfolio/clean-fast-energy-3-4/

Moreover, there are photovoltaic panel mountings at the port of La Rochelle through 11500 m^{2}, as shown in Figure 21 and, generating 1.75 MWp, its commission date was in 2015 [36].

Figure 21: Solar PV panels mountings at the port of La Rochelle

3.2.12 Port of Bordeaux

A new LNG hybrid dredger for the Port of Bordeaux has a water injection dredging system and an LNG diesel-electric propulsion system. There will be two electric motors in the two main propulsion components, each with a nominal output of 1,200kW at 1,600rpm. A 400kW at 1,500 rpm electric motor will be part of the bow thruster auxiliary propulsion system[37].

In 2020, this new and environmentally friendly dredger (L'Ostrea) took the place of the grab hopper dredger La Maqueline. The dredger is able to burn both LNG and Marine Light Diesel thanks to the dual-fuel engines. Natural gas produces 25% less CO_2, 80% less NOx, nearly no sulfur dioxide, and very little particle matter when compared to diesel. The Atlantic Port of Bordeaux will be able to maintain the port accesses and equipment in a way that is less harmful to the environment by using this kind of fuel along with more energy-efficient diesel-electric propulsion and water injection dredging.

[36] https://dome-solar.com/en/photovoltaic-installations/our-photovoltaic-mountings-at-the-port-of-la-rochelle/
[37] https://www.docksthefuture.eu/french-port-opts-for-hybrid-lng-dredger/

The dredger shown in Figure 22 has a hull of approximately 40 m x 11 m. There are 2 azimuth thrusters and 1 bow thruster. There is a water injection pressure of 2.5 bars. The ship has a service speed of 12 knots[38].

Figure 22: Bordeaux's port was fitted out with an LNG-powered dredger

3.2.13 Le Havre Port

For the marine work on the Joannès Couvert quay as part of Siemens Gamesa's building of an offshore wind turbine factory in the Port, the Port of Le Havre has signed a contract with a consortium of businesses led by Eiffage Génie Civil. These renovation projects will take 84 weeks to complete, starting from the date the contract was signed (April 2021), according to the Port's website[39].

Figure 23: Le Havre Port Upgrading Quay for Siemens Gamesa's Offshore Wind Turbine Plant

[38] https://www.lngindustry.com/liquid-natural-gas/23012018/new-innovative-and-eco-efficient-dredger-for-the-port-of-bordeaux/
[39] https://www.haropaport.com/en

The partnership will construct two quayside berths 400 meters linearly from the existing quay. A 200-meter "Jack-up" quay will be used to load large, heavy components that are kept on the quayside, and a 200-meter "Lo-Lo" quay will be used to receive and distribute a variety of components [40].

3.2.14 Port of Constanța

The largest port in Romania, Constanța Port, has started a new initiative to generate solar energy using a floating PV system on berth 99. The device can survive waves with an amplitude of one meter and produce 15,000 kWh yearly. Part of the port's infrastructure as well as nearby public lights are powered by the system. Its mobility makes it special since it can be relocated to locations where electricity is required. Using the energy generated by this cutting-edge technology, the Maritime Ports Administration Constanța plans to supply electricity in the vicinity of berth 99 and its extension for public illumination and tugboats. The system, which enables simple distant data transfer, is made up of floaters, an anchoring system, a staff-accessible platform, tools for installing cables, solar panels (22 panels), and energy storage devices (Figure 24). It could be expanded to include all of Constanța Port's unlit sections, depending on how the new project develops.

Figure 24: Unique floating PV energy production project in Constanta Port [41]

[40] https://www.offshorewind.biz/2021/04/15/le-havre-port-upgrading-quay-for-siemens-gamesas-offshore-wind-turbine-plant/

[41] https://pioneers-ports.eu/portfolio-item/unique-floating-pv-energy-production-project-in-constanta-port/

3.2.15 Port of Bergen

In order to eliminate the need for cruise ships to operate their engines to produce electricity during their existence in the harbor, the port constructed a cutting-edge shore power station. With a 48 Megavolt-Ampere capacity, this is the biggest shore power station in all of Europe. All of the shore power installations at Port of Bergen are owned and managed by Plug. In Bergen, there were already effective shore power facilities for offshore vessels when development on the cruise installations started. Connecting cruise ships to shore electricity has a profoundly positive impact on the environment. Shore electricity from Plug is entirely renewable and comes with a Guarantee of Origin (GoO). This guarantees that electricity is generated from green energy sources like hydropower and wind power. Plug is the result of a partnership between Port of Bergen, and BKK, a Norwegian grid company and provider of energy solutions[42].

Figure 25: The port of Bergen offers emission-free shore power

Port of Bergen has consequently taken the lead in creating the Environmental Port Index (EPI), a reporting tool for operating ships in port, in partnership with DNV and other Norwegian ports. The reporting system gathers a lot of data on how the ship was run when moored in port, with an emphasis on fuel and energy usage. After analysis and quality control, a score between 0 and 100 points is given to the ship. A ship that has done more than the bare

[42] https://businessnorway.com/articles/green-ports-bergen-aims-greenest-smartest-port-europe

minimum to comply with the authorities' standards will receive a very low score, whereas one with minimal emissions of CO_2, NOx, and SOx while in port would receive a high score.

Ports can aid in guiding the shipping sector toward a cleaner future in this way. Green bonuses are based on the EPI score. This indicates that there won't be a change in port fees at Port of Bergen for a ship with a score of about 30. A lower-scoring ship will pay a significant extra cost, whilst a higher-scoring ship will pay less. The first-generation EPI reporting tool was created for cruise ships since they are a substantial source of port-based CO2, SOx, and NOx emissions.

3.2.16 Port of Stockholm

Ports of Stockholm currently has five solar cell system installations that have a total production capacity of 995 MWh/year. Table 2 shows the distribution of solar cell facilities at each port. The first was placed into service at Frihamnen Port in 2013 while the combined solar cells system facilities maximum power production is 995 MWh.

Table 2: The destribution of solar cell facilities per each port

Port	Number of Solar panels	Solar cell surface area (m^2)	Maximum power output (kW)	Electricity (MW/year)
Frihamnen port	885	1400	225	200
Nynashamn port	500	800	125	125
Kapsellskar port	225	400	60	55
Vartahamnen port	166	270	55	55
Stochholm Norvik port	1610	3600	605	560
Total	3416	8551	1070	995

The description of Norvik port and Vartahamnen is included below:

Stockholm Norvik Port

New RoRo and cargo terminal Stockholm Norvik Port is at a great location. Stockholm Norvik, a new deep-water port on the Baltic Sea, provides easy access to one of Europe's most rapidly expanding areas.

There is a solar cell system facility on a 3,600 m^2 that has a maximum power output of 605 kW and can provide electricity up to 560 MWh annually, which is enough to power 25 detached dwellings of average size. The solar cell system was built by Idola Solkraft.

The system is situated on the roof of the port's biggest building, and it will generate power for use in port operations. All of the structures are prepared for the installation of rooftop solar cell systems and built in accordance with Miljöbyggnad Silver environmental standards. All quay-berths in the port are equipped for vessel shore power connection, and the entire port is powered by green electricity that has been approved. The 44-hectare Stockholm Norvik Port lies 50 kilometres south of Stockholm. There are two sections to the port. The container terminal, which takes the place of the CTF container facility at Frihamnen Port, is one component of the port.

Figure 26 : Solar cell system located in Stockholm Norvik Port[43].

Värtahamnen port

The Värtahamnen port is a cutting-edge port with several eco-friendly features. The currents in the Lilla Värtan Bay are not significantly affected by the pier's construction.

According to the highest Gold grade of the Sweden Green Building Council Miljöbyggnad certification system, the Värta Terminal was designed and constructed with the environment in mind. As a result, the building satisfies the highest standards for energy, internal climate,

[43] https://www.offshore-energy.biz/stockholm-norvik-port-launches-swedens-largest-port-solar-cell-system/

and materials. A 270 m^2 high-performance solar panel system is installed on the terminal's roof. The terminal building's display displays how much energy the solar cells supply. The facility generates 55 MWh yearly, which accounts for around 10% of the building's energy usage.

The port area is illuminated by LED lighting masts, which use less energy than conventional lighting. LED lights don't need to be changed as frequently and have a longer sustainable lifespan. The ability to control where and how long port sections are lighted is another benefit of using a control system. The terminal makes use of renewable energy.

The port is set up with onshore power supply facilities so that ships may connect to the onshore power supply and avoid using their auxiliary engines at the quayside. Emissions and noise pollution are decreased[44].

3.2.17 Port of Hamburg

The Port of Hamburg is a seaport located on the Elbe River in Hamburg, Germany, 110 kilometers from the river's mouth at the North Sea. It is referred to as Germany's "Gateway to the World" and is the largest seaport in terms of volume.

Since roughly one and a half years ago, Eurogate, the owner of a container terminal, has been running its own 2.4 MW Nordex N117 wind turbine. With an output of more than 8 GWh, it can supply 25 to 50 % of the electricity needed by the terminal. The CHP, solar power, and wind power already provide two-thirds of the electricity used at the Hamburg terminal. About 13 GWh of electricity is produced on-site via the Nordex N117 wind turbine (2.4 MW), a combined heat and power plant (1 MW), and solar arrays. By 2020, energy usage per container was successfully reduced by 20% to 47.7 kWh. It is the highest wind turbine in Hamburg, standing 200 meters tall and sporting 58.5-meter rotor blades (Figure 27). The wind turbine will produce a CO2 saving of 4,600 tons/year. [45].

[44] https://www.portsofstockholm.com/about-us/environmental-work/environmental-measures/onshore-power-connection/

[45] https://marketing.hamburg.de/energy-transition-in-hamburgs-port.html

Figure 27: Wind turbine at the port of Hamburg

Hamburg Wasser has installed a second wind turbine at the Dradenau wastewater treatment plant in the Port of Hamburg. The 180-meter-tall turbine will generate up to 9,000 megawatt hours of renewable electricity and 3.6 megawatts of power annually, helping the corporation get closer to its 2030 objective of energy self-sufficiency.

There is a new all-electric hybrid dredger that named Chicago. This ship is incredibly strong and ecologically friendly. It will be crucial in preserving the canals' navigability and the draft in the vicinity of Hamburg Harbor, enabling other ships' safe passage. The new dredger, with its performance and green hybrid propulsion, represents another step towards sustainable shipping at the Port of Hamburg[46].

The Port of Hamburg will house the construction of Germany's first significant green energy import facility. This is a critical phase in building the port's infrastructure for the import and distribution of green ammonia. The intended import terminal will be situated in the Port of Hamburg alongside Mabanaft's current tank farm. The plan is to use Air Products facilities in Hamburg to transform ammonia into green hydrogen, which will then be sold to customers in the region and across northern Germany. It intends to start providing hydrogen to Germany in 2026[47].

46 https://www.espo.be/practices/new-hybrid-dredger-with-full-electric-capability-i
47 https://www.espo.be/practices/first-german-import-terminal-for-green-ammonia-in-

The Port of Hamburg has two new diesel-electric hybrid firefighting boats. The state-of-the-art plug-in hybrid boats can operate totally electric and emissions-free for lengthy periods in and around the Port of Hamburg, thanks to their 315 kWh battery capacity. Hamburg's fire department will run Prag, while Dresden will provide assistance to the Hamburg port authority, the fire department, and other parties. They are geared to tackle flames outside of the municipal limits have a maximum speed of 12 knots and are 35.5 meters long. Damen Shipyards Kozle in Poland constructed the vessel's hulls, which were subsequently shipped to Damen Shipyards Hardinxveld in the Netherlands for final assembly[48].

Figure 28: Firefighting diesel-electric hybrid vessels at the port of Hamburg

3.2.18 Port of Kiel

In Kiel, Germany, there is a substantial port for both passenger and freight ships called the Port of Kiel. It encompasses the approach to the locks at the eastern end of the Kiel Canal and is located in the interior of the Baltic Sea inlet Kieler Förde.

On the top of the 175-meter-long gangway to the northern berth at the cruise port, about 300 solar modules were installed (Figure 29) at the beginning of August 2021. The overall predicted system output is close to 100 kW due to the 335 W output of each PV panel. Approximately 90 MWh of green power can be produced annually, depending on the weather. This amount is equivalent to around 30 individual families' annual usage[49].

48 https://www.espo.be/practices/hybrid-port-vessels-at-the-port-of-hamburg
49 https://www.offshore-energy.biz/port-of-kiel-invests-in-solar-power-to-become-climate-neutral/

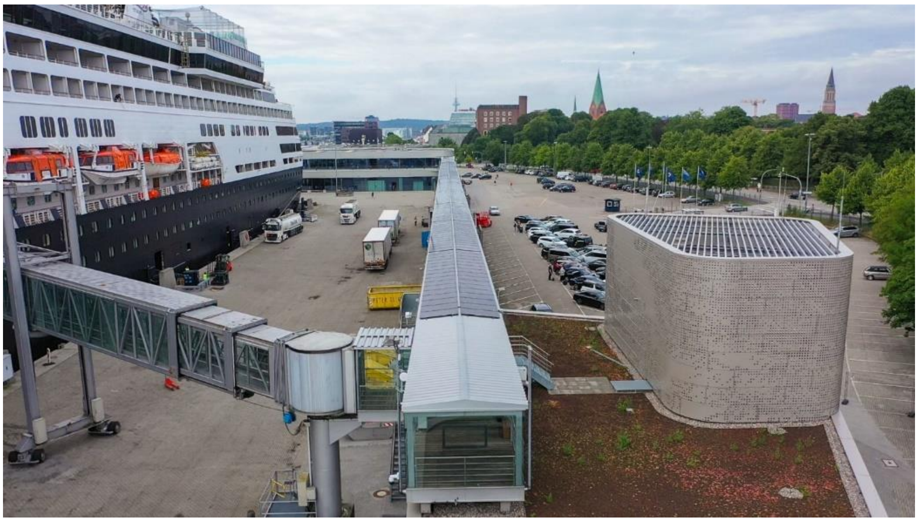

Figure 29: Photovoltaic system installed at the cruise terminal[50]

3.2.19 Port of Ennshafen

The Rhine-Main-Danuberiver runs from west to east, and the north-south rail lines from the North Sea to the Adriatic Sea are connected via Ennshafen port. The worldwide marine decarbonization program does not directly affect the port because it is an interior port. The port strategy document is, however, in line with what is needed for EU-level policy plans and instruments. At the port level, regional initiatives include railroad upgrades, LNG projects, OPS, and digitization. PV investments have been processed, and fresh, larger PV investments as well as investments in a waste energy pipeline, are in the works.

3.2.20 Port of Syros

The design Master Plan of new buildings in the port of Syros provides for the installation of more photovoltaic systems and an energy-reduced design as far as possible. This integration of sustainable technology infrastructure in the port of Syros will further contribute to their goals for emission reduction and overall sustainability [51].

3.2.21 Shoreham Port

Shoreham Port, one of the main cargo-handling ports on the south coast, and Brighton Energy Coop (BEC) have a long-standing relationship. BEC has more than 2000 solar panels on Port

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50 https://www.portofkiel.com/news-reader-en/kiel-can-nearly-maintain-its-cargo-handling-volumes-kopie.html

51 https://www.portofsyros.gr/en/facilities/ports/syros/

structures, including two sizable industrial sheds and a business centre operated by the Port. All BEC's PV systems at the Port were created by an internal team and constructed in 2012 and 2013, generating a sizable amount of the energy required to run this essential Sussex facility.

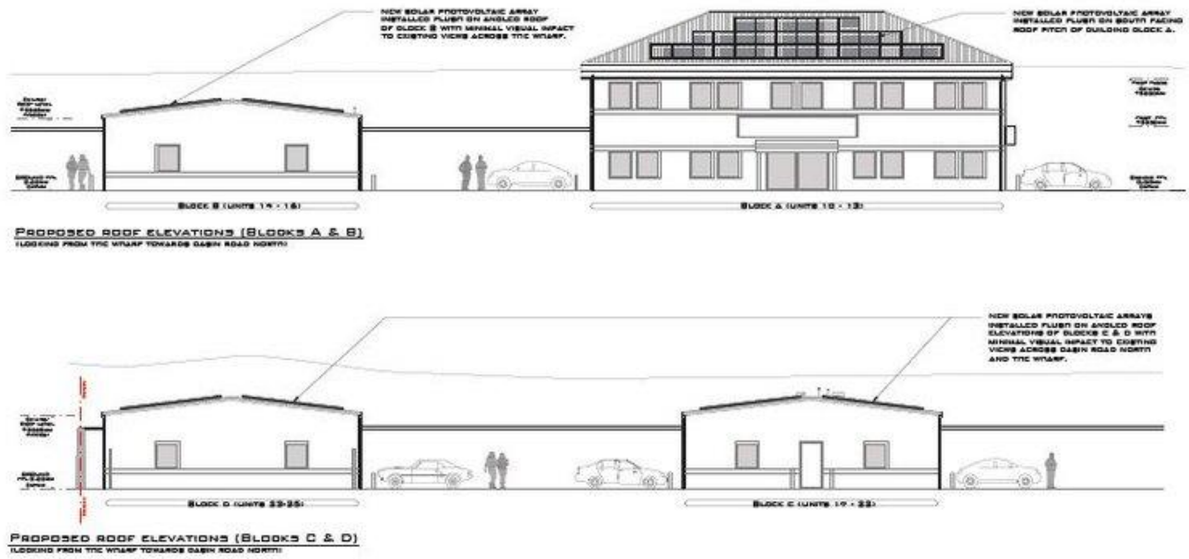

Figure 30: Shoreham Port going green[52]

3.2.22 Port of Seattle

Seattle is an American port located in Washington, United States. Four solar arrays on port facilities have been installed by the port, including a test project on a net shed at Fishermen's Terminal, the rooftop of Pier 69, the port's administrative building, and most recently two arrays at Shilshole Bay Marina. The Port's Century Agenda Goal, to fulfill all growing energy demands through conservation and renewable sources, is being furthered by these initiatives, which show the Port's dedication to the development of renewable energy sources. The Port is getting closer to its objective of becoming carbon neutral or negative by 2050 compared to 2005 thanks to these initiatives, which will cut greenhouse gas emissions by 50% by 2030[53].

<u>Pier 69 Solar Project</u>

52 https://www.shoreham-port.co.uk/need-to-know/news/shoreham-port-going-green-1585/
53 https://www.portseattle.org/projects/solar-power-port

The American Can Company, which created cans for salmon in 1931, erected the three-story, 191,000-square-foot Port headquarters, where the solar array was placed. The Port bought the building in 1988, and later refurbished and remodeled it. Pier 69 is the perfect place to build the solar array because the slanted metal roof faces straight south.

The Port and the State Department of Commerce jointly sponsored the project. The project is expected to produce roughly 120 MWh per year by using 390 solar panels as shown in Figure 30, which would reduce greenhouse gas emissions by 2.0 to 2.5 tons of CO_2. The idea aimed to reduce annual energy expenses by $10,000. The system consists of 390 monocrystalline PV panels from Washington. Puget Sound Solar created and put in the system. 2019 saw the project's completion[54].

Figure 31: Pier 69 Solar Project

Fishermen's Terminal Solar Demonstration Project (Net Shed 5)

The North Pacific Fishing Fleet stores its fishing nets and equipment in the net sheds at Fishermen's Terminal, a convenience that aids in keeping the fishermen there as tenants. Fishermen's Terminal Net Sheds 3, 4, 5, and 6 all need new roofs, so the Port installed one of the roofs using solar energy as a smaller-scale trial project to test solar and collect information for future solar panel installations. The test includes 44 solar panels made in Washington on

54 https://www.portseattle.org/projects/solar-power-port

Net Shed 5. A&R Solar implemented the Cornerstone Architectural Group's design. In 2017, the project was finished[55].

Over 16.6 MWh were produced by the array in its first year of operation, exceeding initial expectations of 1 MWh for the full year by 10%. The electricity generated makes Net Shed 5 "net zero," with any extra kilowatt hours dispersed for other requirements at Fishermen's Terminal. The net shed requires 10MWh of energy to operate annually.

The array is also expected to reduce greenhouse gas emissions by almost half a metric ton of CO_2 annually [56].

Figure 32: Fishermen's Terminal Solar Demonstration Project

Shilshole Bay Marina Solar Project

The new Central and South Customer Service Facilities at Shilshole Bay Marina now include two similar solar arrays. The Port Commission gave the go-ahead for the construction of these additional customer service facilities in 2017. The installation of these solar panel arrays was one of the sustainable design features included in the blueprints. In October 2020, the solar arrays were formally turned on and began generating electricity.

Each building has a solar array that is around 2,000 square feet in size and was installed by A&R Solar under the primary construction contract with Western Ventures Inc. 23,500 kWh is

55 https://www.portseattle.org/projects/solar-power-port
56 https://www.portseattle.org/projects/solar-power-port

the estimated yearly solar generation capacity. Up to 70% of the yearly power usage for the bathrooms is anticipated to be generated by the system.

Figure 33: Shilshole Bay Marina Solar Project [57]

Electricity generated at P69, Fishermen's Terminal, and Shilshole Bay Marina is shown below as of 11/1/2022.

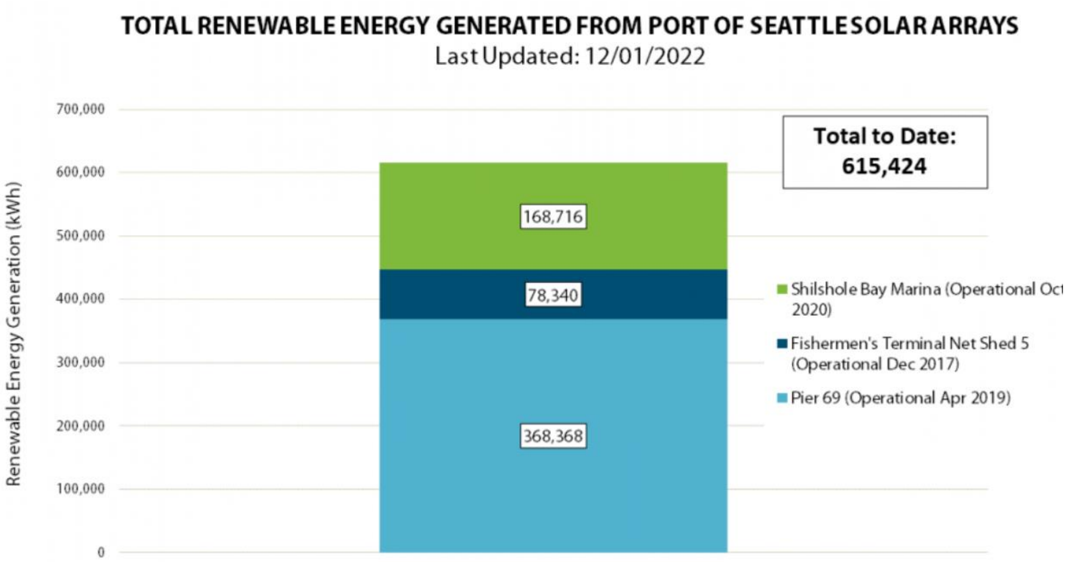

Figure 34: Electricity generated at P69, Fishermen's Terminal, and Shilshole Bay Marina

3.2.23 Port of Oakland

A significant container ship facility called the Port of Oakland is situated in Oakland, California, on the San Francisco Bay. It was the first significant port on the American Pacific Coast to construct container ship facilities.

57 https://www.portseattle.org/projects/solar-power-port

A recently enlarged solar array at Antelope Valley Solar Ranch now includes a stake owned by the Port of Oakland. The Oakland Seaport and Oakland International Airport are only two tenants served by the port's utility, which it owns and runs. Approximately 11,000 MWh of power per year will be purchased by the port from the solar farm near Lancaster, California. The port predicts and thinks investing in this renewable energy would save it money over the next 20 years since solar energy is less expensive than the energy the port would have needed from fossil fuels. The yearly energy output accounts for around 7% of the port utility's total energy requirements[58].

Figure 35: Port of Oakland launches solar project.

The Board of Port Commissioners of the Port of Oakland has approved the purchase of up to $13.5 million in geothermal energy over a 12-year period. For the Port and its tenants at the ports and airport, geothermal energy offers a safe, dependable, and entirely renewable energy source. The Geysers Power Company (Geysers) facilities, located about 75 miles north of San Francisco in Middletown, will be the source of the geothermal energy. With thirteen facilities straddling the boundary between Sonoma and Lake County, The Geysers is one of the world's biggest and cleanest geothermal steam fields and the largest complex of geothermal power plants.

The cost of the geothermal energy purchase, which will last from January 1, 2025, through December 31, 2036, will be around $1,125,000 per year. To supply the Port and its clients with energy, geothermal will make up around 10% of our entire energy portfolio annually. Port Utilities obtains its main sources of renewable energy from a variety of sources, giving

58 https://www.porttechnology.org/news/port-of-oakland-launches-solar-project/

geothermal, biomass, solar, and wind energy a top priority. The Geysers can generate 725 MW of electricity on average, which is sufficient to power 725,000 houses or a metropolis the size of San Francisco[59].

3.2.24 Hutchison Ports

The most cutting-edge port development project in Spain is Hutchison Ports BEST, the first semi-automated terminal in the Hutchison Ports Group. It boasts an eight-track railway facility, the largest on-dock railway terminal of any port in the Mediterranean, which connects it to traffic arriving from and headed towards Southern Europe. It is capable of handling numerous mega-vessels at once.

1832 solar panels have been erected on over half a hectare of structures at Hutchison Ports BEST port. BEST has already committed to purchasing power with a guarantee of being produced entirely from renewable sources by the start of 2022, maintaining its strong commitment to the decarbonization of the industry[60]. This auto-supply infrastructure can provide 1.18 GWh of power, which is around 200 households' worth of yearly electricity use. The installed power is 833.56 kW, or about 1 MW. Solar Profit is the organization in charge of installing the panels. In October 2023, 6 new hybrid cranes were delivered to the BEST terminal[61]. Since they are in charge of moving containers around the various parts of the facility, these cranes, known as Shuttle Carriers, are essential to the terminal's operations. Due to the utilization of a high-efficiency regenerative energy system and the addition of this new equipment, CO_2 emissions will be reduced by up to 40%, significantly enhancing the terminal's energy efficiency. By doing this, BEST reinforces its status as one of Europe's most ecologically friendly facilities. BEST reduces emissions for each cargo by 65% as compared to a regular port.

3.2.25 Port of Lowestoft

The Port of Lowestoft is a harbour and commercial port owned by Associated British Ports (ABP) in Lowestoft, Suffolk, England. It offers direct sea access to the North Sea and is the most easterly harbour in the United Kingdom.

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59 https://geysers.com/geothermal
60 https://www.best.com.es/en/2022/11/21/energy-auto-supply-a-future-challenge-for-terminals-best/
61 https://www.best.com.es/es/2023/10/09/best-da-un-paso-mas-hacia-la-descarbonizacion/

The Gannet, a new workboat, has been placed into service to collect trash, waste, and aquatic vegetation near the Port of Lowestoft. The Gannet's primary job is to remove trash from the water's surface. Its acquisition by APB will be crucial in preventing pollution in Lowestoft Harbour and Lake Lothing. The Gannet does more than gather trash to contribute to Lowestoft Harbour's sustainability. It is hybrid-powered, has solar panels on the roof that provide clean electricity, and is constructed of recyclable aluminium that can be recycled when it has served its purpose. The company that created the vessel is called Water Witch, and it is a family-run firm with headquarters in Liverpool. The ship has been delivered to the port in March 2023.

Figure 36: ABP's Port of Lowestoft team welcome the Gannet[62]

3.2.26 Port of Sète

One of the most significant participants in French marine transportation is the port of Sète-Frontignan. It is owned by the Occitanie/Pyrénées-Méditerranée region and is the second-largest regional harbor in France.

In order to offer clean power to the Port of Sète, two offshore floating solar units have been set up in the Mediterranean Sea as part of the Sun'Sète project[63]. In mid-March 2023, the Sun'Sète project's initial units were launched. The Sun'Sète project is divided into a number of stages. Its finished configuration will have 25 units, a surface area of 0.5 hectares, and a total installed capacity of 300 kW. By the end of 2023, the remaining units ought to be placed.

62 https://www.abports.co.uk/news-and-media/latest-news/2023/lowestoft-new-trash-eating-gannet/
63 https://solarinblue.com/projects/sunsete/

The production is expected to reach 400 MWh/year at that point, and it will be sent via an undersea cable to power the Sète port's infrastructure with clean energy[64].

SolarinBlue's technology has a lightweight, environmentally friendly design that is 90% recyclable because of a treated steel frame and recyclable High-Density Polyethylene (HDPE) floats. The panels are never in touch with the waves, and the floating structure can endure 200 km/h winds and waves that are 12 meters high.

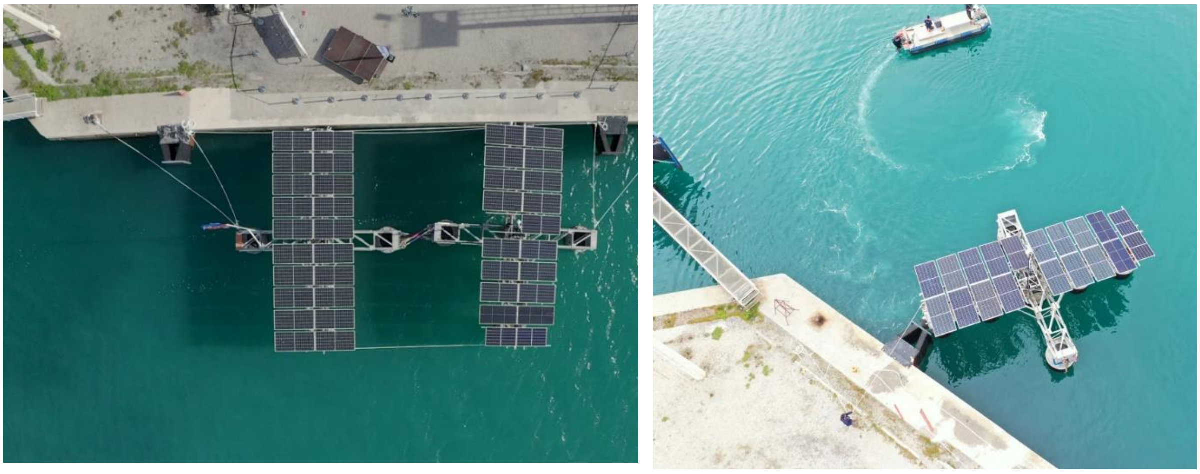

Figure 37: SolarinBlue's offshore floating solar units in the Mediterranean[65]

3.2.27 Port of Bremerhaven

One of the two 'twin ports' of Bremen, the Bremen Ports, is the Bremerhaven Seaport. By substituting hydro-treated vegetable oil (HVO) for diesel in the port's shunt trains, Bremerhaven has been able to reduce "last mile" emissions. As a result, last-mile transportation is substantially cleaner. An initiative dubbed "Climate and emission protection on the last mile in rail freight transport" has made this change possible. The usage of HVO, according to the railroad operators, cuts greenhouse gas emissions by around 90% annually.

3.2.28 Port of Portsmouth

The first port in the UK with solar canopies is Portsmouth International Port. There are currently 2660 solar panels in the port's solar and battery system. Three-quarters of the site's energy requirements are met by energy generation. Additionally, the new battery's 1.5 MWh

64 https://www.espo.be/practices/frances-first-offshore-solar-farm-in-the-port-of-s
65 https://solarinblue.com/projects/sunsete/

capacity stores green energy and will soon allow the port to use 98% solar and battery-sourced electricity during peak hours. The project started with installing roof-mounted solar panels across several buildings, large battery storage, and the first solar canopies at a UK port[66]. It was managed by the in-house energy services and building services teams of Portsmouth City Council, installed by Custom Solar and assisted by engineers at the port. The project's final component, an enhanced link to the national grid, enabled the 1.2-megawatt peak system to operate to its full capability in July 2023.

Figure 38: Portsmouth International Port makes the switch to solar power[67]

3.2.29 Port of Hull

The biggest commercial rooftop solar array in the UK has been launched by Associated British Ports (ABP), and it is positioned at the Port of Hull. 6.5MW of electricity will be generated by the array. 2,600 tons of CO_2e per year would be avoided because of ABP's 6.8 million investment. August 2020 saw the completion of the installation of the 21,000 solar panels, which were powered by 3 PVS-50-TL 50kw inverters and 49 PVS-100-TL 100kw inverters from FIMER, a leading manufacturer of solar inverters worldwide.

66 https://www.espo.be/practices/solar-power-project-at-portsmouth-international-po

67 https://www.portsmouth.gov.uk/2023/08/11/portsmouth-international-port-makes-the-switch-to-solar-power/

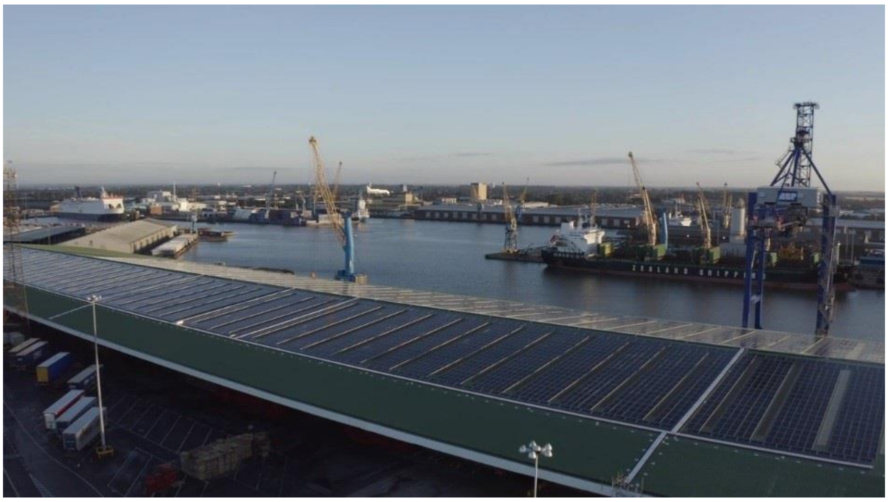

Figure 39: Rooftop solar array in the port of Hull [68]

At the Port of Hull, a new fleet of four-wheeled electric forklift trucks has arrived. The roughly £200,000 expenditure is a part of continuous efforts to lower emissions and utilize more renewable energy produced at the port.

3.2.30 Port of Southampton

The Port of Southampton's newest cruise terminal, Horizon Cruise Terminal, debuted in September 2021. It has over 2000 roof-mounted solar arrays, generating an 871kWp (Kilowatt Peak) system that will produce 850MWh annually.

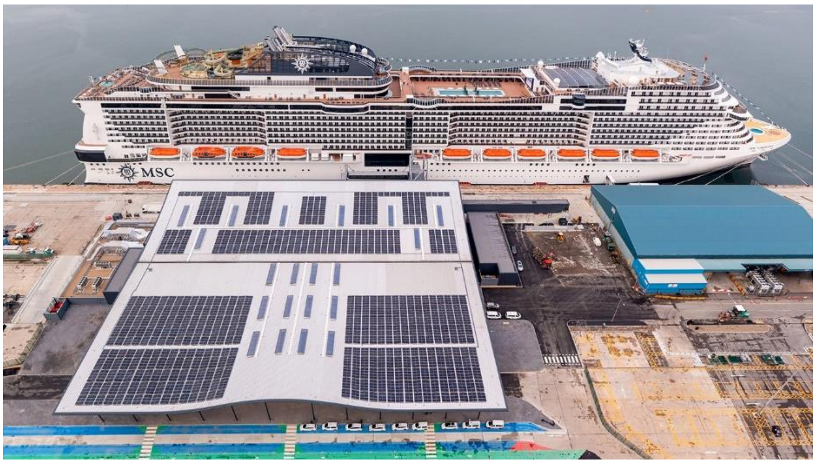

Figure 40: Portsmouth International Port makes the switch to solar power[69]

[68] https://www.abports.co.uk/news-and-media/latest-news/2020/abp-celebrates-the-completion-of-the-uk-s-largest-rooftop-solar-array-at-the-port-of-hull/
[69] https://www.maritimeuk.org/priorities/environment/netzeromaritime-showcase/horizon-cruise-terminal/

The Port of Southampton celebrated the effective installation and operation of its cruise ship shore power plant. In order to berth with zero emissions, ships equipped with shore power may now plug in at the port's Horizon and Mayflower cruise terminals. The Solent Local Growth Deal grant, obtained through the Solent Local Enterprise Partnership (LEP), covered the project's whole £9 million cost.

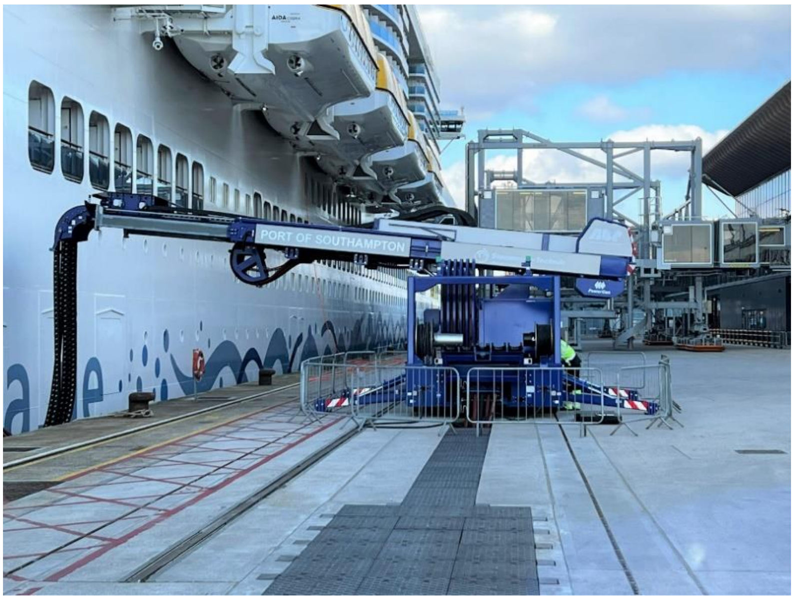

Figure 41: Shore power at Horizon Cruise Terminal[70]

3.2.31 Port of Leith

As the first significant commercial port on the Scottish mainland to provide a shore power (OPS) connection, the Port of Leith. This demonstrates Forth Ports' dedication to lowering both its own and its clients' carbon footprints. Vessels at the port may now use Forth Ports' electricity, produced from non-fossil fuels, by switching to shore power instead of using any of their fossil fuel-powered generators. This is an important milestone in the port's journey toward net zero emissions[71]. The Victoria I, a 40,975 gross-ton ferry operated by Tallink, is powered by the first shore power installation. Since July 2022, the 635-foot ship has been anchored at the port[72].

70 https://www.abports.co.uk/news-and-media/latest-news/2022/shore-power-goes-live-at-port-of-southampton/

71 https://www.espo.be/practices/port-of-leith-first-port-in-mainland-scotland-to-l

72 https://maritime-executive.com/article/port-of-leith-becomes-first-scottish-mainland-port-with-shore-power#:~:text=The%20Victoria%20I%20is%20the,generators%20using%20Forth%20Ports'%20electricity.

3.2.32 Port of Gothenburg

The largest port in Scandinavia, the Port of Gothenburg runs a variety of heavy freight handling machinery as a crossroads for road, rail, and sea transportation. The Gothenburg Port and the Statkraft energy firm in Norway intend to build a hydrogen manufacturing plant there. Construction on a hydrogen-generating plant has already begun at the Port of Gothenburg. The Port anticipates that the facility will begin to run in 2024. Up to 2 tons of hydrogen might be created each day at the new plant, which has a 4 MW capacity. There is currently a significant need for hydrogen-powered equipment in and around the port, and hydrogen might replace fossil-based fuels in a variety of port-related equipment[73].

The Port of Gothenburg has significant knowledge of shoreside connections and is actively striving to get more ships to switch to shore power at the quayside. The first onshore power source to be installed at the Port of Gothenburg is the RoRo-terminal at Älvsborg Harbour. At berths 700 and 712, it was established in 2000. Since 2011, all of Stena Line's ferries have been using the Onshore Power Supply in place of their engines. The Gothenburg Port Authority has developed a brand-new and distinct idea as part of an innovative strategy to supply shoreside electricity for tankers berthed at the Energy Terminal, making the entire system secure, cost-efficient, and environmentally beneficial.

In addition to national and European ports, classification societies, regional oil firms, and the Swedish Transport Agency, the initiative, dubbed Green Cable, is being managed by maritime companies on the island of Donsö. When green electricity is used instead of marine diesel, 1,800 tons of CO2 are saved annually as a result of powering tankers. The Energy Terminal will link the first ship to a green shoreside power source around Q1 2024. Up to 2 MW of power per jetty. 6.6 kW of supply voltage. 50 Hz is the grid frequency[74].

3.2.33 Port of Den Helder

The case study from the Port of Den Helder[75] demonstrates a holistic approach to developing the port as an energy hub in its pursuit to become a sustainable offshore logistics port from

73 https://www.espo.be/practices/hydrogen-production-facility-at-the-port-of-gothen
74 https://www.portofgothenburg.com/about/projects-at-the-port/onshore-power-supply-for-tankers/
75 https://portofdenhelder.nl/business/port-development#:~:text=(1)%20The%20realization%20of%20a,road%20and%20water%20by%202022.

an offshore service port. The port is developing as a maintenance hub for renewable energy extraction in the North Sea, moving away from its position as a maintenance hub in oil and gas extraction. The port strategy also focuses on the development of the infrastructure required for the transition of the port from the North Sea gas hub to the Hydrogen hub. The Port of Den Helder, along with ENGIE [76], Damen Shipyards and other stakeholders, were awarded a DKTI subsidy to develop a hydrogen filling station for maritime and road transport in the region. Green hydrogen transition facilitated by the port will play an important role in driving emission-free shipping throughout the Wadden Sea. The ambition document on the further sustainability of the port aims to have the Port Authority's business operations, climate-neutral by 2025. But the ambition goes further and aims for a completely climate-neutral port chain by 2050. The sustainability development strategy addresses three performance areas within the port: Energy, Emissions, and Circularity.

3.2.34 Port of Gdynia

Gdynia[77] is the base node of the TEN-T network and a Category A port. The location of the Port of Gdynia is related, among others, to the role it will play in the Baltic-Adriatic Corridor, one of the 9 key Trans-European Transport Corridors of the TEN-T networks. Gdynia port demonstrates an active environmental policy and numerous initiatives aimed at mitigating its negative impact. When developing the policy, the criterion of its compliance with strategic documents of a higher order of international and national importance, as well as documents of the regional and municipal level, was guided. These actions include active participation in European partnership initiatives on reducing pollutant volumes entering inland waters. [78] The port monitors harmful particulate matter content in the air and regularly tests the quality of water and soil on the port premises. Control measurements are also carried out beyond the port borders and cover dumping sites for depositing dredging spoil. The implementation of LNG bunkering facilities for ecological fuel as an alternative to traditional fuel is another key operational aspect. These measures fit well with the concept of green ports.

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76 https://www.engie.com/en

77 https://www.engie.com/en

78 Żukowska, S. (2020). Concept of Green Ports. Case study of the Seaport in Gdynia. Prace Komisji Geografii Komunikacji PTG, 23(3), 61–68. https://doi.org/10.4467/2543859xpkg.20.020.12788

3.2.35 Success Cases Summary

A summary of best practices from the successful cases of clean energy ports that have been gathered in the previous section is shown in the following table, specifying:

- Port name and Country code;
- Port type (e.g. Seaport, Harbor, Riverport) and size (from small to very large);
- Category of best practices: RES=Renewable Sources, AF=Alternative Fuels, SSP= shore-to-ship power, EEFF= Energy Efficiency;
- Description of the best practices adopted or planned;
- Generated energy capacity (MWh/year);
- Technical data (if available).

Table 3 : Summary of best practices from the successful cases

Case No.	Port name (Country code)	Port Type (Size)	Category of Best practice	Best practice	Generated Energy capacity (MWh/year)	Technical data
1	Valencia (ES)	Seaport (Medium)	RES	Solar photovoltaic panels to generate electricity on the Principe Felipe dock.	2,353 MWh/year (3% of required energy in port)	surface area of 6,420 m^2 and a 30% slope
			RES	Solar Park is located on top of Valencia Terminal's vehicle silo.	9,000 MWh/year (11% of required energy in port).	10,773 solar modules with a surface area of 27,700 m^2 and 4-degree inclined.
			AF	Hydrogen supply station for the refuelling station on Xità Quay.		two parts: a stationary portion used for receiving, storing, and compressing hydrogen up to delivery pressure and a portable portion with a dispenser for refuelling port equipment.
			AF	Hydrogen-powered ReachStacker, created as part of the European H2PORTS project		
			RES	Wave energy converter (WEC) to provide environmentally friendly power to the port operations supported by the EU-funded project MAtchUP	130 MW	have a total surface area of 105 m^2, which equates to 77 m^2 of land and 28 m^2 of water surface.
2	Gandia (ES)	Seaport (Small)	RES	Solar energy plant in Shed 4	990 MWh/year	4500 m^2, the project is worth $1.71 million.
3	Barcelona (ES)	Seaport (Large)	RES	Solar panels on Fisherman's Wharf	7 MW	
			RES	Solar power plant erected in the Border Inspection Point (PIF) Area.	50% of the building's energy needs	700 panels were put on the building's roof as well as the pergolas in the parking lot

Case No.	Port name (Country code)	Port Type (Size)	Category of Best practice	Best practice	Generated Energy capacity (MWh/year)	Technical data
			RES	Solar arrays in APM Terminals	565 MWh/year (5.12% of the electricity used by the terminal)	980 solar panels
			SSP	SSP systems within the ferry terminal		The method provides an emission reduction per ship of 96% in nitrogen oxides, 8% in sulphur oxides, 94% in particulate matter, and 64% in carbon dioxide.
			AF	LNG supply operations		152,000m^3 of LNG have been supplied through 544 LNG supply operations
4	Rotterdam (NL)	Seaport (Very Large)	AF	Electrolyzer plant will be built on the Tweede Maasvlakte in the port.	200 MW	Up to 60,000 kg of renewable hydrogen can be produced each day.
			AF	Developing an 11-hectare site to house a green hydrogen factory.	1 GW	
			RES	Solar panel system	750 MWh (30% of electricity needs)	3,100 solar panels covering a surface area of 7,500 m^2
			RES	Solar Park atop the Patrizia buildings along Witte Zeeweg 3-21	25 MWp	120,000 m^2 at rooftop.
5	Amsterdam (NL)		RES	Solar panels on port buildings	17 MW	100,000 m^2
			SSP	SSP technologies		

Case No.	Port name (Country code)	Port Type (Size)	Category of Best practice	Best practice	Generated Energy capacity (MWh/year)	Technical data
		Seaport (Very Large)	SSP	Electricity connection for sea cruise at the Passenger Terminal Amsterdam		
			AF	Hydrogen plant in IJmuiden on the Tata Steel site	11 MW	produce up to 15,000 tons of green hydrogen annually
6	Antwerp and Bruges (BE)	Seaport (Very Large)	RES	Wind turbines in Zeebrugge and Antwerp	330 MW	130 wind turbines
			EEFF/RES	LED lighting, rooftops covered with solar panels, and rainwater		
			RES	Concentrated Solar Thermal Energy (CST) farm	1.14MW	two rows of 120 parabolic mirrors. 1100 m^2 of surface area
			EEFF	New battery storage as a part of the PIONEERS project		
			AF	Dual hydrogen-diesel fuel system for straddle carrier		
7	Oostende (BE)	Seaport (Medium)	RES	Floating solar power plant	10kWp	130 m^2 floating solar plant
8	Genoa (IT)	Seaport (Large)	AF	the use of alternative fuels for heating and cooling buildings, such as LNG and biomass		
			RES	Photovoltaic system on the roof of Savona's Palacrociere Cruise Terminal's West Terminal.	120 kW	
			EEFF	Energy-efficient lighting (LEDs)		

Case No.	Port name (Country code)	Port Type (Size)	Category of Best practice	Best practice	Generated Energy capacity (MWh/year)	Technical data
			SSP	SSP system		
9	Ancona (IT)	Harbor (Small)	SSP	Electrification at the quay of Fincantieri shipyard		
			EEFF	Ancona blue agreement addressed the issue of air quality in port environments.		
10	Venice (IT)	Seaport (Large)	AF	Development of the LNG logistics chain		
			SSP	Onshore power supply (OPS) points to serve the ships.		
11	La Rochelle (FR)	Harbor (Small)	RES	Solar panels	7MW	7,580 solar panels
			RES	Photovoltaic panel mountings at the port of La Rochelle	1.75 MWp	11500 m^2
12	Bordeaux (FR)	Riverport (Medium)	AF	LNG hybrid dredger	Two propulsion engines, each with power of 1,200kW at 1,600rpm	hull of approximately 40 m x 11 m. There are 2 azimuth thrusters and 1 bow thruster. The ship has a service speed of 12 knots
13	La Havre Port (FR)	Seaport (Large)	RES	Offshore wind turbine factory		construct two quayside berths 400 meters linearly from the existing quay.
14	Constanta (RO)	Seaport (Large)	RES	Solar energy using a floating PV system on berth 99	15,000 kWh yearly	solar panels (22 panels)

Case No.	Port name (Country code)	Port Type (Size)	Category of Best practice	Best practice	Generated Energy capacity (MWh/year)	Technical data
15	Bergen (NO)	Seaport (Medium)	SSP	Shore power station (SSP)	48 Megavolt-Ampere	
			EEFF	Creating the Environmental Port Index (EPI), a reporting tool for operating ships in port		
16	Stockholm (SE)	Seaport (Medium)	RES	Five solar cell system installations	995 MWh/year	8551 m2 by 3416 solar panels
17	Hamburg (DE)	Seaport (Very Large)	RES	Nordex N117 wind turbine	2.4 MW with an output of 8 million kWh yearly	200 meters tall and 58.5-meter rotor blades. CO2 saving of 4,600 ton/year.
			RES	Wind turbine at Dradenau wastewater treatment plant	9,000 MWh/year and 3.6 MW of power	180-meter-tall turbine
			AF	New full-electric capable hybrid dredger named Chicago		
			AF	Green energy import facility for the import and distribution of green ammonia		
			AF	2 new firefighting diesel-electric hybrid vessels	315 kWh battery capacity	maximum speed of 12 knots and are 35.5 meters long.
18	Kiel (DE)	Seaport (Medium)	RES	Solar modules were installed on the top of the 175-meter-long gangway	100 kWp with 90 MWh/year	300 solar modules
19	Ennshafen (AT)	Seaport (Medium)	RES/EEFF/AF	LNG projects OPS, and digitization.		

Case No.	Port name (Country code)	Port Type (Size)	Category of Best practice	Best practice	Generated Energy capacity (MWh/year)	Technical data
				PV investments have been processed.		
20	Syros (EL)	Seaport (Medium)	RES	Photovoltaic systems		
21	Shoreham (UK)	Harbor (Small)	RES	Solar panels installed on port structures		2000 solar panels
22	Seattle (USA)	Seaport (Very Large)	RES	Four solar arrays on port facilities	615 MWh	
23	Oakland (USA)	Seaport (Very Large)	RES	Solar energy	11,000 MWh/year	
			RES	Geothermal energy	725 MW, 10% of the entire energy portfolio annually	
24	Hutchison BEST (ES)	Seaport (Medium)	RES	Solar panels	1.18 GWh with an installed power of about 1 MW	1832 solar panels
			AF	Hybrid cranes, known as Shuttle Carriers		CO2 emissions will be reduced by up to 40%,
25	Port of Lowestoft (UK)	Harbor (Small)	AF	A new workboat (hybrid-powered with solar panels on the roof) to remove trash from the water's surface		It is constructed of recyclable aluminum.

Case No.	Port name (Country code)	Port Type (Size)	Category of Best practice	Best practice	Generated Energy capacity (MWh/year)	Technical data
26	port of Sète (FR)	Seaport (Medium)	RES	Two offshore floating solar units have been set up	300 kWp (expected to reach 400 MWh/year)	have 25 units, a surface area of 0.5 hectares
27	Port of Bremerhaven (DE)	Seaport (Large)	AF	Utilization of hydro-treated vegetable oil (HVO) in the port's shunt trains instead of diesel.		cuts greenhouse gas emissions by around 90% annually
28	Port of Portsmouth (UK)	Seaport (Medium)	RES	Installation of solar panels and battery system.	1.2 MW	2660 solar panels – battery has 1.5 MWh capacity
29	Port of Hull (UK)	Harbor (Medium)	RES	Commercial rooftop solar array	6.5MW	2,600 tons of CO_2e per year would be avoided by the 21,000 solar panels
			AF	New fleet of four-wheeled electric forklift truck		
30	Port of Southampton (UK)	Seaport (Large)	RES	Roof-mounted solar arrays through Horizon Cruise Terminal	871kWp (850MWh annually.)	2000 roof-mounted solar arrays
			SSP	Shore power plant installation for cruise ship		
31	Port of Leith (UK)	Seaport (Large)	SSP	Shore power (OPS) connection,		
32	Port of Gothenburg (SE)	Seaport (Medium)	AF	Build a hydrogen manufacturing plant	4 MW capacity	2 tons of hydrogen might be created each day
			SSP	Shoreside connections to supply shore power at the quayside		

Case No.	Port name (Country code)	Port Type (Size)	Category of Best practice	Best practice	Generated Energy capacity (MWh/year)	Technical data
33	Port of Den Helder (NL)	Harbor (Small)	AF	Hydrogen filling station for maritime and road transport		
34	Port of Gdynia (PL)	Seaport (Large)	RES/AF	Installation port for wind farms LNG bunkering facilities		

3.3 Policy measures aimed at decarbonization

The integration of the climate dimension in the design of policies with economic relevance, such as energy, transport, industry, or regional development, has been crucial. Climate action is a “massive collective action problem” [79] and policy is one important means of system change which initiates relevant rules, regulations, standards, and incentives. Ports, like many other businesses, operate in a regulatory environment, and therefore, any policy directed at long-term structural changes directly impacts and influences the future development plans of the ports. Policies and decisions play an active role in guiding development towards sustainable and circular solutions. Further, a dynamic relationship exists between public policy and organizational decision-making. There is empirical evidence that supports the notion that climate policy affects organizational decision-making.[80] Public policy measures have the ability to address market failures and establish a conducive environment for innovation and entrepreneurship.[81, 14] In the case of the circular economy, institutional and regulatory factors can act as strategic enablers or barriers to promote innovation towards the circular economy by enabling new forms of cooperation between enterprises and public actors. [82, 83] Largely, there is strong evidence to suggest that public climate policy can significantly impact organizational decision-making, particularly regarding sustainable practices, circular economy, and renewable energy technologies.[84]

In the following sections, the main IMO (International Maritime Organization) and EU (European Union) policy measures aimed at decarbonization are presented.

3.3.1 IMO action on Maritime decarbonization and its impacts on ports

The International Maritime Organization (IMO) was established by Governments as a specialized agency under the United Nations to provide the machinery for intergovernmental

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[79] https://unfccc.int/files/meetings/paris_nov_2015/application/pdf/paris_agreement_english_.pdf

[80] (Kolk & Pinkse, 2007)

[81] (Briguglio et al., 2021)

[82] (de Jesus & Mendonça, 2018)

[83] (Florido et al., 2019)

[84] (Dey et al., 2022)

cooperation in the field of regulation of ships engaged in international trade. IMO is responsible for the global regulation of all aspects of international shipping and has a key role in ensuring that lives at sea are not put at risk, including security of shipping, and that ships operations do not pollute the environment. Adapting IMO rules is a tedious process, the outcome, once ratified by an agreed number of its member states, becomes a new global standard. Member states are then required to transpose IMO rules into their domestic legislation, to make them legally enforceable in their waters. In addition, local regulations may also apply in many regions like the EU.

In 2011, through the adoption of Marine Environment Protection Committee (MEPC) resolution 203 (62)[85] , IMO adopted amendments to MARPOL Annex VI on Regulations for the prevention of air pollution from ships and introduced new regulations on energy efficiency for ships. It was the first set of international mandatory measures to improve ships' energy efficiency. In 2015, reduction targets for international shipping and international aviation were left out of the Paris Agreement. Subsequently, in the past decade, IMO has taken further action, including further regulatory measures and the adoption of the Initial IMO GHG strategy in 2018. The Marine Environment Protection Committee (MEPC) of the IMO has pushed forward with several measures aimed at supporting the achievement of the objectives set out in the initial IMO strategy on the reduction of GHG emissions from ships, in line with the Paris Climate Change Agreement under UNFCCC and the United Nations 2030 Agenda for Sustainable Development. This initial strategy, representing the first global climate framework for shipping, establishes quantitative GHG reduction targets through 2050 and a list of potential short-, mid-, and long-term policy measures to help achieve these targets. This is a policy framework with three interlinked ambitions:

- A reduction in carbon intensity of international shipping by at least 40 per cent by 2030 compared to 2008.
- Pursuing efforts to achieve a 70 per cent reduction in carbon intensity of international shipping by 2050, compared to 2008.

85 https://wwwcdn.imo.org/localresources/en/OurWork/Environment/Documents/Technical%20and%20Operational%20Measures/Resolution%20MEPC.203%2862%29.pdf

- Reduce the total annual GHG emissions from international shipping by at least 50 percent by 2050 compared with their level in 2008, and work towards phasing out GHG emissions from shipping entirely as soon as possible in this century.

The initial IMO GHG Strategy provides a wide list of candidates for short-term, mid-term and long-term measures, including, for example, further improvement of the EEDI and the SEEMP, National Action Plans, enhanced technical cooperation, port activities, research and development, support to the effective uptake of alternative low-carbon and zero-carbon fuels, innovative emission reduction mechanisms, etc.

These measures include adoption of MEPC resolution MEPC.323(74)[86] to invite member states to encourage voluntary cooperation between the port and shipping sectors to contribute to reducing GHG emissions from ships. Thus, many Member States are already taking actions at the national level to facilitate reducing GHG emissions from ships. In November 2020, the MEPC adopted Resolution MEPC.327(75)[87] to encourage Member States to develop and submit voluntary National Action Plans (NAPs). The NAPs are required to include action accelerating port emission reduction activities, consistent with resolution MEPC.323(74).

To reduce carbon intensity of all ships by 40% by 2030 compared to the 2008 baseline, MARPOL Annex VI was amended to include new requirements for EEXI and CII certification. From January 2023, this requires ships to calculate two ratings: their attained Energy Efficiency Existing Ship Index (EEXI) to determine their energy efficiency, and their annual operational Carbon Intensity Indicator (CII) and associated CII rating. Carbon intensity links the GHG emissions to the amount of cargo carried over distance travelled. Member States are working on revising the initial strategy. The Revised Strategy is set to be adopted in mid-2023 at the MEPC session in July 2023.

3.3.2 EU action on Energy use and Climate change

EU policy protects the environment and seeks to minimize risks to climate, human health and biodiversity. Energy use accounts for 75% of the EU’s emissions. The EU's first energy and

[86] https://wwwcdn.imo.org/localresources/en/KnowledgeCentre/IndexofIMOResolutions/MEPCDocuments/MEPC.323%2874%29.pdf

[87] https://wwwcdn.imo.org/localresources/en/OurWork/Environment/Documents/Air%20pollution/Resolution%20MEPC.327(75).pdf

climate package was introduced in 2008. This package (2020 climate & energy package[88]) of legislative measures aimed to reduce greenhouse gas emissions and improve energy efficiency. The package included a binding target to reduce emissions by 20% by 2020 compared to 1990 levels, as well as targets for renewable energy (20% of EU energy) and energy efficiency (20% improvement). The EU played a key role in negotiating the global Paris Agreement (2015) on climate change and committed to reducing its greenhouse gas emissions by at least 40% by 2030 compared to 1990 levels. In November 2018, all EU member states committed to turning the EU into the first climate neutral continent by 2050. They pledged to reduce emissions by at least 55% by 2030, compared to 1990 levels, to get there. To achieve these targets EU has strengthened existing measures and implemented new measures:

1. The EU Emissions Trading System[89] (EU ETS) – as the world's largest carbon market and a cornerstone of the EU's policy to reduce greenhouse gas emissions and combat climate change. It sets a cap on the amount of carbon dioxide (CO_2) that power plants, factories, and other industrial sectors can emit. Set up in 2005, the EU ETS is now in its fourth trading phase (2021-2030) and has undergone several revisions to maintain the system's alignment with the overarching EU climate policy objectives.
2. National emission reduction targets - Member states are responsible for national policies and measures to limit emissions from the sectors not covered by the EU ETS. To meet the EU's new energy and climate targets for 2030, member states are required to establish a 10-year National energy and climate plans[90] (NECPs) for the period from 2021 to 2030.
3. Renewable Energy Directive: The renewable energy directive is the legal framework for the development of renewable energy across all sectors of the EU economy and supports cooperation across EU countries. This directive is a key policy initiative that will enable the transition to a 100% renewable energy grid across Europe. The current RED II[91] requirements from EU countries require a 32% share of renewable energy by

[88] https://climate.ec.europa.eu/eu-action/climate-strategies-targets/2020-climate-energy-package_en

[89] https://climate.ec.europa.eu/eu-action/eu-emissions-trading-system-eu-ets_en

[90] https://energy.ec.europa.eu/topics/energy-strategy/national-energy-and-climate-plans-necps_en

[91] https://eur-lex.europa.eu/legal-content/EN/TXT/PDF/?uri=CELEX:32018L2001&from=EN

2030. However, when in force, the proposed changes in line with new ambitions, RED III will replace these requirements to a new level of 40% of renewables in the EU energy mix.

4. Energy Efficiency Directive[92] (EED): The 2012 directive, as amended in 2018, sets rules and obligations for achieving the EU's 2020 and 2030 energy efficiency targets. This directive aims to improve energy efficiency in the EU by 32.5% by 2030. It sets binding targets for each member state and requires energy companies to reduce energy consumption among their customers.
5. EU Green Deal[93]: This is a comprehensive plan to make the EU's economy sustainable. It aims to reduce greenhouse gas emissions, protect biodiversity, and transition to a circular economy. The EU Green Deal includes measures such as increasing the use of renewable energy, promoting energy efficiency, and reducing waste. The European Green Deal covers all sectors of the economy, notably transport, energy, agriculture, buildings, and industries such as steel, cement, ICT, textiles, and chemicals.
6. Circular Economy Action Plan[94]: The European Commission adopted the new circular economy action plan (CEAP) in March 2020. The new action plan announces initiatives along the entire life cycle of products. It targets how products are designed, promotes circular economy processes, encourages sustainable consumption, and aims to ensure that waste is prevented, and the resources used are kept in the EU economy for as long as possible. It introduces legislative and non-legislative measures targeting areas where action at the EU level brings real added value.
7. Just Transition Mechanism[95]: The primary goal of the mechanism is to provide support to the most negatively affected regions and people and to help alleviate the socio-economic costs of the transition. A financial instrument under the mechanism aims to support regions and sectors most affected by the transition to a climate-neutral economy. It is implemented under shared management, under the overall framework

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[92] https://energy.ec.europa.eu/topics/energy-efficiency/energy-efficiency-targets-directive-and-rules/energy-efficiency-directive_en

[93] https://commission.europa.eu/strategy-and-policy/priorities-2019-2024/european-green-deal/delivering-european-green-deal_en

[94] https://eur-lex.europa.eu/legal-content/EN/TXT/?qid=1583933814386&uri=COM:2020:98:FIN

[95] https://commission.europa.eu/strategy-and-policy/eu-budget/performance-and-reporting/programme-performance-overview/just-transition-mechanism-performance_en

of the Cohesion policy, which is the main EU policy to reduce regional disparities and address structural changes in the EU. It provides funding for projects that support economic diversification, job creation, and the re-skilling of workers.

8. Sustainable and Smart Mobility Strategy[96]: The strategy lays the foundation for how the EU transport system can achieve its green and digital transformation and become more resilient. The strategy aims to boost the uptake of zero-emission vehicles, vessels and airplanes, renewable & low-carbon fuels and related infrastructure. Among various milestones set out, it aims to have zero-emission marine vessels ready to market by 2030.
9. Energy Taxation Directive[97] (ETD): Directive recognizes that energy taxation can play an important role as one of the economic incentives that steer successful energy transition, driving low greenhouse gas emissions and energy savings investments while contributing to sustainable growth.

Overall, the EU's energy use and climate change action reflects the commitment to reducing greenhouse gas emissions and achieving a sustainable future. To ensure a fair contribution from the maritime sector to the effort to decarbonize the EU economy, the EC proposed to extend carbon pricing to the maritime sector. It also aims to set targets for major ports to serve vessels with onshore power, reducing the use of polluting fuels that also harm local air quality. The EU has promoted the introduction of LNG infrastructure in its ports, both with regulation and project financing, mostly under the Connecting Europe Facility (CEF)[98] programme. It has also supported research and development initiatives advancing alternative fuels and innovative energy and transport solutions, mainly under the Horizon 2020 programme. Examples included a fully electric ferry, a ferry fueled by hydrogen from local renewable sources, wind-assisted ship propulsion, and a full-scale demonstration combining several technologies.

96 https://eur-lex.europa.eu/legal-content/EN/TXT/?uri=CELEX%3A52020DC0789

97 https://eur-lex.europa.eu/legal-content/EN/TXT/?uri=CELEX%3A52021PC0563

98 https://wayback.archive-it.org/12090/20221222151902/https://ec.europa.eu/inea/en/connecting-europe-facility

3.3.3 Ports 2030 – Gateways for the Trans European Transport Network agenda

The EU Ports 2030 agenda is a part of the Trans-European Transport Network (TEN-T) initiative. The EU's trans-European transport network[99] policy, the TEN-T policy, is a key instrument for the development of coherent, efficient, multimodal, and high-quality transport infrastructure across the EU. It comprises railways, inland waterways, short sea shipping routes and roads linking urban nodes, maritime and inland ports, airports, and terminals. The core network includes the most important connections linking major cities and nodes and must be completed by 2030. On the core network, by 2030, all maritime ports must be connected with rail and road infrastructure and, where possible, inland waterways. Any maritime port that serves freight traffic must offer at least one multimodal freight terminal, which must be open to all operators and users in a non-discriminatory way and apply transparent and non-discriminatory charges. Finally, maritime ports connected to inland waterways must be equipped with dedicated handling capacity for inland waterway vessels. The comprehensive network connects all regions of the EU to the core network and needs to be completed by 2050. The TEN-T policy is based on the EU Regulation 1315/2013.[100] To support the transition to cleaner, greener and smarter mobility in line with the European Green Deal and the Sustainable and Smart Mobility Strategy, the Commission proposed to revise the TEN-T Regulation of 2013.

Directive 2014/94/EU[101] on the deployment of alternative fuels infrastructure set out a framework of common measures requiring the member states to set up national policy frameworks to establish markets for alternative fuels and ensure that an appropriate number of publicly accessible recharging and refuelling points is put in place, particularly also to enable free cross-border circulation of such vehicles and vessels on the TEN-T network. Maritime ports shall also be equipped with the infrastructure needed to improve the environmental performance of ships in ports, in particular reception facilities for ship-generated waste and cargo residues, with VTMIS (Vessel Traffic Management Information System) and SafeSeaNet. Maritime ports that see at least 50 port calls by large passenger vessels, or 100 port calls by

[99] https://transport.ec.europa.eu/transport-themes/infrastructure-and-investment/trans-european-transport-network-ten-t_en

[100] https://eur-lex.europa.eu/legal-content/EN/TXT/?uri=CELEX%3A32013R1315

[101] https://eur-lex.europa.eu/legal-content/en/TXT/?uri=CELEX:52021PC0559

container vessels, must provide shore-side electricity for such vessels by 2030. This will not only help reduce the carbon footprint of maritime transport, but also significantly reduce local air pollution in port areas.

The 2020 communication from the commission on EU Strategy for Energy System Integration[102] highlights the transforming ports into centres receiving electricity produced offshore, as well as liquid hydrogen, and thereby contributing to enabling the global trade of renewable hydrogen or synthetic fuels. The expansion of hydrogen refuelling stations will also be assessed as part of the revision of the Alternative Fuels Infrastructure Directive and the Regulation on the TEN-T guidelines.

3.3.4 European Green Deal and Horizon Europe ‘s agenda (on ports)

Presented in December 2019, the European Green Deal[103,104] is a comprehensive plan with a set of policy initiatives aimed to transform the EU into a modern, resource-efficient and competitive economy, ensuring:

- no net emissions of greenhouse gases by 2050;
- economic growth decoupled from resource use;
- no person and no place left behind.

The European Commission has adopted a set of proposals to make the EU's climate, energy, transport and taxation policies fit for reducing net greenhouse gas emissions by at least 55% by 2030, compared to 1990 levels. These new proposals will have an impact across entire value chains in sectors such as energy and transport, and construction and renovation, helping create sustainable and jobs across Europe.

The European Green Deal calls for a 90% reduction in greenhouse gas emissions from transport, in order for the EU to become a climate-neutral economy by 2050, while also working towards a zero-pollution ambition. The three main pillars for the future actions to support systematic change under this deal can be divided into:

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102 https://eur-lex.europa.eu/legal-content/EN/ALL/?uri=COM:2020:299:FIN

103 https://commission.europa.eu/document/daef3e5c-a456-4fbb-a067-8f1cbe8d9c78_en

104 https://commission.europa.eu/strategy-and-policy/priorities-2019-2024/european-green-deal_en

1. make all transport modes more sustainable;
2. make sustainable alternatives widely available in a multimodal transport system;
3. put in place the right incentives to drive the transition.

In July 2021, the European Commission adopted a series of legislative proposals to deliver the European Green Deal – the 'Fit for 55' package. The Fit for 55[105] package consists of a set of inter-connected proposals, which all drive towards the same goal of ensuring a fair, competitive, and green transition by 2030 and beyond. Where possible, existing legislation is made more ambitious and new proposals are put on the table where needed. Overall, the package strengthens eight existing pieces of legislation and presents five new initiatives, across a range of policy areas and economic sectors: climate, energy and fuels, transport, buildings, land use and forestry. The legislative proposals are backed by impact assessment analysis, which considers the interconnection of the overall package. The analysis shows that an over-reliance on strengthened regulatory policies would lead to unnecessarily high economic burdens, while carbon pricing alone would not overcome persistent market failures and non-market barriers. Therefore, the chosen policy mix is a careful balance between pricing, targets, standards, and support measures.

FuelEU is a specific part of the European Green Deal that focuses on reducing the carbon footprint of the transport sector. The FuelEU initiative proposes to set a binding target for the use of sustainable low-emission fuels, such as renewable electricity, advanced biofuels, and hydrogen, in the transportation sector. Coming into effect in 2025, the FuelEU Maritime initiatives will require all vessels of 5,000 GT and above to start reducing the GHG intensity of the energy they use onboard. At the same time, all ships must start increasing their use of renewable and low-carbon fuels. The initiative uses a lifecycle analysis when evaluating the GHG intensity of fuels, considering all emissions 'from well to wake', or from when the fuel is produced to when it is burned. This regulation has the same scope as the EU ETS, so it will apply to all of the energy used at EU ports, on voyages between EU ports, and 50% of the energy used on voyages between EU ports and third countries.

105 https://eur-lex.europa.eu/legal-content/EN/TXT/?uri=CELEX%3A52021DC0550

Horizon Europe[106] is the EU's key funding programme for research and innovation. The programme facilitates collaboration and strengthens the impact of research and innovation in developing, supporting, and implementing EU policies while tackling global challenges. Horizon Europe, Work Programme 2023-2024[107] expects to contribute to:

- Application of DC distribution in ports with analysis and definition of possible operating framework and business models for ports acting as energy hubs;
- Development of a coherent energy system planning for electric mobility, considering both the needs and impact for recharging of EVs and onshore power supply of vessels in maritime ports and inland waterways;
- Integrated real-time digital solutions to optimize navigation and port calls to reduce emissions from shipping;
- Developing a flexible offshore supply of zero-emission auxiliary power for ships moored or anchored at sea deployable before 2030;
- Developing small, flexible, zero-emission and automated vessels to support shifting cargo from road to sustainable Waterborne Transport.

3.3.5 Ports Green Deal Master Plan

A clear commitment of the European Green Deal is that transport should become drastically less polluting, highlighting in particular the urgent need to reduce greenhouse gas emissions (GHG) in aviation and waterborne transport. Under the European Green Deal, ports will have to develop Master Plans considering measures and actions as required by:

- sustainable and smart mobility strategy;
- the Alternative Fuels Infrastructure Directive (AFIR);
- the Trans-European Network within Transport Regulation;
- the funding call to support the deployment of public recharging and refuelling points as part of alternative fuel infrastructure;

106 https://commission.europa.eu/funding-tenders/find-funding/eu-funding-programmes/horizon-europe_en

107 https://ec.europa.eu/info/funding-tenders/opportunities/docs/2021-2027/horizon/wp-call/2023-2024/wp-8-climate-energy-and-mobility_horizon-2023-2024_en.pdf

- the assessment of legislative options to boost the production and supply of sustainable alternative fuels for different transport modes;
- the initiatives to increase and better manage the capacity of railways and inland waterways;
- the proposal for more stringent air pollutant emissions standards for combustion-engine vehicles.

The Green Deal Master Plan should include a specific stakeholder engagement programme, a tool specially made for approaching a territory and local communities, taking care of their expectations, and creating a helpful integration to develop a positive climate based on trust and goodwill.[108]

3.3.6 Policy measures review findings

As highlighted above the process at IMO can be tedious and many regions have gone ahead and adopted rules and regulations before the IMO. Such requirements are not global; for example, the EU rules (which, by IMO standards, are regional rules) apply to ships registered in EU countries, as well as to all ships in their waters and ports. 91% of European ports are in or are very close to urban areas. Port managing bodies are mission-driven entities and their relationship with the local community is their top priority. In addition, many European port cities have set their own even more ambitious emissions reduction targets than those existing at the national level. Ports are already working together with the cities to achieve the objectives of the Paris Agreement. European ports are at the crossroads of supply chains, clusters of energy, industry, and blue economy. They can be a key strategic partner in making the European Green Deal happen.

European ports are diverse, and there is no one approach that can be mandated for all ports. Instead, each port should develop a roadmap appropriate to its circumstances to prepare for the energy transition of shipping. The FuelEU Maritime is part of the 'basket of measures' designed to address emissions from maritime transport while maintaining a level playing field. It is fully consistent with other measures presented as part of the 'Fit for 55' package and builds on existing policy tools such as the EU system to monitor, report and verify (MRV) CO_2

[108] https://www.ispionline.it/en/publication/new-green-deal-port-master-plan-transformation-european-ports-29826

emissions and other relevant information from large ships using EU ports. Out of the 12 items in Fit for 55, five are directly relevant to the maritime industry:

1. The revised EU Emissions Trading System (EU ETS)
2. The new FuelEU Maritime regulation
3. The Energy Taxation Directive (ETD)
4. The Alternative Fuels Infrastructure Regulation (AFIR)
5. The Renewable Energy Directive (RED II)

FuelEU Maritime initiative and extensions of the European Emissions Trading System (ETS) to the maritime sector and the Energy Taxation Directive (ETD) will ensure cost-effective emission reductions in the sector and that the price of transport reflects the impact it has on the environment, health and energy security. The action under FuelEU Maritime will get support from the programs under the Alternative Fuels Infrastructure Directive (AFID) and Renewable Energy Directive (RED II).

Renewable fuels in the aviation and maritime sector are not only a strategic element for moving towards a climate-neutral economy but can also provide growth and employment opportunities. The package delivering the European Green Deal is expected to increase demand for renewable fuels for shipping and aviation in the EU.

In the following table, the 5 items in Fit for 55 relevant to the maritime industry, are reported, specifying: the context of change, the evaluation of the timeline, the impact of the change and the complexity level.

Table 4: Items in Fit for 55

Context of change	Evaluation of the Timeline	Impact of the change	Complexity
FuelEU Maritime	Reductions of annual average GHG intensity of energy used on board starting from 2025, with a modest 2% improvement compared to a 2020 baseline.	Supply chain and infrastructure for the alternative energy source required by the ship to meet these targets.	Port and terminal infrastructure. Age, type and size of shipping visiting the port.

Context of change	Evaluation of the Timeline	Impact of the change	Complexity
	Requirements increasing stringently as 6% improvement required in 2030 and a 75 % cut in 2050. From January 2030, freight and passenger ships staying at EU ports for more than two hours will also have to connect to shore-side electricity supply (OPS).[109]	OPS infrastructure and energy demand	Availability of green energy to support OPS
Alternative Fuels Infrastructure Directive (revised directive on alternative fuels infrastructure)	Refueling points for LNG at maritime ports, to enable LNG inland waterway vessels or seagoing ships to circulate throughout the TEN-T Core Network by the end of 2025. OPS in main EU ports (50 port calls by large passenger vessels, or 100 port calls by container vessels) by 2030.	LNG for ships. Shore-side electricity supply for passenger and container vessels.	Port and terminal infrastructure. LNG availability for maritime bunkering. Availability of green energy to support OPS
Renewable Energy Directive III[110]	40% share of renewable energy in EU energy mix by 2030. New renewables target of GHG intensity reduction of at least 13 % by 2030 in the transport sector.	Increased use of renewables in Port energy use mix.	Development of infrastructure aligned to the to the current and future energy demand of the port.

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109 As of 2035, ship operators should plan carefully their port calls to make sure that they can carry out their activities without emitting air pollutants and GHG at berth and compromise the environment in coastal areas and port cities.

110 https://eur-lex.europa.eu/legal-content/EN/TXT/?uri=CELEX%3A52021PC0557

Context of change	Evaluation of the Timeline	Impact of the change	Complexity
Energy Taxation Directive	To incentivize investment in clean technologies, ETD no longer favors fossil fuels. Taxes will be calculated according to the net calorific value of the fuel. Tax exemptions will initially incentivize the use of sustainably produced alternative fuels, electricity and shore-side electricity used by vessels at berth.	Ends the tax exemptions for conventional marine fuels and incentivize the uptake of alternatives. Bunker fuels sold in the EU for voyages within the EU would no longer be tax exempt.	The inclusion of new fuels or changes in tax rates for existing fuels can impact the cost structure and fuel choices for maritime operators, potentially requiring adjustments in their operations and investment decisions.
EU emissions trading system directive	Since 2018, ships above 5000 GT regardless of flag calling at EEA ports have had to monitor and report fuel consumption, CO_2 emissions and transport work per voyage and on an annual basis.	It covers emissions occurring at berths in an EU port, all intra-EU voyages, and 50 % of emissions from voyages sailing in and out of an EU port.	The complexity of the carbon market, including price volatility, compliance obligations, and interactions with other market participants, can pose challenges for ports seeking to engage in emissions trading. It requires understanding and expertise in carbon markets and trading mechanisms to effectively participate and leverage the opportunities provided by the EU ETS.

3.4 Social Innovation and Inclusiveness in Green Ports

The social impact of European ports extends beyond their immediate economic contributions and encompasses various dimensions such as employment, urban development, sustainability, and, most importantly, corporate social responsibility (CSR) (Vitellaro et al., 2022). Recognizing the imperative for sustainable practices, European ports have been trying to implement sustainable practices that positively influence local communities' perceptions. These practices include communication with local communities, participation of the latter in port management, and investment by the port in local development (Felicio et al., 2022).
In doing so, EU green ports not only enhance their operational efficiency but also contribute to a broader narrative of responsible and conscientious corporate citizenship. The merger of economic, social, and environmental considerations underscores the important role that European ports play in shaping the future of sustainability in the transport sector. In the following sections the main aspects relating to the development of green ports and some examples from existing ports are deepened.

3.4.1 Working conditions

The working conditions in European green ports are pivotal to the welfare of port workers and the sustainability of port operations. The working and employment conditions for port workers in the EU are governed by a combination of EU legislation, international conventions, and sectoral social dialogue agreements. The International Labour Organisation (ILO) adopted the Maritime Labour Convention (MLC-2006) to ensure decent working and living conditions on board for all seafarers, regardless of their nationality and the flag of the ships on which they sail. The convention also seeks to limit social dumping to secure fair competition for ship owners who respect seafarers' rights (European Commission, n.d.). The EU strongly supports the MLC-2006 and has transposed large parts of the convention into its legislation. This was achieved through the sectoral social dialogue committee for maritime transport. The social agreement concluded by the European Community Shipowners' Association (ECSA) and the European Transport Workers' Federation (ETF) was implemented into EU Law with Council Directive 2009/13/EC (European Commission, n.d.). Similarly, the standard working hours for staff on board a seagoing ship are 8 hours per day, with one day of rest per week and additional rests on public holidays. The maximum working hours must not exceed 14 hours in any 24 hours and 72 hours in any 7 days. The minimum resting time cannot be less than 10 hours in any 24 hours and 77 hours in any 7 days (Your Europe, n.d.).

The EU's acquis on labour law, equality, and non-discrimination is also substantial for EU workers and has recently become applicable to seafarers. This means that all European ports are required to adhere to these standards, ensuring fair and equitable working conditions for all its employees (European Commission, n.d.). These regulations aim to ensure fair and safe working conditions for port workers in the EU, preventing accidents and enhancing maritime safety.

3.4.2 Educational landscape

The unique demands of the maritime industry often shape the educational landscape in port communities. Port operations have become increasingly complex due to advancements in technology, changes in global trade patterns, and the adoption of sustainable practices. Education equips professionals in the port sector with the knowledge and skills necessary to navigate this complexity. Training programs can cover areas such as port management, logistics, customs regulations, and emerging technologies, ensuring that port personnel are well-prepared to handle diverse challenges. The port sector is also evolving with the integration of innovative technologies such as automation, data analytics, and artificial intelligence. Education plays a pivotal role in fostering a culture of innovation and facilitating the adoption of new technologies. Additionally, Education in the port sector is essential for promoting environmental sustainability. Professionals need to understand the importance of reducing the environmental impact of port operations through measures like green logistics, energy-efficient technologies, and waste reduction.

The Port of Rotterdam, for example, offers port professionals various training programs. These programs focus on the major challenges of port development and management, such as adjusting ports to rapidly changing market dynamics and planning future port infrastructure. The port also offers broad consultancy for developing and managing ports and industrial areas (Port of Rotterdam, n.d.). The Antwerp and Flanders Port Training Center (APEC) also offers a variety of training solutions designed to help port professionals stay up to date with the latest knowledge and skills in the port ecosystem. They offer courses on topics such as supply chain management and hinterland connectivity, smart port technologies, and international port strategy (APEC Port Training, n.d.). In Barcelona, several institutions are offering maritime-related education and training programs. For instance, the Universitat Abat Oliba CEU offers degrees and master's degrees in various disciplines, including maritime studies (Universitat Abat Oliba CEU, n.d.).

These initiatives benefit the workforce and contribute to the long-term sustainability of port-related activities. It is also important to note that insufficient emphasis on maritime education may limit the pool of skilled workers and hinder the overall development of the local workforce. Policymakers and industry stakeholders need to prioritize educational investments to bridge these gaps and ensure the continuous growth of port communities.

3.4.3 Health

The health of individuals associated with port operations is critical to the social impact. Regular health check-ups, access to fitness facilities, and mental health support contribute to a holistic approach to worker well-being. Such initiatives not only enhance the quality of life for workers but also improve overall productivity. A majority of EU states have enacted specific laws and regulations on health and safety in port work. These regulations are designed to protect port workers, who often have one of the most dangerous occupations in the entire EU economy (European Commission, 2013). Before staff can start to work on a ship, crew members must possess a valid medical certificate attesting that they are medically fit to perform their duties. Regular health assessments are required, and staff under the age of 16 are not allowed to work on a ship (Your Europe, n.d.). Additionally, at the international level, the International Labour Organisation (ILO) has adopted the Maritime Labour Convention (MLC-2006) to ensure decent working and living conditions on board for all seafarers, regardless of their nationality and the flag of the ships on which they sail (European Commission, n.d.).

Air and noise pollution, coupled with the intensive nature of port activities, can lead to adverse health effects for both workers and nearby residents. Implementing stringent environmental standards, investing in pollution control technologies, and community health awareness programs are essential measures to address and mitigate these challenges.

3.4.4 Safety

Protecting port operations' safety is paramount for protecting personnel and assets. When a culture of safety consciousness is cultivated among workers, it reduces the likelihood of accidents and incidents, such that continuous improvement and adaptability to emerging risks are key elements of a robust safety framework. The EU has laid down general rules for the protection of the health and safety of workers at work, which apply equally to the port sector. These rules cover various aspects such as the workplace, the use of work equipment, personal protective equipment, machinery, chemical agents, asbestos, carcinogens and mutagens, physical agents, and more (Federation of European Private Port Operators, n.d.). The EU also has specific requirements and procedures for the safe loading and unloading of bulk carriers. These requirements include that terminals in EU ports where solid bulk cargoes are loaded or unloaded only accept bulk carriers that can safely berth alongside the loading or unloading installation. Terminal loading and unloading equipment shall be properly certified and maintained in good order, and only operated by duly qualified and, if appropriate, certified personnel (Federation of European Private Port Operators, n.d.). One way in which terminal operators ensure their environmental performance is by applying for internationally recognized certification schemes such as ISO 14001 of the International Standards Organization or the EMAS Eco-Management and Audit Scheme which the European Commission has developed. It is also provided that terminal personnel involved in the loading and unloading operations shall be provided with and use personal protective equipment. They shall also be duly rested to avoid accidents due to fatigue (Federation of European Private Port Operators, n.d.). Collaborative efforts involving port authorities, workers, and regulatory bodies are essential to fortify safety measures across the industry.

3.4.5 Community development and involvement

The impact of port activities extends beyond the port gates, influencing the overall development of surrounding communities. Effective community involvement and development are crucial for fostering positive relationships between ports and their surroundings. The Port of Gothenburg in Sweden provides an exemplary case where community development initiatives are integral to port planning. Investment in infrastructure, employment opportunities, and social amenities enhances residents' quality of life and fosters a symbiotic relationship between the port and the community. Many European ports have established port information and training centres to educate the public and stakeholders about port operations and maritime industry development (World Port Sustainability Program, n.d.).

Strategic collaborations between port authorities, local governments, and community organizations are essential to ensure an inclusive and sustainable community. There are open port initiatives too, which are aimed to increase transparency and foster a better understanding of port operations among the local community. The port of Antwerp, along with other European ports like Barcelona, Gothenburg, Hamburg, and Le Havre, is participating in the World Ports Climate Action Program (WPCAP), an initiative aimed at reducing CO_2 emissions from shipping and ports and improving air quality, which is beneficial to residents (United Nations Regional Information Centre, 2020).

3.4.6 Gender equality and inclusion

Promoting gender equality in port operations is an integral component of sustainable development, and the emergence of EU Green Ports has provided opportunities for advancements in this regard. Similarly, the concept of inclusion is pivotal for ensuring that the benefits of port activities are equitably distributed among diverse populations. Recognizing and leveraging the diverse talents within the community contributes to a more resilient and innovative workforce.

Gender equality and inclusion are important aspects of the European Union's (EU) policy framework, and this extends to the transport sector, including ports. The EU has a robust policy framework on gender equality, notably the Gender Equality Strategy 2020-2025. The strategy aims to make significant progress towards a gender-equal Europe by 2025. It focuses on ending gender-based violence, challenging gender stereotypes, closing gender gaps in the labour market, achieving equal participation across different sectors of the economy, addressing the gender pay and pension gaps, closing the gender care gap, and achieving gender balance in decision-making and in politics (European Commission, n.d. - Gender equality strategy). The Women in Transport - EU Platform for Change is another initiative launched in 2017 to strengthen women's employment and provide equal opportunities for women and men in the transport sector. This platform encourages actions that promote gender equality in the transport sector (European Commission, n.d. – Women in transport). Additionally, On 27 December 2022, a new directive came into force that seeks to improve the gender balance in corporate decision-making positions in the EU's largest listed companies. The directive is aimed to ensure that gender balance in corporate boards of listed companies is improved across the EU (European Commission, n.d. - EU action to promote gender balance).

The Port of Le Havre, France, exemplifies efforts to promote gender diversity in traditionally male-dominated roles. Targeted recruitment initiatives, mentorship programs, and support networks contribute to breaking down gender barriers within the industry. The Port also hosted a training course titled "Women in Port Management" aimed at improving ports' management and operational efficiency. The course was attended by female officials from maritime and port authorities from developing countries (PortNews, n.d.).

3.4.7 Collaboration and co-creation to achieve tangible solutions between EU green port

Collaboration and co-creation between EU Green Ports are instrumental in addressing shared challenges and fostering innovation. Through knowledge-sharing platforms, joint research initiatives, and collaborative projects, these ports collectively work towards developing and implementing sustainable solutions. The Port of Rotterdam Authority, Germany's Fraunhofer Institute for Solar Energy Systems (ISE), and the Australian government have teamed up to develop a joint hydrogen hub in Western Australia. This is a prime example of collaboration and co-creation between EU green ports. The initiative is in line with the Port of Rotterdam's ambition to become a hydrogen hub for Northwest Europe. The TrHyHub project aims to build a modern port industrial complex for large-scale hydrogen production for both local use and export. Five Northern European port authorities announced that they are joining in partnership with the Mærsk Mc-Kinney Møller Center for Zero Carbon Shipping to lay the foundations for a green corridor serving Northern Europe and the Baltic. The concept which was presented at COP-26 in Glasgow in November 2021 calls for cooperation between ports, shipping lines, and others to incentivize routes that would support the development of net-zero propulsion technology and the infrastructure required for the transition to green fuels (Port Technology International, 2023).

Another example is the Mærsk Mc-Kinney Møller Center for Zero Carbon Shipping's initiative with the port authorities of Gdynia, Hamburg, Roenne, Rotterdam, and Tallinn. Their project is designed to demonstrate the early commercialization of alternative fuel supply chains, provide a roadmap to scaling the supply chains, and create a blueprint for rolling out green corridors in other locations. This is a vital step towards accelerating the decarbonization of the shipping industry and meeting the EU's 2030 climate ambitions. The project, which includes shipping majors Maersk, CMA CGM, and COSCO Shipping Lines, calls for a plan by the end of 2022 and beginning the transition to zero-carbon fueled ships by 2030 for commercial shipping on one of the busiest ocean shipping routes in the world (The Maritime Executive, 2022).

The Port Authorities of Rotterdam and Gothenburg have also signed a Memorandum of Understanding (MoU) for the realisation of a Green Corridor to support sustainable shipping. Under the agreement, the ports will further strengthen ongoing cooperation on decarbonisation and digitalisation. As part of the Green Corridor initiative, the ports will establish a common framework for cooperation to promote the use of alternative fuels to meet goals of the Paris Agreement. The parties intend to connect the Green Corridor between Gothenburg and Rotterdam to a larger network of deep-sea corridors – including the European Green Corridors Network launched in March this year by the Maersk Mc-Kinney Møller Center for Zero-Carbon Shipping (Port Technology International, 2022). The establishment of collaborative frameworks ensures that solutions are not only effective but also adaptable to the diverse contexts of different ports.

3.4.8 End use-centeredness/focus

EU Green Ports recognizes the importance of end-user perspectives in shaping sustainable practices. Ports such as Gothenburg and Copenhagen actively engage with local communities and end-users to understand their needs and concerns. Through public forums, feedback mechanisms, and participatory planning, these ports ensure that sustainability measures align with the communities' values and expectations. This end-user-centered approach not only enhances the social license to operate but also fosters a sense of shared responsibility for sustainable port practices.

Flynn et al. (2011) extend this discussion to the port industry, proposing the development of customer-centric and community ports to meet the evolving needs of port users. Collectively, these studies underscore the significance of prioritizing end-end user needs and experiences in the design and operation of European ports. Radulovic (2022) emphasizes the importance of human-centered design in the maritime single window, particularly in the navigation of commercial vessels. Halme et al. (2022) introduced the concept of Ethical User Stories in the digitalization of port terminals, focusing on the passenger flow. Kazemi et al. (2022) presented a case study on the usability and user experience of an open community web portal in the smart ports' domain, underscoring the importance of user feedback and iterative improvements. Collectively, these studies underscore the significance of end user-centeredness in the design and operation of European ports.

EU ports have a unique character, combining both public and commercial interests. This hybrid nature allows them to cater to a wide range of end-users, from shipping companies to logistics providers, and even the general public. The Port of Rotterdam in the Netherlands is a prime example of a hybrid port. It has a unique character that combines both public and commercial interests (European Sea Ports Organisation, 2016). The port is involved in various activities, including security and safety against physical, cyber, and hybrid threats. European port authorities are developing different ways to connect with their stakeholders. This includes end-users, and the focus is on ensuring that the services and facilities provided meet their needs and expectations. In line with the new TEN-T policy framework, ports are doing their utmost to play their role as nodes in a multimodal transport chain. This involves ensuring seamless connectivity and integration with other modes of transport, which is crucial for end-users. Transparency is increasingly considered a way for port authorities to maintain their license to operate. Sharing data on environmental performance and being transparent in the accounts is becoming common practice. This transparency is beneficial for end-users as it allows them to make informed decisions (European Sea Ports Organisation, 2016). These trends indicate a strong focus on end-user-centeredness in EU ports. However, the exact strategies and approaches may vary between different ports and regions.

3.4.9 Scalability and replicability

Ensuring the scalability and replicability of sustainable practices is crucial for widespread impact. The European Union's Green Deal initiative provides a framework for scaling up sustainable practices across ports. Ports like Antwerp and Le Havre serve as models for successful replication, implementing innovative technologies and eco-friendly policies that other ports can adapt. Establishing standardized benchmarks, sharing best practices, and facilitating technology transfer contribute to the scalability of sustainable initiatives, fostering a collective effort towards a greener European port sector.

For example, the “Green airports and ports as multimodal hubs for sustainable and smart mobility” project is a significant initiative under the European Green Deal. It addresses wide socio-economic perspective, covering sustainable and smart mobility, technical, operational, economic, environmental and social aspects, relevant to shaping the green ports of the future and their integration with other sustainable transport modes, the hinterland, cities and urban mobility. The concept of green airports and ports as multimodal hubs has gained significant traction in recent years, driven by the urgent need to address environmental concerns and promote sustainable development. These hubs serve as critical nodes in the transportation network, integrating various modes of transport to enhance efficiency, reduce carbon footprints, and foster smart mobility solutions. A primary focus of these projects is scalability and reproducibility, representing scalable solutions that can be replicated/gradually scaled up to larger or scaled down to smaller ports ensuring the ability to accommodate growing demands while maintaining sustainability standards (European Maritime Spatial Planning Platform, n.d.).

Another great example of a scalable and reproducible project in the Port of Antwerp is the PIONEERS project (Port Technology International, 2021). The Port of Antwerp leads this project and involves a consortium of 46 ports and stakeholders. The project is funded by the EU Horizon 2020 and aims to develop efficiencies in maritime through sustainable port design and digital transformation. It aims to inspire transferability to other ports. Best practices on digitalisation and green technologies will be researched amongst the ports involved, which include the Port of Antwerp, Port of Barcelona, Port of Constanta, and the Port of Venlo. One of the key initiatives of the PIONEERS project is the creation of a Green Port Masterplan, which serves as a guideline to all port stakeholders interested in greening their port operations towards 2030 and 2050 EU emissions targets.

Another example is the Le Havre Smart Port City project (Port Technology International, 2020). This project is a part of the HAROPA port group and aims to coordinate maritime and city operations12. Over the next 10 years, the Port and wider community will explore wireless connectivity through the 5G Lab initiative. This project demonstrates the Port of Le Havre's commitment to digital transformation and provides a model that can be replicated in other ports around the world.

3.4.10 Learning and adaptation

Learning and adaptation are intrinsic to the continuous improvement of sustainability practices in EU Green Ports. Ports such as Marseille-Fos and Southampton invest in ongoing training programs for their workforce, ensuring that employees are equipped with the skills needed for evolving technologies and sustainability standards. Additionally, ports actively participate in collaborative learning networks, sharing insights and lessons learned. The ability to adapt to new information, emerging technologies, and changing environmental conditions is critical for the agility and success of EU Green Ports in its journey towards sustainability.

Examples of learning programs within EU ports include the Transnational Networks for the 'Greening' of Ports, which facilitates policy learning to improve environmental performance and promotes sustainable development in ports. It involves collaborative efforts where port authorities design policy measures and tools to enhance their environmental performance (Lawer, 2019).

Another example is the European Sea Ports Organisation (ESPO), which represents the port authorities, port associations, and port administrations of the seaports of 22 Member States of the European Union and Norway. They provide a platform for knowledge sharing and learning among European ports (European Sea Ports Organisation, n.d.). The European Union also offers various programs that help individuals in many EU countries further their education, skills, and personal development. These programs can be beneficial for port employees to enhance their knowledge and skills (European Union, n.d.).

3.4.11 Instruments to monitor social innovation and inclusiveness in ports

Social innovation and inclusiveness are important aspects of port management, as they can enhance ports' social and economic benefits for all stakeholders, especially the local communities. Social innovation refers to the creation and implementation of new solutions that address social problems or needs, such as improving access to education, health care, or employment opportunities. Inclusiveness refers to the participation and empowerment of diverse groups of people, such as women, youth, migrants, or people with disabilities, in port activities and decision-making processes.

There are various instruments that can be used to monitor social innovation and inclusiveness in ports in Europe. Some of these instruments are:

- **Digital technologies**: digital technologies can enable port stakeholders to communicate, collaborate, share information, access services, and participate in port governance more easily and effectively. Digital technologies can also facilitate collecting and analysing data on port performance, impacts, and outcomes related to social innovation and inclusiveness. For example, digital inclusion scorecards can help identify pockets of digital exclusion where efforts are falling short (Leveraging Digital Technologies for Social Inclusion, 2021);
- **Cluster policies:** cluster policies are policies that support the development of specific sectors or regions based on their comparative advantages or synergies. Cluster policies can foster social innovation and inclusiveness in ports by creating networks among port actors, providing financial support or incentives for research and development projects, facilitating knowledge exchange and learning opportunities, etc. For example, the Digital Hub Initiative in Germany aims to promote digital innovation and competitiveness in selected regions (OECD, n.d.);
- **Sustainability indicators**: sustainability indicators are measures that reflect the environmental, social, and economic dimensions of sustainability. Sustainability indicators can help monitor social innovation and inclusiveness in ports by assessing their contribution to the 17 Sustainable Development Goals (SDGs) adopted by the United Nations3. For example, some SDGs related to social innovation and inclusiveness are SDG 1 (No Poverty), SDG 8 (Decent Work and Economic Growth), SDG

10 (Reduced Inequalities), and SDG 11 (Sustainable Cities and Communities) (Di Vaio and Varriale, 2018);

- **Stakeholder engagement:** stakeholder engagement is the process of involving relevant parties in port planning, implementation, evaluation, or improvement. Stakeholder engagement can enhance social innovation and inclusiveness in ports by ensuring that their needs, interests, values, perspectives, etc., are considered. Stakeholder engagement can also foster trust, cooperation, dialogue, feedback, etc., among port actors. For example, stakeholder workshops, surveys, interviews, focus groups, etc., can be used to collect input from port users, workers, suppliers, contractors, NGOs, government agencies, etc.

3.5 Key findings from Interviews with Port Stakeholders

Based on the stakeholders' interviews reported in Annex II, the purpose of this section is to showcase the diverse needs, concerns, and priorities of the maritime sector stakeholders, which provide a crucial understanding of the current state of art of green transition and decision-making. By analysing these insights, it was possible to get a holistic view across the sector uncovering potential challenges and obstacles to green energy transition in ports and opportunities and solutions alike. This section addresses stakeholders' concerns directly, and ultimately, extracts the most useful findings to guide towards the future of energy transition in ports.

The key findings, divided for specific thematic groups, are described in the following sections.

3.5.1 Green Energy Transition

Ports play a pivotal role in this transition, serving as hubs for innovation and collaboration between different stakeholders, including industry experts, policymakers, and academic institutions. Key themes include the need for regulatory adaptation, investment in infrastructure, and the development of new skills within the workforce. Additionally, the interviews underscore the importance of cross-sector collaboration, highlighting examples of successful green initiatives and the challenges faced in implementing sustainable solutions. Through these discussions, the SEANERGY project illustrates the maritime sector's commitment to reducing its carbon footprint and advancing towards a more sustainable future.

To craft a detailed narrative on the "green energy transition" based on the project's interviews with stakeholders, key insights around the transition of ports towards greener fuels and energy sources should be synthesized in the following:

- **Adoption of Greener Fuels and Energy**: Highlighting the shift towards LNG, hydrogen, and electrification of port operations;
- **Innovative Technologies and Infrastructure**: Discussing the integration of renewable energy sources, like solar and wind, and the development of necessary infrastructure for alternative fuels;
- **Regulatory and Policy Frameworks**: Analyzing the role of government policies and international regulations to adapt them to each port's specific case in order to succeed in green energy transition. In the journey towards green energy transition, the role of regulatory and policy frameworks cannot be overstated. Initiatives like the European Union's Fit For 55 package aim to reduce net greenhouse gas emissions by at least 55% by 2030, compared to 1990 levels, setting a robust regulatory foundation for the transition. This package includes a comprehensive set of proposals to make the EU's climate, energy, land use, transport, and taxation policies fit for reducing net emissions and facilitating the adoption of greener fuels and energy practices in ports. Moreover, the implementation of international standards such as ISO 14064 and ISO 14001, as highlighted in one of the interviews as well, provides a structured approach to measuring, managing, and reducing greenhouse gas emissions and implementing effective environmental management systems in port operations. These standards not only guide ports in achieving environmental and economic benefits but also in enhancing their sustainability credentials. Furthermore, the establishment of a Direct Emission Allocation Plan (DEAP) could serve as a pivotal tool for ports, enabling them to allocate emissions directly related to their activities and tailor their strategies for emission reduction more effectively. The integration of these regulatory frameworks and standards, alongside active stakeholder collaboration, is essential for ports to navigate the complexities of the green transition successfully, ensuring that policies

are adapted to each port's specific context and laying the groundwork for a sustainable maritime sector;

- **Stakeholder Collaboration**: Showcasing examples of successful collaborations between ports, local governments, businesses, and communities to drive sustainable changes;
- **Environmental and Economic Benefits**: Evaluating the environmental impact reduction and potential economic gains from green energy adoption. The transition towards green energy in European ports is not only reducing environmental impacts but also showcasing significant economic benefits through innovative circular economy practices. For instance, the Port of Strasbourg has become a beacon of sustainability by collaborating with 22 companies to enhance resource management and minimize waste.[111] Similarly, the Port of Rotterdam leverages residual heat from industrial processes for neighborhood heating, illustrating how ports can contribute to urban sustainability. These examples underscore the dual benefits of environmental conservation and economic efficiency, highlighting the ports' role in pioneering circular economy initiatives that lead to tangible reductions in emissions and foster sustainable urban-port collaborations.

Their insights highlight the importance of the interconnectedness of technological, economic, and social factors in achieving a sustainable transition to green energy in ports. However, it is crucial that in all stages of energy transition there is simultaneous training and workforce development.

3.5.2 Training and Workforce development

3.5.2.1 Training Needs

The transition of European ports to cleaner fuel and energy highlights the need for a skilled workforce, emphasizing the necessity of future-proof training, education, and lifelong learning opportunities. This transformation requires a multidisciplinary approach, urging the Commission to foster social dialogue and centre port workers in the digital and green shift, while also making the industry more appealing to women.

[111] Resulting in a decrease of 3267 tons of CO2 emissions and significant cost savings.

All stakeholders, regardless of their EU region, highlight a critical need for comprehensive training programmes to support the transition of ports to greener fuels and energy not only for new-profile professionals but also to upskill the existing workforce for the next decades. Among stakeholders, there is a consensus on the necessity for skill development in handling new technologies, understanding sustainable practices, and adapting to the evolving landscape of the maritime sector. Training needs span from technical knowledge about emerging green technologies to operational training on energy efficiency and environmental management. A particular emphasis must be placed on reskilling and upskilling the existing workforce and ensuring ongoing education to align with the sector's green transition.

Likewise, collaboration with academic institutions and learning from the best practices brought out by pioneering ports are suggested as methods to accelerate learning, adaptation and implementation. Moreover, the importance of creating a culture of innovation and inclusivity within the maritime industry is underscored, promoting gender equality and encouraging a diverse workforce to partake in this major transformation.

The interviews revealed that the ports, vital for global trade and soon for renewable energy, are aiming for zero emissions by 2050, the goal set out in the European Green Deal to this transition is comprehensive training for both technical staff and general workers, ensuring awareness of climate change, decarbonisation, and the adaptation to new technologies and practices for energy efficiency and sustainability. Traning cover a wide range of programmemes from in-depth courses on specific technologies like offshore wind farms and cybersecurity to broader topics on environmental sustainability and the European Climate Law. Ensuring no worker is left behind, these programmes are designed for the entire workforce, promoting a culture of inclusion, sustainability and efficiency.

Moreover, ports are facilitating knowledge exchange and best practice sharing through collaborative platforms, speeding up progress towards sustainability. Public authorities support this transition by promoting knowledge sharing, setting energy-efficient selection criteria for concessionaires, and encouraging the integration of decarbonization into strategic planning. This synergy of training, collaboration, and public-private partnership is pivotal for ports to evolve into resilient, green energy hubs, ready for the challenges and opportunities of the future.

More in detail, the interviews reveal a multifaceted view on the training needs for the transition of ports to greener fuels and energy. Key themes include:

- **Diverse Training Levels Required**: From technical knowledge in new fuels and energy solutions to general workforce efficiency, there is a strong emphasis on equipping both new and existing professionals with the skills needed for handling new technologies and facilitating smooth energy transitions in ports;
- **Incorporation of Green Technologies**: Training needs to cover the implementation and management of green technologies such as solar panels, wind turbines, and LNG facilities, showcasing the importance of understanding both the technical and operational aspects of these sustainable solutions;
- **Focus on Decarbonization**: Specific training on decarbonization strategies and practices is highlighted, indicating the need for personnel to be well-versed in reducing carbon footprints through various means, including energy efficiency and alternative fuels;
- **Regulatory and Economic Consideration**s: There's a noted requirement for training on navigating the complex regulatory landscapes and understanding the economic implications of the green transition, including funding, investments, and cost management;
- **Collaborative and Innovative Approaches**: Training programmes are suggested to encourage collaborative approaches to problem-solving and innovation, reflecting the interdisciplinary nature of port transitions to green energy and the need for stakeholder engagement;
- **Continuous Learning and Adaptation**: The dynamic nature of green technologies and strategies calls for ongoing training and professional development to stay abreast of the latest advancements and best practices in the field.

The significance of these findings lies in complete conformity to the European Parliament's report on developing a comprehensive European port strategy and the European Green Deal's port-related targets. The transition of European ports to cleaner fuel and energy sources is not just an environmental imperative but also a significant workforce development challenge, necessitating a comprehensive approach to training and skill development spanning ports, the maritime, transport, trade and shipbuilding sectors supported by adequate public and private funding. Said report and the insights from the stakeholders gathered in the video interview emphasize the necessity for future-proof training, education, and lifelong learning opportunities, while fostering social dialogue, placing port workers at the center of the digital and green transition, and ensuring gender equality. This approach acknowledges the vital societal role of ports in providing many direct and indirect jobs and stresses the importance of safeguarding fair and safe working conditions for all port and maritime workers.

To successfully navigate this transition, ports must invest in training programmes that equip workers with the knowledge and skills needed for new technologies and processes related to cleaner fuels and energy systems. This includes understanding renewable energy sources, energy efficiency measures, and the operation of new infrastructure such as electric charging points and hydrogen fuel stations.

Additionally, given the European Green Deal's emphasis on reducing emissions and promoting sustainable practices, training programmes should also cover environmental management, circular economy principles, and sustainability best practices in port operations.

In conclusion, the shift towards cleaner fuel and energy in European ports creates a pressing need for comprehensive training and education programmes. These programmes should aim not only to develop technical competencies but also to foster an understanding of environmental stewardship and sustainability principles. By doing so, ports can ensure that their workforce is well-equipped to contribute to the EU's ambitious environmental goals and to thrive in a greener, more sustainable maritime sector.

3.5.2.2 Job Growth and Employment Opportunities

The transition of European ports to cleaner fuels and energy is closely tied to job growth and broader employment opportunities, supporting the EU's climate objectives and economic expansion. The global shift to clean energy could be a turning point in the job market, creating a net increase of 10.3 million jobs by 2030, with the electrical efficiency, power generation, and automotive sectors being key contributors. The EU sees significant employment potential in renewable energy, particularly in heat pumps, biofuels, and wind power, with Germany, France, Spain, and Italy leading in renewable energy jobs.

Renewable energy's integration, like offshore wind and hydrogen production, is set to boost electricity generation in industrial ports, potentially reaching 70% by 2050, up from 5% today. This growth not only aids in decarbonizing port operations but also drives economic and job creation in new industries. Eurelectric, the European association for the electricity industry, notes that electrifying port operations can reduce pollution and emissions, with a potential to halve the carbon intensity of port energy use, despite increases in production and cargo throughput.

The European Commission's Joint Research Centre report highlights that the green energy transition can create jobs in clean technologies, making labour markets more resilient and contributing to a climate-neutral economy. Employment in the energy sector could reach 87 to 100 million jobs by 2050, dependent on decarbonization policies' ambition. This underscores the importance of reskilling and addressing gender imbalances. The move towards greener port technologies not only fosters environmental sustainability but is also crucial for economic growth and job creation in the EU.

The SEANERGY project stakeholder interviews across all regions in the EU emphasize significant anticipated changes in job growth and employment opportunities due to the transition of ports to greener fuels and energy. With ports and maritime sectors transitioning away from fossil fuels, there is an expected increase in demand for professionals skilled in new technologies and energy solutions. This transition necessitates both the creation of new job roles (such as LNG operation specialist or cyber threat intelligence analysts to avoid attacks in the smart grid) and the retraining of existing workers to handle innovative technologies and sustainable practices. Furthermore, the development of green energy solutions and infrastructure in ports is highlighted as a driver for innovation and economic development, positioning port cities as hubs for technological advancement and job creation in the green energy sector. These changes underscore the importance of diverse training programmes and the need for collaboration between ports, educational institutions, and industry stakeholders to ensure a skilled workforce capable of supporting the green transition.

The port industry is evolving due to the green transition, sustainability, and digitalization. These changes are creating jobs, attracting businesses, and strengthening local economies. Innovations not only generate employment during construction and operation but also make ports attractive to new ventures, increasing job opportunities. This shift impacts employment, especially in sectors previously dependent on fossil fuels, requiring reskilling for emerging roles in green shipping and technology. Building a skilled workforce capable of adapting to these new demands is crucial. Continuous reskilling and upskilling ensure the workforce remains competent, contributing to the industry's evolution and the green transition.

Stakeholders in the maritime industry, academia and experts in port-city relationships highlight the notorious shift towards green transition in ports, emphasizing technological innovation and its influence in employment. These shifts are expected to lead to job growth and new employment opportunities in various sectors of the maritime industry, especially for those skilled in green technologies and sustainable practices. Ports are becoming hubs of innovation, requiring a diverse range of professionals to support energy mix diversification and the implementation of circular economy initiatives, thus creating a promising landscape for job creation and professional development in the green transition of maritime operations.

All stakeholders highlight that the transition to greener fuel and energy in ports is expected to drive job growth and create new employment opportunities. This transition requires a range of new professionals and retraining for existing ones, particularly in handling new technologies and energy solutions. Additionally, the diversification of the energy mix in ports demands more professionals across various sectors. Circular economy initiatives and sustainable urban-port collaborations, like the ones described in the section below, are exemples of innovative approaches that can also spur job creation in the coming decades.

3.5.3 Circular Economy

The interviews underscore the vital role of circular economy principles in the transition of ports to greener fuel and energy. Initiatives such as using residual heat from industrial processes for neighbourhood heating demonstrate sustainable urban-port collaboration. Ports are engaging in circular economy projects, including recycling plastics found in water and developing onshore power supplies that consider the energy demand of the city. These efforts highlight the importance of innovative, sustainable practices in reducing environmental impacts and enhancing energy efficiency in port operations.

Stakeholders in all different sectors of expertise emphasize the importance and implementation of circular economy practices in the transition of ports to greener fuels and energy across the EU. Examples from specific ports, such as the Port of Rotterdam using residual industrial heat for local heating and efforts in Strasbourg for enhanced resource management and waste minimization, showcase practical applications of circular economy principles. These initiatives contribute to CO_2 emission reductions and highlight the role of ports in fostering sustainable industrial environments and promoting sustainable transportation methods. The interviews underscore the necessity of integrating circular economy approaches to achieve environmental sustainability and economic gains, demonstrating a proactive stance towards reducing carbon footprints and enhancing green infrastructure in port operations.

All of the stakeholders video interviews underscore the pivotal role of circular economy practices in transitioning ports towards greener fuels and energy sources providing us the best examples which are the following:

- **Innovative Circular Economy Initiatives**: Ports are implementing circular economy strategies, such as utilizing residual industrial heat for local heating, and showcasing sustainable urban-port collaborations;
- **Resource Management and Waste Minimization**: Examples like the Port of Strasbourg, where 22 companies collaborate to enhance resource management and reduce waste, illustrate the benefits of circular economy principles in environmental sustainability and economic efficiency;
- **Cross-Sector Collaboration**: The success of these initiatives is rooted in collaboration across various sectors, integrating environmental sustainability with economic activities and public-private partnerships.

These insights highlight the circular economy's critical role in achieving sustainable port operations, emphasizing innovation, collaboration, and strategic planning.

The relationship between ports transitioning to cleaner fuel and energy and the circular economy in Europe is a growing area of focus that aims to create more sustainable and environmentally friendly port operations. This transition involves several key initiatives and projects designed to integrate circular economy principles into port operations, thereby reducing waste, increasing the use of renewable resources, and fostering innovation and sustainability. The transition of European ports to cleaner fuel and energy is closely aligned with the principles of the circular economy, aiming to create more sustainable and efficient systems that minimize waste and maximize resource use. European ports are adopting circular economy practices to transform hydrocarbon waste and other materials with a high environmental footprint into new recycled, pollution-free fuels. This not only helps in reducing pollution caused by vessels but also supports environmental sustainability as a core aspect of the economy. Initiatives such as the recycling of hydrocarbon waste into carbon-neutral fuels and the conversion of industrial gases into biofuels are examples of how ports are integrating circular economy practices into their operations.

3.5.4 Gender Equality

The interviews highlight the importance of gender equality in the maritime sector, emphasizing the need for cultural shifts at educational and industry levels to promote inclusivity. Strategies include showcasing gender neutrality in maritime expertise, raising awareness from childhood, emphasizing skill over physical strength, ensuring equitable hiring practices, and adopting policies that support diverse workforces. Encouraging women in leadership roles and striving for work-life balance are crucial. These initiatives aim to create an inclusive environment that supports career advancement for all genders, contributing to a more diverse and innovative maritime sector.

The stakeholders' interviews highlighted the need for a cultural shift in both education and maritime industries, fostering gender equality and inclusivity to move away from the perception of these fields as male-dominated. The stakeholders, and most notably the AIVP representative, proposed policies that support women's career advancement, including family-friendly regulations to ease the decision between motherhood and professional fulfilment.

From these insights, the decalogue below is essential to initiate a multifaceted cultural shift promoting women's participation in the maritime sector:

1. **Showcasing the gender-neutrality of expertise: n**o expertise is defined by gender. The outdated notion that men are better suited for maritime careers needs to be

challenged. The focus must be placed on the diverse set of skills, knowledge and experience that women can bring to thrive in the maritime sector careers;

2. **Raising children awareness of the maritime world:** introducing maritime careers to children's minds at an early age is key. Parents, educators, and role models play a vital role in sparking curiosity and enthusiasm for the maritime sector regardless of gender;
3. **Emphasizing the skill-based nature of maritime jobs (IT, critical thinking, entrepreneurship) rather than physical strength**: aptitudes, not physical strength, are the foundation of success in the maritime industry. Today's maritime professionals need a diverse skill set that includes IT, critical thinking, and entrepreneurship. By focusing on these competences, we can open up new opportunities for women and challenge the traditional image of the maritime worker;
4. **Inculcating these views in all levels: from primary school to higher education**: it is necessary to integrate maritime-related topics into the curriculum at all levels, from primary school to higher education. By making maritime careers a visible and attractive option for girls, we can help them envision a rewarding future in this exciting field;
5. **Procuring equitable hiring practices where qualifications and expertise are central, not gender**: provide development opportunities and optimise employment. Hiring processes should be transparent, objective, and free from gender bias. The most qualified candidates must be chosen regardless of gender, background, family situation;
6. **Adopting more policies that actively promote a diverse workforce**: set targets for gender representation in maritime positions. Implement initiatives to attract and retain women in the maritime industry;
7. **Equal hiring positions, because you are looking for an expert with a specific profile**: it is needed to view hiring as a quest for the best talent, regardless of gender. Evaluate candidates based on their skills, experience, and qualifications. Promoting a merit-based hiring system that rewards excellence benefits the whole maritime sectors;
8. **Enhancing visibility and opportunities for women in leadership positions:** celebrate and promote women in maritime leadership roles. Mentor and support women aspiring to leadership positions. Break down barriers and create pathways for women to break the glass ceiling;

9. **Striving for an adequate balance between professional and personal life:** flexible work arrangements and family-friendly policies should be encouraged, acknowledging the importance of work-life balance in achieving career success and supporting women in managing their professional and personal responsibilities;
10. **Empowering women to flourish in their careers, regardless of motherhood:** women's contributions, regardless of their family status, should be recognised and valued. Nurture an inclusive and supportive work environment where women feel empowered to pursue their career goals while balancing motherhood. Guarantee an inclusive and welcoming workplace culture for all.

3.5.5 Port-City Collaboration

The stakeholders' interviews underscore the pivotal role of port-city collaboration in the green energy transition. This collaboration is manifested through various innovative practices, including the adoption of new fuels and energy solutions, the enhancement of infrastructure, and the development of renewable energy technologies. All stakeholders stress the necessity of cross-sector collaboration, sharing best practices, and engaging in knowledge transfer to foster sustainable solutions for all ports, including those that have had a slow start to make the shift towards energy transition. Successful examples of port-city collaboration, such as the use of residual heat for neighbourhood heating and the integration of green energy solutions that benefit both ports and cities, illustrate the potential for mutual growth and sustainability through collaborative efforts as explained in the previous sections.

All the interviewees emphasise the critical role of ports and port cities in the green energy transition, focusing on the importance of innovation hubs in ports, the societal benefits of technological advancements in green energy, and the challenges of social acceptance of new technologies. The transition towards greener ports is seen as a collaborative effort involving various stakeholders, including port authorities, industry experts, and local communities. The interview highlights the interconnectedness of port-city collaborations in advancing sustainable energy solutions and reducing the environmental impact of port activities.

The transition of ports to cleaner fuel and energy significantly benefits from port-city collaboration, particularly in adopting electrical innovations and new power solutions.

Increased communication between ports and cities is essential for managing challenges and maximizing opportunities for reducing emissions. For instance, the Ports of Rotterdam and Antwerp have invested in shore power facilities and collaborated with city and national authorities on electrical innovations through significant initiatives like the European Union MAGPIE and PIONEERS initiative. These collaborations are crucial for building resilience in power sourcing, integrating smart grids, and ensuring sustainable energy production, ultimately supporting the broader goals of sustainability and reducing carbon emissions in port operations and urban environments.

The relationship between ports transitioning to cleaner fuel and energy and port city collaboration is a critical and evolving aspect of global efforts to reduce maritime and urban pollution, combat climate change, and promote sustainable development. This relationship is multifaceted, involving technological, economic, environmental, and policy dimensions, the key aspects of this kind of relationship are summarized as follows:

- **Technological Innovation and Infrastructure Development:** Ports transitioning to cleaner fuels and energy sources, such as liquefied natural gas (LNG), hydrogen, electricity (for battery-operated vehicles and equipment), and renewable energy (solar, wind), require significant technological innovation and infrastructure development. Port city collaboration is essential in this context, as cities often provide the necessary support infrastructure, including energy supply chains, electrical grid enhancements, and transportation links. Collaboration ensures that the development of port facilities aligns with the broader urban infrastructure and energy systems, facilitating a more efficient and sustainable integration;
- **Regulatory and Policy Frameworks:** Effective policy and regulatory frameworks are crucial for encouraging ports to transition to cleaner fuels and energy sources. Port city collaboration can lead to the development and implementation of shared environmental standards, emissions targets, and incentives for clean energy adoption. This collaborative approach can ensure that ports and cities work together towards common environmental goals, leveraging local, regional, and national policies to accelerate the transition to cleaner operations;

- **Economic and Environmental Benefits:** The shift towards cleaner fuels and energy sources in ports can have significant economic and environmental benefits for port cities. Reducing emissions from port operations can improve air quality, benefiting the health of city residents and reducing healthcare costs. Economically, investing in green port technologies can spur job creation in new sectors, such as renewable energy, clean transportation, and environmental monitoring. Collaborative initiatives between ports and cities can maximize these benefits by aligning economic development strategies with environmental sustainability goals;
- **Community Engagement and Social Responsibility:** Port city collaboration emphasizes the importance of engaging local communities in the transition to cleaner port operations. This includes raising awareness about the environmental and health impacts of port activities, involving stakeholders in decision-making processes, and ensuring that the benefits of cleaner ports are equitably distributed. Such collaboration can enhance social responsibility, foster public support for sustainability initiatives, and ensure that the transition to cleaner fuels and energy sources is inclusive and just;
- **Global Networks and Partnerships:** Finally, port city collaboration on cleaner fuels and energy extends beyond local and regional boundaries, connecting to global networks and partnerships. Ports often participate in international alliances, such as the World Ports Climate Initiative, to share best practices, technologies, and strategies for reducing emissions. Through these collaborations, port cities can leverage global knowledge and resources, scale up successful initiatives, and contribute to international efforts to mitigate climate change.

In short, the relationship between ports transitioning to cleaner fuel and energy and port city collaboration is a dynamic and essential component of global sustainability efforts. It underscores the need for integrated approaches that combine technological innovation, policy coordination, economic incentives, community engagement, and international cooperation to achieve a more sustainable and resilient future for port cities and the global maritime industry.

3.5.6 Europe's Inland Waterways Ports

Inland waterways and inland shipping play a vital role in Europe's transportation and logistics network, contributing significantly to the region's economic development, environmental sustainability, and congestion relief efforts. The interviews emphasize the critical need for sustainable practices in inland ports and inland waterways ports in order to maintain competitiveness and relevance. Highlighting barriers like economic, regulatory, and financial challenges to adopting clean energy sources such as hydrogen and electricity, it showcases success stories like the Netherlands' first hydrogen-powered vessel. The interviews highlighted various perspectives on the role and challenges of inland waterways, inland shipping, and inland ports in the context of decarbonization and green energy transition. Key points from these discussions include:

- **Island Ports as Testbeds**: It was noted that while mainland or larger ports are more suited for widespread application of new technologies due to their infrastructure, small island ports can serve as pilot cases for innovation, especially if they are connected to the national electrical grid. This connection facilitates the use of renewable energy sources and makes these ports advantageous for testing decarbonization strategies from a comprehensive perspective, including shipping, port operations, and local road transport;
- **HAROPA Port's Approach**: Cédric Virciglio from HAROPA Port, managing ports along the Seine axis in France, detailed their focus on strategy, energy transition, and ecological projects co-funded by the EU. A significant technology highlighted for emission reduction is onshore power supply (OPS), which faces challenges like grid capacity and implementation costs. HAROPA's efforts include equipping terminals with OPS and exploring over 100 OPS systems for river units, emphasizing the necessity of public funding for such initiatives;
- **Challenges in France**: For inland water ports in France, the primary challenge is the scale of operations, with many being small-scale or individual operators. Efforts are underway to subsidize greener boats and implement OPS along the Seine River, with collaboration, funding, and expertise being key to overcoming these challenges.

Electrification and fuel cells are viewed as promising solutions for river transport, given their suitability for the distances involved;

- **Inland Navigation on the Danube**: The discussion highlighted e-fuels as a potential for CO_2 reduction but also pointed out the broader scope of greenhouse gas and emissions management. The industry is exploring short-term measures like using alternative fuels and electrifying smaller boats, with infrastructure development being a critical factor. Skepticism exists around e-fuels due to cost, production challenges, and infrastructure readiness for handling and storage.
- **Alternative Fuels and Onshore Power Supply(OPS)**: The importance of alternative fuels, such as hydrogen, and OPS in reducing CO2 emissions was stressed, with a focus on the mobile and static areas of operation. Challenges include the adaptation of infrastructure for new energy sources, regulatory barriers, and the need for economic incentives to make green transitions viable for operators;
- **European Federation of Inland Ports' Perspective**: Transitioning to clean energy sources is seen as crucial for inland ports, especially those near urban areas, to stay relevant and reduce emissions. Economic and regulatory barriers exist, with a lack of clear business models for new energy sources and the need for updated infrastructure and permissions for transporting and handling fuels like hydrogen.
- **Harmonizing OPS Along the Danube**: The need for technical specifications, grid availability assessments, and collaborative projects to establish OPS along the Danube was emphasized. Europe's focus on inland waterway transport as an environmentally friendly option underlines the importance of alternative fuels, next-generation engines, and OPS in achieving decarbonization goals.

The complexities of transitioning inland waterways and ports to greener operations are a challenge across the EU that can only be overcome by technological innovation, regulatory support, and financial investment as underscored by the interviewed stakeholders.

3.5.7 Summary of stakeholder's interview key-findings

The following table encapsulates key outcomes and recommendations derived from the thematic analysis of the interviews. In particular, this table captures the essence of the insights and strategic directions discussed in the interviews, paving the way for addressing the maritime sector's challenges and opportunities within the green transition.

Table 5: Summary of Stakeholder's interview key-findings

Thematic Group	Key Outcomes/Recommendations
Green Energy Transition	• Ports are pivotal for adopting cleaner fuels and energy, emphasizing electrification and renewable energy integration; • The need for ports to act as green energy hubs, leveraging proximity to renewable sources like offshore wind farms; • Importance of stakeholder collaboration for successful transition and regulatory support for enabling green initiatives; • Adoption of green hydrogen as a key alternative energy carrier for sectors hard to electrify.
Training and Workforce Development	• Critical need for comprehensive training programs to upskill the existing workforce and prepare new professionals for green transition challenges; • Emphasis on multidisciplinary approach and continuous education to align with the sector's evolving landscape.; • Collaboration with academic institutions and learning from best practices for accelerated adaptation and implementation; • Fostering a culture of innovation and inclusivity within the maritime industry to encourage diverse workforce participation.
Circular Economy	• Highlighting circular economy principles as crucial for sustainable port operations and energy transition; • Initiatives like using residual heat for neighbourhood heating/cooling systems and recycling plastics found in water exemplify practical applications; • The success of circular economy initiatives is rooted in cross-sector collaboration and public-private partnerships; • Ports are encouraged to integrate circular economy approaches to reduce carbon footprints and enhance green infrastructure.
Gender Equality	• The need for cultural shifts at educational and industry levels to promote gender equality and inclusivity; • Strategies suggested include showcasing gender neutrality in maritime expertise, equitable hiring practices, and support for women in leadership roles; • Importance of considering gender and intersectional perspectives in the green transition, viewing gender equality as essential for sustainable development; • Encouraging policies that support diverse workforces and family-friendly regulations to balance motherhood and professional fulfilment.

Thematic Group	Key Outcomes/Recommendations
Port-City Collaboration	• Port-city collaboration is pivotal for the green energy transition, benefiting from shared innovative practices and infrastructure enhancements; • Successful examples include the use of residual heat for neighbourhood heating and green energy solutions benefiting both ports and cities; • Emphasizes the necessity of sharing best practices and engaging in knowledge transfer to foster sustainable solutions; • The interconnectedness of port-city collaborations in advancing sustainable energy solutions and reducing environmental impacts is highlighted.
Europe's Inland Waterways Ports	• Sustainable practices in inland ports and waterways are urgent to maintain competitiveness and relevance; • Addressing barriers to adopting clean energy sources such as hydrogen and electricity with examples like the Netherlands' first hydrogen-powered vessel; • The necessity for support from government levels in building clean energy infrastructure and supportive regulatory frameworks; • Inland ports are seen as crucial for the decarbonization strategy, with emphasis on technological innovation, regulatory support, and financial investment for greener operations.

In a significant step toward realizing these objectives, 25 stakeholders from diverse fields—including academia, the transport and shipping industries, international organizations, port authorities, and regulatory bodies—were engaged in video interviews. These discussions not only bridged information gaps that could potentially stall immediate actions but also illuminated the diverse business models, resource allocations, and opportunities at the regional level. A critical examination of current policies revealed misalignments with actual port operations, thereby identifying areas that necessitate adjustment to facilitate energy transition more smoothly.

A pivotal outcome of the stakeholder interviews is the identification of dialogue and knowledge transfer as essential accelerators for decarbonizing the maritime sector. Engaging a wide array of industry participants has underscored the importance of developing and integrating cutting-edge technologies and ensuring that professionals are well-prepared to implement these solutions effectively and securely.

The discourse with stakeholders covered a variety of disciplines crucial to the green transition, including renewable energy, fuel technologies, the circular economy, and sustainable business models, among others. It became evident that managing and sharing resources such as hydrogen, water, electricity, and heat within port regions is vital. While no singular solution exists for the green transition, the interviews highlighted promising energy scenarios that leverage environmental sustainability, stakeholder cooperation, and business viability.

Furthermore, the discussions placed a strong emphasis on promoting gender equality and diversity within the maritime sector, advocating for equal opportunities in training and employment to dismantle traditional stereotypes and foster an inclusive industry environment.

4. Analysis of Regional Workshop Results

As mentioned in Section 2.3, each of the four workshops focused on a European region with the aim of analysing the social, economic, and technological barriers and potentialities perceived by the maritime sector to carry out the energy transition and decarbonization. In the following sections, the results summarized by VPF regarding each European region are reported.

4.1 Social Barriers and Potentialities

With regards to social barriers and potentialities among the maritime sector energy transition and decarbonization, the main workshop results are reported as follows:

West-Mediterranean Region:

Most of the people who formed the roundtables have decarbonization strategies in their companies (it is important to keep in mind that many of the organizations present work on energy transition projects and/or decarbonization, so having their own strategy is a must). In fact, some participants commented that they even help other companies with their decarbonization strategies. Most of them have departments in their organizations dedicated to this topic, which is considered in decision making and they offer training to employees.

- Barriers: the following social barriers were identified in the roundtables:
    - Monitoring and implementation challenges: effective monitoring of decarbonization measures is considered a barrier. Implementation challenges arise due to the complexity of managing both the technical aspects and financial aspects of projects. Companies need expertise in handling the different dimensions of these initiatives to avoid potential failures;
    - Need for high-quality information: access to reliable and comprehensive information is crucial for informed decision-making regarding decarbonization measures;
    - Need of expertise in management: developing expertise in managing the aspects of decarbonization projects is essential to prevent failure due to inadequate financial planning.

- Potentialities: in all the roundtables, most organizations had an energy transition department within their company which is seen as a potentiality, having a driving force. Their priorities included defining a comprehensive energy transition strategy for their organizations, ensuring compliance with environmental regulations and standards related to decarbonization, researching and adopting innovative technologies for decarbonization, assessing environmental impacts, and providing ongoing training to employees to promote environmental awareness and the adoption of sustainable practices in the company. Additionally, they mentioned that oftentimes the energy transition department fell under the board in their organization schemes, which allowed for easy access to board members in terms of decision-making, showing the company's commitment to decarbonization as well as facilitating the implementation of measures.

  Other potentialities mentioned were the importance of organizations (such as innovation centers) to set the tone within the sector. Cooperation between port authorities was commented, as well as working with research centers, especially in terms of training, and collaboration with other companies of the sector to propel decarbonization.

  Communication was also touched upon, as strategies for raising awareness within the organizations and driving force for change.

East-Mediterranean Region:

The main social barriers related to port decarbonization, according to the region, are:

- Limited acceptance of big-scale RES projects providing the necessary capacity to cover the electricity needs of cold ironing;
- conflict of the use of limited space around ports in islands for different activities (tourism, industry etc);
- smaller island ports lack the personnel and skills to develop and implement a successful decarbonization strategy
- scarcity of resources in small island communities
- seasonality due to tourism makes effective infrastructure planning hard

To overcome these gaps, the initiation of citizen engagement and participatory planning processes with a focus on the benefits from port decarbonisation were recommended. The port-island interface which gives strong reasons to local and port authorities to invest in the port energy transition as this can be beneficial to the quality of life of island communities and visitors by improving local mobility, air quality, noise pollution and the island's image as sustainable destination

Inland waterways-The Danube Region:

The Danube Region is currently at the beginning of working on the first steps regarding energy transition, so social aspects are not regarded as barriers or potentialities.

The conclusions reached the possibility of creating three new jobs in the port environment, with the agreement that job creation is not considered an issue so far.

North Atlantic and Baltic Region:

The social barriers and potentialities identified in this workshop were:

- Barriers:
  - Stakeholder engagement: along with the complexity of stakeholder analysis,
  - Resistance from port management: to drive change and implement green energy policies;
  - Conflicting roles of ports: ports are seen as both undesirable due to pollution concerns for local residents and as significant sources of employment and opportunities for the local population;
  - Lack of communication/collaboration between ports due to social and cultural differences.
- Potentialities:
  - Social image as a driver for decarbonization: customer pressure and public relations, which oftentimes drive the energy transition and decarbonization of ports;
  - Rise in environmental awareness, which helps with ambitious goal setting;
  - Collaboration: communication between stakeholders, sharing best practices/lessons learned.

4.2 Economical Barriers and Potentialities

Regarding economic barriers and potentialities among the maritime sector energy transition and decarbonization, the main workshop results are reported as follows:

West-Mediterranean Region:

Economic concerns were the main aspects mentioned on the roundtables, including risks of financial loss, failure to recover investments, or inability to generate expected profits. Addressing these barriers requires high-quality information to make informed decisions and financial support, such as non-repayable grants to incentivize the adoption of decarbonization strategies.

- Barriers: the following social barriers were identified in the roundtables:
  - Requirements for economic subsidies: some economic subsidies have many requirements, which create barriers for companies that don't meet the criteria, limiting their access to subsidies and hindering their decarbonization efforts;
  - Uncertainty in economic conditions: uncertainty stemming from economic conditions makes it challenging for companies to commit to decarbonization initiatives and invest due to potential financial risks;
  - Risks with emerging technologies: there's a challenge with technologies aspiring to enter the mix without sufficient technological, financial, or legislative maturity. This uncertainty presents numerous risks, making investments of millions of euros daunting. Public administration support through innovation funds is essential, but there's a need for filtration and assessment of technologies by the public administration to mitigate risks;
  - Cost concerns and long-term benefits: there's a perception that investments in decarbonization and technological demonstrators are economically daunting. Doubts persist regarding the economic viability of these initiatives. Upfront costs are a concern and require public administration intervention for support.

Some ideas that were mentioned to overcome these barriers include:

- Financial support and incentives: providing non-repayable grants and financial support can encourage organizations to take risks and invest in decarbonization and energy transition technologies they might otherwise hesitate to adopt;
- Flexible subsidy criteria: adjusting subsidy criteria to accommodate a broader range of companies, especially those unable to meet difficult requirements, can increase participation and support in decarbonization efforts. Specifically in Spain, where over 90% of companies are SMEs, it would be helpful to cater some subsidies to these companies as some requirements for funding are not easy to meet by smaller businesses;
- Adapting to economic conditions: strategies must be flexible and adaptable to prevailing economic conditions, allowing companies to navigate uncertainties and make informed investment decisions in decarbonization measures despite economic challenges;
- Creating internal markets to mitigate risks: to reduce risks associated with high investments in emerging technologies, a strategy could involve creating internal markets that gradually amortize the investment. For instance, establishing an energy tariff that covers costs over a specified time and provides renewable energy to operators can generate a viable business model, mitigating risks associated with the adoption of new technology.

- Potentialities: the following social potentialities were identified in the roundtables:
  - New business models in electrical infrastructure: port authorities view the electrical issue as a new business model, transitioning from individual concessionaire contracts with energy companies to becoming central in decarbonization efforts. They aim to become focal points for renewable energy, necessitating modifications in the legal framework;
  - Smart grids and energy communities in ports: the implementation of smart grids and energy communities within ports is seen as a viable model. This mirrors energy communities in municipalities, allowing for energy sharing during peak and off-peak hours. Port authorities are envisioned as undertaking roles such as energy marketers and distributors, necessitating legal framework modifications;

- Emerging business models in green logistics and supply chain: innovations in supply chain management and green logistics offer promising business models. Optimization in transportation logistics, adoption of sustainable practices in loading/unloading management, and offering sustainable maritime logistics services are highlighted. Exploring alternatives to energy storage also stands as a potential avenue for transformation;
- European projects for energy management in ports: participation in European projects focusing on energy management tools within ports highlights the internal market concept. Regulatory system barriers exist in adjusting or modifying existing systems to manage energy surplus and deficits efficiently, compelling the need for regulatory adjustments.

East-Mediterranean Region:

Based on the European Commission regulations, the financial support for smaller (less critical) ports should be sourced from national budget or regional funds. Greece has many small-scale (local) ports that encounter many issues, and therefore, the available funds are not sufficient to cover the infrastructure works in all ports. Additionally, the competition for European financing opportunities in upgrades of port infrastructures is high, whereas without external funding these types of projects are not feasible. Nevertheless, private initiatives in collaboration with the state are often observed, such as in the Astypalea and Chalki islands case. Another barrier to the port decarbonization is the high cost for converting a conventional ship to integrate onshore charging. In small ports, cold ironing investments have long payback periods, rendering those investments even more challenging.

An incentive for shipping companies to undertake this investment could be a potential tax reduction on the electricity bills and the possibility of selecting the electricity provider and negotiating the electricity supply contract. Another issue to consider is that as in the case of marine fuels, benefits and incentives should be awarded for the onshore electricity consumption.

Regarding business models, in Greece, the regulatory authority investigates whether the ports will only have an operational role in the supply of electricity or if they will be able to become providers as well. For smaller island communities, an interesting business model could be the formation of an energy community including the port and local authorities, citizens and local businesses promoting common investments in clean energy projects advancing the island's green transition as a whole.

Inland waterways - The Danube Region:

From the economic point of view, the main results were:

- Barriers:
    - Cost disparities in green investments: investments in green infrastructure or operations often entail higher costs compared to traditional investments. The lack of economic competitiveness in green initiatives poses a significant barrier;
    - Incomplete regulatory framework: the absence of a comprehensive regulatory framework for greening port operations and investments contributes to the economic barriers. The lack of clear directives and requirements hampers the drive for greener practices. This affects decision-making at a strategic level, particularly in ports where the higher costs of green investments need justification;
    - Need for favourable framework conditions: to incentivize the reduction of CO_2 emissions, there's a need for framework conditions that make such initiatives economically attractive and feasible. Investment decisions in infrastructure, mobile equipment, and operational elements are contingent on the viability of the business cases;
    - Uncertain business models: the absence of a well-defined, viable business model for decarbonization initiatives poses a significant economic barrier. The lack of clarity regarding profitability or return on investment inhibits stakeholders, including ship-owners, from embracing decarbonization measures like e-fuels due to high production costs;
    - Requirement for strategic greening plans: establishing strategies for greening investments and operations, including action plans and specific projects, is crucial. Port administrations, in collaboration with operators and relevant companies within the port area, need to take the lead in developing and implementing these strategies to surmount the economic barriers hindering decarbonization efforts.
- Potentialities:

- The establishment of a Directorate-General for Mobility and Transport (DG) and port expert group in 2021 facilitates the transfer of knowledge, best practices, and lessons learned from leading European ports. This knowledge exchange assists port administrations in formulating strategies, developing action plans, and implementing projects to advance their energy transition. Over the next two years, ports aim to acquire comprehensive knowledge about CO_2 emissions within their operational scope. This knowledge serves as the foundation for initiating actionable measures. External resources such as studies like DG Move's "greening of ports"[112] contribute additional insights, enabling the development of consolidated and comprehensive action plans;
- Access to funding programs: identifying projects and programs that offer funding to subsidize the cost disparities of green investments and technologies is crucial. Assisting ports in accessing public funding at national and European levels serves as a vital incentive for the successful implementation of their energy transition strategies;
- Enhancing competitiveness in inland navigation: to attract more cargo from other transportation modes, inland navigation must enhance its competitiveness. This involves a targeted approach towards adopting alternative fuels for various vessels, including smaller vessels, passenger vessels, and port pushers. This strategic shift aims to make inland navigation a more attractive and viable transportation option.

North Atlantic and Baltic Region:

Also, for this regional area, the main results are reported below:

- <u>Barriers:</u>
  - Lack of regulatory clarity: which poses a risk for "stranded assets" and investments;
  - High initial investment costs, as well as space limitations and the need for extensive cooperation, slow down the processes;

[112] https://commission.europa.eu/system/files/2020-10/move_sp_2020-2024_en.pdf

  - Challenges in implementing uniform business models: adapting ports to comply with local laws and practices of individual countries hampers the implementation of standardized business models, limiting uniformity across ports;
  - Port limitations due to fossil fuel dependency: existing ports face limitations as the European Union moves away from fossil fuel usage, causing concerns about the lag in the green transformation process within ports. Additionally, concerns were raised about the potential influence of major oil companies, posing a risk to slowing down the green transition of ports.
- Potentialities:
  - Shaping business models locally: adapting business models to local needs could transform ports into energy hubs;
  - Proactive management involving local community: ports should adopt proactive models where local communities and stakeholders actively participate;
  - Transporting offshore electricity through ports: proposals to use ports for offshore electricity production are seen as potential business models that could increase port efficiency.

4.3 Technological Barriers and Potentialities

Similarly, to the previous sections, workshop results regarding technological aspects are summarized below for each regional area.

West-Mediterranean Region:

The roundtables agreed that achieving zero emissions objectives with the current state of technology is unlikely. There is still a need for investigation, and new technology needs to be developed to achieve zero emissions objectives. If zero can't be reached, the consensus is that, nevertheless, the carbon footprint can be reduced; there is a lot of technology, research is being done on it, and it is demonstrated in many things that it can be done. Additionally, the current process of fossil energy consumption was mentioned. The opinion is that it is very difficult to change the paradigm.

- Barriers:

- Security risks associated with new technologies: introducing new technologies, such as hydrogen, brings forth security concerns that need addressing;
- Reliable access to supplies: ensuring consistent access to necessary supplies, particularly affordable and sustainable ones, is crucial for a successful energy transition;
- Need for advancements in technology: development of both emerging (e.g., hydrogen generation, electrolyzers) and incipient technologies is imperative. Maturity and implementation are necessary to reduce costs and ascertain their commercial viability;
- Maturity gap in existing technologies: current technologies lack maturity, both commercially and in emerging stages. This deficit calls for further development to meet the demands of transformation, particularly in port operations where fuel and electrification are essential for operational changes;
- Challenges of scalability, and energy storage: The main challenges repeated throughout the roundtables revolve around cost-effectiveness, scalability, and efficient energy storage. Access to capital, incentives, subsidies, robust regulations, emission targets, consumer preferences, and corporate responsibilities are considered critical factors.

Some strategies that were mentioned to mitigate these technological risks are:

- Diversifying operations and services to reduce dependence on a single technology;
- Being adaptable to changing market trends and acknowledging the continuous advancements in technology;
- Establishing policies and fostering cooperation to divide risks among stakeholders;
- Nonetheless, uncertainty prevails regarding the longevity of technologies, emphasizing the importance of choosing options with lower operational costs and improved regulatory frameworks.

- <u>Potentialities:</u>
  - Diverse technological options: possibility to employ a mix of technologies encompassing electrification, energy efficiency, and process improvements. Onshore Power Supply (OPS) was highlighted as a swift method to curb emissions,

particularly effective when cruise ships are connected to ports. However, its success relies on universal implementation across all ships and enhanced electrification capabilities within ports;

- Adoption of new technologies: despite current limitations in green hydrogen production, storing generated hydrogen during the day for nighttime use, such as a battery, was proposed as a viable option for deeper electrification in ports;
- Use of alternative fuels: alternative fuels such as methanol and ammonia were mentioned as potential alternatives. Rather than changing maritime engines (considered challenging), the focus is on decarbonizing fuels to reduce dependence on third countries;
- Balancing mature and emerging technologies: there's recognition that not all initiatives need to rely solely on newer, less mature technologies (like hydrogen). Instead, leveraging more established technologies (for example, photovoltaics) could be equally effective without the same level of risk. Some technologies may struggle to be implemented without incentives, public financing, or private investment, while others might offer short-term profitability;
- Digitalization and big data utilization: leveraging digitalization and big data emerged as strategies to gain competitive advantages, enhance energy management, and improve operational efficiency. The integration of these technologies is essential to minimize fossil fuel consumption and optimize operations.

East-Mediterranean Region:

The region agrees that climate change, particularly extreme weather conditions, affects the operation of the ports. Therefore, investments are needed first and foremost to tackle the impacts of climate change and support the resilience of the ports. The main results are:

- <u>Barriers relating to the electric network energy capacity:</u>
    - Short-Side Electricity (SSE) systems are of high power and energy (especially in the case of cruise vessels);
    - High Energy demands can lead to grid stability issues, mainly for non-interconnected islands.

- Barriers relating to the spatial arrangements inside the port:
    - Spatial limitations inside the ports (this phenomenon is more intense for small ports);
    - Unmapped old cable routings inside the port;
    - Different types of vessels serving the same position (the SSE & CMS system is different for different types of vessels);
    - Non-adequate depths for the trenches serving the SSE MV cables.
- Barriers relating to the Port's Electrical Network Energy Upgrade:
    - The existing infrastructure regarding its electric network can't serve the high demands of the SSE system;
    - Upgrade if the existing substations are mandatory;
    - Upgrade of the distribution network inside the port needs to be taken into consideration;
    - Non-adequate depths for the trenches serving the SSE MV cables
- Potentialities:
    - Great wind and solar (In certain cases even wave) resources provide great cvhance for the installation of RES
    - Development of cold ironing infrastructure: it is one of the most trending and emerging projects of energy upgrade in ports;
    - Creation of "green corridors" between the islands: it is seen as an initiative that potentially can activate the development of green innovative technologies;
    - Regulatory sandbox: it can provide a suitable framework in which the deployment of innovative applications for the green transition of ports can be activated
    - The existence of several short ferry connections between neighbouring islands or islands and the mainland poses a great chance for ferry electrification projects

Inland waterways-The Danube Region

Also, for this regional area, the main results are reported below:

- Barriers:

- Limited e-fuel testing scenarios: there's uncertainty regarding e-fuel testing scenarios. The lack of established testing grounds raises questions about the reliability and effectiveness of e-fuels;
- Availability of e-fuels along the Danube: questions arise about the sourcing and availability of e-fuels along the Danube route. Lack of clarity exists about where and how these fuels will be produced and distributed, as well as potential subsidies for their use;
- Diversity of vessels and energy sources: the Danube River's varying stages require different types of vessels and energy sources, complicating the adoption of a uniform solution. Diesel is prevalent in infrastructure, but different vessels require different energy sources, posing a challenge to standardization;
- Inadequate electrogrids for inland cruise vessels: the existing electrogrids along the Danube might not be sufficient, especially for inland cruise vessels that demand higher voltage;
- Unclear strategies for energy transition: lack of clear strategies or options for achieving energy transition goals creates uncertainty about where to invest—whether in hydrogen, e-fuels, or other alternatives;
- Need for mobile infrastructure: current funding schemes primarily focus on static infrastructure, neglecting the importance of mobile infrastructure for vessels' refuelling needs, similar to military and sea ships. It's considered crucial to include mobile infrastructure considerations for economical refuelling options for shipowners.

- Potentialities: some ports in the region have initiated data collection on CO_2 emissions and are at the initial stages of planning and decision-making for "greening" the port environment. Ports like Vienna, Ennshafen, Giurgiulesti, and those in Serbia have already taken steps such as implementing photovoltaics, harmonizing OPS, and establishing LNG fuelling stations.

The region's industry is exploring various energy sources, including e-fuels and hydrogen, to reduce CO_2 emissions. Other options, such as electrification of small ferry boats and steam usage, are also under consideration. The following technological options were mentioned:

- E-fuels and hydrogen focus: there's a focus on e-fuels and hydrogen as potential energy sources, but the challenge lies in their sourcing and availability;
- Onshore Power Supply (OPS): onshore power supply is crucial for decarbonizing the inland waterway sector. The capacity of existing electrogrids is essential for successful implementation. Collaborative efforts are emphasized, especially through project implementation focusing on OPS, to shift more freight from roads to environmentally friendly inland waterways and railways;
- Carbon capture technologies: collaborative efforts with international companies are ongoing to develop technologies for capturing CO_2 and other particulate matters in the sector;
- Efficiency improvement strategies: strategies like reducing vessel speed when approaching ports/locks, implementing OPS for static port operations, and integrating photovoltaics in ports are being considered.

North Atlantic and Baltic Region:

From the technological point of view, the main results were:

- Barriers:
    - Safety issues: both for society, port operators, and ship staff;
    - Infrastructure limitations: lack of available space in ports;
    - Lack of technological maturity: as well as technical inconsistency between port and ships;
    - Human element: lack of expertise in port operators, lack of knowledge, as well as lack of standards for fuels/technologies;
    - Lack of energy: high cost of high-power connection to the grid, as well as lack of energy storage capacity on board ships;
    - Availability of alternatives, such as green fuels, and the high carbon intensity of electricity in some countries/regions.
- Potentialities:
    - Establishment of bunkering hubs and creation of green corridors;

- Operational optimization: including the development of pre-studies (risk assessment- technical feasibility, economic feasibility);
- Inclusion of upstream fuel suppliers;
- Offshore electricity transportation through ports: Proposed as a potential business model, transporting offshore electricity production through ports is seen as a way to increase port efficiency;
- Alternative fuels: explore opportunities in methanol and ammonia production.

5. Recommendations for Fostering the Uptake of Renewables and Alternative Fuels

5.1 Regulatory Measures

Maritime decarbonization is a critical global priority as the shipping industry is a significant contributor to greenhouse gas emissions. To address this challenge, various policy-driven actions (as detailed in 3.3) have been implemented at international, regional, and national levels. The Green Deal provides a policy context that emphasizes the need for sustainable and low-carbon transport, including maritime transport and ports. The FuelEU Maritime Initiative is aimed to accelerate the uptake of sustainable alternative fuels in the maritime sector, including ammonia, hydrogen, and biofuels. The Alternative Fuel Infrastructure Directive is relevant for ports as it encourages the development of infrastructure for alternative fuels, such as liquefied natural gas (LNG), hydrogen, and electricity, which can be used by ships calling at ports. The Renewable Energy Directive (RED) is a key policy instrument of the European Union aimed at promoting the use of renewable energy sources and achieving the EU's renewable energy targets. While primarily focusing on the energy sector, it has implications for port decarbonization efforts, as ports play a significant role in facilitating the deployment and integration of renewable energy. These policy initiatives set binding targets for the share of sustainable alternative fuels in maritime transport.

These policies aim to drive the adoption of cleaner technologies, promote energy efficiency, and incentivize the transition to low-carbon fuels. Many ports in Europe are taking policy-driven actions to reduce carbon emissions from shipping. It demonstrated that EU-level policies trickled down tonational-level strategy or ambition. This national level strategy then influences the port level plans aimed at energy management and emission reduction investments. It also demonstrated that synergy in decarbonization policy at the EU, national, and port levels is crucial for effective and coordinated efforts towards decarbonization. The case studies (reported in 3.2) highlight that there are several examples of policy-driven action on port decarbonization as part of the EU's decarbonization strategies. However, at the same time, it highlights the various implications for the ports. The ports are required not only to comply with upcoming regulations but also need to recognize their role in:

1. New Energy Supply Chains.
2. Facilitating energy transition of the maritime traffic served by the port.

The European Sea Ports Organization (ESPO) calls for a new assessment of the importance of Europe's ports in the TEN-T network to reflect the current and future role of ports in the supply of clean energies. More than 40 amendments tabled by six different political groups supporting this idea had been tabled. Up to now, ports are considered part of the "TEN-T club" if they move enough tonnes and/or TEU. While throughput is still a valid criterion to measure the importance of ports, ESPO believes it is time to also consider the crucial role ports play as hubs in the green transition and Europe's security of energy supply. The new energies are of importance for Europe, and the related supply chains (such as hydrogen, wind, etc.) are more important in terms of volumes and space needed than fossil energies and fuels. They also come with specific transport needs, infrastructure and connectivity, storage and new supply chains.

Therefore, by counting only tonnes in ports, the TEN-T policy risks ignoring the importance of ports in building and strengthening the supply chain for the new energy landscape. Following the Council, on top of the current volume criterion (0.1% of the EU total volume of port cargo), a port can also be part of the comprehensive network if "its total annual cargo volume (bulk and non-bulk) exceeds 500,000 tonnes and its contribution to the diversification of EU energy supplies and the acceleration of the roll-out of renewable energies is one of the main activities of the port". The Council is thus clearly recognizing this new role of ports and the importance of having these ports as nodes of the future TEN-T network.

High ambitions in the absence of an enabling environment also place undue pressure on the ports. Due to data paucity, it is challenging for ports to compile data from all port companies (terminals, shipping…) and demand emissions reduction actions, as concessions last many years and make it difficult to demand new requirements.

The finance and technology barriers exist and do not reflect a combined effect as reflective in policy and ambition. Other challenges include legislation barriers such as lack of the H_2 regulatory framework and personal and institutional capacity required for the energy transition. Coordination and collaboration with various stakeholders, locally and internationally, is also a challenge for ports. Some ports are also struggling with balancing the need for rapid progress with ensuring long-term viability and sustainability. Concerns have also been raised that political ambitions are far ahead of the financing realities, especially economic viability. More realistic outlooks with plannings needs to concentrate on really promising solutions.

EU decarbonization strategies encourage alignment and coherence among different policies and initiatives. Ports need to ensure that their decarbonization strategies align with national and regional policies, as well as international agreements such as the International Maritime Organization's (IMO) strategy for emission reduction and regulatory requirements for the ships. Aligning policies fosters consistency, avoids conflicting requirements, and promotes a unified approach towards decarbonization. There is evidence of policy driven action aimed at decarbonization of Ports, but Decarbonization strategies require significant investments from ports to implement the necessary changes. This includes investments in new technologies, infrastructure upgrades, and workforce training. Ports need to secure funding and explore financing options such as public-private partnerships, green bonds, and grants to support their decarbonization efforts.

European ports are very diverse in the markets they serve, the type of vessels they accommodate, geographical location, size, tasks and responsibilities. To achieve the objectives of the European Green Deal and to help the transition of the shipping sector, each European port is developing a roadmap featuring a detailed plan of pathways for facilitating the greening of the maritime sector. These roadmaps need to be informed by the policy at the EU level, and each port’s peculiar circumstances must be considered. Therefore, strategy at port level needs individual ambitions and to be accompanied by a timeline which engages all relevant stakeholders, including the port, shipping lines and the energy sector.

Along with the regulatory compliance requirements environmental responsibility, reputation and competitiveness is driving voluntary action to reduce GHG emissions in several ports. Ports serve as key nodes in global supply chains and interact with various stakeholders, including local communities, government authorities, and environmental organizations. Taking voluntary action to reduce GHG emissions demonstrates responsiveness to stakeholder expectations and fosters positive relationships with these groups.

Ports, however, encounter high capital costs, technology readiness issues, financial risks, and safety concerns as main barriers to making a case for investment in new fuels and infrastructure to support the energy transition. One important thing to note is that providing onshore power to ships requires a lot of electrical power and many local utilities do not have the capacity and necessary infrastructure to deliver this power to ports. Coupled with the issue of general system instability and the loss of power quality due to increased renewable penetration in national grids, it will pose a sizable challenge for ports to ensure the safe supply of electricity to their shore power systems in the future.

It is also vital for ports to take an integrated approach while facilitating energy transition. It is recommended that compliance with upcoming regulatory requirements should be seen as an opportunity for ports to develop as energy hubs. Ports can engage in partnerships and collaborations with energy companies, grid operators, and other relevant actors to develop joint projects that integrate renewable energy solutions, such as smart grids and energy storage systems. This cross-sectoral integration will enable ports to become key players in the transition to renewable energy.

In conclusion, the policy-driven action on port decarbonization as part of EU decarbonization strategies has implications that range from regulatory compliance and technological innovation to infrastructure development and collaboration with stakeholders. Ports need to adapt to these implications, seize opportunities for competitive advantage, and contribute to environmental sustainability by reducing emissions and embracing low-carbon practices.

5.1.1 Role of different government in EU to promote inclusiveness in ports

The role of EU governments in promoting inclusiveness in ports is crucial for ensuring equal access and opportunities for all stakeholders involved. Ports play a crucial role in the economic development of countries, serving as gateways for trade and transportation. Given the diverse range of stakeholders and potential social and environmental impacts associated with port operations, governments in the EU have a significant role to play in promoting inclusiveness in ports. Therefore, it is essential for the EU to foster a more inclusive approach to port management that balances the interests and needs of all parties involved: port authorities (PAs), port users (such as shippers, carriers, logistics providers), port communities (such as local authorities, civil society organisations), port workers (such as seafarers), port regulators (such as national authorities), port investors (such as private companies), and port customers (such as consumers). Such an approach would enhance the efficiency and competitiveness of ports while ensuring their sustainability and social responsibility.

However, achieving this goal is not easy in practice. Many obstacles and tensions hinder effective cooperation between different levels of government in EU ports: legal fragmentation; institutional fragmentation; policy fragmentation; budgetary fragmentation; political fragmentation; cultural fragmentation; geographical fragmentation; etc. These factors create gaps and overlaps in responsibilities; duplication or inconsistency in rules; lack of coordination or communication; conflicts or disputes over resources or interests; etc.

To overcome these challenges and promote inclusiveness in EU ports, the following actions can be taken by different governments at different levels:

- **At the national level**: governments can adopt coherent and consistent policies that support the development and regeneration of ports and their cities, in line with the EU's strategic objectives and priorities. They can also allocate adequate and flexible funding to PAs and other actors involved in port activities, as well as provide technical assistance, capacity building, and innovation support. They can also foster dialogue and collaboration among different stakeholders, as well as involve them in decision-making processes. They can also monitor and evaluate the performance and impact of port policies and actions, as well as ensure accountability and transparency;
- **At the regional level**: governments can coordinate their policies with other neighbouring countries or regions to create synergies or complementarities among different ports or areas. They can also support cross-border cooperation among PAs or other actors involved in port activities, as well as facilitate mobility, integration, or exchange among them. They can also promote regional development strategies that address common challenges or opportunities related to ports, such as infrastructure, transportation, energy, environmental protection, social inclusion, etc;
- **At the local level**: governments can empower local authorities to plan, manage, or regulate their ports or areas according to their specific needs or circumstances. They can also support local initiatives that enhance social cohesion, cultural diversity, or civic participation among different groups living near or working in ports. They can also

foster local partnerships among PAs or other actors involved in port activities, as well as encourage innovation, entrepreneurship, or creativity among them.

5.2 Social and Inclusiveness Measures

Nebot Gómez de Salazar and Rosa-Jiménez (2020) and Jansen et al. (2018) both highlight the importance of social integration and inclusive growth in port development. Nebot Gómez de Salazar and Rosa-Jiménez (2020) specifically discussed the need for port authorities to incorporate the demands of local communities and develop activities that foster maritime culture. Jansen (2018) emphasizes the role of partnerships in driving inclusive growth, suggesting that they are the missing link between micro-level business strategies and macro-level effects. Ircha and Morency (2020) discussed the challenges women face in traditionally male-dominated workplaces and suggested steps for attracting more women to port jobs.

The inclusiveness of ports is influenced by a range of factors, including economic, regulatory, and geographical entry barriers. Societal issues, such as negative attitudes and stereotypes, language barriers, and a lack of diversity in management and staff can further compound these barriers. In the context of sustainable development, seaports face system-based barriers, including deficient collaborative policies, structural and managerial constraints, and market constraints (Katuwawala and Bandara, 2022). These barriers can hinder ports' ability to contribute to the Sustainable Development Goals. Therefore, addressing these barriers is crucial for promoting inclusiveness in ports.

Batalha et al. (2023) further underscores the need for a more comprehensive understanding of the social roles of ports, which can impact their inclusiveness. The ports of the European Union (EU) and other international ports are substantial contributors to employment, offering positions to a diverse array of citizens and individuals with varying qualifications and skill sets in the region. In brief, their contributions encompass the following areas: (i) promotion of environmental stewardship and economic development; (ii) development of transportation infrastructure; (iii) facilitation of cultural exchange; (iv) leadership and justice within the community; (v) recreation and tourism; and (vi) assistance with emergency response and humanitarian aid operations. Nevertheless, despite these challenges, port cities like

Rotterdam have the potential to be hubs of diversity and inclusivity, given their history of trade, migration, and cultural exchange (Hein et al., 2020).

The main barriers to inclusiveness in ports can be summarized as follows:

- **Gender disparities:** research in the EU port sector has highlighted significant gender disparities, with women making up only 2% of the workforce (Jeevan et al., 2020; MacNeil and Gosh, 2017). These disparities are attributed to a range of factors, including male domination, lack of awareness, and physical competence (Jeevan, 2020). Efforts to address these disparities have been slow, with gender equality measures in European ports progressing through stages from gender segregation to sustainability (Barreiro-Gen et al., 2021). However, these efforts have not been entirely successful, with the need for more effective policies and measures to achieve gender equality in the transport sector (Adorean et al., 2023);
- **Cultural diversity:** the cultural diversity in EU ports may present both opportunities and challenges for inclusiveness. EU ports attract a diverse workforce from different cultural backgrounds. However, cultural differences can lead to misunderstandings, communication challenges, and a lack of integration. Unconscious biases and ethnocentrism may hinder collaboration and create barriers to inclusivity. However, this diversity can also lead to disparities in inclusive development, as noted by Zielenkiewicz (2020). Therefore, while cultural diversity in EU ports can be a barrier to inclusiveness, it also offers the potential for greater understanding and cooperation among diverse communities;
- **Stereotypes and prejudices:** deep-seated stereotypes and prejudices based on race, ethnicity, or nationality can shape individuals' perceptions and treatment of their colleagues. Overcoming these cognitive barriers is essential for creating a truly inclusive work environment;
- **Unconscious bias:** cognitive biases, such as affinity and confirmation bias, can influence decision-making processes. Without awareness and intentional efforts to mitigate these biases, hiring, promotion, and recognition may be skewed, perpetuating inequalities.

The exploration of social innovation and inclusiveness in green ports within the European Union underscores the pivotal role of ports not only as economic engines but also as agents of positive societal change. The imperative for inclusive growth agendas, aligned with sustainable development goals, reflects a progressive vision that acknowledges economic, environmental, and social interconnectedness. European ports, exemplified by initiatives like the World Ports Sustainability Program, are actively embracing this vision, demonstrating a commitment to environmental stewardship, collaborative governance, and the betterment of local communities. However, the journey towards inclusiveness faces challenges, particularly in addressing gender disparities and navigating complex socio-cultural and cognitive factors. To navigate these challenges, a holistic approach is recommended, encompassing comparative strategies, demographic analyses, inclusive technology adoption, and strengthened community engagement, all aimed at fostering a more sustainable and inclusive future for green ports in the EU.

The pursuit of sustainability in EU green ports goes beyond individual efforts, emphasizing collaboration, end-user engagement, scalability, resilience, and a commitment to learning and adaptation, i.e. through co-creating, co-learning, co-working together in an environment where gender issues are addressed and marginalized communities are involved. Besides, by fostering a culture of collaboration and co-creation, prioritizing the needs of end-users, ensuring scalability and replicability, fortifying sustainability and resilience measures, and embracing a continuous learning mindset, EU Green Ports can collectively contribute to a more sustainable and resilient future for the European maritime industry in terms of achieving climate justice, sustainable development and social justice at the first place. Thus, ensuring equitable access to green technologies in EU green ports is contingent upon making the benefits of the green energy transition accessible to all communities. This prevents the emergence of environmental justice issues that would place the burden of environmental problems disproportionately on marginalized/vulnerable populations. By promoting cultural inclusivity in green EU ports, creating jobs, engaging the community, ensuring equitable distribution of benefits, and educating and raising awareness among citizens, including port employees – the desired transition is largely accomplished. In summary, this holistic approach benefits individual ports and creates a ripple effect, promoting sustainable practices across the entire EU port sectors.

5.3 Corporate Responsibility

"Corporate Responsibility Initiatives," are often referred to as corporate sustainability initiatives or CSR (Corporate Social Responsibility). They are actions implemented by an organization to manage and integrate ethical, social, environmental, and economic considerations into its business operations. These initiatives aim to ensure that the company operates sustainably, environmentally friendly, and socially responsible.

Corporate Responsibility Initiatives reflect a growing awareness of corporate responsibility towards society and the environment. Many consumers, investors, and stakeholders increasingly demand that companies adopt sustainable and responsible practices to contribute to a healthier and more equitable future.

Some key areas of interest for Corporate Responsibility Initiatives include:

- Environment: initiatives to reduce the environmental impact of business operations. These may include policies to reduce greenhouse gas emissions, adopt sustainable waste management practices, and use renewable energy;
- Social Responsibility: actions to improve the well-being of the communities in which the company operates. This can involve investments in education, health, and infrastructure programs in local communities;
- Ethical Governance: initiatives that promote transparency, integrity, and ethical corporate governance. This can include the establishment of ethical codes of conduct, the promotion of diversity, and the adoption of transparent governance practices;
- Sustainable Supply Chain: actions to ensure that the company adopts sustainable practices throughout the entire supply chain, promoting responsible and sustainable suppliers, for example;
- Worker Rights and Labor: Initiatives to ensure ethical working conditions and respect for workers' rights. This may include non-discrimination policies, workplace safety guarantees, and respect for union rights;

- social and Economic Impact: Assessments and initiatives to understand and improve business activities' social and economic impact on society.

Corporate responsibility initiatives in European ports are crucial for promoting sustainability, reducing environmental impact, and addressing social and economic concerns. Here are some key areas and initiatives that European ports can focus on to reach decarbonization objectives:

1. **Green Port Common Policies:** develop and implement comprehensive and specific EU green port policies that outline the commitment to environmental sustainability. This can include projects aiming to reduce carbon emissions, improve air and water quality, and minimize the ecological footprint of port operations. It is important to decline the Green port policies for each Specific Region;
2. **Renewable Energy Adoption and alternative fuels:** invest in and promote the use of renewable energy sources within port facilities. This may involve installing solar panels, wind turbines, or other renewable energy infrastructure to power port operations and reduce reliance on fossil fuels. In addition to that, encourage the use of alternative fuels and electric vehicles within port premises. Ports can provide incentives for port operators, shipping companies, and logistics providers to use low-emission vehicles, utilize onshore power supply when in port, and transition to alternative fuels;
3. **Emission Reduction Targets:** set and publicize clear emission reduction targets aligned with international and regional climate goals. Regularly report on progress and initiatives taken to achieve these targets, demonstrating a commitment to transparency and accountability;
4. **Waste Reduction and Recycling programs:** implement comprehensive waste reduction and recycling programs within the port. This includes minimizing single-use plastics, promoting recycling practices, and adopting a circular economy approach to manage waste generated by port activities;
5. **Community Engagement:** engage with local communities to address concerns and incorporate their perspectives into port development plans. Establish mechanisms for dialogue, public consultations, and partnerships to ensure that the port's activities benefit residents and businesses;

6. **Biodiversity Conservation:** develop and implement biodiversity conservation plans within port areas. This may involve creating green spaces, preserving natural habitats, and adopting sustainable landscaping practices to support local ecosystems;
7. **Energy Efficiency Programs:** implement energy efficiency programs to optimize energy use across port facilities. This can involve upgrading equipment, adopting energy-efficient technologies, and conducting regular energy audits to identify areas for improvement;
8. **Sustainable Supply Chain Practices:** encourage and collaborate with supply chain partners to adopt sustainable practices. This includes promoting responsible sourcing, reducing transportation-related emissions, and supporting environmentally friendly logistics solutions;
9. **Employee Well-being and Development:** prioritize the well-being and development of port employees. This can include initiatives such as health and safety programs, professional development opportunities, and employee engagement activities.
10. **Social Responsibility Specific Programs:** contribute to social development initiatives in local communities. This may involve investing in education, healthcare, and infrastructure projects to enhance the overall quality of life for nearby residents;
11. **Certifications and Standards:** obtain and maintain certifications and standards related to environmental management and corporate social responsibility. This can include certifications like ISO 14001 for environmental management or participation in programs like the EcoPorts initiative;
12. **Climate Resilience Planning:** develop and implement climate resilience plans to address potential impacts of climate change on port operations. This includes evaluating risks, implementing adaptation measures, and ensuring long-term sustainability;
13. **Improve Stakeholder Collaboration in ports:** collaborate with industry associations, governmental bodies, and non-governmental organizations to share best practices, stay informed about emerging sustainability trends, and collectively address challenges facing the maritime sector.

5.4 Education and Training Programs

Education and training programs in EU ports play a crucial role in ensuring a skilled workforce, promoting safety, and addressing the evolving needs of the maritime industry. These programs cover a wide range of areas, from technical skills related to port operations to broader aspects such as sustainability and innovation.

The education and training programs are often delivered through partnerships between port authorities, educational institutions, and industry organizations. Continuous updates and adaptation of programs are essential to keep pace with technological advancements, regulatory changes, and evolving industry best practices.

About environmental sustainability programs in EU ports focus on minimizing the environmental impact of port operations and promoting green practices. Programs align with broader EU policies aimed at reducing carbon emissions, improving air and water quality, and fostering sustainable development.

Below are there are some key components and examples of education and training programs that can be developed in EU ports:

1. **Port Operations and Logistics training programs** which cover the fundamental aspects of port operations, cargo handling, logistics, and supply chain management. Some examples are courses on port management, container handling operations, and logistics planning;
2. **Safety and Security** with a focus on safety protocols, emergency response procedures, and security measures to ensure a secure working environment, for instance, Training on fire safety, first aid, and security awareness for port personnel;
3. **Programs addressing environmental regulations, sustainable practices, and the integration of green technologies in port operations.** Some examples are Courses on reducing emissions, waste management, and the adoption of renewable energy sources;
4. **Training programs focusing on the latest technological advancements**, automation, and digitalization in port operations, like courses on the use of IoT, blockchain, and smart technologies in port management;
5. **Port Community Engagement Initiatives**. These are programs promoting collaboration and communication among various stakeholders within the port community (Workshops on stakeholder engagement, community relations, and public outreach).

Comprehensive educational and training programs are essential to foster the uptake of renewables and alternative fuels in the EU. These programs can help develop a skilled workforce, raise awareness about sustainable practices, and facilitate the adoption of clean energy technologies. Here are recommendations for designing and implementing educational and training programs in the EU:

1. **Integrate Renewable Energy and Alternative Fuels into Maritime Curricula.** Collaborate with maritime academies, universities, and training institutions to integrate courses on renewable energy, alternative fuels, and sustainable maritime practices into existing curricula;
2. **Professional Development for Maritime Personnel.** Offer specialized training programs for maritime professionals, including port managers, engineers, and ship crew members, to enhance their knowledge of renewable energy systems, alternative fuels, and related technologies and novel operational philosophies for vessels powered by alternative fuels;
3. **Online and Blended Learning about Sustainability.** Develop online courses and blended learning programs to make education more accessible to a wider audience. This flexibility allows individuals to acquire new skills without significant disruptions to their work schedules;
4. **Certification Programs for Renewable Energy Technologies.** Establish certification programs that validate the proficiency of individuals in safely implementing and managing renewable energy technologies specific to the maritime sector;
5. **Collaboration with Industry Experts.** Foster partnerships between educational institutions and industry experts, including renewable energy companies, technology providers, and port authorities. This collaboration ensures that training programs are aligned with industry needs and are kept up to date with latest developments in technology;
6. **Incorporate Environmental and Regulatory Training.** Modules on environmental regulations, sustainability standards, and compliance requirements to ensure that professionals are well-versed in the legal aspects of adopting renewables and alternative fuels.

Maritime academies, universities, industry associations, or specialized training providers may offer these courses. Additionally, online platforms and e-learning resources may offer modules or courses related to sustainability in the maritime sector. Individuals interested in such training should explore options based on their specific needs and career objectives.

5.5 Technological Innovation Approaches

Based on the collected best practices, reported in section 3.2, there are recommendations for the port environment to enable the transition towards socially and environmentally responsible behavior within all ranges as done in the successful cases. The recommendations can be divided into different scopes such as Port Energy and port operations. In addition, in sections 5.4.1 and 5.4.2 a special focus on safety and communications relating to using alternative fuels has been done.

The recommendations for port energy pertain to giving customers greener energy during port operations. This can be achieved using renewable energy, alternative fuels, or alternative power sources.

The best place to use renewable energy sources such as the sun, wind, ocean, and geothermal energy, is at the port. The use of renewable energy to meet port energy demands has become increasingly popular, as shown in the best practices analysis. As an alternative, ports are recommended to lower GHG emissions by buying power through the Renewable Energy Purchase Initiative when renewable energy utilization is not feasible. It is recommended that ports collaborate and invest in other businesses that are part of renewable energy cooperatives to increase the scope of renewable energy utilization.

Photovoltaic (PV) or solar water heating systems are the two types of solar energy generation. Winter output is subpar, whereas summer production is outstanding. PVs are utilized in off-grid applications such as remote beacons, buoys, and navigational aids. As shown by the ports of Best Practices, solar panels are installed on rooftops of buildings, warehouses, and cold storage warehouses in addition to open fields where space is available for construction. Therefore, PVs are recommended as a measure for low-carbon green ports.

The amount of area available for wind energy generation limits ports' capacity to construct both onshore and offshore wind generators. Because offshore generators are usually deployed in offshore wind farms and are too large to be linked to the port's grid, ports are recommended to work with wind farm developers to create power purchase agreements.

Biological and navigational barriers limit ocean energy, although it is possible to harness energy from ocean waves, tides, salinity, and temperature variations. The energy contained in the strata of the Earth is used via geothermal energy. In addition to being utilized to heat or cool buildings, workplaces, and warehouses, heat is also converted into electricity.

Port equipment may run on alternative fuels, and ports may build facilities to produce these fuels on their own (i.e. having their own supply). The first transitional fuel recommendation is the utilization of LNG to power the port equipment as done in the port of Bordeaux, where LNG is used as fuel for the dredger. The LNG can be used to minimize the port's GHG emissions. Therefore, it is recommended in the short term to increase the supply chains of LNG in port areas to facilitate its utilization in fuelling the different operations inside the port for example, port trucks, reach stackers, tugboats, and yard hustlers, while infrastructure and supply of sustainable alternative fuels are prepared. In the meantime, it is recommended that ports focus on collaborating with producers, suppliers, and end users of alternative fuels such as hydrogen, ammonia, methanol, etc. That requires extensive preparation for safe integration into port fuel supply chains and operations. For example, storage and bunkering of liquid hydrogen to vessels require specialized cryogenic equipment that can maintain cryogenic temperatures during stationary storage as well as during the bunkering processes. Furthermore, fuels such as ammonia that are highly corrosive and toxic require specialized equipment for maintaining safe storage temperatures and to withstand corrosion. It is recommended that port authorities create thoroughly examined plans for the safe storage, integration, and use of alternative fuels in collaboration with the relevant stakeholders.

Furthermore, based on the best practices analysis, it is found that alternative power sources in port areas are recommended such as utilization of Onshore Power Supply (OPS) for powering the ships during their stay in ports. The provision of shoreside electrical power could reduce noise in the port area, improve energy efficiency, and reduce harmful GHG emissions and particulate matter pollution generated by ships' diesel engines/generators. It is important for the port to supervise developments for onshore power for smaller terminals in the port area. To establish an infrastructure so that the entire area is provided with shore power capabilities.

As GHG and CO_2 emissions are directly correlated with the amount of fuel used, energy efficiency comprises operational and technological steps to cut port energy consumption and move toward the use of renewable energy. Energy efficiency methods reduce the total amount of energy consumed by port operations by reducing energy losses or reducing energy demand. Different measures can be used to reduce energy consumption and improve energy efficiency. For example, Light emitting diode (LED) lighting is a very straightforward yet effective solution that is commonly used in many ports in buildings, docks, yards, storage facilities, warehouses, and tugs; It reduced Port of Venice's energy use by 70–90%. Another way to increase energy efficiency in buildings and warehouses is to control the HVAC system. Similarly, for warehouses and storage spaces, white wall paint, lamp cleaning, insulation for cold storage, and curtains are advised.

Planning and overseeing every transaction involving energy producers (supply) and consumers (demand) is the responsibility of energy management. Regarding the involvement of the port authorities in Hamburg and Genoa in energy management, Ports set up energy management plan (EMP), then analyze the data, put cost-cutting and profit-maximizing measures into action, and keep an eye on them. One way that EMP reduces costs associated with energy consumption, peak loads, and greenhouse gas emissions is by increasing policy and decision-makers understanding of energy efficiency. As well the greatest chance arises when EMP combines logistical operations with port electrical management.

A microgrid creates a single unit that manages dispersed energy resources; as a result, it may function in both grid-connected and island-mode modes by connecting and disconnecting from the main grid. In addition to increasing the use of renewable energy sources, the microgrid incorporates energy storage, combined heat and power (CHP), and additional backup generators that can regulate supply and demand. In the islanded mode, port energy may therefore be supplied independently. As a result, the microgrid is regarded as essential for ports to manage their energy needs, electrification, and compliance with emissions standards in the future.

Digital technologies are available to help locate, monitor, and aggregate data to assist operational efficiency and the environment. Fuel consumption is decreased by the advancement of intelligent logistics in a way that ensures certain processes occur as optimally as feasible, such as big data analytics and remote sensing. For instance, using the Internet of Things (IoT) to track smart operations, fuel use, and logistical flows. Electronic Data Interchange (EDI) and One-stop E-business Portal Site facilitate communication between terminals and shipping lines. Blockchain technology is used in Antwerp, IoT sensors are used in Rotterdam to help with maintenance and repair, and 3D printing is used at the Port of Hamburg.

A general set of recommendations has been summarized as shown in the following Table.

Table 6: Summary of technical recommendations

Scope	Categories	Recommendations
Energy sources	Energy generation sources	Utilization of renewable energy sources in port areas, for example, the utilization of solar panels on building roofs, floating solar panels offshore/onshore wind turbines, and wave energy converters to generate clean energy. Utilization of geothermal energy to generate clean energy for the port.
	Alternative fuels	Utilization of alternative fuels such as LNG, methanol, hydrogen, ammonia, and biofuel for port operations. Development of biofuel production facilities to produce biogas and Biofuels.
	Alternative power sources	The utilization of power sources other than fossil fuel-run engines and generators onboard ships to provide cleaner power to cover the harbour operations of ships.
Port operations	Equipment	Replacement, repowering, and refitting of older carbon emission sources such as equipment or engines
	Energy efficiency	Energy-saving measures for buildings, warehouses, storages, yards, harbor craft and marine services, reefers, cargo handling equipment, and employees' commuting Use of energy management systems and plans e.g., ISO 50001, EN 16001, EN 16258. Energy management technologies (e.g., energy storage systems, reclamation, smart grids, virtual power plants, and microgrids)
	Digitalization	The use of digital transaction technologies (digitalization) (e.g., Electronic Data Interchange (EDI), E-business, port community system, and single window)

Scope	Categories	Recommendations
		Use of smart and intelligent technologies, (e.g., Internet of Things (IoT), blockchains, 5G technologies)

5.5.1 Safety aspects of alternative fuels

As the maritime industry embraces alternative fuels to reduce its environmental footprint, ports play a critical role in ensuring the safe and efficient handling of these new fuels. To achieve this goal, ports must implement a comprehensive approach that encompasses risk assessment, training, infrastructure development, and inclusive collaboration.

The development of safe and inclusive operations in EU Ports begins with a thorough examination of the risk and location-based risk of each of the alternative fuels being considered for a low-carbon energy system. These include but are not limited to compressed gaseous hydrogen, liquid hydrogen, methanol, liquid ammonia, LOHCs, bio-fuels, etc. Although strict guidelines have been developed for LNG operations through IMO Guidelines for Port Cooperation and Information Sharing on LNG Bunkering Operations (2019)[113], many alternative fuels are still in their risk-based assessment phase and will require close collaboration from all stakeholders for safe development.

According to a report on alternative fuel bunkering done by DNV (2021) for the Port of Amsterdam, these risk profiles are broadly categorized into the following areas of concern: fire focus area, explosion focus area, and poison cloud focus area. However, not all fuels have all three focus areas. For example, ammonia and methanol both have poison cloud focus areas as both gases exhibit properties of lingering vapour clouds near ground while H2 does not (DNV, 2021)

To develop safe and inclusive operations ports, it is important to undergo the processes described below to ensure that the base design of bunkering infrastructure, choice of equipment, operational procedures are developed such that they are inherently safe and do not rely on the lack of human error for safety.

- Risk Assessment and Mitigation:

[113] https://emsa.europa.eu/damage-stability-study/items.html?cid=77:publications&id=3207

- Hazard Identification: conduct a comprehensive hazard assessment to identify potential risks associated with the handling of alternative fuels, including their physical properties, combustibility, and compatibility with existing infrastructure;
- Risk Mitigation Strategies: Develop and implement risk mitigation strategies to address identified hazards. This may include specialized handling equipment, spill containment systems, personal protective equipment (PPE), and emergency response plans;
- Training and Awareness: Provide comprehensive training to port workers on the safe handling of alternative fuels, including the specific hazards, emergency procedures, and PPE requirements.

- <u>Infrastructure Development:</u>
    - Design and Layout: design and layout port facilities to accommodate the handling and storage of alternative fuels, ensuring proper segregation from incompatible materials and potential sources of ignition;
    - Storage Facilities: develop dedicated storage facilities for alternative fuels, incorporating segregation, containment, and fire protection measures;
    - Filling and Transfer Systems: implement specialized filling and transfer systems for alternative fuels, ensuring compatibility with the fuel type and preventing contamination;
- <u>Inclusive Collaboration:</u>
    - Industry Collaboration: foster collaboration among port authorities, fuel suppliers, ship operators, and regulatory bodies to develop standardized safety procedures and training protocols;

By prioritizing safety and inclusivity, ports can effectively manage the transition to alternative fuels, supporting the maritime industry's environmental sustainability goals while ensuring a safe and inclusive working environment for all port stakeholders.

6. Customized Regional Factsheets of Recommendations

6.1 Factsheet content

The main goal of the customized regional factsheet is to provide essential information about the countries involved in a specific EU Region and the main recommendations to consider fostering port decarbonisation, the development of renewable energy systems and alternative fuels use. Considering the desk research, the literature and best practices reviews, the results from the workshops and from the stakeholders interviews, main recommendations related to social, financial and technological barriers have been identified and used to create a regional factsheet dedicated to the four EU regions: North Atlantic and Baltic Region, East-Mediterranean Region, Inland waterways – The Danube Region and West-Mediterranean Region. The factsheets reported in Annex IV have the same structure reported in the figure below:

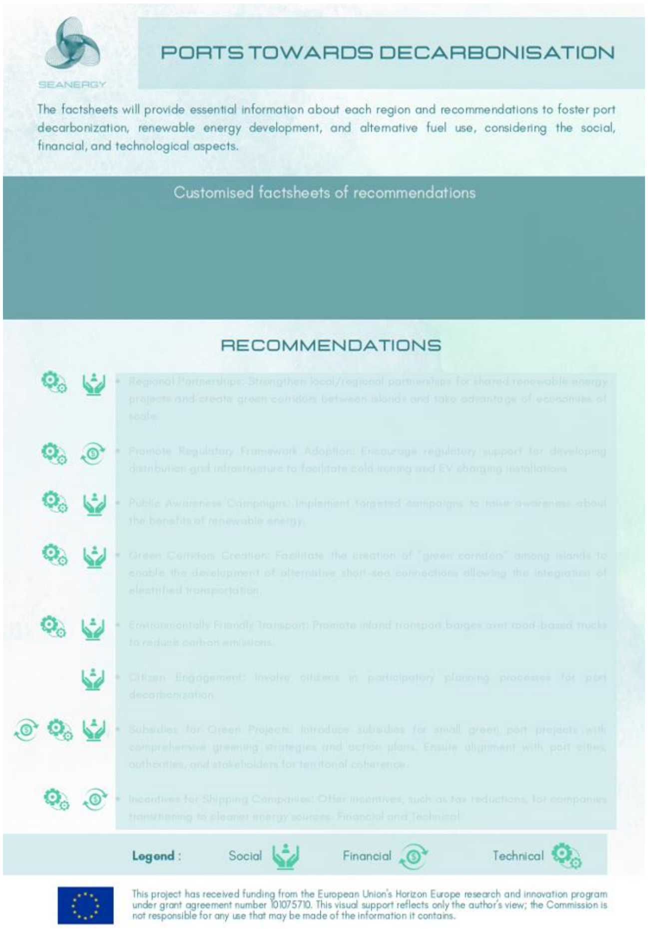

Figure 42: Customised Regional Factsheets model

7. Conclusions

European ports are increasingly recognised as critical actors in the transition to cleaner fuel and energy, playing a key role in the broader green energy transition. This relationship stresses the ports' ability to make the best out of their strategic positions, infrastructure, and operations to integrate renewable energy sources, electrify port-related operations, and support the adoption of cleaner fuels and innovative technologies in maritime transport.

Ports enjoy a unique position to become green energy hubs due to their proximity to sources of renewable energy, such as offshore wind farms, and their role in connecting various sectors of the economy. By electrifying operations and using renewable power for activities such as electric cranes, logistical vehicles, cold storage, and service vessels, ports can significantly reduce their carbon emissions and contribute to the electrification of the transportation sector, too. This direct electrification, along with the use of clean power for docked ships through cold ironing, not only reduces local air pollution and emissions but also enhances energy efficiency across port activities.

Moreover, ports have the potential to act as catalysts for the wider adoption of green hydrogen as an alternative energy carrier and feedstock. This is particularly relevant for complex sectors that cannot be directly electrified, such as aviation and intercontinental shipping. The production of green hydrogen through electrolysis, powered by renewable electricity accessible to ports, offers a path to decarbonize these sectors and replace oil and emitting fuels.

Achieving this vision of ports as green energy hubs necessitates concerted efforts and collaboration between port authorities, industry sectors, research institutions, and government agencies. Policymakers play a crucial role in facilitating this transition through regulatory support, incentives for renewable energy projects, and investments in necessary infrastructure to enable energy system integration. The EU's policies, including the gradual phase-out of internal combustion engines and the extension of its Emission Trading System to maritime and aviation sectors, are positive steps towards incentivizing investment in renewable energy and sustainable transport solutions at ports.

This concerted effort to transform European ports into front-runners of the green energy transition underscores the intimate relationship between ports' transition to cleaner fuels and the broader objective of achieving a sustainable, decarbonized energy system. As these initiatives unfold, ports not only contribute to reducing emissions but also reinforce their strategic importance in Europe's economy and as major employers.

7.1 Summary of Key Findings and Implications for Port Environment

Through the in-depth analysis by the European region of barriers and opportunities carried out through desk research, workshops and face-to-face interviews with port stakeholders, it has been possible to identify which are the key findings and the implications for EU Port Environment.

The analysis identified three main types of barriers, interconnected with each other:

- **Social Barriers**: stakeholder engagement, resistance from port management, lack of communication/collaboration between ports;
- **Economical and regulatory Barriers**: lack of economic subsidies, uncertainty in economic conditions, risks in long-term business models, lack of precise regulatory framework;
- **Technological Barriers**: safety risks associated with new technologies, challenges of scalability, maturity gap in existing technologies.

In the following table, general recommendations that can be applied in EU ports to overcome the barriers are reported. By implementing a combination of these recommendations, ports can significantly contribute to reducing their environmental footprint and embracing a more sustainable future.

Table 7: General Recommendations for EU Ports

N°	Recommendation	Description	Examples
1	**Common Regulatory Framework**	Implementation of a Common European regulatory framework that supports the use of renewables and alternative fuels in ports.	Tax breaks, subsidies, or other financial incentives for adopting sustainable practices.

N°	Recommendation	Description	Examples
		It will be necessary to ensure that national policies align with European Union (EU) directives and strategies promoting sustainable energy and transportation.	Leverage EU funding programs to support renewable energy and alternative fuel projects in ports.
2	**Infrastructure Development**	Make investments in the necessary infrastructure for renewable energy and alternative fuel sources.	Ensure that ports have the necessary charging stations, storage facilities, and refuelling infrastructure for electric vehicles and alternative fuels.
3	**Partnerships and Collaboration**	Foster collaboration between port authorities, energy companies, and relevant stakeholders to create joint ventures or partnerships. This collaboration can facilitate the development and implementation of renewable energy projects.	Encourage collaboration among European ports through initiatives like the European Green Ports Network. Facilitate the exchange of best practices, technologies, and experiences related to renewable energy and alternative fuel adoption.
4	**Financial Incentives**	Provide financial incentives for ports and shipping companies that adopt green technologies.	This could include grants, low-interest loans, or subsidies for the purchase of electric vehicles, renewable energy installations, or alternative fuel infrastructure. Establish financial support mechanisms at both national and EU levels. Offer grants, subsidies, and favourable financing terms to ports investing in renewable energy infrastructure and alternative fuel facilities.
5	**Research and Development**	Invest in research and development to identify and develop new technologies and solutions for sustainable port operations.	This could include advancements in energy storage or energy communities, more efficient renewable energy systems, or the development of new alternative fuels.

N°	Recommendation	Description	Examples
6	**Training and Education**	Provide training programs for port personnel to familiarize them with the operation and maintenance of renewable energy systems and alternative fuel infrastructure. Educate stakeholders on the benefits of green technologies.	
7	**Environmental Certification**	Establish and promote environmental certification standards for ports. Ports that meet certain sustainability criteria, such as the use of renewables and alternative fuels, could receive certification, enhancing their reputation and attracting environmentally conscious clients.	This can include certifications like ISO 14001 for environmental management or participation in programs like the EcoPorts initiative; or ISO 50001 for energy management system.
8	**Demonstration Projects**	Implement demonstration projects showcasing the successful integration of renewables and alternative fuels in ports. This can serve as a model for other ports, demonstrating the feasibility and benefits of adopting sustainable practices.	
9	**Information Sharing**	Facilitate the sharing of best practices and success stories among ports globally. Learning from the experiences of others can accelerate the adoption of renewable energy and alternative fuels in port operations.	
10	**Public Awareness Campaigns**	Raise public awareness about the environmental impact of port operations and the benefits of using renewables and alternative fuels. Public pressure and support can	

N°	Recommendation	Description	Examples
		encourage ports to adopt sustainable practices.	
11	**Technology Standards**	Establish and promote standards for clean technologies in ports. This can ensure interoperability and compatibility, making it easier for ports to adopt and integrate renewable energy and alternative fuel solutions.	
12	**Carbon Pricing and incentives for Low-Emission Vessels**	Implementing carbon pricing mechanisms to internalize the environmental costs of traditional fuels. This can make renewable energy and alternative fuels more economically attractive for ports. Introduction of incentives for shipping companies using low-emission vessels.	This could include reduced port fees, preferential berthing rights, or other economic advantages for ships employing alternative fuels or advanced emission reduction technologies.
13	**EU Funding Programs**	Leverage EU funding programs such as Horizon Europe, Connecting Europe Facility (CEF), and Innovation Fund to support research, development, and deployment of renewable energy and alternative fuel projects in ports.	
14	**Electrification Infrastructure**	Prefer to invest in onshore power supply (OPS) infrastructure to support electrification of ships while docked. This can reduce emissions during port stays and encourage the use of electric propulsion systems.	
15	**Public-Private Partnerships**	Encourage public-private partnerships to accelerate the adoption of sustainable practices in ports. Collaboration between governments,	

N°	Recommendation	Description	Examples
		port authorities, and private entities can help pool resources and expertise.	
16	**Educational Programs**	Implement educational programs to raise awareness and build expertise among port stakeholders regarding the benefits and implementation of renewables and alternative fuels	
17	**Support the Alternative Fuel application in ports.**	To develop safe and inclusive operations ports, using alternative fuels, is important to implement Risk Assessment and Mitigation plan and to support the infrastructure development from the economic and technical point of view.	
18	**Holistic Approach**	Use an holistic approach to encompass comparative strategies, demographic analyses, inclusive technology adoption, and strengthened community engagement, all aimed at fostering a more sustainable and inclusive future for green ports in the EU.	Emphasizing collaboration, end-user engagement, scalability, resilience, and a commitment to learning and adaptation, i.e. through co-creating, co-learning, and co-working together in an environment where gender issues are addressed and marginalized communities are involved.

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ANNEX I

List of interviewes and main Contact information

INTERVIEWEES/STAKEHOLDERS				
N°	**Name**	**Role**	**Sector**	**Nationality**
1	George Caralis	Professor/Researcher National Technical University of Athens (School of Naval Architecture and Marine Engineering)	Academia	Greek
2	David Daniels	Senior Researcher at Sweden's Road and Transport Research Institute	Transport Industry	American, working in Sweden
3	Turi Fiorito	Director of EFIP (European Federation of Inland Ports)	Port Industry	Belgian
4	Fanny Lossy	Director of Environment, Maritime Safety and Offshore at ECSA	International Organisation	Working in Belgium
5	Herfried Leitner	General Manager of TTS	Transport Industry	Austria
6	Jorge De la Fuente	Maritime Administration in the navy	State Administrative Body	Chilean
7	Jennie Folkunger	Head of Environmental Sustainability in the Port of Trelleborg	Port Industry	Swedish
8	Luisa Spaggiari	Consultant at Ramboll in the Marine, Coastal and Ports Department	Consultancy	Colombian/Italian, working in Denmark
9	Ksenija Hajdukovic	Senior associate of the Port Governance Agency	State Administrative Body	Serbian
10	José M. Pagés Sánchez	Director of Agenda AIVP 2030	Port-city relation Port Sustainaibility	Portuguese, working in France

INTERVIEWEES/STAKEHOLDERS				
N°	**Name**	**Role**	**Sector**	**Nationality**
11	Francesco Russo	Professor in Reggio Calabria University (Department of Information Engineering, Infrastructure and Sustainable Energy)	Academia	Italian
12	Zineb Debboun	Project Manager Officer at APM Terminals (Spanish Gateways Organisation)	Port Terminal	Spanish
13	Cédric Virciglio	Director of Strategic Steering at HAROPA Port	Port Activities/Industry	French
14	Robertas Valantejus	Executive Director at Association of Lithuanian Stevedoring Companies	Port Industry	Lithuanian
15	Manfred Seitz	Director General of the Danube Commission	International Organisation	Austria
16	Allen Ofea	Principal Officer of Pollution and Safety Response	Maritime Authority	Solomon Islands, upskilling in Sweden
17	Susann Dutt	Member of the Executive Committee of EOPSA	Industry Association at European level	Swedish
18	Robert Rafael	General Secretary at Pro Danube International	International Organisation	Hungarian, working in Austria
19	Dimitrios Lyridis	Professor, National Technical University of Athens (School of Naval Architecture and Marine Engineering)	Academia	Greek

INTERVIEWEES/STAKEHOLDERS				
N°	**Name**	**Role**	**Sector**	**Nationality**
20	Stefanos Dallas	EU Program Manager, Protasis	Industry	Greek
21	Federico Torres	Director of Ecological Transition at the Port authority of Valencia	Port Authority	Spanish
22	Fulvio Lino di Blasio	President of the North Adriatic Sea Port Authority	Port Authority	Italian
23	Loizos Georgios	Director, Regulatory Authority for Energy, Waste & Water)	Regulatory Authority	Greek
24	Javier Cervera	Head of Energy Transition in Baleària	Shipping Company/Industry	Spanish
25	Javier Ares	Director of Port Terminals at Valencia Port	Port Terminal	Spanish

ANNEX II

Interview Transcriptions

List of Acronyms

Abbreviation / Acronym	Description
ADMIE	Greek Acronym for IPTO
AIVP	Association International Villes et Ports (International Association of Ports and Cities)
ALFION	ALternative Fuel Implementation in igOmeNitsa port
ATP	Atperson Formación y Empleo SL
CAPEX	CAPital EXpenditures
CCUS	Carbon Capture Utilisation & Storage
CIPORT	Cold Ironing in the PORT of Piraeus
CMAC	Container Management Systems
CMS	Content Management System
DAFNI	Network of Sustainable Greek Islands
DEASP	Environmental Energy Planning Document
DEDDIE	Greek Acronym for HEDNO
DG MOVE	Directorate General of the European Commission for Mobility and Transport
EALING	European flagship Action for cold ironING ports
ECSA	European Community Shipowners Association
EHOO	EnnsHafen Port
EMAS	Eco-Management Audit Scheme
EOPSA	European Onshore Power Supply Association
E-SAF	Electro-fuelled Sustainable Aviation Fuel
EU-ETS	European Union-Emission Trading System
FAME	Fatty Acid Methyl Esters
FPS	FutureProof for Shipping
FSRU	Floating Storage Regasification Unit
GV	Great Value
HAROPA	port of le HAvre- ROuen-PAris
HEDNO	Hellenic Electricity Distribution Network Operator
HVO	Hydrotreated Vegetable Oil

Abbreviation / Acronym	Description
IPTO	Independent Power Transmission Operators
ISO	International Standards Organisation
LED	Light-Emitting Diode
LNG	Liquified Natural Gas
MAGPIE	sMArt Green Ports as Intergrated Efficient multimodal
MSc	Master of Science
MWA	Megawatts
NTUA	National Technological University of Athens
OECD/OCDE	Organisation for Economic Co-operation and Development
OPEX	OPerating EXpenses
OPS	Onshore Power Supply
PGA	Port Governance Agency
PMO	Project Management Office
RAEWW	Regulatory Authority of Energy, Waste & Water
RES	Renewable Energy Sources
RINA	Registro Italiano Navale
RO-RO	Roll On- Roll Off
ROPAX	Roll On Passenger ferry service
RPA	Robotic Process Automation
RTG	Radioisotope Thermoelectric Generator
SEANERGY	Sustainable EducationAl programmeme for greenER enerGY
SME	Small and Medium Entreprises
SOCRATE	Synergie pour une Organisation Collective et Raisonnée sur l'Axe Seine de la Transition Énergétique. (Synergy for a Collective and Reasoned Organisation in the Seine Axis for Energy Transition)
TIMAD	Traitement Informatisé des Marchandises Dangereuses (Data Processing for Dangerous Goods)
TTS	Transport Trade Services
VNF	Voies Navigables de France (French Inland Waterways)
VPF	Fundación Valenciaport
WMU	World Maritime University

1. INTERVIEW WITH GEORGE CARALIS

- George Caralis (hereinafter GC)
- Petros Markopoulos (hereinafter PM)

PM: Hello Mr. Caralis. Thank you very much for participating in the SEANERGY interviews.

GC: It is my pleasure and thank you for your invitation.

PM: It was really important to also have you on board in the event that we organised some weeks ago, together with other participants from the port, from universities and the industry. I would like to follow up on that event.

GC: IT was a very interesting event; I would like to add.

PM: Thank you for your input and kind words. It is true that it was a really interesting conversation. Many things came up and there is a lot of work to be done, it seems in the coming years, with these stakeholders coming together and trying to push the decarbonisation of ports. I would like to go to the first question of our interview, if you believe that ports can really transform into clean energy hubs.

GC: I would say that they can and they should be. Why? The answer is obvious for me. Ports are a reference point of the islands: local activities, tourism, trade, communication meet there. So, it is an opportunity for the islands and I think their ports should be a referential field of application of new technologies, of renewable energy and energy saving technology in the context of energy transition.

PM: So based on your background and expertise, what do you think…which types of renewable energy sources do you consider more suitable for integration in ports or near ports?

GC: For the reasons that I mentioned earlier, in ports and in Greek islands, we have the privilege to combine not only the most cost effective of these technologies, like photovoltaic and wind energy, but also the more innovative demonstration in small projects or the exploitation of wave energy, offshore or *floating wind*.

PM: Regarding these innovative technologies, which do you think are the bottlenecks and we have not seen until now many implementations of them, especially in Greece?

GC: It is not easy…there are some bottlenecks and challenges to deal with. For the floating (wind power?) first, I would say that besides the fact that we only have globally only a couple of demonstration projects and only ne 1 commercial floating windfarm we see today the potential of this technology and the discussion related to it, so I believe that with the demonstrative small-scale floating wind project, for example of the order of 50KW in Greece, in a Greek port, could be feasible, it could be possible to be realised. I think Greek companies and universities could be involved for the design and the construction of these…small-scale O.K. We talk about small-scale.

Now, what regards offshore wind, the conventional offshore wind, which is more commercial today, however, not in the Mediterranean Sea yet. So, probably, I think it would more difficult in comparison to the floating, if we consider the lack of infrastructures and companies involved in the installation and transportation, etc.

And last, for the wave (energy), I would say that, of course, we know that wave energy could be exploited by a variety of different types of technologies and applications. Obviously, we are in the beginning of this exploitation, but I would consider some similarities with the floating offshore wind. Why not apply a small demonstration project within a Greek port with a multi-purpose floating structure for offshore wind and wind energy exploitation together.

PM: O.K. That is a very good recommendation. I keep that and I hope that there will such initiatives in the future. I know there has been some research on that but we have not seen something really operating yet. Regarding the offshore wind (power) that you mentioned, the fixed bottom ones, which is now a commercial, in fact, technology, but we have not seen as you mentioned in the Mediterranean Sea. What is the reason for that? What is the extra difficulty for the Mediterranean Sea for offshore wind (power)?

GC: It is obvious that the technical issues are solved. There are other challenges for its implementation in the Mediterranean. So, I would focus first on land planning issues, especially due to the fact, this is also related to the ports, because the land area is limited in ports, so we have to consider marine solutions. At sea, the land planning issues in the sea are not clear and we need to clarify many legal aspects, policy and strategic planning for this implementation. All these are not clear today in Greece.

Secondly, we need to consider modern project financing tools. From my point of view, again, here, there is a great opportunity for ports. Recent development shows that there are many corporations which are positive to be involved and co-finance in innovative projects in ports or islands. You know this better than me, you have experience with these kinds of projects. These companies and corporations are looking forward to great advertisement and promotion, thanks to the position of ports in the Greek islands. Last but not least, social acceptance is critical and maybe this is another unique chance to involve local authorities, local population and local investors in these projects.

PM: That final remark… I keep that too, because I believe it is true that the local communities, both authorities and investors have got a lot to contribute in such projects, but they lack the capacity unfortunately in many cases. And that is where partners and stakeholders come, like universities or companies like DAFNI is true that they can offer some added value, consulting doing technical studies and so on. So, I think this is also a field where universities can contribute a lot.

GC: We are looking forward to the collaboration in this direction.

PM: I am happy to hear that. So, as a final question from my side, I would like to ask you. From the event that we had last week, it came out that cold ironing is the most appropriate and low-hanging fruit, let us say, for the Greek ports to start the electrification of ports and ship loads. However, the demand requires a very high amount of energy and power. The question there is: based on your experience in renewable energy in the Greek grids. Can grid operators provide the necessary infrastructure upgrade? And how fast could that happen?

GC: I hope so, and maybe we should ask them if they already do support this upgrade, but I would like to underline here that RES penetration in most islands both interconnected and not interconnected islands, in both case the RES penetration is moderate. I would say it is in the order of 10-25% max. This is even less than what it is in the main land. This is strange if we consider the abundant wind and solar potential in the islands, but it could be justified, and we understand this, if we consider the technical constraints and challenges that we have to deal with and the special characteristics of isolated power systems. So, in any case, this means that cold ironing in Greek islands, in short term, would be based mainly on diesel generation, which is far away from our target of energy transition in Greek islands and ports. So, we have to consider also this, to take this into account, when we discuss about cold ironing.

PM: In a way, we should prioritise greening the energy mix, especially in non-interconnected islands and maybe then discuss the cold ironing, since it really has a high applicability in Greek ports?

GC: Or both of them together. Do not forget the one and the other.

PM: Yes, right. Or just focus on the port maybe to say that we balance the energy of port, both in generation and demand locally. A final question, if I may, George, do you think that the lack of space in ports could be solved through the net-metering scheme, trying to find areas around the island that are more suitable for installations of that scale that can cover the port's needs? As you know, in many cases, the ports inside the cities or town, and it is sometimes difficult.

GC: Yes, why not? Especially for the large-scale projects, this will be the case. Also, for offshore, it will not be offshore near the port, necessarily.

PM: OK. I would like to thank you very much for this interview.

GC: My pleasure.

PM: And we will be soon to follow-up soon, since we have a lot of things going on, regarding Syros demo port but also regarding activities of the project on European scale.

GC: Perfect. Thank you very much.

PM: Thank you very much and we will be in touch.

GC: Have a nice day.

PM: Goodbye! You too!

GC: Bye-bye!

2. INTERVIEW WITH DAVID DANIELS

- David Daniels (hereinafter DD)
- Beatrice Dauria (hereinafter BD)

BD: Hello, Mr. Daniels. Thank you for accepting your interview. It is very useful to have you here and hear your voice for the SEANERGY Project. I will ask you mainly 3 questions. My first question is: What do you think are the main drivers for energy transition in ports? You can select among: a) regulatory pressure b) economic benefits c) environmental concerns d) reputation and branding, e) technological development or f) others that you can describe.

DD: Fantastic! Thanks! It is a great question. I am happy to be here and happy to answer. Those are all…I love multiple-choice questions; they make my job so easy. I think in this case the answer is all of the above. Of course, it is all of the above. Decarbonisation in ports is not a port problem. Decarbonisation is a societal problem and a global problem as we all recognise. So, the port aspect of is not an issue that is restricted to ports, it is an important issue for ports, and it is also an important issue for other sectors. It is not a just a single country or a region; it is not a European problem or it is not a North American problem. It is a global problem. So how do we address the whole problem? Well, it is not a port problem, it is not a transportation problem, it is not a maritime problem: it is an energy problem and a climate problem and port is just one aspect of that. That is where I am coming from, I do not come from a port perspective, I come at it from a system's perspective and a global perspective. So, the port aspect of it, how I look at it, is not "*how do we decarbonise ports?*" or even *"how do we decarbonise shipping?"* It is "*<u>how do we decarbonise the economy?</u>*". When you look at it that way, it becomes scarier and harder to do from the standpoint of the ports, because ports do not control the economy, obviously. A ship owner owns the ship and nothing more. They cannot control anything beyond those boundaries. The port can control what happens in the port, but they have limited control over what happens just outside the port. The municipal authorities might own what is outside the port and be able to control that, but they have less control as you get further inside the port. Then, once a ship leaves, they lose control. So everyone has overlapping responsibilities in levels of authority and yet the problem is global and society-wide and economy-wide.

On the one hand, that is very intimidating and very hard to…" Who *controls that? Who has responsibility?"* But I like to look at it the other way around, which is to say, it opens up the opportunities to find solutions that also do not restrict themselves just to a ship. It is not just about the shipping fuel. It is not just about the ports or the port operations. This is when you get things like the concept of the port as an energy hub. *"Can the port serve its own needs and those of the surrounding community?" "Can the port serve as landing place for offshore energy?"*, *"Can it be a hub of energy transformation?"* Of course, the answer is *yes* to all of those. What else could it do? *"Could the ports support decarbonisation of the transport sector outside the port?", "Can it help long haul trucking?"* There is no reason it could not if it is an energy hub. It can also be the source of energy for other sectors. What about the industrial sector? Are they in close collaboration and cooperation? It always has been ports and the industrial sector. "*What about in the green future, when the forms of energy may change, will those relationships change?*" I think the answer is almost certainly yes. How will they change? You know, no-one knows, those are the fun questions. I think it is a good challenge, decarbonising ports, but it also leads to some really interesting opportunities and I am interested in exploring those opportunities outside the ports themselves.

BD: Thank you very much. Moving to my second question: Which role do you think technology can play in facilitating energy transition in ports?

DD: Yes, of course, technology is key of course, right, *sine qua non.* If you do not have the technology, obviously you cannot decarbonise. "Which technology?" is always the question. Into which basket do we put our eggs? Do we cover multiple baskets? Do we pick one? Governments, for a very very long time, have a very longstanding tradition of never picking the right technology winner, so how do you manage that? But at the same time, if you spread yourselves too thin, there is only a limited amount of capital. If we try to develop all technologies, that is not a very good use of societies' resources. So, there is a little bit of a *conundrum* there. Clearly, technology innovation is necessary. The usual answer is that you rely on the private sector to develop the technological solutions. I am a firm believer in innovative capability of the private sector to develop these things. Of course, they will need help, but the help is maybe one of removing barriers, rather than pushing particular solutions.

BD: Thank you. My third and last question, if you want to explain to us a bit what your role is, what your area of expertise is and if you want to cite any success stories in your expertise area.

DD: Yes. Well, my background is actually energy modelling. It is not maritime particularly. Maritime is a component of it, but really, I come at it from a broad energy system perspective. My background is mostly…I am American, as you can tell from my accent. And I have a lot of experience in the US Government, so I am seeing things from that perspective. I have been in Europe now for about three years. I work in Sweden, for Sweden's Road and Transport Research Institute. Organisationally, we focus on the Transport sector. But in Sweden in particular, and in Europe in general, a very innovative place in terms of the development of the energy sector and the transport sector. So, I am very interested in that interplay, the overlap between the energy sector and the transport sector. I am very happy to be in a place like VTI that allows me to explore that intersection. So, success stories, from my perspective, is probably more around transitions, as we look at different transitions. And I think I am afraid of citing any specific transitions but I think it would be helpful in this area to look at transitions that have happened in other types of transitions and in adjacent industries and adjacent sectors. I would keep going further and further out. If we do not restrict ourselves to ports, and shipping, we are going into other areas of transport and the transportation of goods on the roads. I would go beyond that and look at the transportation of people on the roads. Then, I would go beyond that to transportation of goods through other means.

So, success stories, yes, I would look at the electrification of personal vehicles actually. It is several degrees away from shipping, because it is not goods and it is not maritime, but it is movement of things, in this case, people, and it is in vehicles. There has been a lot of work and studies in that sector about how you decarbonise. There, there were lots of ideas. If you look at the way Norway has handled it, it was through a lot of subsidies and that does works. Nobody would ever question whether that would work. What they could question was whether that model was replicable for other places. What I have seen is that now, totally, is that their neighbour, Sweden, which has not had nearly the same level of subsidies that Norway has had, has essentially worked it out and adopted electric vehicles, or it is beginning to adopt electric vehicles in their personal vehicle fleet without the levels of subsidies that

Norway had. That is really interesting. What has driven that? The conventional wisdom was that *'people do not want these things'*, there are all kinds of reasons why not to get an electric vehicle, *'they are too expensive'*, *'they do not far'*, *'they do not perform well in winter'*… all these things and yet these Swedish people are buying electric vehicles. Why? I do not really have the answer to that question actually. But it is my example of being careful of the conventional wisdom. If you look at transforming the maritime industry, there are a lot of barriers to transforming it. There are technical barriers, there are regulatory barriers, there are organisational barriers, there are business models barriers, there are all kinds of barriers. But, once the system starts transforming, it can start transforming quickly, and kind of against all expectations like Sweden has done with electric vehicles for instance. So, I would look for opportunities and indicators where things might start changing in the maritime sector and going after that, rather than looking at it like *"this is a big challenge"* and trying to figure out how we push forward, how we push through this challenge. Look for places where this challenge is being overcome, find those solutions and encourage them. It takes a bit of humility to recognise that maybe we do not have the right solutions and we have to let those solutions bubble up organically and enjoy them. That might be the right way to do it.

BD: I really thank you very much.

DD: Happy to be here!

BD: I have no more questions. Thank you.

DD: O.K. Thank you. That was all fun.

3. INTERVIEW WITH TURI FIORITO

- LOSSTuri Fiorito (hereinafter TF).
- Karin Voglsam (hereinafter KV).

KV: Good morning, Mr. Turi Fiorito, you are the director of European Federation of Inland Ports. Thank you for taking the time and accepting our interview because your voice is very important for us for the Seanergy project. My name, you know me already, is Karin Voglsam, project manager of Ennshafen. If you agree, we will start with the interview.

TF: Yes, thank you for inviting me.

KV: First question for you is how important do you think is transition to clean energy sources in ports and especially for inland ports?

TF: I think it is the most important topic that we have for the coming years/decades to do, because the entire economy wants to make this transition and if we want to stay relevant in that area, then we have to follow that as well, you cannot ignore it. Especially because inland ports are located in cities or close-to-city areas, the society expects us to take those roles because they can see our ports and they want these places to be with as little emissions as possible. And if we want to stay relevant within the transport market and the logistics industry, then we need to this as well. Or else, if you become outdated, the world passes you by, and you will not really have a role in it.

KV: Yes, you are very right. Thank you. The second question is what do you think are the most promising solutions for economic and regulatory barriers to energy transition in inland ports.

TF: I will start with economic barriers. The challenge of course is that for most of this transition there is no clear business model yet, because fossil fuels are still cheaper, their competitive position is so strong, that it will take a long time for electricity and hydrogen to pay off. So, that is the first problem we have and that is something that we have to solve. The only way to do that is through support from national, international and local governments, because we need that extra funding to bridge the gap between the absence of the business case and eventually getting a business case. I think that is the most important thing from an economic perspective. Once the whole network is there and it can compete with fossil fuels, I think then we are there. It will be okay. Then ports will be able to develop it in a much quicker fashion.

When it comes to regulatory barriers, there are so many that it is very tricky for me to say. On the one hand, for just electricity questions, we need the entire electricity grid to be updated, not just in ports, in many member states. That is a huge transformation that is happening everywhere. When it comes to things like hydrogen, ammonia, methanol, any other type of clean energy resources, we need the regulatory permissions to be able to do the things that we want, such as, special planning, the permission to be able to transport the most dangerous fuels, for instance, hydrogen. We need to get the rules and the regulations ready to be able to transport them in a good fashion, so that is also a thing. You know it also links back to the economic barrier because regulatory uncertainty means that people are less likely to invest in these new solutions.

KV: Yes, thank you. And the third question is: Do you have any success story within your area of expertise?

TF: Specifically on clean energy? Well, I think we are starting to see the first success stories now, before the summer (2023), we saw the first hydrogen inland vessel to be launched in the Netherlands. We are also seeing more and more uptake of things such as electric battery vessels for shorter range work, such as the CESS Programme. At the same time, we are also able to see things developing in the sense of onshore power supply. I know that that is not the most effective thing because that is not batteries or hydrogen, but in many places, we still have to develop it and roll it out. I think it is one of the easiest success stories that you can find when it comes to cleaner energy sources and helping with the less emissions of pollutants in the air, especially in city areas. So those three are the major success stories in the area of clean energy.

KV: Thank you very much. These were our three questions. Would you like to tell us some additional thing? I am open now. Otherwise, I would like to thank you for taking your time and giving your expertise in the Seanergy project.

TF: I think I have covered everything. I am being a little cheeky and looking at the questions that you were going to ask. There is an interesting question about mobile and static areas. I think it is a very important topic that we do not talk about enough, because I think that it is very important for energy sources for inland shipping, we have to think about mobile infrastructure as well. For instance, if I go back to hydrogen for refueling, it does not only have to be at a set point. We will also have to explore things such as local vessels that can refuel hydrogen vessels on the move, because given the way that hydrogen works and loading time, it might be the best solution. What we have to remember there, in our funding schemes, in national and European, is that we have a very static definition of infrastructure. We have to be ready to make the argument that we have to change also our thinking so that we can include mobile infrastructure, such as vessels that can allow refueling, a bit like you see sometimes in military aviation or deep-sea ships. I think something similar could be done in the navigation for the renewable fuels. I just wanted to add this.

KV: Great! Do you think that there can be any financial barriers to update the technology of the vessels to achieve energy transition?

TF: Yes, in general, I think that is what I was trying to say about the business case problem. Right now, there is no business case for a ship owner to update or refit their vessel for new clean energy, because you cannot compete with your colleagues that are (dependent) on fossil fuels. That is the problem. As long as we do not solve it, it is going to be very difficult for any proper business to make the change to cleaner energy sources. Just like, unless you make it attractive for someone to buy an electric car, then they will not buy it, right? It is no different for somebody on the business side. I think if governments can tackle that question: how do we bridge this difference? Then we will see a much faster uptake. And I know that the ship owners will be willing to change their vessels once it becomes economically viable. We often like to say “Oh it is an old-fashioned sector, that does not want to change their vessels”. No! People want to change their vessels, if it makes economic sense. But if they know that they will lose business once they have it, then nobody is going to do it. You cannot expect them to do so. I think in the sector it is the biggest challenge that we have. Once we solve that, I can see the route much clearer.

KV: Super! Thank you very much. Have a nice day.

TF: You are welcome. You too.

4. INTERVIEW WITH FANNY LOSSY

- Fanny Lossy (hereinafter FL)-
- Beatrice Dauria (hereinafter BD)

BD: Hello, Ms. Lossy. Thank you so much for accepting our interview.

FL: Thank you for having me here today.

BD: We are very happy to have you here. It is very important for us to hear your voice and it is very important for the SEANERGY Project. I have three questions. We can start from the first question. Do you think green energy transition will create new jobs in the shipping environment?

FL: Yes, indeed. We believe that this new green transition, but also, the digital transition is going to create new jobs in the shipping industry. There is also a need to train our current workforce on our seafarers on the vessels for the challenges that are coming, and make sure that they remained skilled and trained all along their careers.

BD: My second question is do you think there are any potential negative impacts of energy transition in ports. If yes, if you can describe it.

FL: Yes, I would call them challenges. We are now at the beginning of the green transition that we can see. The first challenge for shipping is the lack of availability of green fuels, if we can call them like this, at the moment, in the market. So, they should be available for the shipping and not at the commercially available price. So, this is the main challenge that it is difficult for shipping to access those fuels. Another difficulty is that you have so many options for shipping not only one type of fuel, like for aviation that you only have e-kerosene, which makes it more difficult for us to go on this transition. It can also make it also difficult for ports to adapt, and to know where to have their bunkering infrastructure for example, in order to make sure that they can actually provide the services for the vessels. Obviously, still having different fuels also means that they need to be available in different ports in Europe, to make sure that our ships can come and call at those ports and refuel for their operations. So I think that is really the challenge that we are facing now and hopefully we will see these volumes getting in the market in the coming years and helping us towards this green transition in shipping.

BD: O.K. Thank you. My third and last question is if you would like to explain a little bit about your role, your area of expertise and if you would like to cite any success story in your area of expertise.

FL: I am the Director of Environment, Maritime Safety and Off-shore at ECSA. ECSA is the European Community Shipowners Association, and represents twenty national associations of shipowners at the EU level – shipowners based in the EU and in Norway. We have our Secretariat based in Brussels. We work towards the EU-policy making to make sure that the voice of the shipping is heard at the EU level. Well, one recent success story, also linked to the greening of shipping. As you may know, there has been the revision of the EU ETS, so the trading system schemes, which includes now shipping. So ships will have to pay for the emissions now at the new EU ETS. As ECSA, we have worked very hard to convince the EU policy makers to ensure that a part of the revenues generated under the EU- ETS is put in a special envelop for shipping to ensure that there is funds towards the decarbonisation of the maritime sector. This is very important to us because we need those research and innovation and those projects to help us decarbonise our operations.

BD: Very interesting. Thank you.

FL: Thank you.

BD: Thank you very much for your availability.

5. INTERVIEW WITH HERFRIED LEITNER

- Herfried Leitner (Hereinafter HL)
- Interviewer (hereinafter KV)

Good morning, Mr. Herfried Leitner, you are representing TTS (Transport Trade Services GmbH) in the function of General Manager. Thank you for accepting our interview. Your voice is very important to us. My name is Karin Voglsam and I am the project manager of Ennshafen Port. If you agree, I will start now with my three questions.

HL: Absolutely! Zero problem. Counting you!

KV: Thank you! From your point of view, what are the possibilities/advantages of using e-fuels in Danube shipping? You, as expert.

HL: The possibilities, of course, it is extremely wide to find another source of energy, the advantages…from a technical point of view, there might be some advantages for the ship owners with respect to cost reduction or cost development in general. The advantages are rather on the side of the environmental impact which our industry is forcing on, which it has. So, I think we all are clear about that greening is big part of our efforts which we have to do in the next decade. We have to become as green as possible, with some countries going more defining targets, with going neutral by 2040s. The whole industry, whole sector is on the search practically for new possibilities of finding energy sources and e-fuels are one of them. So, e-fuels are a possibility. There are some advantages as far as we can see. It is always a question of technical development and the state of art currently and understanding currently what is possible in the e-fuel sector. The advantages are on the green side of the business and CO2 reduction.

KV: OK. Thank you. Do you see other ways in which inland navigation on the Danube could contribute to CO2 reduction?

HL: Yes, of course! E-fuel is a very key issue…there are the possibilities already today. But we also have to understand that CO2 is not everything. At the end, we are talking about greenhouse gas and emissions. That means we are not talking only about CO2, we are talking about hydrogen, we are talking about the particulate matters, we are talking about more factors. If you use one of the possibilities, I think it is generally (…) we are skeptical about the cost of production what we see today. So, to your question how we can reduce CO2, there are other short-term measures which we can do as an industry to reduce CO2 as a particular CO2 emission. You could use FAME, you could use HVO, you can electrify smaller boats, like cargos, ferryboats or port-pushers so that it is already technically possible today. Then enters the question of the infrastructure. But, at the end, there are easier ways than e-fuels. The big question is where do you get e-fuels from? That is the major (issue) And then if there are e-fuels for our engine class, that we have in inland navigation. I do not know if you have any idea about some, but I do not know any interesting scenarios on the e-fuels so far.

KV: OK. The third question is do you know/cite of any success story in your area of expertise? Are there any already?

HL: Do you mean in general with regards CO2 reduction, right?

KV: Exactly, or energy transition.

HL: Yes, of course, there are in energy transition. There are different success stories also on our side. The whole industry, and to see it from the bigger perspective, the whole industry is confronted with stage 5 requirements. Stage 5 requirements do not define clearly that there must be diesel, or what your source of energy is. Stage 5 just goes down to values, so it is the value of the CO2, what is the gasoline, the nitrogen, the particulate matters, all what I mentioned already, so you have to reach it. How you reach it is more a question about the technology that you are using. The technology we have to be clear must also be available wherever you are, in your sailing spectrum. In this case, the Danube is quite difficult. When you have our vessels and our field of activities, we are sailing practically from kilometer zero, from the Black Sea, up to the complete end, Kelheim, to fulfill our contracts. So whatever fuel you are choosing to for the transversion to the Stage 5, you are using to fulfill your green applications, you need to think where you will find this energy source along your travelling route. I do not have to tell you; you are an expert yourself. When we start with a convoy sailing at kilometer zero on the Black Sea, in the Danube, then we are sailing with a nine-convoy, that is a convoy with 9 barges, you can only sail up to the Serbian territory. Then what the German territory you can use 6 convoys, for the Austrian territory 4 convoys. In the German territory you use then very small push-boats. In the end, you are using 3 to 4 different push boat types for transporting from the beginning of the Danube to the end. It makes it extremely difficult then when there are other energy sources than diesel, because diesel is everywhere, we have the infrastructure (for it). The bunker boats are available, regardless if it is in the port of Enns, or in the port of Budapest, or the port in the Belgrade area. Usually, you have it every where available. If you are thinking now of other possibilities, about other sources of energy and of course of e-fuels, the question is how do you get the e-fuels there. Who is going to produce it? For what prices is it going to produce it? How is it subsidised in different countries or is it not subsidised? What is its price? What is the availability in the port of Kelheim? Or what is the price and availability in the port of Enns? There are so many questions about the e-fuels which do not have an answer today. I do not know. You are also more expert than me. It is a question about the allowances and permits to handle them in the ports. As an example, hydrogen, you have the problem that most ports are not allowed to handle hydrogen in a big(ger) manner. It is also not an option now. We are greening the inland navigation sector, but then we are bringing 15 kg of hydrogen with a truck into the port. That makes also no-sense if you need thousands of kgs. This also happens a lot. In our area, what we are doing is working together with the international companies which are specialized in exhausting and scraping systems, which actually are systems after-treatment systems, so we are using normal diesel engines because the energy is everywhere available. Then, in the after-treatment system, we are working with companies to develop here possibilities of capturing CO2 and particulate matters and so on because of two reasons: because we are interested, of course, it is important for us the greening of our fleet, and to fulfill also the obligations of Stage 5 regulations that we have. So, e-fuels for the future? We are rather skeptical to be 100% on this yet. To be honest, if you had some advantages, of course, but we have no experience till now as a sector. Somehow, we have to find the starting point for the e-fuels, where we can start living it, or we can start rolling it out or testing it, and so on. We all remember one day when we were talking about LNGs, we all knew that technically it was possible, the technician knew, but the problem is when you put it into live, when you see it on a vessel and so on, you discover that it might not be that easy to handle. It was not as easy as it was thought in the beginning from a technical point of view. That is what we have to do with e-fuels as well. E-fuels need to be introduced to the industry and the countries have to come together and find a way how the infrastructure should be constructed in the future.

KV: Thank you very much for these very interesting answers. We see that the Danube region and inland navigation is completely different from sea shipping: other problems, other issues to solve.

HL: Yes, that might be right. For ocean shipping, e-fuels are also not, it is more on methanol what the ocean is going for, what they are driven by, or pushed by Maersk and other big shipping liners.

KV: Thank you very much for your interview and have a nice day!

HL: Thank you very much, Mrs. Voglsam! Ciao! Goodbye!

6. INTERVIEW WITH JORGE DE LA FUENTE

- Jorge De La Fuente (Hereinafter JDLF)
- Beatrice Dauria (Hereinafter BD)

BD: Hello, Mr. De la Fuente, thank you very much for accepting our interview. My name is Beatrice Dauria, I am the Project Coordinator of the Seanergy Project and your opinion, the stakeholder opinion is very important for our project. So we would like to ask you three questions regarding these very important topic. My first question is: What do you think are the main energy barriers to energy transition in ports? You can select among: lack of financing, uncertainty about future regulations, limited space for new infrastructure, resistance from existing stakeholders, technical challengers or others that you can specify…

JDLF: First of all, thanks for this interview. It is a pleasure to participate in something like this and support in any way, something so important as this kind of research. According to your question, my first answer, and, according to my experience, it would be something related to the mindset, not only the mindset of the people who are part of the different stakeholders. I think if you have a clear idea of what you have to do for the future, you can change the future in order to achieve what you want to do. For that reason I think, it is not only about economy, efficiency or space, no. You need to change the mindset but to do that, you need more education, financial resources, technical advise…From my experience, I am Chilean, I live in Latin America, today not only mindset is important but also financial resources are really important as well as education. We need more people prepared to face these challenges. For this reason, it is a combination of almost everything.

BD: Moving to the second question, what role do you think the government should play in promoting energy transition in ports.

JDLF: Oh, uhm, government – I think– one of the key elements to do that, in the public sector. The private sector is one sector that can work according to the rules that the public sector or the government puts on the table and make to generate the final transition. For this reason, I think it is really important who they work, it is crucial finally. Every policy is important not only to produce the change but they also have to make something specific to combine the public and private sector, because they have the same objective, in this case, green transition. So it is one of the key elements in my opinion.

BD: Finally, my third and last question. I would like to ask you what your role is , and if you would like to cite any success cases in your area of expertise (if there is one).

JDLF: Ah, interesting! Well, I part of the navy, so the navy is also part of the maritime authority. The reason I have a rank, a uniform…but we work like a maritime administration. For this reason, we are part of the government rules of the port and transport. Any experience? Not directly, but in the north of my country, my country is a large country, we have more than 20 ports in the north. But especially, in that place, we have a mining industry. They are producing a lot of solar energy. They are producing energy that could also be used for ports. I think this idea is interesting. It is not only interesting but I think you can replicate this idea in every place. In the case of Chile and in Latin America, they have a lot of possibilities to produce green energy. And I think this example can be a success referent.

BD: Yes. Thank. Very interesting.

7. INTERVIEW WITH JENNIE FOLKUNGER

- Jennie Folkunger (hereinafter JF)
- Beatrice Dauria (hereinafter BD)

BD: Hello Ms. Folkunger. Thank you very much for accepting our interview. We are very pleased to have you here and to hear your voice. It is very useful for the SEANERGY PROJECT. So, we can start with the first question. How many investments in terms of capital expenditure amount have you done last year in energy transition and green policies? And if you would like to describe the type of investment.

JF: It is a bit of a difficult question to answer for us because our port is in the process of moving from west to the east, so there has been a glide so it is a multi-year process. I think we have been in thar process for about ten years and that involves a lot of continuous investment. I think it is 1.5 billion Swedish crowns or something along those lines. A lot of the projects that we do, of course, take aim at the future and meet in the future needs of our customers. So, it is quite hard to specify it in one year but off the top of my head, last year, we did risk assessment analysis to be able to bunker LNG ship-to-ship in ports, we did a climate assessment in accordance with the green house gas protocol. So it is our port but it is also upstream and downstream. We are also investing in a project where we are using the results of the climate assessment to guide our actions, because in that we learnt that the majority of the emissions that are tied to our port actually stem from the trucks, because we are almost exclusively a roll on-roll off port so the ships are actually a minor part. So our philosophy is that the fuels that the ships that are ferries once they will get one way or another, but we also have to focus on the trucks on the landside of things because that is where a large part of emissions are. We also invested in doing prepatory work to apply for wind turbines and they are coming up now in the next year, and we invested about a million euros into a sewage treatment plant so that we can receive the sewage from all the ships. So, yes, there is a lot things and of course a lot of the investments are part of EU projects, so they are baked into a massive cake but yes there is a lot of investment.

BD: Could you remind us about the port you are working for and your role?

JF: Yes! I am the Head of Environmental Sustainability in the Port of Trelleborg. Our port is a bit unique, in the sense that we are not a landlord based operation. We have the landlord function, but it is ours, as we own the land but we also have the operations so we have no external operators or anybody coming into port. We own everything ourselves, which is quite an advantage because it allows us a lot of flexibility in terms of what we want to do. It is not a long decision process. One person across the hall has an idea that we should do something and we ask someone else at the other end of the building and we do it, basically. We used to say that we had about four customers, which is a bit of a simplification but it is our four shipping companies. It is TT-LINE, STENA LINE, UNITY LINE and FRS (Baltic), all together, they own 15 ferries or so. That also simplifies things for us, because it is a limited group of actors that we are dealing with and communicating with, so we have a proximity that is perhaps somewhat unique, I would say.

BD: Thank you. Moving to my second question, what kind of support or incentives would be helpful for promoting energy transition in ports, in your opinion?

JF: I think that the key is communication more so than anything else. Even in a system that is as small as ours, we are not, as a port, included in the decision process about buying new ships. A lot of our ferries in the port are very old. I think their average age is 26 or 27 years old. They might still have a few years, but we are facing a point where the fleets will inevitably be renewed and we are not for many understandable reasons involved in the process surrounding it. For example, what fuels? What ferry are we going to buy? Basically, we have to adapt once the decision has already been made. My fear is that our customers will decide on different fuel pathways. Since our port is right next to the city of Trelleborg, we will struggle to have every single fuel, if we want hydrogen, amonia, methanol. If we want like a fuel buffet, we will be hard to provide, considering our proximity to the city, because there are lot of risk aspects that come into play. It would be incredibly difficult to get permits to store all those fuels. So, I think communication and as much transparency as possible in this commercial hard side of it.

BD: O.K. Thank you. Finally, I would like to ask you if you could cite any success story in your area.

JF: Yes. For me, the biggest success in all of this is all the collaborations that we have. For example, in Sweden, we have a network of Swedish ports and there is a Branch of that, which is the environmental branch. We meet regulargly and we have very good cooperation and very good dialogue and we help each other, we exchange information and we visit each other and we ask each other: ‘How did you do that?’ We would like to do the same thing, ‘How should we go about it?’ That is a very nice successful part of this whole transition is that there is a goodwill. This is not an area where we are competitors. This is an area where we are helping each other and we have really good relationships. We are continously expanding all the time with universities and students and whatever. There is a benefit for somebody.

BD: O.K. Thank you very much.

JF. Thank you!

8. INTERVIEW WITH LUISA SPAGGIARI

- lLUISA SPAGGIARI (hereinafter LS)
- BEATRICE DAURIA (hereinafter BD)

BD: Hello! Ms. Spaggiari. Thank you for accepting our interview. Your presence, your role, your voice is very important for us. I am Beatrice Dauria, the project coordinator of the Seanergy project. If you agree, I will start with my three questions.

LS: O.K.

BD: O.K. The first one, with the current state of art of technologies, how can we get to zero carbon emission goals?

LS: O.K. There are different technologies that have been developed in the recent years but I consider that most of them are at an early stage, so we need to wait longer to use them and to achieve the net zero emission goals. For that reason, most of the research and the actions in the companies are related to capacity building, to build capacity inside the companies to reduce the emissions because we cannot wait until the new technologies are done. We needed to start like 20 years ago, we need to do it, we are already reducing some emissions, but we need to accelerate the processes and the best way is the capacity building inside the organisations and to have collaborative strategies among these activites.

BD: Thank you very much. We can move to the second question. If you consider that the already available technologies are not sufficient, what do you think is missing to reach zero emissions?

LS: I think what is missing is that every company has their own focus and target. I feel that there is an international target, an overall target, but every company company needs to set the main target and actions and goals to achieve it, because if we do not know what we are going to do, it is so difficult to measure it, or measure the work properly. For that reason, I think that the first thing that the company needs to do is to measure energy efficiency and measure how they are using their energy, which kind of energy they are using if it is scope 1 or scope 2, and then they need to define different strategies to improve the efficiency of the energy utilisations. I think this is the first thing they should do. Also, they need to train their own people in every company to define how to reach zero emissions and then step by step, it would be good if they start using a pilot of these new technologies that are going to be in the market soon to analise in the real world if they work or not.

BD: Finally, I would like to ask you about your role, your background and if you would like to cite any success stories in your expertise area?

LS: Now I am working in Ramboll, a consultancy here in Malmö, a consultaning company here in Denmark. I am working in the department of Marine, Coastal and Ports Department and we are consulting some companies. In Malmö we are working hard on off-shore wind projects and also in carbon capture projects, which I think it is really important because it is another strategy to reduce emissions like capturing the carbon that the companies are not going to emit in the environment. I think it is important. Also, off-shore wind energy is another way to improve and reduce emissions because it is a clean and renewable energy. It is important to say that Ramboll is not working any longer with oil and gas, because we are reducing these emissions as much as we can. Previously, before my job here in Ramboll, I worked in Colombia, I led one project where we measure energy efficiency in ports and terminals for containers in Colombia and Chile and we were able to measure which activity clusters is the one which consumes more energy in every terminal, then we compare it within the country. There are 7 different container terminals in Colombia and then we would also compare it with 7 terminals in Chile. We could compare the energy efficiency and the strategies that every terminal is having among the different clusters so we could analyse, for example, that the cooling, for the refigerator containers consumes almost 20% of the energy in every terminal and also the horizontal activities that they need to be done in the yard, like moving the containers in the yard, not to the ships. It is like almost 50% or 40% of the energy consumption. This energy has a big possibility of reduction, because most of this equipment is run by fossil fuel. So, if the terminals in every country decided to electrify this equipment or use more clean energy, the emissions would go down easily. While the Q-cranes, only consume 20% of the energy and most of the times are are electric. So there are not a lot opportunities to reduce the energy consumption in this area.

BD: I would really like to thank you. I finished my questions. It was very interesting. Thank you very much.

LS: Thank you

9. INTERVIEW WITH KSENIJA HAJDUKOVIC

- Ksenija Hajdukovic (hereinafter KH)
- Karin Voglsam (hereinafter KV)

KV: Good morning, Ksenija Hajdukovic

KH: Good morning!

KV: You are representing the Port Governance Agency, the central port authority in the Republic of Serbia, as the function of senior associate.

KH: Yes, that is correct!

KV: Thank you for accepting our interview. Your voice as I already told is very important for us in the project. My name is Karin Voglsam, you know me already, from Ennshafen port, and if you agree, we will start now with the specific questions.

KH: Of course!

KV: Thank You. In your opinion, what does it take to harmonise the onshore power supply in all ports along the Danube?

KH: First of all, thank you for inviting us and thank you for recognising the work of the Port Governance Agency. When it comes to harmonisation, in this specific case, it is necessary to consider multiple aspects. I will provide an example one of the challenges that Europe faces in this context. First and foremost, onshore power supply facilities will definitely play an essential role in decarbonising the inland waterway sector, and their deployment needs to be realised within the coming years. But, first, let's look at the challenges because the year 2030 is just around the corner. Deployment and usage of OPS by the inland shipping sector will be very dependent on the reach and capacity of the existing electric grids. The grid does not always reach the key side of the port area or in an effective manner. Additionally, inland cruise vessels require substantially more electricity and a higher voltage. The existing grids do not always reach these demands. So, these are the main challenges in this area. Therefore, the issue of OPS must be approached comprehensively and co-actively throughout the entire Danube region. So, when we talk about what should be given special attention (to), from our perspective, I would highlight the question of technical specifications and the assessment of needs, as well as the availability of the power grid and project-related matters, of course.

When I mention technical specifications, I mean the harmonisation of technical requirements, so that they are the same for all the users along the Danube. In our opinion, this is the most crucial aspect in the further establishment of OPS. It is closely connected with the mentioned analysis of needs and the availability of the power grid. On the other hand, besides the technical specifications which need to be harmonised along the Danube, a support for the sector of SEANERGY, there are, of course, projects. We believe that collaborative efforts of this issue are extremely important and these can be realised through the implementation of projects focused on OPS and funded by different available sources. Considering Europe's seriousness in achieving energy transition goals, it is commendable that there is a willingness to dedicate the thematic areas of various programmes and funds to this topic.

KV: Yes, thank you very much. Coming to the second question: Do you see other ways in which inland navigation in the Danube could contribute also to CO2 reduction and energy transition?

KH: Excellent question! When it comes to decarbonisation, all ways in Europe are indeed focused on inland waterways transportation sector. And, as we know from an ecological perspective, inland waterway transportation is the most environmentally friendly and the goal is for it to become more competitive in the coming years in order to shift more freight from roads to waterways and then of course to railways. Inland waterway transport is significant on its own, because, as we all know in simple terms, and especially you, working in a big port, a single vessel can carry as much cargo as dozens of trucks. Therefore, Europe's focus on this mode of transportation is quite understandable. As we know the main goal of the Rhine-Danube corridor is for inland waterway transport to serve as the backbone to promote a sustainable and resilient transportation system. When it comes to what can be done within the framework of the inland waterway transport itself, there are several solutions in our opinion. First and foremost, the promotion of alternative fuels with hydrogen being seen as a key driver in green transition. Additionally, the use of next-generation engines with filters, reducing CO2 emission is also important and furthermore, OPS, aforementioned in the first question, is a significant step towards decarbonising water transportation. I would like to emphasise, once again, the importance of collaborative efforts and the sector of SEANERGY. As in the question previous, a positive signal is that the topic of green navigation and the potential for ports to become hubs for alternative fuels are among the priority areas of various projects in the years to come.

KV: Thank you very much. Do you cite any success examples for us?

KH: Yes, our establishment, in the first 10 years of our existence, the PG has been highly dedicated to the development of port infrastructure, including the construction of new international passenger terminals. There is a socially responsible institution who have already recognised the importance of port decarbonisation and initiating the first environmental projects in Serbian ports, such as various waste-management analysis demonstrates definitely this commitment. On the other hand, we are actively engaged in new project calls in DRP and Adrian programmes which prioritise the greening of ports. This also demonstrates our commitment to environmental sustainability and aligns with the broader goals of promoting cleaner and more environmentally-friendly port operations. Our future steps when it comes to success stories in the area of green ports aimed at providing OPS and international passenger terminals in Serbia. We are very confident that in the years ahead, we will be able to share a successful story and contribute to the energy transition in inland navigation, of course and (see) an increased role of waterway transportation in the overall transportation system. Bearing in mind that digitalisation is also a very important step in this process, I would like to mention the exceptional efforts of the agency in simplifying business processes and customer communication and facilitating that communication. Especially, we have introduced several information technologies, including an application for invoicing port fees, an electronic application portal to which users submit their applications. It is important to note that over 96% of applications to the agency are submitted electronically, through the portal, which is an excellent example of paperless operation, and, of course, effective communication. Additionally, we have implemented RPA, a modern technology, and entrusted all repetitive processes to this technology, allowing our employees to focus on more complex and demanding tasks related to the strategy analysis and planning. We are very proud of the fact that, during the realisation of DIONYSUS Project PGA has given very useful inputs as one of the pioneers in this area for RPA technology.

KV: Excellent! Thank you very much.

KH: Thank you!

KV: Thank you for this very useful and interesting statement.

10. INTERVIEW WITH DR. JOSÉ M. PAGÉS SÁNCHEZ

- Dr.Ing José M Pagés Sánchez (hereinafter JMPS)-
- Beatrice Dauria (hereinafter BD)

BD: Good Morning, Mr. Jose Sanchez. Thank you for accepting our interview!

First of all, I would like to ask about your background and responsibilities at AIVP.

JMPS: I am an architect by training, from the University of Lisbon, where I did my Bachelor's and Master's (Degrees). After that, I did my PH. D at the HafenCity University of Hamburg, focusing on port-cities relationships, from issues connected to planning but also to overall governance strategies. Since 2016, I work for AVIP with different roles. Today, I am Director of Agenda 2030, which is mostly one of the three departments of AVIP, focusing on the content production and coordination of our participation in international initiatives from international projects to other cooperation with international organisations, such as the United Nations, the European Union, OCDE, and so on.

BD: Thank you very much for accepting the interview, your expertise and your professionality is very useful for us for the Seanergy Project. If you do not mind, I will start with my questions. My first question is: given your expertise in port-city relations, what role do port cities play in the wider european transition to greener ports especially in the Seanergy Project framework?

JMPS: So, for AIVP it is very clear that ports and port cities play a leading role on this green energy transition in the sense that the maritime (sector) is one of the few global sectors that have jointly decided to move forward new types of fuel, to testing new types of fuels and testing energy carrier solutions. This, of course, requires certain changes in the landside infrastructure, which means ports. And also in ports themselves as well as industrial hubs, you can see that there is a very specific push, and pressure as well towards, green energy transition to reduce their impact, not just of their activities, but also of industrial activities, that they have in the general society as a whole. Additionally, for cities, it is clear that due to the fact of being close to hubs (innovation hubs) such as ports, where many of these changes are taking place could mean signficant benefits of being in the frontline on these technological change. This is something that we are seeing in different European projects, we are seeing it for example also in the MAGPIE Project. Of course, it entails some challenges. New technologies sometimes can create a certain- I would not say opposition but rather mistrust by society because we are familiarised to being close to a gasoline station or gas deposit, but people tend to be scared when it is a hydrogene /amonia facility, which perhaps is not even as dangerous, but it is new. So people might show such mistrust on this new technology. This is the part which port cities need to work on it, but for us it is very clear that they are innovation hubs and they play a leading role. There is one more thing that I would like to add on this. The fact that there is in the majority of European ports, a port-city connection increases the pressure on ports to be greener. If the port would be in an isolated location as some academics and experts in the past (had) predicted, a big port would isolated because they would be more efficient and they would not have to be surrounded by the urban area…The fact that they still remain in the urban areas increases the pressure towards a faster and more efficient transition. This is something that is also very clear. It is interesting how these connections that some people saw in the past as potential hindrance and a problem for the commercial infrastructure and evolution of the port, actually , now, play a very important roles to accelarate this transition.

BD: Thank you very much. Moving to my next question, from an educational standpoint, what types of training or qualifications do you see as essential for the assuring a seamless port energy transition?

JMSP: I think that there are on different levels of training that must occur. The first set is of course on technical knowledge regarding the energy that are being implemented, and also in the designing for planning of industrial infrastructure and maritime infrastructure. This is I think the most obvious one connected to engineering from a high technical point of view but also for the workers that are directly on the field. This is even connected for example when we talk about onshore power supply (OPS), or when we talk about off-shore windpower where ports are also playing a very important role for example.

It requires a very specific kind of expertise. Further on, there is also this kind of training, which increases the efficiency of the ports and maritime actions/processes that are implemented. This is general, brought not just for the more technical workers that are directly on the field but also for the general workforce in terms of how they can do the same operation saving energy, of what processes can be rethought in order to reduce their impact.

BD: Thank you, my question is: as cities look to greener ports, how can they best engage and collaborate with expert groups, like AIVP, to develop a hollistic and sustainable transition strategy in your opinion?

JMPS: How can cities work with AIVP or how can cities work with ports?

BD: How they can engage and collaborate with expert groups, like AIVP.

JMPS: O.K. The partnership of AIVP has always been sharing the best practices, but also bad practices. Perhaps, good practices are a bit more visible and easier to share, while the bad practices are perhaps shared more in private discussions, but, in any case, that is the key departure point. If a port city had a good or bad experience in the developing of a specific green solution or new energy, or new sustainable energy solution, I think this is the key. This is where we have the transfer of knowledge where ports that have become specialised on a specific type of energy and how ports that are arriving now a bit “later” to the place, they can benefit of the experience of these other ports. This is the spirit of AIVP and the spirit of working groups that we have developed on different topics. Further on, it is important to, as I was saying about the social acceptability of new technologies, that is also another field where AIVP can support, in terms of setting the ground for the social integration of new technologies that can contribute for the green transition. This is part of the work that we are doing in the MAGPIE Consortium where more than 10-15 technologies have been tested in specific port environments and we are going to work on this direction. Further on, we can also support in the assessment of the impact that green transition technologies can have on port cities, from the configuration of the landscape to the existing infrastructure and its capacity and availability, to the working as a network. This is something that we also need to understand. Perhaps, not all ports need to become hydrogen power houses, not all are suited for that. So it is about working as a network. For that (reason), I think there is a possibility further on an ambition in the mid and long term to set specific guidelines for step by step approaches that we can prepare on the experiences of members of port cities all over the world and how others can learn in the process. We have our agenda 2030 based on this principle, one of them is sea energy transition. The goal is to go further in each one of these goals in order to develop specific literature for this, and literature not meaning scientific literature, for that there are much more capacitated institutions out there but based more on the projects that have been developed and then developing very pragmatical approaches or guidelines for the different port cities.

BD: Thank you. My next question. In the scope of the energy transition, which sectors within the port industry do you anticipate will experience significant job growth or diversification ?

JMSP: Which sectors of the port?

BD: Within the port industry, yes, regarding job growth.

JMSP: particularly in the ports that are today fossile-fuel basis, for example like the Port of Rotterdam or Port Antwerpen, ports where this sector plays a big role. There is where there will be a more inmediate effect in the short-term, because it is where the change of fuels will happen quicker, where these industries will probably need new kind of professionals working in them. Perhaps it is not a matter of (hiring) new kinds professional but more the transformation, the education and training of the existing professionals. That is one thing to deal with the new fuels and kinds of technology. The other thing that we also see then, but this is difficult for me to foresee, for example, when we talk about the usage onshore power supply, for cruisers or for cargo ships. This is a far as I know, it is a position that the team that is in charge of the operations team did not exist before, as this is a completely new technology that is being provided. I do not think that it is going to have a big impact but it is going to have a big role because it is the position/the main technology that we see in the European corridors are being implemented for the short-term “results” as if the evolution of fuels will take a bit longer, but in terms of providing the electricity onshore technologies are really prepared in that sense. So, there is a new kind of professionals that will exist in that field.

Then, for example, when we talk about ports becoming hubs for the energy transition on solutions that are not now on traditional port activities. For example, off-shore wind farms. This requires a connection to land, and this connection usually happens in ports.

This is what you see in the area of Normandy and Le Havre. This is a new kind of facility that requires a new type of professional in terms of more of the industrial background, more than specifically maritime, but still, this activity will happen inside the port, because their proximity plays an important role and the final preparation of the technology to be implemented on the field happens inside the port. In these cases, we are talking about quite big numbers in terms of different professionals that can work in this field. This, of course, will not be in every single port. This is something that , what we are learning – I think- from the energy transition is while until we had only solution mostly, which was oil-based products, what we see now is that we are going to have very different kinds of solutions for energy cargos, from LNG to Hydrogene from using electricity coming from renewable sources. This diversification is going to require different profiles of ports, different profiles of industries and different profiles of professionals working in these ports. This is going to be one of the main challenges because each port will need to find its niche.

BD: O.K. Thank you. Another question is: the concept of circular economy is becoming increasingly pivotal in urban planning. Can you mention some examples of how ports can become key contributors to this circular economy within their respective cities?

JMPS: Yes, of course. One of my favourite examples is something that started in the Port of Rotterdam, but now is seen in other ports, is the use of residual heat from industrial processes and how this can directed towards the heating infrastructure of neighbourhoods. This is a technology that has existed for several years, I am not sure if even a decade, but definitely several years it started -as far as I know- in the Port of Rotterdam but more ports are starting to use it. I think Le Havre also has it and other places. This is the perfect example of circular economy because we are using something that we were wasting onto the atmosphere, that perhaps was not as harmful or as dangerous as debris or toxic waste, but still something that was being wasted. Instead, we are able to capture it and through pipeline infrastructure redirect it towards the heating of urban neighbours. These urban settlements are benefiting from the proximity of port by having a heating system that is sustainable, using something that was going to be wasted, which is the heat. I think- for me- this is the most simple and brilliant examples of how being close to a port can be beneficial for a city. There are other examples focusing on reducing waste. They are in an early. For example, using plastic that has been found on the water on the port can be recycled for other uses but I think that these examples so far have been more exploratory more than large-scale industrial-based. There are cases like the Port of Strasbourg, which is not a huge port compared to Hamburg/Rotterdam and so on. They do have specific agreement among the port community to establish circular economy processes. So the companies in the Port are aware of the waste that is being generated by other companies and how it could potentially be reused. Not only just for that but also in terms of being more efficient. What I like about this is not the specific technology being used but it is the fact that it is a work that has been developed with the port community itself. It is a path towards efficiency of production processes inside port areas.

BD: Thank you. The next question: the port industry, like many, is undergoing a cultural shift. In your opinion, what strategies or initiatives can be adapted to enhance gender equality for women within this sector?

JMPS: I think it is something that has to happen in several levels. The basic one is from the most early stages of the Educational System to show that not just ports, but all science fields (math, technology…) are for both genders. This is the departure point. It is about showing how from the early stages of the Educational path , I am talking about children, to get girls and boys equally familiarised with the maritime world. This is something that we defend in port centres from the beginning. It is fundamental, from the beginning, to break the idea that the port and maritime sector is focused on men and manly jobs and so. This is a cultural step that needs to be taken right from the beginning. This has to be accompanied along the industry. The majority of the jobs that are going to happen in the port industry in the coming decades are not going to be based on muscle and brute force. They are going to be based on skills, computational skills perhaps, critical thinking, engineering skills. These do not have a gender. This is why it is important to show this in different levels of education from very young children, to primary, secondary schools, showing how the maritime fields can be an interesting way to develop a job.

That is the base. Further on, it is a matter also of having polices that can be directed towards increasing the diversity of the workforce. This is always a balance, because I think it is a matter also about hiring the most qualified professional , but then, like it happens in many other fields, I think that we can set targets for each industry, each port and each company in terms of (defining) what kind of profile we want and how we can increase diversity in the workforce. In equal hiring positions, I am not sure, if we should discriminate (positively) or should ignore men but it (women positions) is something that should be encouraged.

It is about enhancing career steps/career paths inside the companies in itself. One of the main problems that we also see is that we lack today women in leading roles as well. If you look for example at port authorities in Italy, I do not think there is one single woman president of a port authority, as far as I know. I know there are women in other important positions, like General Secretary of different port authorities and so on, and as heads of technical departments. If you look in Spain , there are some examples. Right now, Mar Chao has become the president of the Port of Valencia, the biggest port in Spain. There is also not long ago, there was the president of the Port of Huelva, which was also a woman, recently the president of the Port of Cádiz is also a woman, but still in the leading positions are very much men-dominated. I think this is important inside the port authorities, the port institutions, inside the companies to have also career paths that can encourage women to take also these leading roles. It is something that is clear. Another one, to conclude, this is perhaps more of a personal opinion. I have a two-year old daughter and I have seen how demanding it is to be a mother. I think it is crucial to have family balanced policies that can take out of the pressure of women, who of course have to give birth and to be able to breastfeed, but at some point it is important to find a balance where parents equally share the burden and that there is a flexibility that does not affect the career of a woman. So somebody who needs to take more important roles inside big structures like port authorities, when you are in your mid-thirties would not have to make the choice between either being a mother or having a career in the maritime sector. I do not know what your position is as a woman, I know that I am the interviewee, but this is what I have been learning.

BD: Of course, I totally agree.

JMPS: I know it is a bit personal, but this is what I see, I think it is unfair that until two young professionals are in their thirties their career evolution path can be similar. But there is some point where mother nature forces us to make a certain choice: Do you want or not want to have children?

And it is an important decision that depends mostly on the woman and what she wants to do with her body. If she decides to have children, she should not be punished for having them. She should receive the support that allows her to continue with her career path, in case this is what she desires. This is the only way how you are going to have women in leading roles more often and more visible. Otherwise, it puts a tremendous pressure and burden on the shoulders of a woman.

BD: I do agree. Totally. I will jump to my last question : drawing from AIVP's experience, can you share case studies or examples, where port cities exemplify the best practices in sustainable development and port-city collaboration for greener energy?

JMPS: There are several examples that can be quoted. One is circular economy, the one mentioned before about the heating system, but we see for example the pressure towards cruises for example this happens a bit also in the cooperation between ports and city. In Lisbon, they are trying to develop the onshore power supply also all through the power demand of the city. Not that there is a technical operation in the strict sense, but there is a certain dialogue based on that. We see also examples of Marseille. In Marseille, there is something quite concrete. It is a cooperation between port-city and the development company on how to have technical facilities inside the port that can use the water from the bay in order to be used for the heating and cooling system of the close neighbourhood. This could only happen because there was a cooperation between the city , the developer, the energy company and the port authority in order to facilitate the access to the water, the reuse of this water and the presence of the technical facilities and the connection across all these levels. This is the case of Marseille. Other cases, if I remember correctly, I am talking a bit off my head now, the case of Bilbao, they have 4 or 5 large-scale wind energy generators , windmills, on the port that it has tremendous capacity to generate energy to cover the port grid. In some cases, if I remember correctly, I will have to check to give you 100% correct information, there can be a surplus than can be later sold or passed onto the urban network in order to provide green energy. This is also an important example. I think that we are going to see this more and more in different places. Then, all the time when we talk about the off-shore wind farms, this is a classic example of cooperation. Because the problem that we have of sustainable energy generated by the wind is the fact that it is difficult to storage, it has to be used. The majority of wind farms are not are not really producing the energy for the port authority itself, mostly for the urban environment. However, the assembling and the connection of these wind farms with the broader network is very often done via the ports.

BD: Thank you , thank you very much.

JMPS: I am very sorry that I arrived so late

BD: no, do not worry. Thank you for your availability and for sharing your thoughts.

JMPS: If you need to expand on any of these questions, please let me know and we can complement you with more cases.

BD: O.K. We will contact you.

JMPS: I prefer to give you the correct information rather than saying things that I remember.

11. INTERVIEW WITH FRANCESCO RUSSO

- FRANCESCO RUSSO (hereinafter FR)
- BEATRICE DAURIA (hereinafter BD)

BD: Dear Mr. Francesco Russo, thank you for accepting our interview. We are very happy to have you here today. I would like to ask you three questions, which are very useful for us for the Seanergy Project. My first question is: What do you think are the most promising solutions for overcoming technological barriers to energy transition in ports?

FR: The first question is very interesting. I know that today there is a certain delay in the global maritime system, because I do not find in scientific literature a very well-organised structure/line of research for the different solutions for the reduction of environmental impact that you can be really recognised. In this way, I think it is better if we can find three main fields where we can work to reduce environmental impact in general. The first one is the supply of the energy. The supply of energy today is important because we can produce more and more energy inside the port and then we eliminate in the origin the problem of decarbonisation. In this way, I think the problem of the supply at the port is very important, because this energy is without the problem of carbon (emissions), as it is produced in different ways, by the sea waves, sea currents and so on. The second aspect is the energy that you have produced with the classical wind generator but in different form and this is the first part, I think. The second one is the level of demand. This is the point where the main researchers and organisations concentre their attention. You can see that the problems that are actually discussed, like in the conference today, is the modification of the engine, the problem of energy transport, from on and off shore, and so on. The problem of demand is just one problem. There is the other problem that is the supply. And then there is the intermediate problem which is the interaction between demand and supply. In this case, you have a very large field of technical advancement proposals in this moment. In that interaction you have, for example, the micro smart grid of new generation, the problem of storage and so on. Again, I do not see in the technical discussion, in the normative regulation, in the EU approach a specification in this field. I think that the specification is…how do you say? Distort(ed), just (focused) on demand. I think that there are more and more other very important aspects that are not in technical literature and in the EU normative.

BD: We can move to my second question. If you consider that the already available technology is not sufficient, what do you think is missing to reach zero emission?

SD: The second question is a second part with respect to the first one. And in this way, my consideration/approach again is the possibility to modify the supply at ports, because in a way, the demand is important because the demand is if you stay in the port. The approach is just on the seaside. And seaside, then you have the problem of the engine, the ships, and so on, is very well approached. But there is another big very important part that is not approached. For example: which are the technological aspects that for me actually are in delay? For example, It is the problem of the caissons in the dock. You have a new generation the caissons to produce energy from sea waves, but for example in Europe, you do not have a specification for these technologies. And there is a very important delay. The scientifical approach is very advanced but the technical not. This is the gap that I see at the moment regarding gas. The same is for example for the wind. In the wind, what do we have? We have the horizontal generator that is the basic one, and then very advanced wind generators with different heights and so on.

But if you consider on what you need in the port, you do not need the horizontal axis but you need the vertical axis. In the vertical axis, you have again a delay (in the development). The third element, for the ports, again, is very important. In general, you have outside the port very important marine currents and you have scientifical approach again to use the turbine in the sea, just outside the port. But, again, there is another gap between science and technical.

I think in this field these are very important possibilities to advance in decarbonisation. My idea is that the main attention is just on the seaside but you have landside and landside for demand, and the whole field of supply without advancement, without support from EU Commission, from the DG MOVE, from the different EU Regional DG. You do not have support for supply or for landside on demand.

BD: Thank you. My third and last question. I would like to ask you what your role and background are and if you would like to cite any success stories in your area of expertise.

FR: My idea is that there are various case studies. I just cannot recall. There is a very small case study that is tourist port not a commercial port. The tourist port is in Calabria region, in the very south of Italy. It is interesting because in this port, the municipality took a very important decision to go in nearly zero-emission production inside the port.

BD: What is this port?

FR: Just the last information. (chuckle). This port modified all the structure of the docks and of the protection of the port, using a specific caisson, with specific turbines, with specific objects to transform the waves into electricity. And then the whole port now, all the electricity that you use in the port is produced by the waves. And some vehicles that you use inside the port, different cars, different small vans and so on are electric, they use all the electricity produced by the waves. This port is the port of Roccella Ionica. I think that it is a very small but interesting case, because there is a direction that is very interesting, an important choice taken by the city/municipality to have zero emission. If you consider that this is a very small tourist port in the south of Italy in a region with a very high delay of development, with many problems of different types. I think it is a very interesting reference case to consider.

BD: Thank you, very interesting. Thank you very much for your availability and your opinion.

FR: Thanks.

12. INTERVIEW WITH ZINEB DEBBOUN

- Zineb Debboun (hereinafter ZD)
- Marina Arroyo (hereinafter MA)

MA : Good morning, we are here with Zineb who will introduce herself shortly. Thank you very much for your time and for participating in this interview in the framework of the SEANERGY project.

ZD : Thanks

MA : First question, could you give us a little introduction about yourself, what is your name, position and company that you work for ?

ZD : I am Zineb Debboun, I come from APM Terminals, I work in the PMO department linked to the Decarbonization team in the APM Terminals Spanish Gateways organization.

MA : O.K. and in order to get into decarbonization and all these topics that we were discussing yesterday in the SEANERGY workshop, do you measure your carbon footprint?

ZD : Yes, we do indeed measure our carbon footprint. For us, it is a fundamental step in our strategy towards energy transition. It allows us to identify improvement actions within the organization and that is what makes us establish new actions to improve our terminals. It's one of the things we have in mind. Also, at APM Terminals Spanish Gateways we have launched a new proposal or a new objective which is to certify ourselves with the ISO 14064 and have our carbon footprint verified with the new version of the ISO.

MA : Arroyo Have you carried out any energy transition or decarbonization projects?

ZD : Yes, that's right, in our company we have started a decarbonization project in which I am actively involved. We are currently working in a multidisciplinary team, like the one I mentioned yesterday. It is a multidisciplinary team where we are defining a roadmap, which will allow us to achieve our ambitious decarbonization objective as APM Terminals. We have the goal of reducing 70% of emissions in 2030 (this as a group), and achieving neutrality in 2040.

MA : Before the European objective, right ?

ZD : Yes, that's right. It is also very important that for us the issue of energy transition, it is not something new. We have been certified in ISO 14001 since 2010. We are also certified in the EMAS Regulation, so we are working on it.

MA : What are the main economic barriers that stop or slow down investments in this matter?

ZD : For us, there are many economic barriers. We have focused a lot on technology because in the end, technology for us is vital, machinery, we have heavy machinery and, well, within the organization investing in new technology is something that has a cost. That is why it is one of the main economic barriers that stops and slow us down in green investments.

MA : What type of economic support or incentive would be useful to you to promote the energy transition ?

ZD : Zineb Debboun Well, to promote the energy transition in the port we believe that economic support and incentives are essential. It is something essential, both within the port authorities and for Puertos del Estado (nationally). We have been in several forums and we have realized that they are aware of the difficulty of this process and are committed to providing the necessary means to achieve a more efficient and effective energy transition. Now, at APM we have already began our journey and we believe that it is one of the objectives to achieve, but of course, we need the support of the State. In this case, what I have previously mentioned, economic support, incentives, are essential to promote the energy transition.

MA : Have you made any investments during the past year in terms of energy transition or sustainability?

ZD : That's right, as I mentioned before, we are a group of terminals, so we have terminals in Barcelona, Valencia, Gijón... In Barcelona, for example, we have a solar panel plant, we have switched to LED lighting... Also, one of the mappings we have is to change the lighting in all the terminals, as well as the reefer bridges with electricity generation in Barcelona... we are working on it.

MA : And do you plan to make any investments in this area in the near future ?

ZD : We are creating a roadmap, which will lead us to what investments to make in relation to decarbonization issues. We are very clear that we want to go towards this path of decarbonization and we are working on this roadmap to see where it takes us.

MA : And do you have a budget ? Or are you still planning for these investments?

ZD : Yes, we are in the process of defining it.

MA : What role do you think public authorities should have in promoting the energy transition ?

ZD : Port authorities and *Puertos del Estado* play a fundamental role within the maritime world, for us they are essential in the promotion and energy transition in the port, that is evident. They have the experience and knowledge within the sector that allows them to establish policies, promote innovation, collaborate with other parties within the maritime organization, to guarantee the success of the energy transition, work together with entities such as us the concessionaires or the operating companies, because I believe that we can have a competitive port, a green port.

MA : Yes, we all have to work together towards the same objective, right ?

ZD : Indeed.

MA : What are the main regulatory barriers that stop or slow down investments ?

ZD : In this case, the main barrier identified is the lack of legislation. For us, the lack of specific legislation for this area is one of the key points, such as regulation of the OPS, etc. I don't know, we still don't know where to go, legislation for us is a key point.

In this case, what we commented, to overcome these barriers it is essential that the competent authorities work on the creation of clear, updated legislation that supports and promotes the energy transition.

MA : That's great, because you've already answered part of the next question. And, in terms of economic barriers, how do you think they could be overcome?

ZD : The energy transition in ports is not only about legal or regulatory requirements, you also have to maintain competitiveness, you know ? and maintain long-term competitiveness. For us it is important to promote a dialogue and collaboration with both port authorities and operating companies, as well as other actors, suppliers, etc. to identify the specific needs and challenges of the port and seek joint solutions that drive the energy transition towards a greener and more sustainable operation and be the first to implement it. That is the most important thing, being the first to implement innovative energy solutions in the Mediterranean is what will make us more competitive, which is very important, because the energy transition is not only about regulatory requirements, it is also about competitiveness.

MA : And do you think that the energy transition in the port will generate new jobs?

ZD : Yes, I not only think it can generate new jobs, but it can also drive upskilling within each company, because this is a new world, and that is what happens, because it forces the people who are working in this to update themselves. For us, of course yes, it is not only about promoting new jobs, but also the same people who are within the companies, updating in technology, etc. and work towards a green path.

MA : Do you have peopl within your company that are dedicated to this topic? Well, yourself, right ?

ZD : Yes, indeed. At APM Terminals Spanish Gateways we have established a decarbonization team, as I mentioned before, and we have a multidisciplinary team where almost all of us touch a little bit of everything. We have a person who is from the legal department, who in addition to having worked in the port for many years, in the maritime sector, also studied a master's degree in the environment. We have another woman who works on security issues, and she is the expert on audit issues, for example. Well, in my case, I have worked in both operations and projects. We also have a commercial person from the commercial department, you know ? It is a multidisciplinary team. We also have a person at a global level, working with us hand in hand. Furthermore, at a global level we already have a decarbonization team. As I have mentioned, it is a group objective, and since it is a group objective we are already working on it.

MA : Yes, that's very good to hear. And have you detected any shortcomings in training issues regarding energy transition or decarbonization?

ZD : In the decarbonization team we recognize the importance of continuous training to address the success of energy projects. Yes, it is true that we have already gotten involved, for example, in ISO 14064 issues and we are training, etc. When you refer to shortcomings, really when we need something specific in technical issues of energy efficiency, we look for the best. The truth is that within our organization we have a team of experts and we rely on them.

MA : Is there any type of profile or courses that have been useful to you or that will be useful to you in this matter? You mentioned ISO 14064, I don't know if any other topic ?

ZD : Several topics. For example, for ISO 14064 we have called a specific person who handles the issue of audits and we have detailed it 100%. It is true that the issue of energy efficiency is still not clear in ports. There are many people who tell you, “but what is decarbonization? What is the energy transition ?” There are still many words that people don't know. It is true that there is still a long way to go, inside the port we are still green in that sense, you know ? And I think that yes, training is also very important, training is very important, promoting this in the ports, of course, 100%.

MA : Let's hope that the SEANERGY project can help on this issue. O.K. and what role do you think technology can play in facilitating the energy transition ?

ZD : I think technology plays a key role. The facilitation of the energy transition itself, it goes hand in hand, at least in the ports, especially the decarbonization of heavy machinery through research, development, implementation of technological solutions... Technology is fundamental, It is part of this business, we go hand in hand, without technology it could not be done.

MA : In your opinion, what are the main technological barriers that stop or slow down green investments?

ZD : In our company we have focused on electrification. For us it is a key proposal. What are the technological barriers? Well there are many. There is still no equipment that is tried and tested, that is clear to us, no one on the market has provided us with something innovative or something that is tested. Each company is doing pilots, but it is not yet proven.

MA : So in terms of maturation, right ?

ZD : Yes, there is a lack in maturation. There is still technology in heavy machinery, and everything that exists needs to be tested and all the port companies are testing it. For example, the Reach Stacker, in terms of hydrogen, is being tested... And in our case, as a Group, we are already focused on electrification.

MA : What kind of technological solutions do you think could help your company reach 0 emissions ?

ZD : Yes, what I mentioned before, electrification is one of the proposals that APM Terminals has taken as a group. Now, we have not backed away from any other proposal, we are carrying out several pilots globally to see which is the most suitable solution.

MA : You are investigating.

ZD : Yes.

MA : O.K. These are all the questions from my side, thank you very much for participating and for everything.

ZD : Thank you for having me.

13. INTERVIEW WITH CÉDRIC VIRCIGLIO

- Cédric Virciglio (hereinafter CV)
- Beatrice Dauria (hereinafter BD)

BD: Good morning!

VC: Good morning!

BD: Mr. Virciglio, Cédric, thank you very much for your availability. It is very useful for us to have your view and your opinions for the SEANERGY Project.

VC: O.K.

BD: If you agree, I will start with my questions. First of all, I would like to ask you what your role and your background are.

VC: I am Cédric Virciglio, I am the Strategic Planning Director at HAROPA Port. HAROPA Port is the single port authority of the Seine axis in France, so managing 3 ports: Le Havre, mainly dedicated to container traffic; Rouen, mainly dedicated to breakbulk cereals, and the inland port of Paris, specialised in last mile logistics, where there are more than 70 platforms to deliver goods into the inner city of Paris and all the île-de-France region. HAROPA port is the first port of France. In my duties, I have to work on Strategy, European Affairs, International Development Equity, Consulting and Trainings and we are managing a lot of projects regarding energy transition, ecological transition, also co-funded by the European Union.

BD: Thank you very much. Let us start the next questions. What are the implications of the energy transition for jobs and the economy in EU Maritime Port Cities?

CV: It is definitely a key challenge for port and for cities. I think in the last ten years the port economy has changed a lot, so the fossil economy related to petrol, coal is now done, so we need to invest a lot to succeed in energy transition, that means to have to prepare the field, we have to provide green electricity, we have to work on onshore power-supply. We have already worked a lot with the cities of Le Havre, Rouen and Paris to cut air pollution by using sustainable fuel, by putting in place also energy stations with hydrogen, with LNG, with electricity fast-charging for trucks into the port and next to the city, with the aim to improve air quality. So I believe that a port which did not succeed in energy transition will be dead in the coming years, so we have to be prepared for new alternative fuels for maritime side but also for aviation. For instance, in HAROPA port, we are providing today the fuel for the airport of Paris and recently we have the pleasure to host in our ports two companies that will produce eSAF to provide it to the Parisian airports to clean also the aviation side. It is clearly a huge topic that has been to be tackled by the city and the port together with all the stakeholders because at the end the port has not all the cardings there so that means that we have to work with the shipping companies, we have to work with terminals also to be zero-emission based, and of course all the industries already settled in the ports to create an ecosystem friendly for all the energy transition economy.

BD: Thank you. My second question is: what are the most promising technologies for reducing emissions in EU maritime ports? How can governments and businesses support the adoption of these technologies in your view?

CV: For me, there is one technology already in place and in the market is the onshore power supply. With the regulations that have been put in place in the European Union with the package Fit For 55, so there are few regulations and few maritime regulations, now, each open port have to implement OPS in 2030 and, at the same time, the shipping company will be obliged to be plugged if the OPS system is ready in the port. I think that is feasible right now. It takes time because we have some issues with the capacity of electricity in the Powers, also in place, between the cranes and the berth to be able to put this kind of system but we are working now hard on that. For instance, at HAROPA port, we already started the works to equip our cruise terminals in Le Havre, Rouen and Honfleur, that means that ship-plugs will be available for cruise ships. We are also launching studies to equip our containers' terminal in Le Havre and, in the meantime, we are also working on the inland site, with our colleagues from VNF (Voies Navigables de France) who is managing authority taking care of the river, we will implement a network of more than 100 OPS systems for fluvial units. From my point of view, it is the best system today, but it is very costly. That means today to find a business model without public money (we get some money from the European Recovery Plan, from the French side), we have made some application to Connecting Europe Facility (CEF) and if we want to succeed in a very short time, public money is needed to be ready and on time for 2030.

BD: Thank you. My third question is: How can energy transition be integrated into the urban planning of EU maritime port cities.

CV: In France, for instance, each maritime port has to draft a strategic plan. Our current strategic plan runs from 2020 to 2025 and it was in fact fully integrated. The strategic plan has been written with all the stakeholders, the cities, the companies in the port, the shipping companies and other associations so it was clearly a key topic. By law, in France, all the chapters on energy transition have to be drafted and put in place. For us, it is something very natural. Discussion and exchange with the cities is a key point. We meet with the major each month. The team of the city and the team of the port are working closely together on several topics, especially in the case of Le Havre, so it is really a key point and something to continue and to enhance.

BD: O.K. What are the implications of the energy transition for workers and communities in EU maritime port cities in your view?

CV: I think the main challenge is the training and having the right pedagogy to explain to the people working in the port that the time is changing so that we cannot do like we did before and sometimes if you explain in the wrong ways, you can create some tensions in the port communities, that is of course not the objective. That is why are also working in masterplan in a project that we call in France “Projet Entreprise”. In this paper, two chapters are fully dedicated to outwalk with our collegues to remake energy transition as the baseline of our activities by explaining why we are investing in OPS, by explaining why we are working with companies working on hydrogen, by explaining how to manage new alternative fuels like ammonia, as we have done before with LNG. They key are trainings and clear speech on energy before our colleagues, and of course the directors, and the people in the field and also in operations. I think this is a key factor for success.

BD: My next question was clearly connected to this one and you already answered. How do you see the role of education and awareness in accelerating the green transition in European ports, but you already answered. Moving to the HAROPA port. We have some questions relating to HAROPA. What are the most promising technologies to reducing emissions and waste from the HAROPA port region? Do you find any barriers to the adoption of these technologies?

CV: I think that finally the technologies are more or less already there. The barriers are many. Mainly the price. If you want cleaner fuel, better quality, that means we have to use different types of fuels, more expensive, and that is one key topic. I clearly believe that in the coming years, we have already faced this challenge, but we will find a solution to have more affordable prices in hydrogen and ammonia. The production today is mainly outside Europe, so we have to bring it back into Europe. We also need a huge investment in the electricity grid because the amount of electricity need for cars, for OPS, for trucks will be huge and we are not prepared for that right now but it is feasible because we are working with the French electricity network and the companies who provides the electricity capacity to industry and the cities. We have to bring that at the same time as we implement a new type of fuel or new type of commodities to succeed in the green transition. On the other side, it is clearly to enhance and to have more and more goods on the rivers and on trains, because at the HAROPA port we are very lucky: the Seine river is really our backbone, linking our three ports and the second consumer basin in Europe with the Paris region, which counts for 25 million inhabitants approximately. We have the river to put all the goods coming into LeHavre on barges and send on our platform into Paris. That is also the sense of HAROPA port, creating green corridors, starting at LeHavre, finishing in Paris and we already see big companies like IKEA, like Goodman are building energy positive worlds around Paris. They are putting again their container on barges. They are going to Gennevilliers to our main platform to continue into the Paris region, and then they are using smaller ships to go into the city and then electric cargo bikes and so on. For instance, IKEA launched a new warehouse in Limay about 95,000 sq meters, directly connected to the river and dedicated to e-commerce. If you are in Paris and you need a new bed, armchair, tables, you go on their website, you place the orders and it will be delivered by this kind of solutions. I think it is very important to have both in parallel, working on new technology, how to improve the service and on the other side, train to put more and more goods in the river. And for us, as a port, our mission is to provide the right infrastructure to do it. After all, it is the market that have to act in competition between roads and the river, but our role is to set the conditions for it to be possible.

BD: Thank you. How does the HAROPA Port act in favour of preserving the environment in the Seine Estuary?

CV: That is also a key point for us, because today, HAROPA Port is managing 60,000 Ha on the Seine axis from Le Havre to Paris. And, from these 60,000 Ha, more than 5,000 are natural protected areas, like NATURA 2000 and so on. We are very lucky because we are in the estuary, so the biodiversity is huge. We have a lot of projects already for birds. For instance, we created an island, right next to Le Havre to let the birds have a rest during the migration between Europe, Asia and the North of Europe. We also have a lot of programmes to protect the quality of the waters, by using sometimes a different kind of bacteria or algae. We are looking into innovative concepts in bluing the maritime economy and using nature to serve the port economy. That is really one of our mottos. That is why also with the creation of the HAROPA Port, the merging of the 3 ports, we dedicated one person to watch all these aspects in all the territories. That is really a strong guideline for our action regarding biodiversity and nature.

BD: How is the HAROPA green transition and the circular economy plan integrated into the urban planning of the HAROPA Port Region?

CV: Again, that is with the dialogue that we have between the cities and the different ports, because, at the end of the day, if we did not have these kinds of forums to exchange our ideas on the type of the industry needed. Of course, the city needs jobs for people living in the cities. But if you are coming with something dangerous, people have to know exactly what it is. It depends really on the culture of the people living in the cities. I will give you a concrete example:

In Le Havre, in the industrial port zone, you have more than 70 Seveso sites, you know Seveso, like the city in Italy in which 20 years ago there was a big accident. So, in Le Havre, people are used to it, they know that they live in a scary area, but in the meantime, they know that the port and the companies have very strict standards, very high standards regarding safety and security. That is why we have never had such big problems in Le Havre. In Rouen, it is a little bit different because all the industries are along the river, not on one side, there was a huge accident in a company, not set in the port, but outside, called Lubrizol. It is very tricky now to explain to the people that you want to settle a new industry regarding petrol in the port. That is again the only way is to have dialogue with the citizens, with the city to explain our development plan to bring jobs and economic development to the region.

BD: Thank you. How can HAROPA attract new business and investments that are in line with its green transition goals?

CV: We are very lucky in fact, because I think that at least for the North of Europe, we are one of the last ports with space available, already prepared. Today, we have more than 1000 Ha ready to welcome new companies. In Europe now, all ports have a role to play in European sovereignty, in welcoming new companies coming from Europe but also abroad. In the last six months, we had nice announcements from companies from the USA, from Japan, Korea: "I want to invest in France", in technology linked to PIT recycling, in technologies to produce sustainable aviation fuel for the airport of Paris, companies doing green hydrogen for the proposal (proposed?) industries already settled in the ports. With all the companies, the big CO2 emitters on the Seine axis, along with the port, we have created an association called SOCRATE, like the Greek philosopher, the end is to work together to produce green hydrogen for industrial purposes and at the same time implementing CCUS to capture carbon, liquify the carbon and build the first hub of exporting carbon outside Europe, mainly in the North Sea, in the whole gas sector.

BD: You have developed an innovative tool which comprises environmental data and a module to track operations related to the flow, and the TIMAD hazardous materials managements. Do you think it could be implemented in other ports in France?

CV: Yes, absolutely and it is already the case in fact, because TIMAD and S-WING and the port community system, we are selling the software in other ports in France and even abroad. That is why we created a GV with a company called SOGET. SOGET are port software editors, it was funded in the past a long time ago by the port of Le Havre. Now, HAROPA port and this company SOGET created a GV to work in this kind of software and on selling it where it is possible. That is one option. The other option is really participating and taking part in European projects especially HORIZON 2020, HORIZON Europe. We are part of the MAGPIE Project, putting four ports together. Rotterdam is the leader, Council of Exchange, Delta port and, of course, HAROPA port. We are more than 45 partners and we are working on technology that could be tomorrow disseminated in other ports, regarding digital tradings, new kind of energy supply change, the digital aspect, masterplan for green ports. I strongly believe that cooperation between ports is absolutely key because we will gain time and money by just exchanging the best ideas and trying to implement them in our port ecosystems.

BD: Thank you. Moving to a wider perspective, talking about France, what are the challenges regarding green energy transition for inland water ports in France (Seine, Loire, Rhône, Rhin-Meuse,…). Sorry for my French.

CV: No, perfect! In fact, the biggest challenge regarding the greening of inland sector, especially in the river is today the size of the company that operates in the river. In France, it is not like in Belgium or the Netherlands, where they have mid-size companies, it is more single people, running a boat, except one or two companies like SOGESTRAN. That is why we are working with the local communities, with the people, and again with the VNF, to put in place some programme that provides subsidies to greener boats, greener ships. In that sense we also implement the network of 100 OPS system for fuel units along the Seine River. The key is cooperation, money and expertise. If you own a boat, that you got it from your father, and your father got it from his father, of course, you cannot spend 200,000€ to buy a new one. That is the first thing, and the other thing is that the infrastructure has to be ready. O.K. If you have today a ship running on hydrogen, finding hydrogen to put into the ship to run it afterwards, today it is difficult and expensive. That is why we invest in dual-use fuel stations, serving also vessels, trucks, normal cars, but also barges to be able to start to have an offer regarding alternative fuels that could be used tomorrow on the river. Up to day, I strongly believe that, especially for the Seine river, battery fuel-cell could be the right solution, because, if you look at the distance, a trip between le Havre and Gennevilliers, right next to Paris, takes 46 hours. That could be done by using fuel cells. Hydrogen is possible but it is more expensive. It is more volatile and you need a special technology in the tank to keep it and the way to refuel with hydrogen is not as easy as to refuel with normal fuel. That is why I strongly believe that electricity could be the right option right now. We will see in the future if something else happens, but I think right now, to start, electricity and fuel cells are the best solution.

BD: France counts with several non-interconnected zones (Corsica, other islands and Overseas Domains) which are not connected to the metropolitan energy grid, could you explain how the green energy transition will be implemented in these areas?

CV: That is a big challenge. I think if you look at islands like Corsica, or outermost regions like La Réunion, Guadeloupe, la Martinique there are two key challenges. One is they are lacking space but at the same time they have wind and they have sun. That is why today they are investing a lot in photovoltaic panels, and they are trying to build onshore and offshore windmills. For sure, right now, it is not sufficient. It is a start. I think the capacity is huge. Again, it is not so easy, space is lacking, infrastructure is not always up-to-date, so the connection to the continent is vital for them. I think, if you take the example of Corsica, between Marseille and Corsica, they already implement OPS for ferries and so on. I believe new technologies, using, for instance, the waves in the sea to produce electricity could be an option but I think we have to work on it in the coming years because it is a key challenge. We cannot ask people to be green 100% electric, if you can't provide the right electricity, especially in the islands. It is a key topic. It will start surely to start appear again with photovoltaic panels and so on but I believe we need new innovative technologies to be sure, to be fully-independent regarding energy production.

BD: My last question. Could you tell us more success cases of energy transition in France?

CV: Yes, I think, more generally, it is the cases of HAROPA Port, Dunkerque, Marseille. The last announcement that has been made has been regarding Gigafactory and electric vehicles, batteries, alternative fuels for the maritime or aviation, the implement of OPS in French ports. Today, it is already in place and it is working. This means the market is confident of the ecosystem of the French ports and the capacity of France to deliver on energy transition. We have a strong asset of course with the nuclear powerplant that provides zero-carbon electricity. I know it is still a big challenge on the European side whether nuclear electricity is green or not, it is CO2-free but it not green or neutral level. I believe that we need a mix, we cannot deliver all the power with only wind and sun so having in the back-up the nuclear power system, completed by the electricity coming from wind and sun is the right share. And I think, that is a key factor that explains why France attracts such this kind of investment right now. We are also a big country, that means the demand is interesting regarding the market side. The business case is also running. Our logistics sector is also working well with the three biggest HAROPA port, Marseille, Dunkerque, their connectivity is very good. I think these are strong assets to succeed in energy transition.

BD: I really thank you very much, I finished my questions, but it was very useful to have your view, which will be integrated in the SEANERGY project in the main outcomes of the SEANERGY project.

CV: Thank you, Beatrice. It was my pleasure. Have a good day.

14. INTERVIEW WITH ROBERTAS VALANTEJUS

- Robertas Valentejus (hereinafter RV)
- Beatrice Dauria (hereinafter BD)

BD: Good Evening, Mr. Valantejus. Thank you very much for accepting our interview.

RV: Thank you, Beatrice. Thank you for inviting (me).

BD: Thank you. We are very happy to have you here. It is very important to hear your voice, and it is very important for the Seanergy Project. I will start with my first question, which is: in your opinion, which are the main technological barriers that stop or slow green investments of your company?

RV: As I am representing the Association of Lithuanian Stevedoring Companies, I would talk not about my association as such but about the challenges for our members, which are actually not only stevedoring companies but also port terminal operators in Klaipèda. As most of the ports, Klaipèda Port companies experience similar challenges. We can group them roughly let’s say into infrastructure challenge, technology-choice challenge, I would say, and the different regulations related barriers and technologies. When talking about regulation, it means that in Lithuania, at least, private companies and big companies, not SMEs, not small companies or medium companies, which most port operators are. Funding for those big companies is very limited, differently from state-owned companies or small and medium entreprises. This, we see as an obstacle to implement new and experimental, mostly, technologies. So change in funding patterns and funding regulations would be of big help to port operators. If we talk about infrastructure, then we see it also an obstacle especially for electricity supply in our port, because most of our electrical energy grids are saturated already or at least connection points are without any spare capacity. So major investments by infrastructure operators, such as electricity grid operators or port authorities in the port area would be of great importance to our companies. And, of course, when we talk about choice among various technologies, our companies are at the crossroads, as most of technology implementors. For example, what to use for future fueling of ports cargo handling equipment. Should we go for electricity? Should we go for hydrogen? Should we go for *'bio'* and *'geo'* or something like that? So, this patterns for new technologies development is very uncertain yet. I think these are most of the challenges that we meet.

BD: Thank you. Moving to my second question: What sustainable infrastructures do you have in place in your port? Are there any other good examples in the region?

RV: If we talk about greener energy supply for shipping, for example, we have in Klaipèda, an LNG terminal which is a floating storage of a regasification unit (FSRU) and we have small-scale LNG. These technologies are considered transitional but if we talk about bio LNG, then it could be good enough for use in the future and for lowering CO2 emissions. These experiences in this technology can also be used later in carbon capture storage, so we see opportunities in this. Our FSRU operator in Klaipèdos Nafta in our port is looking further into LNG, bio LNG, carbon-caption storage, so we would like to use their experience in the future as well. They also transfer their knowledge to other terminals abroad. For example, there are already operators of two LNG terminals in Germany and one in Brasil. So they are not only using technology in Klaipèda Port but also sharing their experience to other ports as well.

If we talk about other insfrastructures, solar panels in port terminals could be mentioned. Some of them are installed in office buildings, some of them on warehouses, on checkpoints -on the rooftop of checkpoints. So these are also gaining popularity among our terminal operators. There are also automated gate control systems, which also could be considered as a kind of green technology, eliminating wasted time waiting in the queue for trucks carrying containers for example.

Among those that could be mentioned I would say that low voltage on onshore power supply systems are necessary to be installed in all the quays but they are not very popular. We are looking further to install high-voltage onshore power supply stations intially to RO-RO vessels, RO-PAX ferry terminals and to container terminals as well. But these are still in planning stage in our port. Also, if we talk about cargo handling equipment in terminals, most of the terminals use electrical-powered ship-to-shore cranes, port-and-gantry cranes, and also there are some mobile cargo handling equipment such as mobile cranes or hybrid or fully-electric used in terminals as well. And electrification of container terminals at a late stage is considered too. For example, RTG, diesel electric RTGs will be replaced by or retrofitted to electric RTGs, electrically driven. So these are most of the examples.

BD: O.K. Thank you. My third and last question if you want to please explain to us a bit your role, your position, and if you want to cite any success story in your area of expertise.

RV: I would say that more and more port companies and our members understand the importance of green port operations. Going further, some of them have already implemented environmental and social reporting systems. Some of them provide also regular sustainability reports, so they are going not just comply to requirements but they are going further. They are not yet required to provide sustainability reporting but this is their own initiative. Our port, for example, and the port authority also – I think- already applied for Port Environmental Reporting System Certificate and started procedures to get it. Our port has its green port concept developed as well. I think this is the way forward in consultation with all stakeholders for our port to move in this sustainble future. I think that we are in the right direction together with other European Ports as well.

BD: I really thank you very for your answers and your contribution.

RV: Thank you for asking/interviewing me.

15. INTERVIEW WITH MANFRED SEITZ

- Mr. Manfred Seitz (hereinafter MS)
- Karin Voglsam (hereinafter KV)

KV: Good morning Mr. Seitz. Good morning, Manfred. You are the director of the Danube Commission, in the function of Director General. Thank you for accepting our interview within the Seanergy Project. Because your voice and expertise are very important for us, if you agree, we can start with our three questions. First question is: what do you think are the main barriers to energy transition in the Danube region ports?

MS: Thank you very much, Karin. I would like, a bit, to reformulate the question before I can answer it. In a way that we say: ok, what are the preconditions to decarbonise port operations? I think that is the core of the question if I understand it right. First of all, we need framework conditions which make it attractive and also economically feasible for reducing CO2 emissions, because, behind, there are investment decisions. Investment decisions for infrastructure mobile equipment and also other elements of operations which emit CO2 emissions. These investments have to be based on business cases. Wishful thinking is what happens, it is quite widespread at a political level, but that is not the basis for an investment decision. Not yet. So have to look at the regulatory framework, all these investment decisions on the side of the port administrators and the port operators. Regulatory framework, there I mean more or less, what is the set of regulations and laws which **falls** on port administrators on port administrators and port operators to reduce CO2 emission from their activities?

When we look at these regulations, we have a number of forthcoming regulations that are already in place, but they are not concise and they are not a very demanding regulatory framework that forces decisions and changes the conditions for companies here. It is clear that there are a lot of objectives for greening. Finally, there is now a set of regulations coming with the *Fit for 55* package, so we see there is the need for decarbonising the activites, but still not a level where we can see that all these activities can be transferred into successful business cases. That means that, on the other hand, that we have to be aware that investment into green infrastructure/equipment/operations might cost more than other investments.

Nevertheless, this brings me to the second point, when we have the situation that we do not have a very forceful drive or forceful demand from the regulatory framework, we must also look into decision-making at a strategic level, so that ports know that there will be the need for greening/decarbonising and that they have to do and accept these investments that are more costly than traditional investments.

On the side of public administrations, this could be possible. Nevertheless, there is also the case of green public procurement. It is not mandatory in all the Danube countries. So even, if you would like to be green, to make a green investment as a public port administration, you might face the problems of having to justify higher costs as part of the public procurement. It sounds like one small area, but we should not forget it is also essential.

This means the ports will have to be dedicated. This is why I am coming to the second point of the regulatory framework, the homework of the ports, which has to be done, they need a strategy, they need a strategy on energy, how to create the investments and operations. The strategy usually needs to come with an action plan and concrete projects. Here, we see also that we are just at the beginning of our joint work. Ports here I mean the port administration to take the lead to develop a such a strategy for each port location together with the port operators and companies that are part of the port area. That is an issue.

Not having such a strategy and not having defined these joint projects to implement the action plan is at the moment a barrier. You cannot green without having a bigger picture, having the vision properly down in agreed action plan. By agreed, I mean by the port administration, the port owner and also within the port operating companies. This is a long answer to a short question but the main barriers make it short are the lack of a complete regulatory framework which makes it mandatory to green the port operations and port investment. We still do not have that yet. On the other side, we are not also prepared yet at the ports with the proper instruments, meaning strategy, action plan and projects.

KV: Thank you very much. Very important information for this small question at the beginning. We see that you are an expert in this field. Coming to the next question, what kind of support or incentive would be -maybe- helpful to promote energy transition in the Danube Region ports? Are there any? Could there be any?

MS: What we can see at the moment, what we can do at the moment, and what we, the Danube Commission is doing with the help of the expert group of port operators, which was set up in 2021, this is a transfer of know-how so best practices and lessons learnt from those ports which are front-running in Europe and this happens also in many industries, for example the port industry. It is always important to see what works, where the others are going, what you can more or less achieve, what technologies there are, what equiment there is in the market for a straddle carrier or whatever port equipment reach stacker which operates on batteries which are certified protect and cost-efficient already. This information is important in this phase now to provide. This is also what the Seanergy Project has as the all-over objective to be able to deliver these best practises and the lessons learnt. I think we will also have to help the port administrations to come up with their strategies as part of a consultative process together with the port operators, public port operators and private port operators, depending on the port governance structure to elaborate these actions plans and projects. For the projects, we will need to find programmes which have public funding available, because at this stage public funding is relevant also to subsidise the cost differences of green investments and technologies towards/against non-green investments/technologies. Looking also into this, helping the ports to find ways to access public fundings at a national level, at a European level, that is also an important incentive/element in the implementation strategy. I think it is also important for the European Union to complete the picture and to come up with the continuation for the implementation of the *Fit for 55* package to its full extent.

KV: Yes! Absolutely with you. Besides these incentives and the know-how transfer to the ports, are there any other success stories in your field of expertise?

MS: We are unfortunately right at the beginning, I would say, in the Danube Region. In our expert group of the Danube Commission, we started that is already the right way, and we have mobilised some ports which started the exercise to look into collecting their CO2 emission at the moment. This is the first step when you have to reduce your CO2 emissions, you need to know what your CO2 emissions are. This is exercise is going on now in several ports. From there, I think you can now draw your baseline and you will also have to start your planning exercise and your decision-making towards green measures and towards greening projects.

For this, we already have some examples: port of Vienna, Port of Ennshafen, I think you also started this stock-taking exercise, Port of Giurgiulest, and I think also our friends in Serbia have something running already or in the pipeline. That is what I expect within the next two years, all ports at least will have the knowledge of how many CO2 emissions are produced at a certain port location, what the sources are because these are the bases for taking action.

Taking action… as I said…a long defined strategy and action plan I am not aware that a port is already at this level, but this is exactly what we would like to achieve with our working group and also with the joint-workshop with Seanergy. I think we will also see additional input from the outside, through the DG Move funded study about greening the ports, which will also provide some guidelines for these consolidated comprehensive action plans and for concrete approaches, etc. This is what I expect from this study.

Really success stories in bigger implementations I am not aware. Some of the ports have done already some investment in photovoltaic, this is the usual business but I would not call that a consolidated approach towards decarbonisation. These are measures where I think every business is now looking into saving energy costs, because the fossil-fuel energy (prices) are skyrocketting due to the aggression of the Russian Federation to the Ukraine. I think it became rational to invest a bit more into photovoltaic. These are the business cases that all of a sudden are there. But really it is up to the port administrators and port operators who must come together to say " let's do, let's develop it, how do we really achieve this reduction of 55% of CO_2 emissions until the year 2030? ". I think at the moment this does not exist yet in the Danube Region but it is exactly what we would like to achieve and that is also why we started this initiative on the side of the Danube Commission within the expert group to support port operations. And last, after this political signal with their statement for the decarbonisation of the ports, and port operations, let us make this as our own joint work for the next years.

KV: Thank you very much, we see that the inland ports are at the first step, we can say. At the beginning and going step by step forward.

MS: I am confident that we have put the boat into the water. Once in the water, I think we can push now the button start the engines. Once the engines are there, the vessel will make progress. The aims are clear, coming from the European Union perspective, the climate goals, and all the countries are committed to this goals, EU-members, non- Eu members. That is why we know where to head. We still have to push the button to drive a powerful engine behind and reach the goals.

KV: O.K! Thank you very much for giving your input and your very good expertise into the Seanergy project.

MS: Thank you very much and good luck for the next steps in the project.

16. INTERVIEW WITH ALLEN OFEA

OFEA ALLEN (hereinafter OA)

BEATRICE DAURIA (hereinafter BD)

BD: Hello Mr. Ofea, thank you very much for accepting our interview. We are very happy to have you here, because we do think that your opinion will be useful for the Seanergy Project. If you want I will start with my first question. What do you think are the main barriers of energy transition in ports ? You can choose among: : lack of financing, uncertainty about

future regulations, limited space for new infrastructure, resistance from existing stakeholders, technical challengers or others that you can specify…You can choose, also, more than one.

OA: Thank you for having me. The first question that has been asked about the barriers to energy transition in ports I would say the cost of the equipment for both operations and infrastructure itself, when compared to the normal costs in the ports right now it is very significant. So I would say for the small island development states the cost matters most when it comes to energy transition. It is one of the main barriers. And also, the uncertainty about the future regulations. So at the moment, for example, even the alternative fuels for bunkering facilities in ports is still uncertain. We do not know what is the…how do you call it it? the silver bullet solution for the ports.

BD: Yes, I understood your point. Thank you. My second question is: what role do you think the government should play in promoting energy transition in ports?

OA: Thank you. So, the government plays a critical role. First of all, if they can give exemptions to green equipment and facilitate investments in new technologies . Also, when we talk about ports, are very crucial governments in putting stakeholders together. Some stakeholders have these conflicts of interests, so there must be some kind of negotiations. It is only the government who can bring those stakeholders together, to sit and negotiate at a table.

BD: My third and last question, I would to ask you: What is your area of expertise? What is your role? Would you like to cite any success story in your area of expertise?

OA: So, I am here currently at the World Maritime University doing the MSc on Environmental Energy Managment, but in my country I work as a Principal Officer of Pollution and safety response. So I would reflect what has been going on in my country in terms of ports. I will say there is an initiative by the Regional Pacific Community about implementing and installing these solar panels and LED lights for our port. It has had a drastic cost reduction on the energy in terms of cutting the fuel costs when we install these solar panels and LED lights at the ports.

BD: Very interesting! Thank you very much for your answers and for your interview!

OA: Thanks for having me!

BD: Bye!

17. INTERVIEW WITH SUSAN DUTT

- Susann Dutt (hereinafter SD)
- Beatrice Dauria (hereinafter BD)

BD: Hello Ms. Dutt. Thank you very much for accepting our interview. We are very happy to have you here and we are very interested in your opinion, and I would like to ask you three questions.

SD: Thank you for inviting me.

BD: My first question is what role do you think the government should play in energy transition in ports?

SD: I think that the governments have a very crucial role to support the transition to alternative fuels in the maritime sector. First of all, I would like to pinpoint the role of clear regulations and policies, what is expected. So every stakeholder feels confident that this is the roadmap forward, so I think that is critical. I believe that in the EU it is really clear right now that at the EU level with the FIT55 package and all the regulations coming on, but it is also important for government level in each country to support what is going on the EU. I am thinking also on a more local level, but still quite big level, in California, the California Air Resources Board having really clear 15 years back in time, regarding the implementation of onshore power supply in Port Los Angeles and Port of Long Beach. They have set very clear regulations, not 100% from year one, but gradual implementation of higher and higher percentage of onshore power supply for all vessels connecting to the port. And I guess it is already now from 2023, that 100% of the vessels need to be connected to onshore power supply. So that is one example. Another clear example is Puertos del Estado in Spain they have also been clear about this is the roadmap forward to make sure that all the Spanish Ports will be able to offer onshore power supply even before the legislation in Europe. So more of that clear direction, another one could be incentives. The governments can work on incentives. I know that some countries in Europe, like Denmark, Sweden, Germany, France and I guess also Italy and maybe also Spain have now approved tax exemption for the energy use when connecting to the onshore power supply. So that could also be an important part in helping to speed up the implementation of different technologies, to give incentives. And then, the previous speaker before the break today, she was talking about emission trading system that is now also being implemented for the shipping companies and the vessels. That is not also to talk about the carrots (the incentives) but also the sticks. This could also be an important part. Other additional things – I believe- governments can do are to offer grants and financial support for different programmes related to alternative energy but also implementing different technologies, and also to the academia, like World Maritime University, to really make sure that there is enough financial support to do the important work that they are doing. Not just World Maritime University, but all academia, there are enough financial resources for that important role.

BD: Thank you, moving to my second question: How important do you think it is for ports the transition towards clean energy sources? [a) not important at all. b) slightly important. c) moderately important. d) very important. e) extremely important.]

SD: Which one do you think I pick? (laughter). I would pick e) extremely important, for many different reasons, but , of course, the ports are the hub for the maritime industry. If the maritime industry as well as all the other sectors of society are going to go through an enormous transformation now to receive zero emission, everyone needs to be playing along, ports even more. I also know that many many ports in Europe, but also, in other parts of the world, do have very very ambitious climate targets, to meet those climate targets implementing alternative energy sources and greenhouse reduction technologies are crucial, for so many reasons. I also know that, besides the different high-ambition targets, they (ports) also have programmes in place now to speed up the implementation of the local solar and wind energy, hydrogen…so it is coming!. So, e). Yes.

BD: E. Thank you. I would like to ask you what your area of expertise is, what is your position, your role. You already mentioned very interesting success cases, but maybe you want to add other success cases in your area of expertise.

SD: When I think about best practices, there are of course many with onshore power supply because I am representing EOPSA, European Onshore Power Supply Association but my heart belongs to the Port of Gothenburg I had been working there for 20 years. Port of Gothenburg was one of the first ports in the world to offer onshore power supply with high voltage, already 23 years ago. So I would very much like to highlight that best practice case. Thanks to the very clear customer demand regarding creating a green transport corridor it was from the forest product shippers to rent, so they wanted to create this green transport corridor through the Port of Gothenburg in Sweden. And one investment out of many that became reality was that investment in onshore power supply with high voltage so without very clear customer demand but also a great collaboration in between a number of important stakeholders and a really bright electrical guy in the port of Gothenburg, this became true. From that year and on a lot has happened.

BD: I really thank you for your interview and your answers.

SD: Thank you!

18. INTERVIEW WITH ROBERT RAFAEL

- Robert Rafael (hereinafter RR)
- Karin Voglsam (hereinafter KV)

KR: Good Morning, Robert Rafael, you are representing Pro Danube International, in function as General Secretary and also as a Port Danube Management as General Manager. Thank you for accepting our interview. Your voice is very important for us. My name, as you know already, is Karin Voglsam, I am the project manager of Ennshafen, and if you agree, we can start with our three questions now.

RR: Yes! Very good morning! Thank you for thinking of us in these interview series.

KR: Thank you. The first question: Do you think there are any potential negative impacts of energy transition in ports?

RR: No, I am quite convinced that this energy transition is or should have at least positive effects on everyone, including ports. I am also convinced that ports can be path-finders, first movers in this, because in most of the ports there are spaces, facilities, quite good circumstances to facilitate that. If I need to think of something negative is, but that is also not only related to ports, is the hesitancy that we are facing both as companies and as private people, that currently, at least in our understanding, there is no clear way/actions how to achieve carbon neutrality exactly, how to move forward. If I need to highlight one negative impact is this, that we do not know exactly the way. So, we do not know what to prepare for, whether to prepare for hydrogen production and storage in ports. We know that there are mandatory requirements for onshore power supply, that is one thing, but we know that this does not fulfill or answer all the questions. So, hesitance in one word if I need to say something negative.

KV: Thank you. In inland navigation, there is a mobile area and a static area. The mobile area is where vessels are moving in the Danube and a static area, as we think, is docking in the port. What possibilities do you see to reduce CO2 emissions or to achieve energy transition in the mobile or in the static area?

RR: Right. Let me start with the mobile. I think high on the agenda is the alternative fuels with less CO2 emissions, and air pollutant emissions. This is what we just discussed at the ports. There, it is quite difficult to say what type or what types are there, but we might break down the topic to smaller groups. So, we can/might need to start with vessel types or berth vessel types which can introduce alternative solutions, like for ferries. Electricity can be an answer. Or lakes electricity can be an answer. In port pushers, there can be some kick-starters who can do something in the mobile area, so during moving. Also, when it comes to navigation, like, as slow steaming in the maritime, or in other commodities, maybe not full-speed ahead is the answer in the future. Maybe we can reduce speed. Maybe we can start reduce speed while arriving to ports, or when arriving to locks; that could also avoid congestion and so on and so on. In the static part, we talked about onshore power supply, that is one of the options and one of the requirements at European level, but we also know that it has challenges. If in ports downtown, in cities, we start introducing onshore power supply, it might have a negative impact on the inhabitants in the vicinity, so that also needs to be done carefully. Well, this is what I see for the two modes/parts.

KV: Thank you! Do you see any success story in your field of expertise?

RR: Quite some, when we take on the European level, we can check those first hydrogen-fueled vessels, the introduction of the electricity and those zero-emission barges in the Netherlands. In our Danube region, we see rather some initiatives from ports. We know that in quite several ports, such as, in Vienna, for example, in the vicinity there are some photovoltaic panels installed in the rooftop of buildings. We also see some photovoltaic movements in the port of Constanza, also in Serbian ports. These steps are being made. You might remember, in the energy masterplan project there was LNG infrastructure installed in the port of Ruse, unfortunately, it is not used yet to its maximum extend. There are some more movements in the Danube Region in the ports, vessels are not that frequently a subject for watching this for the time being unfortunately.

KV: Thank you very much for taking your time and giving us your expertise. Let us see what is going on further in the Danube Region. Thank you very much, Robert.

RR: Thank you and good luck with the project!

19. INTERVIEW WITH PROF. DIMITRIOS V. LYRIDIS

- Dimitrios V. Lyridis (hereinafter LD)
- Kostas Komninos (hereinafter KK)

KK: Hello, Mr. Lyridis!

DL: Hello!

KK: Thank you for joining this short interview, following up our session in SEANERGY regional workshop. I wanted us to discuss a couple of things regarding your views on the issues, discussed also in the regional workshop. First of all, I would like to ask you about your position in the Technical University of Athens, what is the role that do you see the academic institutions like NTUA in the process of green transition for ports?

DL: For ports. Yes, I think it is two-fold. One is a little bit more strategic and more, let us say, facilitating the transition in the sense that they can assist in developing new technologies through research mainly; new technologies that lead to easier decarbonise specially for ports and vessels maybe, but specially and also for ports. So, research is one area.

The other area is that they can assist in the application of more innovative technologies, that is, since these technologies are bit advanced, it might take a little bit more know-how in order to, for example, decarbonise through shore-side electricity in some other areas. So, the know-how and how to apply this and validate the actual effect of these new technologies can be done through higher tech institutions, like universities.

KK: That is reasonable. So, yes, I mean supporting also the baby steps of the transition, let us say. O.K. That is clear. Do you think that the educational programmes of the institutions, and the institutions themselves, are adjusting at the same pace as the technology progress and (that they) provide new educational content to the students related to the latest progress on green ports and shipping? Like in NTUA, do you have courses related to electric propulsion and shore-charging infrastructure?

DL: I think in that sense, universities are a little more advance than what is actually happening. I mean we have been discussing electric propulsion for years and also shore-side electricity in theory at least for years. We were actually the first ones to build the small pilot applications in one of the ports in Greece. So, I think that universities in this area, not only in electrification and also in other new technologies, are a little bit more advanced that are actually assisting the policy-makers and driving a little bit the stakeholders into more advanced areas and more advanced technologies that have to do with decarbonisation. It is not an explicit course on decarbonisation, but in all the courses we do something that it is very important, all the technologies that we teach to our students are related more or less to decarbonisation nowadays.

KK: Do you see interest from their side regarding innovative technologies or would they focus more on traditional naval engineering and they think these are too exotic?

DL: Both are needed but the students are always more drawn by more innovative things, so I think it is quite exciting for them, how naval act actually evolves.

KK: O.K. That is good to hear. And last but not least, I know that you and your research lab are quite active in research projects, so would you have something to share with us, some key takeaways from recent research projects that focus on port decarbonisation?

DL: In terms of research, I think I would not exactly call them research projects, they are a little bit more development projects I should say. Providing shore-side electricity does not take a lot of research. More research is needed in the regulatory environment and actually in technical solutions. So, in that sense, we have been involved in almost the decarbonisations of almost every port in the South-East Med, from Cyprus to Slovenia, and, of course, most ports of the ports in Greece but also in Bulgaria and Romania. So, we have been quite active in this one. We were, as I said, in a sense, pioneers in installing shore-side electricity, first as a pilot application, the first small port in Greece, the port of Kyllini. We have studied most of the electrification positions in all other major ports.

We have also been involved in alternative fuels. There, in terms of research, we have a very interesting project on the using of ammonia on port vessels, which will also entail the cooperation of ports as well, because they will need the bunkering infrastructure and design of a liquid-hydrogen carrier. We have been involved for many years in all the alternative fuels. This, of course, requires the assistance in ports. It is not possible nowadays to see a port and a vessel separately: they are part of one system, of one, let us say, value chain that has to do with shipping. This is very important. So, you have to decarbonise them at the same time.

KK: And a very short comment, do you think that island ports can play a role of testbeds in small-scale ports or do you think this is more the mainland intervention that we see in ports and this is not so applicable?

DL: No, the mainland ports, or the bigger ports, because Heraklion, for example, is also a large port in an island, but the large ports are where it necessary and where it is easier to apply because there is sufficient infrastructure there. However, small ports can become pilot cases, as we did with the case of Kyllini, for the time being at least, as long as these islands are interconnected to the electrical grid of the country, where it is making it easier to use the renewable energy sources, to exploit them better. Otherwise, it is not so easy to exploit them. It is a very closed system. I think they are good testbeds. They also have the advantage of tackling the decarbonisation issue from all angles, not only from shipping and ports but also from the roads that they are using every day, for everyday people in their houses. In that sense, it is better than a large port. But to decarbonise the port specifically, then I think the large port is more suitable.

KK: Great! Thank you Mr. Lyridis for this short discussion.

DL: Thank you!

KK: I am sure we will have more time to discuss in the near future. Thank you.

DL: Thank you. Bye-bye!

20. INTERVIEW WITH STEFANOS DALLAS

- Stefanos Dallas (hereinafter SD)
- Petros Markopoulos (hereinafter PM)

PM: O.K. Hi, Stefanos! Thank you for participating in the interview for SEANERGY Project. We have PROTASIS (with us today). Could you please introduce yourself, your role and the company shortly?

SD: Yes, sure! So, first of all I would like to thank you for letting me participate in your workshop in the previous week, regarding decarbonisation in ports. I am Stefanos Dallas, I am the EU Project Manager at PROTASIS S.A. PROTASIS is an engineering and consulting company, that delivers expert consulting services specialised in system solutions for self-reliant efficient operations of electrical networks and installations. We act as a part consultant and system integrator for protection, control, and monitoring system and subtension automation systems as well as smart-metering systems on power generation and supply networks.

Our company is a key player in the power and energy sector, offering integrated systems, expert studies and technical consultancy services and ensuring the reliability and safety of electricity generation and supply is a top priority for us. We are deeply committed to promoting environmental sustainability actively contributing to decarbonisation, electrification, smart-efficiency and eco-friendly solutions which align with our corporate general and strategic development.

PM: Great! Thank you very much for this introduction. Yes, PROTASIS has an impressive profile. That is one of the reasons why we think it is very important to address you as an important player of the Industry sector in Greece regarding port decarbonisation. I will go straight to our first question which is based on the studies that you have carried out so far, and your experience so far. Which technologies regarding port decarbonisation are the most

right for installing in ports, and especially, in Greek ports, I would say, according to your view?

SD: So, I will begin by saying that, all these efforts have become and developed taking into account EU's commitments to reduce the emissions by 55% by 2030, the "Fit for 55". Subsequently, make the EU carbon neutral by 2050. So, it becomes crucial for all ports to comply with these regulations. Notably, I think the ports in the Mediterranean are a little bit behind this overall progress since the northern ports, in North of Europe have taken significant steps in implementing electrification systems which include shore-side electricity supply, battery chargers for battery ships.

Moreover, I can say that we have collaborative efforts to advance in hydrogen technology for fueling ships that can be supplied from ports. But, despite the global push towards decarbonising the ports, not all the above-mentioned technologies that I mentioned above have reached the maturity level for their widespread implementation. So, for the time being, we can say that the shore-side electricity installations, the so-called cold ironing, can emerge as the most mature technology for several reasons. First of all, all these technologies are already in operation, as I have mentioned they have been installed in a broad area in northern Europe, but we can say these technologies have also been implemented in some Mediterranean ports in Spain, France…in Greece, we can say that in Kyllini port although it was a pilot implementation for small passenger vessels.

Moreover, electricity, as maritime fuel, is positioned as one of the most environmentally friendly options for the sustainable future. All the manufacturers of these systems, the OPS systems, they have expressed their confidence for the *ecoships*, foreseeing an increased demand in the future. Since let's say, the deadline for 2030 is not far away, the ports will start demanding more and more this type of systems.

Finally, in this technology we can live outside the cable management systems. Let's say, it is a part of the OPS, the systems that connect the port to the vessel. These systems are continuously evolving to meet the diverse demands of each vessel and port, contributing to the maturity of this technologies, especially the last one the cable management systems can be different for each port and vessel.

PM: That is clear. Thank you very much. I think it is something that confirms also what came up from the workshop, in fact, that cold ironing is the rightest technology. Therefore, in this direction, I would like to ask if you can tell us more about the solutions PROTASIS is working on, either in the application level, the implementation level, or on study level, speciafically in which ports do these solutions apply?

SD: Let us start discussing the studies for these OPS systems. Our company has developed several studies for a lot of ports, both national and international for different types of vessels through said projects, i.e. EALING, ALFION, CIPORT, etc you can perform studies for the ports of Piraeus, Rafina, Igoumenitsa and Volos. And, of course for the port of Costanza in Romania and Burgas and Varna in Bulgaria. So, for us it is the knowledge that we are day by day working on that, we are getting better. We extend our knowledge on these systems. The most important is that we perform these studies, the Fit studies, for these systems for different types of vessels. Each type of vessel has different demand, different design and so on.

Regarding, let us say the solutions, except from the studies. What we can say is that there are two major areas where our company can make a significant contribution, as we said all the ports are stepping towards decarbonisation. The first one is the centralised energy management systems and the second one is cybersecurity. Regarding the first one, we think that as discussions revolve around the decarbonisation of ports, and enhancing energy efficiency, we envision transforming the port into an energy hub, so this involves the integration between various production systems renewable energy sources, battery systems and so on and how we can manage high-energy consumption, such as the shore-side electricity systems, vessel chargers and so on. So, this type of system is essential for optimising the operation of these systems. As an example, we have designed a system for the port of Igoumenitsa, under the framework of the ALFION project, which effectively manage the three OPS positions and the energy storage systems in order to perform the best efficiency of these two systems.

The second critical consideration is the cybersecurity of these systems. You can think of an scenario where a cruise vessel has been supplied with electricity and let us say that we have an intruder/hacker that is targeting this system and causes blackout.

You can imagine the consequence. So, taking our experience into account with transmission and distribution operator systems, we can enhance the cybersecurity of these systems providing an additional layer of protection against these potential threats.

PM: O.K. Thank you very much. These are really important aspects and it is good that we have companies, like PROTASIS, that are working on this as well and all the agents that are also crucial for the implementation of these systems. Finally, as a final question, I would like to ask you based on your studies carried out so far, which technical challenges have you identified regarding port decarbonisation? Of course, I understand that the main focus until now has been related to cold ironing.

SD: O.K. Thanks for asking that, it is something that we are facing again and again. Say, for the main issue, we can face different types of technical challenges. As we covered in the previous question, there are technologies that are ready for deployment and others that need further development. However, with the current technologies, there are several challenges addressed. But one of the critical issues that all ports will encounter is the substantial energy demands of this system. For example, we can take as an example the port of Piraeus, the biggest port in Greece and its passenger terminal. In order to supply five vessels, the port needs to provide power that exceeds its existing energy demands by x2 times (double). Let us say that in a case study was that the energy demand right now for the port was 10 MW and for five positions in the passengers' terminal, it will need almost 13.5 MWA.

So, these are two key points. First, we need to consider how the national grid can handle this increased power requirements since more and more ports will ask for more power. It is note-worthy that the national grid operator HEDNO is actively working on this matter. And secondly, the ports themselves must strategise on upgrading their local grids to effectively meet these heightened demands. The grid of the ports was not constructed for such high demands, so we need to think further how we upgrade the system.

Additionally, there are special challenges for the ports, even that these systems have a significant footprint, and many ports have special limitations within their territories, considering the fact that a lot of ports are inside urban areas. So, they have a space limitation.

Let us something more general. It is crucial to emphasise that when we talk about electricity as green maritime fuel, we must speak of the energy mix of the power that is produced in order to supply these vessels. This power production must align with greener practices to meet the broader environmental and sustainability goals. Of course, there are a lot of other technical challenges, but they are more technical. For example, we have special issues with the CMS systems, that they have their footprint and there are limitations for example in a container terminal. They do not have sufficient space for the installation of these systems. Of course, each part is focusing on the challenge and they are trying to solve (them). This is continuously developed. Solutions to these challenges are day-by-day appearing and this makes us very happy.

PM: I like to complete the interview on a positive note! I appreciate that. What I think is really important here is that when ports were initially designed of course all these needs for space and infrastructure were not taken into account. I think this is what makes it extra difficult to install them, since their equipment is dangerous. You cannot leave it hanging. It needs also cybersecurity. You mentioned a lot of aspects that need to be taken into account, the extra capacity in power. All these create a complex system with a lot of parameters that have to be taken into account. Alright, Stefanos, thank you very much for this interview. I do not know if you want to add something more, something extra.

SD: No, I would like to admire your effort in decarbonisation of ports. It is something that we will face in the following years and actions like yours lead to the next step. I think carbon neutrality is something that we need to really consider and take seriously into account.

PM: Thank you very much. Of course, we will need your expertise and know-how when we are approaching the local authorities and try to convince them to move forward with actions like that. We will be very happy to work with you in that step as well. All right, thank you very much and will be in touch.

SD. Thank you

21. INTERVIEW WITH FEDERICO TORRES

- **FEDERICO TORRES (hereinafter FT)**
- **MARINA ARROYO (hereinafter MA)**

MA : Good morning Federico, thank you very much for participating in the SEANERGY project interview.

FT : Thank you very much for inviting me.

MA : To start, so that they can know you a little, could you tell us what is your position? What part of the Port of Valencia do you come from?

FT : I work in the Port Authority of Valencia and I am the Director of the Ecological Transition area of the port authority here, which, as you well know, manages 3 ports, Valencia, Gandía and Sagunto.

MA : Do you measure your carbon footprint?

FT : Yes, yes, of course. Since 2008, we sensed that the carbon footprint is a very representative value of the emissions generated in a port and we not only measure the emissions of the port authority, we are one of the few or the first ones to begin the study of the carbon footprint of the entire port. That is, not only scope one and two, but scope 3 of the old ISO 14064 standard, which has now recently been modified. Therefore, we have a very accurate assessment of what the port's activities impact, not of the port authority, but of the port, within the scope of greenhouse gases, to the point that this footprint has been validated by the Ministry, it is certified, and we not only have it certified with the Calculate seal, but also with the Reduce seal. Therefore, we have taken a qualitatively important step in not only knowing what we impact, but also in reducing those impacts that we generate.

MA : And have you carried out any energy transition or decarbonization projects?

FT : Oh, yes.

MA : Quite a few ?

FT : Yes, the truth is that we already have an important trajectory. As I said, since 2008 we have been aware that the port's activity, the impact it generates, obviously we have not simply stood by observing, but we have gotten down to work. And we are working on an ambitious plan to achieve 0 emissions by 2030. As you know, the regulations require a decarbonization of 55% of emissions in 2030, and 100% by 2050. We wanted to take a qualitative step in this decarbonization project and reach net zero emissions by 2030.

This is not only a desire, but it is a determined commitment where we already have a very detailed study of the actions that we have to carry out in 8 lines of work that we will later comment on, and within those lines of work we have also already begun to develop concrete actions. We are already implementing and just finishing, for example, 3 photovoltaic installations, with which we are going to have, let's say approximately 20% around 24% of the energy consumed in the port, being energy renewable.

We are about to raise a topic related to the decarbonization of ships when they are docked in the port. What is called OPS, Onshore Power Supply or cold ironing or electrical supply to ships, and this is a qualitative step because in terms of the knowledge we have of the effects, of the impact, in the port, we have calculated that 45 % is the due to ships. If we place the electricity supply in Onshore Power Supply, we will already have that 45% reduction potential. The other 25% is the machinery.

We are also working on an ambitious project to use hydrogen in machinery, apart from electrification. Therefore, we would have the other 25% reduction and we are already talking about 60%, almost 70% of emissions reductions. That is, with the other 8 lines of work, we are already, well, we are very hopeful that we will be able to reach emission reduction values in 2030. Very, very close to that 100%.

MA : What are the main economic barriers that stop or slow down green investments in the port authority?

FT : Perhaps I would not dare to say economic barriers, the truth is that obviously all these investments have important costs, even more so due to the idiosyncrasy that ports have that when you see a port you see huge surfaces, you say, gee, this is an ideal place to work and install photovoltaic (power)plants.

What we must never forget is that the leitmotiv of a port is the movement of goods, so these surfaces are dedicated for that use, and we cannot use the space that has a priority use for us, which is the movement of goods. Therefore, we are using or developing these facilities where there is a very significant economical extra cost, especially in the metal structures that we have to implement to support the photovoltaic panels.

But, the port authority's commitment is very decisive. Our strategic plan has generated a very specific line of the 0 emissions plan, where we are investing very significant amounts of money. In total, we can be talking about approximately between 150 and 200 million euros.

I insist, the main barrier would perhaps be the administrative barrier. It is very discouraging for us that, for example, if we are talking about electrification, then obviously we will have to have energy capacity, either renewable energy or increasing our energy needs in terms of moving from medium voltage to high voltage installations.

Well, to have the permit to construct a substation, paid for and supported by funds from the port authority, we have spent more than 2 years, practically 2 and a half years, to obtain an authorization, that is a real brake on what is the implementation of the new regulatory requirements. Therefore, what I would say is that one of the main barriers that we must try, obviously, with the controls that must be absolutely safe and reliable; but the streamlining of administrative procedures which are a requirement, that should be one of the greatest demands and one of the greatest easiness that should be proposed to us. We have just presented the study for the environmental impact of another very interesting initiative, which is the use of wind energy in the port.

We have the idea of, well we already have the preliminary project to install 3 wind turbines with an average power of 6 megawatts, with which we would have 18 megawatts installed.

And as I say, in the environmental processing, let's hope that it is not another 2 and a half years simply to obtain the permit and from there start of the project, since a project of these characteristics is 2 years, it would already be 4 or 5 years away. That is, from when we have the preliminary project until the reality can then be seen. 5 years are an excessive amount of years for a project in which decarbonization is one of the priority axes, not only of the port authority, but of many institutions, including the Government and not only the national Government, but the European Government.

MA : In the end, technologies become obsolete too if you wait so many years.

FT : Well, we have been in the paradox, the sad paradox that the first photovoltaic project, when we proposed it, due to the administrative processes, as I say, of many deadlines, of many demands, of many requirements, the photovoltaic panels that we installed were already out of stock. And that is not a question that has to be invented. It has happened to us and in the second project they were not outdated, but they were not current, because others came out in the same physical space, with greater power. In other words, this time lag between the approval of an administrative project and its technical implementation can lead to these frustrating situations and technologically leave them out of the market.

MA : And what kind of economic support or incentives could be useful to promote the energy transition in the port?

FT : Well, obviously, like any change, it does require support on many occasions, administrative support, support, let's say, from governments, from administrations, given that it is a change and any change implies, well, that transformation, that coupling , that adapting the facilities, the new requirements. And there it could be done, fundamentally with agility in the processes, as we have commented. But also, well, some type of bonus or some type of incentive (it is true that currently there are all the projects, the Next Generation), but really nowadays obtaining help from a Next Generation project is absolutely very complicated.

And we say it knowingly. Some of these decarbonization projects are being subsidized by Next Generation projects and the complexity is really such that I highly doubt that SMEs, small and medium-sized companies, will be able to obtain this financing. Therefore, if before we talked about agility, now we should also use the word facilitation, that is, we must make it easier for these new subsidy possibilities to arrive in a much more agile and much more comfortable way so that small and medium-sized companies also have the ability to use these funds or these bonuses.

MA : We have talked before that investments have been made in recent years in photovoltaics and wind, etc., and in the future, is there any investment planned or programmed in this area, also in energy transition?

FT : Yes, fundamentally electrification, because of course when we talk about Onshore Power Supply, about ship supply, what is really complex and not easy for people to understand is everything that goes underground, all the infrastructure that we have to do. To reach the ships with this electrical supply is truly very complex. To give you an idea, we have had to, now taking advantage of all the new infrastructure and the new road distribution that is taking place in the port, take more than 16 special tubes, 16 200 mm tubes, to be able to connect the cables, because the power that we are talking about is very high. And to be able to have energy capacity, that is, one thing is the energy capacity, the substation, another thing is the distribution and then the implementation in the specific terminals. All of this, let's say "network of facilities", entails truly significant costs and what we are now implementing is two pilot experiences to once we have seen the effectiveness and connection capacity, establish this entire network throughout the port. And that, obviously, we have to do in the coming years and with very powerful investments.

MA : What role do you think public authorities should have in promoting the energy transition?

FT : Well, absolutely fundamental, that is, we like to be a bit of a tractor force, that is, to be able to do ourselves what we demand from companies, so that they see that it is actually possible to do it. I believe that it is fundamental, for example, in this step of the transition, that we can be the engines and tractors to provide new initiatives. For example, we are aware that the use of hydrogen is going to be one of the big bets in the future and, while hydrogen is still competitive in terms of cost, theport authority has started the H2Ports project for the use of hydrogen in port machinery. Let us remember that it is 25% of our greenhouse gas emissions.We are aware that, either we generate the demand, or the private company is not going to start these processes until the economic fit is 100% profitable. What we have to oversee is that the technology is feasible, it is possible, it is appropriate and then, obviously, begin that process of facilitating that technology arrival and that it arrive at a reasonable cost.

Because let's remember that environment in English is written or pronounced "environment", with the "e", and the "e" is for euros, that is, if the technology is not affordable for companies, we can run the risk that this process be slowed down, which for us not only do we want it not to slow down, but to speed up and move forward to this year of 2030.

MA : Of course. And, what are the main regulatory barriers that stop or slow down green investments in the port authority?

FT : What we mentioned before.

MA : Processing, right?

FT : Yes, mainly the administrative procedures. With that we are not saying at all, or rather I am not saying that a procedure, a regulation, a compliance does not have to be carried out.

What we are saying is that these regulations, those compliance, those demands; they can't last 2 and a half years. It is simply that the means have to be put in place by whoever is responsible of this, so that all the controls that have to be done are carried out, but in an absolutely reasonable time.

MA : And how do you think these barriers could be overcome? In other words, by reducing the deadlines, do you see it viable for this to be achieved?

FT : In the end all these projects are being approved by technicians.The one who develops a project is as technical as the one who reviews it. Therefore, it could have, let's say, facilitate the administrations, since they made contracts with private companies to streamline these processes through responsible statements from the competent technicians in which the projects comply with the regulations and, then, the State or the administration carry out subsequent checks. And if there is a failure, then obviously the study would have to be recomposed and redone, but, if both are technicians, the one who reviews and the one who develops it, then a responsible declaration could be valid, or incorporating more technicians so that the studies and analysis are carried out at more appropriate timeframes.

MA : In this sense, do you think that the energy transition in the port will generate new jobs in the port environment?

FT : Absolutely, absolutely. To the point that we are even testing through an initiative of Opentop from Fundación Valenciaport, a very innovative project, in addition to a Valencian startup, which is the use of photovoltaic panels in spaces that could be very difficult to think of its placement. It has the innovation part of its placement in its assembly and its use, since this is already generating a new positioning for this type of company, where if the results are favorable, the expectation of growth, for example, in this initiative, it can be really very interesting for this company. All the new challenges, such as decarbonization, cause the work paradigm to vary and vary in jobs, perhaps of higher quality, with greater added value. And we are now in that process, we are now in need of using new fuels. We have simply talked about hydrogen, we have talked about electricity, there are countless new products, synthetic fuels, methanol and many others. There is a capacity for research, analysis and being able to produce products that will obviously generate a number of very, very interesting jobs. Even in the port authority itself, right? You have an ecological transition department. What kind of profiles are dedicated to these topics? Well, the profiles are fundamentally engineering profiles, because the energy transition, what I also like to do is to frame the energy transition within a great concept that is sustainability. That is to say, there is really now a very important step towards this concept of energy use. But let's not forget that sustainability, even more the energy transition, is one of the legs that is gaining the most popularity. But sustainability, as I say, has a much broader spectrum. Yes, it is true that in the energy transition, this part of engineering has greater relevance, but we are also talking about many kinds of environmental specialists, from the point of view of water, air, soil, waste, etc. Therefore, the generic concept of sustainability and the more specific item of energy transition, it does mean that at a certain moment the profiles adapt to specific, let's say more specific, needs. Energy, because of its conception, seems to be more linked to the concepts currently found in engineering.

MA : In this sense, also, do you carry out training on energy transition, sustainability...? Or is there any specific topics that are useful to you?

FT : Well, we are now finalizing, and we have already released some specific courses on the generic concept of climate change, what it implies and what are the consequences of climate change, such as decarbonization, decarbonization plans…

And we are now finalizing a more specific course to analyze all these methodologies, all these new products, all these new facilities, what they consist on, how they are based, what are the criteria, when is it better to use one or the other. That is, specific training is being carried out and not only on energy transition, but also on another process that is truly very very important in ports and that is the adaptation that ports must have to these new climatological patterns.

It is essential that ports have the capacity to adapt. What happens with these higher high temperatures on the asphalts, on the metal structures, on the plastic structures, on the facades, on what makes up all the urban furniture? What is happening with the rising sea level, with the structures, with the water now touching metal structures that were not previously foreseen? We are already doing studies where these variables, what is affecting is that the port, in meteorological cases, is stopped for longer periods of time. Every year, the port stops due to weather conditions, waves, fog, etc.; for increasing amounts of time. That ultimately causes a loss of competitiveness as well. Therefore, this whole concept of decarbonization, which is how we can combat the effects of climate change, but also, how to also act on the effects that are already occurring, that is, how do we adapt jobs to these new situations? This whole set of situations is what we are trying to do, so that people are knowledgeable, but not only knowledgeable, but also know how to face the problem of decarbonization and the problem of definitive adaptation, since we are very active in generating these courses, especially so that we can give an adequate response to these two types of problems.

MA : Very relevant nowadays.

FT : Absolutely.

MA : What role do you think technology can play in facilitating the energy transition in ports?

FT : both the current and the technology that is to come are essential. That is, what we have to try to find out, to try to analyze, is which technologies are the most appropriate, because the paradox will arise that there will not be a single technology, that is, the paradigm of which is the best here? I believe that different technologies must coexist for different uses, where one use one or the other will perhaps be more appropriate. Earlier I was talking about, for example, a very exciting project where we have now is to generate methanol, which is a fuel that could be very interesting. In addition, through waste water waste from the generation of gases that are emitted in this process. Therefore, we will also be incorporating the concept of circular economy, the concept of reusing waste and that remains to be defined, assessed, and analyzed; its profitability, its use, its capabilities, how much volume can be generated, its profitability... That is, all of this is through technology. Therefore, technology at the moment is one of the fundamental pieces to provide a more adequate response and, above all, a more accurate response to different types of problems.

There is traditional technology: photovoltaic, wind, which will respond to a very large percentage, but the other smaller percentages will be with the adaptation of more specific technologies, which are the ones that we have to begin to analyze now and envision to give let's say, that 100% response.

MA : In your opinion, what are the main technological barriers that stop or hinder green investments in the port?

FT : We have to take into account that we are a port authority, a port authority where we have certain capabilities for action. In our case, we are lucky to have a foundation, we have Fundación Valenciaport, which is what serves us as an instrument of innovation, an instrument of development, and it is what we can rely on to give that response. Those ports that do not have an instrument, it is difficult to make day-to-day management compatible with everything that it entails. All the actions that we have to do, considering the issues of innovation. In the end it is dedication and knowledge, in our case we have that through Fundación Valenciaport and that barrier of difficulty simply by having time to dedicate to it, we compensate it with Fundación Valenciaport.

MA : What type of technological solutions that exist currently on the market, or are pilot tests, do you think would help the port achieve zero emissions?

FT : Well, some of them we have already commented on, there are the traditional ones and those that we are now trying to analyze, such as for example, the use of a study that we are doing, or a coupleof very absolutely innovative studies that must be carried out in a port is… what is there a lot in a port? In a port there is a lot of water, there are many trucks, there are many containers, there is a lot of space...

Well, our reflection was to say: What can we do with each of those things, of which there are many? There are many trucks, so we are going to see and we are analyzing how to obtain braking energy at the access doors. It is a very exciting project where we have already started a line of work. In a port we have a lot of water. What energy can we put into the water that can serve us for this decarbonization process? Well, we can put photovoltaic panels, but of course, a photovoltaic panel in exposed waters, there is no technology available to analyze. Well, we are analyzing what there is, the ability to place photovoltaic panels in exposed waters. In lakes, in rivers, there is a technology that is already very well known, but not in exposed waters. There is space, and we have said that we have made a first investment in spaces that are all the dikes, all the vertical parts, using them for photovoltaic energy generation, which is not going to be, let's say, of greater efficiency. Absolutely, because they do not have the appropriate inclination, but we are going to see what their energy generation capacity is in that area.

We are now thinking about the railway lines, a large distribution of railway lines has been made in the port. What happens in those spaces? As long as they are not occupied by locomotives, can we also put photovoltaic panels there? Can't we put up panels ? It is another study that we are going to analyse. That is to say, we continue to think about those situations where we can continue developing technology and where, rather, to see if technology is capable of giving us solutions to these new situations that we are proposing.

MA : Of course. Well, from my side these would be all the questions. Thanks for your time. It is clear that the Port of Valencia has carried out and is developing many projects. We have talked about the various technologies... So, well, I believe that by 2030 we will achieve the goal, right?

FT : Well, to finish, I do like to end by saying that we have already gone from theory to facts. Soon we will see physical things, real things, where we will also meet that objective, that double objective of zero emissions in 2030 and energy self-sufficiency, which is also very important in order to have, let's say, continuity in the port. And also another piece of information that is to conclude and is the fact that it is possible to be sustainable in the port, as I said, we have been calculating the carbon footprint since 2008 and the great satisfaction for us is that the port continues to increase its level movement of goods at very important levels, but no less important is the reduction of the carbon footprint due to the implementation of this series of measures that we are doing. Therefore, the conclusion is that we are in a line where it is almost the conviction, at least we want to play with that conviction, if we do not reach 100%, we will reach 99.99%.

MA : Which will surely help. Thank you very Much.

FT : Thank you.

22. INTERVIEW WITH FULVIO LINO DI BLASIO (I)

- Interviewer (hereinafter I)
- Fulvio Lino Di Blasio (hereinafter FLDB)

I : What is your name, what organization do you work for and what is your position?

FLDB : My name is Fulvio Lino Di Blasio and I am the President of the North Adriatic Sea Port Authority, as well as I am a Special Commissioner of the government for the cruises, and a Special Commissioner for the environmental and productive recovery of the Montesyndial area, another strategic investment in our port.

I : **Do you have any personnel in your organisation dedicated to the energy transition and decarbonisation issues? If so, please, describe.**

FLDB : Yes, we do have 2 special units. One is dedicated to fundrasing for this special project. It is a unit that is working closely with the public administration and the European Commission, in order to get as much as possible from these institutions. Secondly, we have a technical team that is dedicated to help the Port Authority, our Concessionaire, our partners in the transition into a green port system.

I : What role do you think public authorities should have in promoting energy transition in Ports?

FLDB : First of all, in our strategic plans, we have to create and dedícate one special pillar to energy transition as we have done in our port and in other ports in our country. Secondly, we have to invest a lot in training, so we need knowledge and we have to train our engineers and our colleagues in order to be ready for this new challenge. And the third pillar is to work with our concessioner. I mean, we have to put a clear indication in our criteria to choose a new concessioner, criteria linked to energy transition. We can no longer afford to choose investments that are not linked to this priority.

I : What are the main economic barriers that stop or hinder green investments in your organisation?

First of all, is the cost because new technologies, new investments in this area are really a challenge for us. In my opinion, we have two main actions. First of all, to create and to study exemptions from the State Aid Rules. So public investment, a public intervention in order to support these investments. On the other hand, I would suggest stronger effort in financing research in order to harmonise the different technicalities and the different tools that we have to share among all the ports that are involved in this challenge.

I : What type of economic support or incentives could be useful for your organisation?

FLDB : Public incentives, for sure, we have to reduce the taxes, and we have also to reduce the administrative burden that is linked to launch these new initiatives. So, both administrative simplication and financial support.

I : **Have you carried out any energy transition or decarbonisation projects in your organisation?**

Well, first of all by planning our capacity to measure our emissions. So we drafted, using DEASP, that is our document for the basis to monitoring our emissions. And now, we are in the process of drafting a new strategic document that is called Green Energy Plan that will help us towards the net-zero emissions system. We have been using also the results of the EALING Project, that is a project financed by the Connecting Europe Facility, so by the European Commission. We have also had the chance to receive public funds for some important projects. First of all, I would mention the Onshore Power Supply investment, where we have got roughly €90,000,000 to plan cold ironing in Venice and Marghera. On the other hand, in the last years, we have been launching and signing voluntary agreements called Blue Flags. So, all the cruises and the naos, goods ships called in Venice agreed on switching the fuel system to a low-sulphur fuel. So, we are, in this case, reducing a lot the emissions and the impact on the city and on the citizens.

PART 2

This interview was not videorecorded. However, the stakeholder decided to add more information about their green transition process.

- Interviewer (hereinafter I)
- Fulvio Lino Di Blasio (hereinafter FLDB)

I : What is your name, what organization do you work for and what is your position?

FLDB : My name is Fulvio lino Di Blasio and I am the President of the North Adriatic Sea Port Authority, which comprises the ports of Venice and Chioggia, and Special Commissioner for the realization of temporary morings and associated interventions for the safeguarding of Venice and its lagoon

I : Do you measure your carbon footprint?

FLDB **:** Yes we have been measuring the carbon footprint of the Ports of Venice and Chioggia since 2020 via the document called DEASP (Environmental and energy Port Autority Plan), which is reviewed every 3 years. It measures the situation “as is”, e.g. the carbon footprint of the direct and indirect aspects of the organization. Basically, it takes into account consumption of all port activities as terminals’ ground operations, ships emissions, port services and Port Authority’s buildings and activities.

I : Have you carried out any energy transition or decarbonization projects within your organization?

FLDB **:** Yes we have started with setting the base for steady monitoring campaigns, to measure energy consumption, via the above mention document DEASP. However, we are in the process of drafting the first strategic planning document to guide us toward net-zero emission. These document will laso stem from the outputs of the results of EALING project, which include, to name a few, the clean power supply plan. For this reason, in Venice, in addition to the DEASP, a Green Energy Plan is being drafted to identify sources and ways to procure "green" energy.

Other activities that are underway in Venice, in compliance with EU Regulation of sustainable fuels is the implementation of the cold ironing system, which currently concerns the passenger sector (cruises/ferries/yachts), and is worth €90 Million euros for the total investment.

In the past 10 yrs, via voluntary agreements such as VENICE BLUE FLAG, the vessels entering the lagoon have agreed to use LOW SULPHUR Fuels only.

Last but not least, with the funds of a National Recovery and Resilience Plan pillar, aimed at the environmental sustainability of ports (so called Green Ports), in 2024-25, we will start implementing a total of more than 12 Million euros grants to improve energy efficiency

I : What are the main economic barriers that stop or hinder green investments in your organization?

FLDB : A clear exempion of State Aid Rules for the start-up phase of decarbonization which is costly and legally binding for the public authorities but also for private undertakers. Moreover, the uncertainty in the procurement (supply) of a certain type of green energy sources, in the long term (decades), could put at risk the return on investment and the balance of the business plan.

I : What type of economic support or incentives would be useful for your organization to promote the energy transition in ports?

FLDB **:** The reduction of the *"red-tape"* bottlenecks and a general simplification of procedures for accessing funding, which should be given in advance, with a greater focus on results and not on reports.

I : What role do you think public authorities should have in promoting the energy transition in ports?

FLDB **:** Public authorities, like we are, should be coordinators and facilitators. I would bring back the fruitful bottom-up procedure for the identification of the already mentioned GREEN PORTS projects. As Port Authority, we have organized permanent roundtables with provate stakeholders, gathering a full array of great ideas, and the most impactful projects have been selected.

Beyond the state aid issue, the working tables with terminal operators have been very interesting for all the parties involved. Another issue then, could be the revision of procedures and requisites, in the granting of concessions: to identify among the rewarding criteria precisely the energy aspects.

Moreover, our strategic vision aims to increase the compatibility of port development with environmental protection. A port system, therefore, that, in collaboration with other scientific and research institutions in the area, systematically conducts cognitive studies of the lagoon ecosystem, monitoring the current state, ongoing changes, as well as the potential effects resulting from the port and human activities present.

I : What are the main regulatory barriers that stop or hinder your organization's green investments?

FLDB **:** State Aid rules should provide some kind of exemption for the startup phase of decarbonization projects involving public and private stakeholdes.

I : How do you think the economic and regulatory barriers to the energy transition in ports could be overcome?

FLDB **:** National Ministries should cooperate more in multi-thematic working groups addressing the challenges stemming form decarbonization (e.g. non only from a strategic but also from a pragmatic point of view, encompassing the spillovers on fiscal and regulatory system, public concessions and other elements).

I :Do you have personnel within the organization dedicated to energy transition/decarbonization issues? If so, please describe.

FLDB **:** Yes we have a reserach and Development Project Unit that is in charge for finding the right funding opportunities , stemming from European or National funds, and we have a dedicated Enviromental Unit , iembedded in the Technical Department that deals daily with all energy related issues for execution of projects.

I : Do you carry out training on energy transition/decarbonization in the organization? What type of courses would be useful to you?

FLDB **:** We are assessing the viability to have an Energy Manager.

I : In your opinion, what are the main technological barriers that stop or hinder your organization's green investments?

FLDB **:** At the moment, the lack of capability to produce massive amounts of Green hydrogen.

I : What type of technological solutions (existing on the market or pilot tests) do you think would help your organization achieve zero emissions?

FLDB **:** Adequate quantity production of Green Hydrogen.

23. INTERVIEW WITH GEORGE LOIZOS

- George Loizos (hereinafter GL)
- Petros Markopoulos (hereinafter PM)

PM: Good morning, Mr. Loizos. Thank you so much for participating in this SEANERGY Interview. I would like a very short introduction from yourself about yourself and your role as a regulator (in the Regulatory Authority of Energy, Waste and Water).

GL: Alright. Thank you very much for this interview. My name is George Loizos. I am the Director of Strategy and International Affairs and, simultaneously, I am the Head of the Department of Electricity Networks and New Technologies. Under the second part of the Networks and New Technologies, I am speaking today to you and especially for the project cold ironing on the decarbonisation of the ports.

PM: Thank you very much. So, let's the first question which is how could the regulatory authority for Energy, Water and Waste contribute to enabling and accelerating the ports decarbonisation in Greece?

GL: O.K. The regulator in Greece…What is the problem, first? The problem is that with new technologies, the need for a special regulatory framework is most of the times, more ahead of the existing regulatory framework; and the same applies to the ports, to the cold ironing

Project. We have some models in the existing framework, like the closed distribution system, like electromobility, but none of them is wanted in the ports. So, we have to invent a new framework. The legal tool is the so-called 'regulatory sandbox' or regulatory experiment. This is not…The regulatory experiment is much different from a research project, much different from a pilot project, it is a trial. It is actually a derogation, a license for a derogation of parts of the existing framework. It is a derogation. Usually, it is a derogation on unbundling issues, on tariff methodologies, on the way the players participate in the electricity market because in the cold ironing, like in electromobility, we may also have services, instead of only electricity market, I mean, selling of energy. So, in this respect, we need some legal flexibility, but we also need to try and learn. This is where the regulatory sandbox comes and allows for three or four years, the experimentation, the derogation which is according to the European Framework. It is permitted through this procedure to derogate from the European Framework, because this is the only way. You cannot make a national law by yourself, a unilateral legal initiative without the permission of the European Union. You have to do something within the Framework of the European Union and this is way. It has to be for three or four years, but also, there must be caution, because the designed experiment must have probability to succeed and to be accepted in the following European Framework that will come. It has to be in a way that it must have possibilities to be accepted. This is the danger. We cannot design something completely out of the norm and then expecting by lobbying to make it happen. It must have some roots to reality. This is what we are working for. The regulatory framework cannot be done by a company, it has to be done by the Ministry and the regulatory authority. It cannot be done by a distribution network operator; it cannot be done by a demand or retail player. It has to be done by official authorities. The players will apply for the derogation they want. The regulatory authority will accept. Maybe, the Ministry has a veto right, I mean within two months, it can say I approve or I do not approve the regulatory decision and after that, the road is free to proceed. This is the concept of the regulatory framework and the regulatory sandbox. I am giving so many details because it is misunderstood with a pilot project and who can do it.

Of course, we are working with the Ministry towards this direction. Other countries like France, Britain, Italy are working on this more than five years, but in Greece, we have not established that. It is not new in Europe, but it is new in Greece and it needs some time to digest.

PM: Yes, totally understood. Thank you very much for this response. The regulatory sandbox seems like a really important tool to accelerate the decarbonisation of ports. I would like to ask you, following up on that: How is, more concretely, the regulator supporting the incorporation of green transition technologies and infrastructure in Greek ports?

GL: O.K. Other than this initiative, we have funded some studies to quantify the demand in ports. We are talking about several ports in Greece, with different types of ships going to them and including cruise ships and container ships. We have since 1 and a half years ago studied the demand in order to see what infrastructures need to be approved by the distribution network operator and the system operator, at ADMIE and DEDDIE respectively. This was needed because RAEWW approves the infrastructure development plans of these operators.

After that, we wanted to see the implications in the tariffs, in the prices and the effect on consumers. As it is the case with all new technologies, they have to be subsidised in a way. They have to be socialised. If all new technologies come at the same time, the burden for the consumer is a lot; the economic lot could be quite heavy and we need to see the effect of that.

So, we are funding studies. We funded the one on the need for infrastructure. And the second study that we are currently running is the market model, that we believe will have the highest probability to be accepted and succeed. This work has been going on for the second half of 2023 and will continue in 2024. We will have some more solid then. In practical terms, we are working on the models. Definitely, from what I have seen so far, we will need some derogations. This is why we discussed before about the legal tool to allow the derogations.

PM: That is a very coherent strategy.

GL: The port is like an airport, that is a closed distribution network in a legal terms. But the model of a closed distribution network is not the model that the ships and the market of ports really want. They want a different (one). Although one is an aiport and a sea port, the (same) model cannot be applied.

PM: O.K. That is an interesting insight. This sounds like a really coherent strategy. Moving forward with the studies on the market and at the same time trying adapt the regulatory

sandbox because of its needs to move forward. We are looking forward to the results. As a final question, I would like to ask you if you think that small island ports, like, for example, the port of Syros, that we have as a demo port in the SEANERGY project, and I say small, of course, because they are smaller compared to the mainland ports, like Piraeus or Igoumenitsa, if they can play a testbed role when it comes to green transition?

GL: In my view, allow me to say, I would definitely characterise them as small and large ports, as you say but I would also put another category, if they belong to an inter-connected island or non-interconnected, because the project is to interconnect all the islands in the Aegean Sea except five or six really small islands. So, when I first heard your question with “small”, my mind went to those really tiny islands, like Astypalaia, for example. I am saying this differentiation in the categorisation because if the island and its port is interconnected, it will be legally bound to what we do in the port. They will not have much flexibility. But, if we go to an island that is not going to be interconnected at all, then this island could be for marketing purposes regarding electrification, like Astypalaia, like Halki, like Tilos. These, in my view, are very useful to prepare the public opinion, because they are very flexible, they are cheap as projects, they are five-million-euro projects to electrify everything. And in this way, people are getting familiar to the idea of electrification. They could go, some of them, for holidays and see it happen. And it is quick. It is cheap and the low-hanging fruit. And easier legally. Syros, already interconnected, although small, I do not doubt that it is small, has a problem that belongs to the large market. And in this sense, we need something heavier legally. Syros, although small as you say, will go to a larger conglomeration. An island like Syros would have cruise ships, passenger ships. Then, we would make group with ports like Syros and make an experiment, as a category, different from Pyraeus. We can make another experiment. In this sense it can be a testbed. From what I am saying you can see that I do not consider Syros as small as you do.

PM: Yes, exactly, because it is interconnected.

GL: To me, it is not a small as I understand from your question, although there are not many ships. It is difficult legally. Legally, it is not small. It is part of the bigger market because it is interconnected. And even Poros that acquired publicity for cold ironing. What is cold ironing? Electrification as long as you are at berth. O.K. But they are not for this solution. They are going for the electrification of taxi boats. This is not cold ironing, it is electrification of small boats. It is not restricted by the legal framework. As well, marinas, which are not a port, they are a tourist port, they give electrification services for years. Outside of any framework, if you consider it. There are large marinas, that nobody discusses about their framework, they have a plug. If you go and visit a marina, you will see. There are plugs and you put and charge whatever you want to charge. This is like a normal electricity consumer in marinas. Why is that? Because they electricity network in a marina is low-voltage, it is not medium voltage or high voltage. What I am saying, sometimes, like brainstorming, because we need to put some limits to the problem. This is what I have to say for this as well.

PM: O.K. That is very interesting approach. Thank you very much for participating in the event some weeks ago. We have discussed all these issues and we are very happy to have you also in the next steps of the project and continue this very interesting discussion.

GL: I am also very grateful to you because your efforts really help innovation because you prepare, and it is a way to spread the ideas to people that want to progress and you initiate some thoughts. This is nothing but benefit to the whole thing, because ideas need acceptance.

PM: That is right. Thank you very much once again, and we will be in touch.

GL: You are welcome. My pleasure.

24. INTERVIEW WITH JAVIER CERVERA

- Javier Cervera (hereinafter JC)
- Marina Arroyo (hereinafter MA)

MA: Good morning! We are here with Javier. Thank you very much for participating in our interview.

JC: Thank you for the invitation.

MA: So, to start, could you tell us a little bit about yourself, your name, the company you work for, what your role is?

JC: O.K. My name is Javier Cervera. I am the Head of Energy Transition in Balearia. Balearia is a Spanish maritime company. It is the leader of cargo and Passenger (company) here in Spain. This is my position in the company.

MA: Do you measure your carbon footprint in Balearia?

JC: Yes, we do, from many years ago, we have the obligation since 2018, mainly for the vessels, that is for us more than 95% of the emissions. We have been doing it from the beginning, but now with the regulation, we are doing our reporting to Europe.

MA: Have you carried out any energy transition or decarbonisation plan?

JC: Yes, we have just started, because, as I already told you, more than 95% of the emissions are because of the vessels. We started 7 years ago with the LNG vessels. LNG is fossil fuel but it is less, a 25% less emitter than the typical ones, that ran on petrol, that are mainly in the global flips. So from that moment, 7 year ago, we have been incorporating natural gas, we already have 10 vessels on the fleet, more than 60% of the ships that we use in the company.

MA: What are the economic barriers that stop or slow down this sort of plans in your organisation?

JC: This project on natural gas, when we started 7 years ago, it was environmnetally and economically an advantage. But, as we know, in the last few years, natural gas increased its price a lot because of the wars. For the future and for the future of the decarbonisation field the barriers can be the provision of volume that we need and a stable price for a long time to do the investment in the vessels.

MA: What kind of economic support or incentives would be useful for your organisation to carry out the energy transition?

JC: We have already had support from Europe, for retrofitting 6 vessels, and support for an electric vessel that we own, from this year (2023), here in the Mediterranean. Investment for the CAPEX is important, but as I just mentioned before, I think that the price stability of the for the future, for renewable fuels is important, because the price is going to be higher than that of fossil fuels and we need this stable price, even knowing that it will be higher, but at least that the volume and the contract period is established to be sure of the investments.

MA: For sure! What role do you think public authorities should have in promoting energy transition?

JC: The public port authorites?

MA: or the Government or organisations.

JC: O.K. I think here in Spain because the *Next Generation Funds* we have a lot of subsidies line for the decarbonisation in every sector and we have some part focused on the maritime and the ports. I think the most is to try to do procedures as simple as possible to get this money if you have a nice investment that can reduce emissions fast in this next medium-period. I think the subsides are there but we need that the procedure and the timeline to be shorter to apply.

MA: so this would be a barrier regarding public authorities?

JC: Yes, this is a barrier, currently. I know that for the Next Generation Funds you need a lot of papers, reports, etc. But I think it is possible to make an effort to try to shorten it a bit.

MA: How do you think that these economic and regulatory barriers could be overcome from your point of view? One point would be for the administration to shorten down these procedures. For the organisations, what could be a way to improve? For example, for the site may be have knowledge of the procedures, or to have a clearer knowledge of the economic packages that they can apply for?

JC: I think that the most useful thing is that you have a clear project that you are going to incorporate in your company. I think that is more important than really to think of a new thing to be subsidised. If you have a clear project and a timeline, your work packages, in your normal business. I know that the support and the subsidy can fit perfectly with that. The most important is that you have your project clear and a line to invest in your company.

MA: You answered a little bit before, but do you have personnel or a department in your organisation that is dedicated to energy transition or decarbonisation project?

JC: Yes, we have many areas in the company with different roles: on energy transition in my case, focused on decarbonisation projects onboard and the vessels; other positions in my team, for example, to produce renewable energy or fuels for the future, people with the measure on board in every vessel, etc. Everything is connected to the objective, that is obviously decarbonisation and the reglamentation is requesting from us these reductions.

MA: Of course, do you carry out any training in terms of decarbonisation or energy transition? What type of courses would be useful for your organisation?

JC: For the organisation, the more technical people that we are involved in, we have the expertise or we can focus more on technical courses to be focused exactly on the thing that we are managing. For a bit more general for the other workers in the company to know about decarbonisation in a basic or medium position, we have some speeches inside the company: why we are getting this way for the carbonisation, with the technology in this case for natural gas, for biomethane that we are starting to incorporate, why we can invest in hydrogene just in this starting point, because in this field that there is still not much reassurance at all, etc. We do internal courses to teach about that because energy and decarbonisation is something really concrete about this sector and in every business, not exactly a general course focused on the maritime to teach general professionals in the company.

MA: Also, because it would be more interesting for them to know what they are doing in their day-to-day, to raise their awareness. O.K. And in your organisation, what are the main technological barriers that stop or hinder your organisation from investing? For example, we spoke a little bit about LNG or natural gas or retrofitting. I do not know if there were any technological issues when you first started with that?

JC: Yes, we are the leaders in incorporating LNG in the Mediterranean Sea. We were the first Spanish company and now we own 10 LNG series. We have had a strong barriers on the way, because of the technology, because of the new bunker on the ports, etc. And new barriers are coming really for the new future fields. Not for the decarbonisation that is compatible with LNG, that is by biomethane, we have infrastructure in Spain for natural gas and LNG, but hydrogene and derivatives like methanol and amonia. We need to start to define the infrastructures that are needed and to define the procedures for the bunkering from the ports to the vessels. So we still have a long way to do in these new fields.

MA: Do you have an opinion on what type of technological solution that already existing in the market, which one would be the most useful in your company to reach zero emissions?

JC: For our company, you need to know that we are a short sea-shipping company, that means that we are docking in a port, once, twice or three times every day, that means that we can bunker fuel every day. Other shipping companies, like container ships or bulk carriers , they are sailing days and weeks, so they need another type of fuel, knowing that they can only refuel /refill only once a month! So, diffferent solutions. In our case, we can incorporate for example some partly-electric directly batteries. This is not possible in container ships because they cannot be incorporating that only for less than 1% of their trip. We can incorporate that, we can incorporate the renewable natural gas, this is the biomethane, because of the fact that we have natural gas. However, other companies, in long distance, or other container ships that are consuming LNG, they can apply for that too. So it depends on the route, you can apply for one or another fuel, because of the occupancy of the energy and the density of the fuel onboard. This is important because our business is to move cargo and passengers and not to move the fuel. So different solutions. For us, short sea-shipping, natural gas and decarbonisation solutions like biomethane and starting with electric (batteries) can be enough for the next two decades. In other vessel companies, they have more complicated things to do and they have think about methanol, ammonia, not procedure compressed hydrogen, etc. But, we have two or three decades ahead, why cannot a new technology still appear to solve these kinds of barriers?

MA: Thank you very much. These are all the questions from my side. I do not know if you have anything else that you would like to tell us.

JC : No, only thanks to you and the project for having interviewed me. I am very happy to be here sharing our experience in Balearia. Thank you very much.

MA: Thank you very much, it was very interesting to learn more about your experience and have the perspective from a shipping company. So, thank you very much.

25. INTERVIEW WITH JAVIER ARES

- Javier Ares (hereinafter JA)

❖ Marina Arroyo (hereinafter MA)

MA : Good afternoon, we are here with Javier, thank you very much for participating in this interview. Could you give us a little introduction about yourself, what company do you work for? What is your position?

JA : Good afternoon, thank you. I am Javier Ares and I am the director of Terminales Portuarias in Valencia. We are now integrated into a group, a French multinational, since 2020, called Rubís Terminal, which is dedicated, like us, to the activity of terminalstorage for bulk liquid products, with terminals in France, in Northern Europe, in Rotterdam and in Antwerp... And well, we are already a fairly important percentage of this group, approximately almost 30% of this multinational is us. Our main activity is the storage and dispatch of liquid products in bulk of any type. In Valencia it is more specialized in the world of petroleum products more than anything else, especially in the field of chemicals, which was the origin of Terminales Portuarias in Valencia. Over time we have diversified the activity because what was required in the 90s is not the same as what is required now. So we are already evolving to biofuel products, and other type of products that are more sustainable. And part of the basic industrial product that continues to work and that we continue to store for our customers.

We can also highlight that we have grown, since 2011 we made a very large expansion of storage, with prospects of reaching other types of markets, considering sustainability, kitchen waste, the fuel issue, taking into account biofuel, such as those of plant origin and we are also fuel suppliers to ships within the port through bunkering service. And this is something very interesting because it is evolving towards more bio-sustainable fuels. We hope that this year or next year at the latest we will be able to carry out pilot tests in Valencia, to be able to supply ships with biofuel.

MA : That's very interesting. And in this sense, what you are telling us about sustainability, and climate change, do you measure your carbon footprint?

JA : Precisely. Every year, for some time now, we measure our carbon footprint. We have been members of Ecoport for years and we have a specific agreement with the Port Authority on good environmental practices, and we have certifications such as ISO 14000 and EMAS, we have had EMAS for quite some time, and one of the characteristics is to measure the carbon footprint. Also, due to the type of activity we have, and that we are evolving; we have many authorizations related to the environment. Among these authorizations, many ask you to control emissions, so, at this point we are working on it. We have managed to greatly reduce the carbon footprint of our activity. Also because all of our main activity runs on electricity, almost all of it; and the energy that the port authority supplies us nowadays is certified with renewable energy, which is very important.

MA : Yes.

JA : Therefore, our carbon footprint is quite low in that regard. I can also comment that we have made investments in recent years related to the environment, more specifically photovoltaic panels. I think we were one of the first to install photovoltaic panels in the Port of Valencia. We have a small inconvenience due to the typology of our facilities. Part of it are from 1990 and others are from 2011. At that time, people were not thinking about environmental issues and port facilities are normally governed by land that is concessioned, practically 100% for the activity to which you are dedicated. You are not thinking in the short-medium term about other types of environmental activities. So we have had to figure out how we can contribute in this way to reducing the carbon footprint, by looking for spaces where we can make photovoltaic installations.

Due to our characteristics, having flammable products, we cannot place installations anywhere. So we have searched and we have found some spaces to place photovoltaic panels. The installations that are made related to engines and other equipment are already installed with equipment that regulates this consumption, so you are not generating an excess, nor you are consuming more than you need, which is important. We have a load regime, we do not use the equipment 100%. We use the equipment below that percentage, trying to achieve maximum performance, and to do so we installed drivers that help you manage all this type of equipment. We also have network analyzers throughout the facility, so you can know at all times what you are consuming, where you can generate savings in terms of electrical consumption, regardless of the economic reduction it may represent, which is not a big deal, but you do a reasonable management.

MA : More efficient.

JA : More efficient use of the resources. We are also looking to see if we can do it next year. We have boilers for heating products that require temperature conservation. Currently they are doing it with diesel and we are going to change it to natural gas. If the project goes well, we will do it next year. We are working this year on how to bring natural gas to the installation, and what it means economically to be able to install natural gas. The boilers must be changed to other type of boiler, and this year it will depend on the budgets we have, if not we will surely undertake this next year. With this, we will have our energy sources quite controlled to reduce our consumption and thus carbon footprint.

MA : Very good. And what are the main economic barriers that stop or hinder investments in energy transition and decarbonization?

JA : For us it is not that there is a slowdown due to economic issues. In the end you have to strike a balance between the investment and what you are going to get. If we wanted to do a large project, what would happen is that maybe the investment would be so large that it would not make any sense because we could not afford it.

MA : Of course.

JA : Within our field, we are already working towards decarbonization. The mother company which is Rubis Terminal began a study this year for all the terminals in Europe, with the aim of obtaining total decarbonization by the corresponding year (I think it is 2050). This has already been launched to see the work that is needed. Why do we have to start now? Because you can find technical solutions that do not exist. What technical or technological solutions do you need to be able to carry out this decarbonization? In facilities like us, there are already things that are being done: the panels, being able to change to gas and so on, or making equipment that manages consumption much better. But there is something that is more related to emissions, which is more complex to do. Although the regulations that we have due to our activity and the variety of products and services we have is very demanding; we have a lot of authorizations, and we are subject to a lot of legislation. In the end, it is as I say, in the end we have more certificates than a dentist's office (no offence to dentists).

MA : Right.

JA : We are subject to so much legislation, industry legislation, environmental, customs... there is a lot of legislation. So, regardless of how the legislation evolves and we comply with this legislation, let's say that in the more medium-long term future, we are already studying it. But of course, why this? Because there is going to be a time when we will need some type of technology to help us do this.

MA : In this sense, what type of economic support or incentives would be useful to promote the energy transition?

JA : Well, let's see, I think that the public administrations intervene a lot here or should intervene a lot. That is because legislating is very good, but complying is very difficult.

MA : Right.

JA : So, with this challenge that we have in Europe, of course, the technological or investment need that you need can be very large, and certain types of companies, within their size, will be able to commit a certain amount or not. If they won't be able to, in some way, someone will have to help them. So, this balance, investment - profitability, will be quite difficult to maintain. I think that here, in this case, at the level, we are talking about being in Europe, we will have to regulate and we will have to see what kind of help will be needed. More or less, this is happening with the vehicle issue. Now there is a moment, a transition of doubts with the issue of vehicles, motorization, electricity, fossil fuels, and so on; that there is a moment of uncertainty that at some point will have to be determined, right? So, I guess this will pass with time. In ports, there are also a lot of completely different activities. In Valencia, the most important activity is related to container terminals. But there are other activities, which are not insignificant, but which will also have their impact.

MA : Yes.

JA : For us it's the same, regardless of what we are doing now, because having an electric vehicle or not can help to a greater or lesser extent. But other types of activities, which are much larger, with higher volumes, in the end there will be a moment when, this balance, the Public Administration, will have to determine something. And I think this is still very far.

MA : In this sense, what you were commenting on, what are the main regulatory barriers that you think stop or hinder this type of investments and processes?

JA : Well, now in terms of regulatory measures, there is no great progress. Yes, there is a lot of expectation for the future. But currently, I believe that those that are in place, at least on our part, are being fulfilled. What we have to see is, when a regulation related to this issue is made, we will have to see the range of activities that may be affected and how it will have to be applied. That is to say, activities like the ones we have in Valencia, there are other countries in Europe that have a lot of them. In Rotterdam, activities related to terminals, in Hamburg, in Antwerp, they are huge, they have huge terminals. In Spain you also have large terminals, there is a refinery, there are elements important enough so that when there is regulation; think about all these types of activities. I believe that there is still a long way to go in this.

MA : Do you have personnel within your terminal that is dedicated to energy transition or decarbonization issues?

JA : Now in the company, which is the multinational, there is a department that was at the beginning of the year, that is only going to be dedicated to this type of activities and issues. The Tepsa company, when it was absorbed by the group, contributed a specific person, who did something related to this, before the sale took place. Now this person is at the headquarters, which is in Paris, and in a department that is dedicated exclusively to this matter for all the group's terminals.

MA : Do you carry out training on energy transition or decarbonization?

JA : Well, this year we have not done anything because this is quite new and then next year, in our training plans we will include everything that is related to changes and environmental management. Yes, we do training every year related to the environment, but it is more related to our activity and the environment. But, according to this projection that is going to be made, we will not start doing any type of training until next year. Once this department is well defined, when it is working, part of its job will be to provide appropriate training so that everyone is integrated into this type of activity.

MA : Before we talked a little about the topic of photovoltaics, biofuels, boiler changes, etc. What role do you think technology can play in facilitating the energy transition?

JA : Let's see, the objectives of the energy transition undoubtedly involve an issue of technological improvement. Being able to supply ships with a biofuel is not a matter of saying "I will give you this amount and another and see what happens." There is previous work by someone who has done their mixtures, their checks... because what we are talking about is something as important as you being able to leave a boat in the middle of navigation, completely stopped. You can ruin its engine. So this technological pre-work is done before we can carry out a pilot test, as we hope to do. This year I don't think we're going to arrive on time, but next year we will be able to do this. Of course, you can't risk having a transoceanic passenger who, halfway, tells me "gentlemen, the ship has stopped." **MA : It wouldn't be feasible indeed. And, what are the main technological barriers that stop or hinder this type of investment?**

JA : Well, I think that now there are too many ideas and very little development. So, I think in the end...

MA : Maturation.

JA : And maturation. That is to say, we have many ideas, green methanol, green hydrogen... On the topic of biofuels, HVO... There are things that are already working, but there is much left to prove. And here, in this aspect, the public administration, I believe, must intervene because, who is the first to dare to incorporate this technology? Because these are investments of large sums of money. We have seen it with biofuel treatment plants. A plant with this type of technology costs a lot of money and to produce something that is relatively not so cheap.

MA : Right, and what type of technological solutions that are on the market or pilot tests, do you think would help Tepsa achieve zero emissions?

JA : Well, for us now, being able to achieve zero emissions is more focused on an issue of emissions, because our storage, there is no regulation that controls the issue of emissions of all the products that we have, but that in general there are in the manufacturing companies. That is why work is being carried out to see what is needed and what may be needed technologically, to be able to achieve decarbonization. At least in this type of activities, in others it will be different, but ours is focused on that path.

MA : I think those are all the questions for my part. I don't know if you want to tell us anything else?

JA : If you have any concerns, I am at your disposal.

MA : Thank you very much for participating in our interview.

JA : Javier Ares Thank you

ANNEX III

Ports of the Future

SEANERGY

the Sustainability EducationAl programme for greeNER fuels and enerGY on ports

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SEANERGY

WP 1

TASK 1.4 – Ports of the Future

SUBTASK 1.4.2 – Initial Tech-Port Matchmaking

Prepared by Team Rina Consulting S.p.A.

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Table of Content

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Sub-task 1.4.2 Goals

SEANERGY

01

Identification of different European port archetypes according to SEANERGY scope

02

Carrying out a preliminary matching between the developed archetypes and “Catalogue of Technologies” (Deliverable 1.2) results

03

Port archetypes matchmaking first verification: port archetypes-technologies association applied to SEANERGY Demo Ports

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Introduction (1)

Ports have a key role in international logistics being visited by several means of transport daily.

According to IEA (2020), Ports have the opportunity to support the green transition by supplying electricity to visiting carriers or others.

The port, defined also as an energy hub, will be an important competitive advantage in the future and concurrently satisfying the requests of the different port stakeholders.

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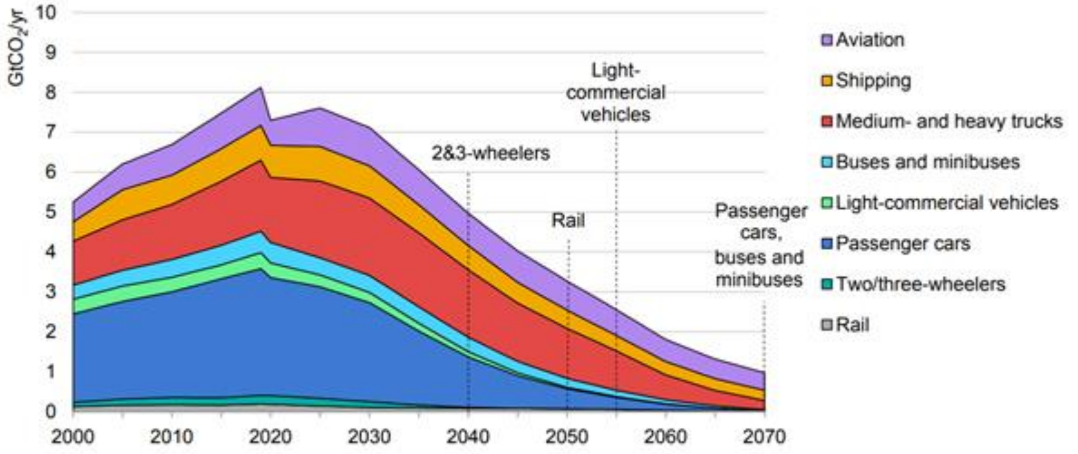
Introduction (2)

The UN International Maritime Organization predicts that maritime transport will reduce emissions of 250% by 2050. At the same time, the maritime industry, which today accounts for 3% of the world's total greenhouse gas emissions, needs to invest in order to be more sustainable, in fact transport accounts for around one-fifth of global carbon dioxide (CO_2) emissions from energy sources. **In order to do that there is a need to shift from fossil-fuel-powered vehicles to vehicles running on fossil-free fuels, like hydrogen or biofuels, or electricity produced by renewable sources like solar, wind and hydropower.**

GHG emissions forecast for mean of transport by IEA (2020).



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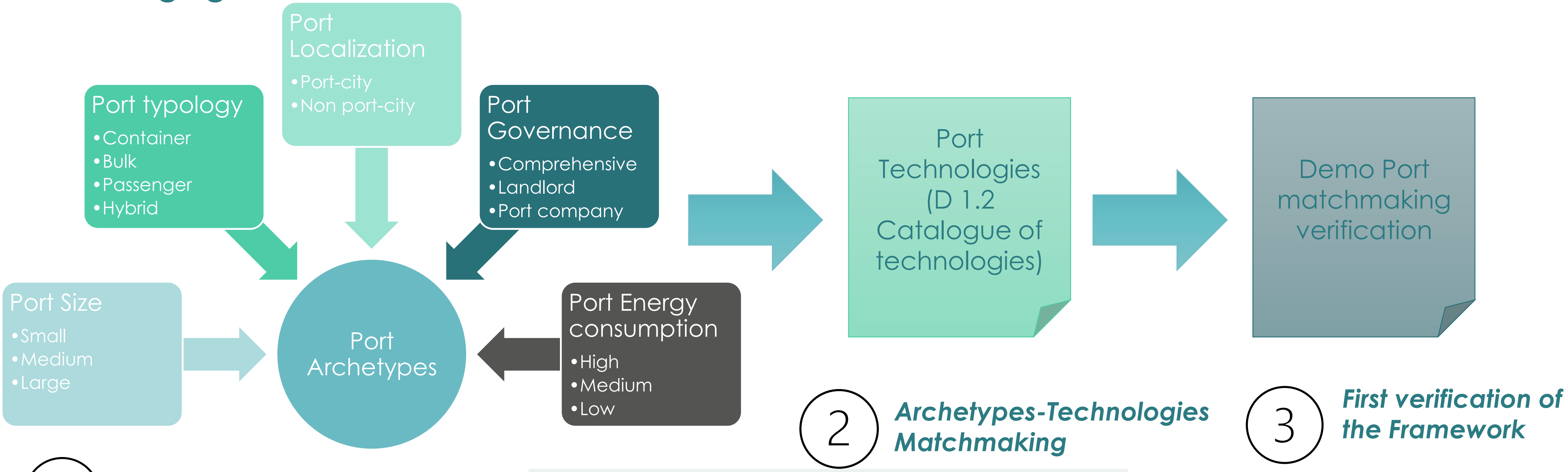
Methodology

What is a Port Archetype?

Port Archetypes refer to typical or distinctive features that are commonly found in the European ports.

The Methodology carried out to explain Subtask 1.4.2 is composed by 3 steps reported in the following figure.



1 *Port archetypes identification*

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1. EU Port archetypes identification

The first activity consists in the **identification** and the **selection of the EU port archetypes.**

Port Archetypes has been identified through different port characteristics and port sub-variables that characterize EU Ports in order to consider different variables following SEANERGY scope.

The port archetypes that has been identified for their matchmaking with Catalogue of Technologies are five:

- **A. Port Typology**
- **B. Port Localization**
- **C. Port Size**
- **D. Port Governance**
- **E. Port Energy consumption**

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A. Port Typology archetype (1)

Port Typology means the port specialization. In other words, it considers the kind of goods/services that are handled in the EU ports. In this archetype have been identified 4 main port typologies:

1. **Container port** (both Gateway and Transshipment port) – which is a port specifically designed to handle, storage and transfer containers. They are equipped with specialized cranes and other equipment as reach stackers and trucks in order to load, unload and storage containers
2. **Bulk port** - which is a port specialized in handling bulk cargo, such as raw materials like coal, ore, grains, and fertilizers. These materials are typically loaded and unloaded from ships in large quantities and stored in stockpiles before being transported to other destinations by truck, train, or ship. Bulk ports are equipped with specialized handling equipment, such as conveyor belts and stockpiling systems, to efficiently process large volumes of bulk cargo.

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A. Port Typology archetype (2)

3. **Passenger port** - a passenger port is a port designed to accommodate passengers and their belongings, typically as they embark or disembark from cruise ships, ferries, or other vessels. These ports typically include terminal buildings with waiting areas, baggage handling facilities, and customs and immigration facilities. They may also offer shopping, dining, and entertainment options for passengers.

4. **Hybrid port** - which is a port that handles different types of goods (for example both container and bulk cargo). These ports typically have different terminal and facilities in order to handle the different types of cargo, such as container terminals for containers and bulk handling equipment for bulk cargo and terminal buildings for passengers.

According to SEANERGY Project goals, the Port typology archetype does not consider other kind of port typologies as, for example, Marinas, fishing ports or military ports.

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B. Port Localization archetype

According to OECD (2013), regarding port physical localization, a distinction has been made between:

1. **Port-city** – This kind of port is situated in a coastal area inside an historical maritime city or metropolis as Genoa, Valencia or Rotterdam. These ports have various impacts on their cities, both positive and negative. Most of the positive impacts are related to economic benefits and employment. Main negative impacts include environmental, land use and traffic issues/adverse consequences inside an already densely populated area.
2. **Non port city** – This kind of port is usually located in a strategic area outside a city which allows the port to be connected to the mayor logistics infrastructure connections as Gioia Tauro or London commercial Port. The benefits of a Port outside a coastal city are different. In fact, this kind of port does not have space problems and it has generally more space than a port-city. Moreover, the social and environmental impact of this port in communities is less than a port-city (for instance, no traffic impact and less pollution inside the coastal city).

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C. Port Size archetype

This archetype considers the dimension of a port in terms of volumes of goods yearly handled. According to ESPO (2021) and European Union (2019), EU ports can be categorized in three sub-variables:

- ✓ **small ports;**
- ✓ **medium ports;**
- ✓ **large ports.**

The table shows the port size sub-variables for each port type.

Dimension	Commercial port	Passenger Port	Hybrid Port
Small	<10M Tons	<200k pax	All Port activities below Small benchmarks
Medium	10M Tons to 50M Tons	200k pax to 1M pax	At least one medium benchmark is reached by Port
Large	>50M Tons	>1M pax	All Port activities are above Large benchmarks

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D. Port Governance archetype

There are different models of EU Port governance which are based upon the respective responsibility of the public and private sectors in port management. According to Vezzoso (2015) the three main models of port governance in EU are:

1. **Comprehensive port** – which is a port managed by a public body responsible for the organization and control of all the activities that take place in the port, conceived as a public service and not as business activities. This model is usually used in Mediterranean ports.
2. **Landlord Port** – This model is characterized by the concentration of the managing body of the port on the tasks of development and planning of the territory, while traffic management is left to private companies.
3. **Port Company** – which are ports configured as companies. In fact, the Port Authority is directly responsible for the management of the port and the related services, as well as the investments necessary for the maintenance and development of the infrastructures.

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E. Port Energy consumption archetype

This archetype considers the energy consumption per year of an EU port in terms of annual total energy consumption in MWh as a sum of all port activities carried out inside the Port for all energy carriers. This distinction is important because of allows the Port Authority to understand the port efficiency and what policies and technologies it can apply inside the port. Following SEANERGY scope, inside the Port Energy consumption archetype has been identified three variables:

1. **High energy consumption –** means that the total annual energy consumption of the port is over 1.000.000 MWh per year
2. **Medium energy consumption –** means that the total annual energy consumption of the port is between 200.000 MWh and 1.000.000 MWh per year
3. **Low energy consumption –** means that the total annual energy consumption of the port is between 0 MWh and 200.000 MWh per year

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Demo Ports archetypes identification: **Valencia Port**

A.	Port Typology	Hybrid port
B.	Port Localization	Port city
C.	Port Size	Large port
D.	Port Governance	Comprehensive port
E.	Port Energy consumption	Medium energy consumption

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Demo Ports archetypes identification:
Syros Port

A.	Port Typology	Passenger port
B.	Port Localization	Port city
C.	Port Size	Small port
D.	Port Governance	Landlord port
E.	Port Energy consumption	Low Energy consumption

ΔΗΜΟΤΙΚΟ ΛΙΜΕΝΙΚΟ ΤΑΜΕΙΟ ΣΥΡΟΥ

SEANERGY

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Demo Ports archetypes identification:
Ennshafen Port

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A.	Port Typology	→	Hybrid Port
B.	Port Localization	→	Non-Port city
C.	Port Size	→	Small Port
D.	Port Governance	→	Landlord port
E.	Port Energy consumption	→	Low Energy consumption

ENNSHAFEN

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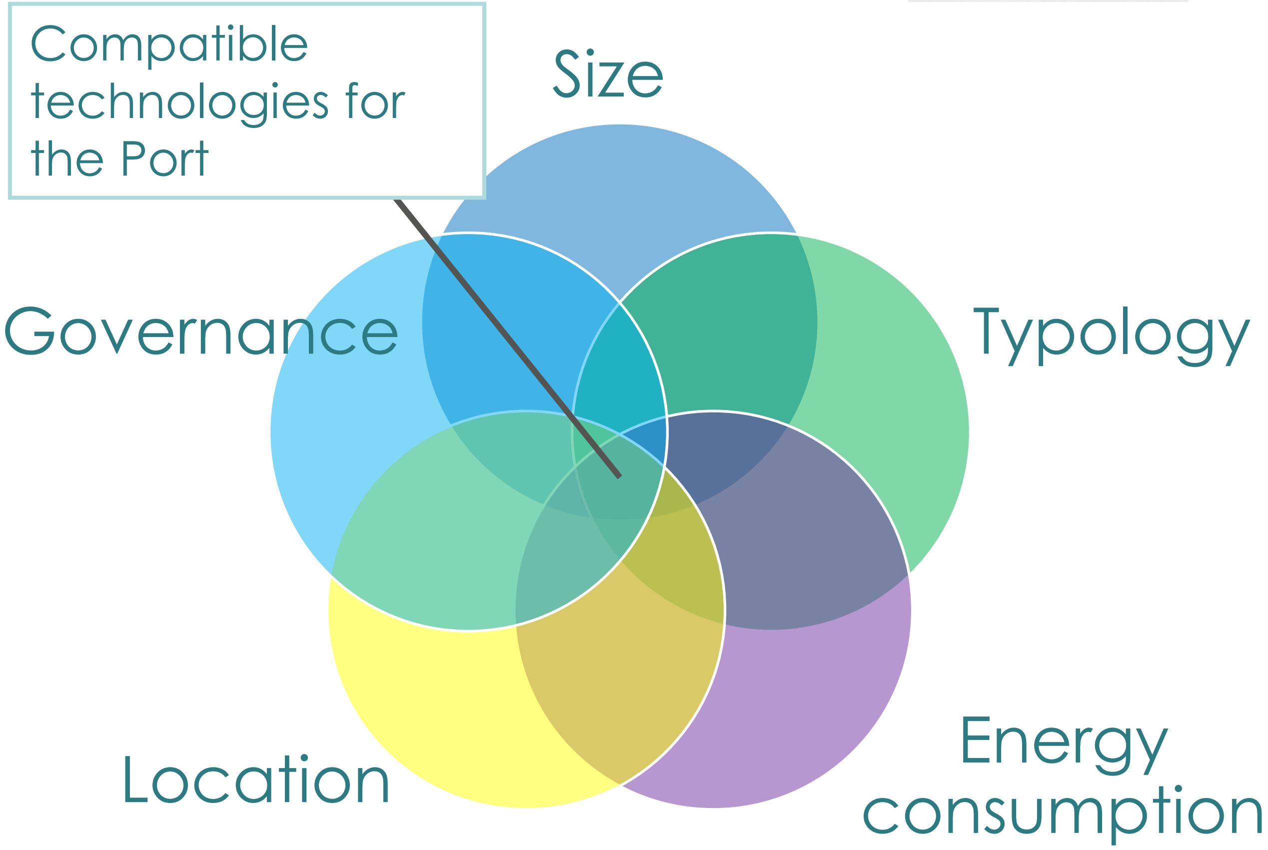
2. Port archetypes and technologies matchmaking

The second activity is the first matchmaking between the port archetypes identified in the previous activity with the technologies of the SEANERGY Catalogue of Technologies (D. 1.2).

For each archetype and its variables have been associated a list of technologies that can be applicable for the archetypes.

The interpolation between the different archetypes allows the identification of the compatible technologies and solutions for all EU ports with their main characteristics and peculiarity.



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3. Matchmaking Demo port first verification

The last activity consists in the first verification of the devolped framework that aims at connecting port Archetypes and the technologies for the sustainable energy generation and fuel alternative technologies for port decarbonization.

In order to carry out a first validation of the port archetypes and their matchmaking with the technological solutions, the process of port archetypes-technologies association will be applied to Project Demo Ports: Port of Valencia, Port of Syros and Port of Enns.

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THANK YOU
FOR YOUR ATTENTION

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ANNEX IV

Regional Customised Factsheets of Recommendations

PORTS TOWARDS DECARBONISATION

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The factsheets will provide essential information about each region and recommendations to foster port decarbonization, renewable energy development, and alternative fuel use, considering the social, financial, and technological aspects.

Customised factsheets of recommendations

East-Mediterranean Region

Bulgaria **Croatia** **Cyprus** **Greece** **Romania** **Slovenia**

RECOMMENDATIONS

- Regional Partnerships: Strengthen local/regional partnerships for shared renewable energy projects and create green corridors between islands and take advantage of economies of scale.
- Promote Regulatory Framework Adoption: Encourage regulatory support for developing distribution grid infrastructure to facilitate cold ironing and EV charging installations.
- Public Awareness Campaigns: Implement targeted campaigns to raise awareness about the benefits of renewable energy.
- Green Corridors Creation: Facilitate the creation of "green corridors" among islands to enable the development of alternative short-sea connections allowing the integration of electrified transportation.
- Environmentally Friendly Transport: Promote inland transport barges over road-based trucks to reduce carbon emissions.
- Citizen Engagement: Involve citizens in participatory planning processes for port decarbonization.
- Subsidies for Green Projects: Introduce subsidies for small green port projects with comprehensive greening strategies and action plans. Ensure alignment with port cities, authorities, and stakeholders for territorial coherence.
- Incentives for Shipping Companies: Offer incentives, such as tax reductions, for companies transitioning to cleaner energy sources. Financial and Technical

Legend : Social Financial Technical

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PORTS TOWARDS DECARBONISATION

SEANERGY

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Customised factsheets of recommendations

Inland Waterways - The Danube Region

Austria **Bulgaria** **Croatia** **Germany** **Hungary** **Romania** **Serbia** **Slovakia**

RECOMMENDATIONS

- Worker Support: Provide comprehensive assistance and retraining for workers during the transition to decarbonized practices.
- Collaborative Efforts: Foster collaboration between inland ports and share best practices in decarbonization.
- Alternative Fuels for Vessels: Boost inland navigation by adopting alternative fuels for various vessels.
- R&D Investment: Invest in research and development for e-fuels and hydrogen, collaborating with the private sector.
- OPS Infrastructure Enhancement: Prioritize efforts to enhance Onshore Power Supply (OPS) infrastructure and shift freight to eco-friendly waterways.
- Efficiency Improvement: Implement strategies to improve efficiency, including renewable energy in port infrastructure.
- Enhancement of financial support: Invest for upgrading of infrastructure of the inland ports in the direction of decarbonisation.
- Intelligent Traffic Management: Explore traffic management systems to minimize congestion and enhance energy efficiency.

Legend : Social Financial Technical

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PORTS TOWARDS DECARBONISATION

The factsheets will provide essential information about each region and recommendations to foster port decarbonization, renewable energy development, and alternative fuel use, considering the social, financial, and technological aspects.

Customised factsheets of recommendations

West-Mediterranean Region

France **Italy** **Luxembourg** **Malta** **Portugal** **Spain** **Switzerland**

RECOMMENDATIONS

- Energy Diversification Programs: Support energy source diversification with innovation and efficiency programs, offering non-repayable grants. Financial and Technical
- Mitigation of Investment Risks: Create internal markets to mitigate risks in emerging technologies, such as establishing energy tariffs. Financial and Technical
- Alignment with Environmental Commitments: Align strategies with environmental commitments and adopt decarbonization technologies. Social and Technical
- Cooperation and Training: Promote cooperation between port authorities and research centers, focusing on training for decarbonization. Social and Technical
- Green Logistics Innovations: Embrace innovations in green logistics and invest in eco-friendly maritime logistics. Social and Technical
- Digitalization and Big Data: Integrate digitalization and big data for enhanced energy management and optimized operations. Social and Technical

Legend : Social Financial Technical

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PORTS TOWARDS DECARBONISATION

The factsheets will provide essential information about each region and recommendations to foster port decarbonization, renewable energy development, and alternative fuel use, considering the social, financial, and technological aspects.

Customised factsheets of recommendations

North Atlantic and Baltic Region

Belgium, Denmark, Estonia, Netherlands, Finland, France, Germany

Iceland, Ireland, Latvia, Lithuania, Norway, Poland, Sweden, UK

RECOMMENDATIONS

- Renewable Energy Utilization: Harness wind and hydropower resources for renewable energy production in port operations.
- Sustainable R&D Investments: Encourage research and development for sustainable marine resource utilization.
- Collaborative Sustainability Programs: Increase collaboration and partnerships among ports through sustainability training programs
- Stakeholder Engagement: Recognize social image as a driver for decarbonization and leverage public relations for energy transition.
- Community and Business Model Localization: Implement proactive management models and adapt business models to regional needs.
- Innovative Business Models: Explore business models like offshore electricity production for port efficiency and sustainable transformation.

Legend : Social Financial Technical

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