

T2.2.1 - Report on study visits

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List of Abbreviation

EMAS	Eco-Management and Audit Scheme
EMS	Environmental Management System
GIS	Geographic Information System
ISO	International Organization for Standardization
PERS	Port Environmental Review System
EU	European Union
OPS	On-shore Power Supply
S	Secondary
P	Primary
PPs	Project Partners
LNG	Liquefied Natural Gas
LBG	Liquefied Bio Gas
VPA	Venice Port Authority
ThPA	Thessaloniki Port Authority
PPA	Piraeus Port Authority
TPA	Trieste Port Authority
DPA	Durres Port Authority
BAR	Port of Bar
LUKA KOPER	Port of LUKA KOPER
CERTH	Centre for Research of Technology Hellas
VTS	Vessel Traffic Service
STM	Sea Traffic Management
SSS	Short Sea Shipping
TEN-T	Trans-European Transport Network
GHG	Greenhouse Gas emissions

1. Methodology for identifying and selecting ‘best practice’ ports

1.1 Definition of ‘best-practice’ ports

Various definitions have been introduced and used over time within multiple sectors, business environments and contexts for defining a certain policy or intervention to be a ‘best practice’. A thorough review of such definitions enabled to assess common features and come-up with the following widely accepted definition of a best practice: *“a policy or intervention which has been implemented in a real-life setting and has demonstrated evidence of high effectiveness and efficiency, compared to other alternatives, with regard to processes and outcomes, thus also presents increased likelihood to be successfully replicated in another setting”*.

For identifying a best practice and distinguishing it from an emerging, promising or leading one, certain criteria are often applied focusing mainly on its impact and quality of evidence. As presented in Figure 1, a best practice is being characterized by: high effectiveness and efficiency, wide reach, full compliance with existing standards and regulations at different levels, proven value considering implementation and operation costs vis-a-vis quantified financial benefits, long period of operation and increased level of integration with the relevant context.

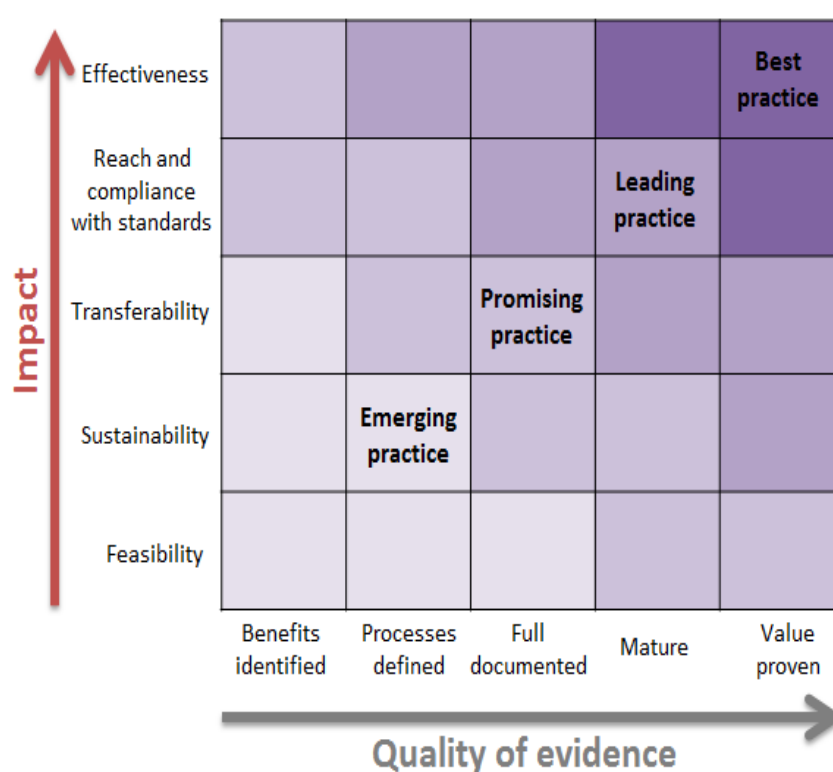


Figure 1 - Criteria for the best practice identification and assessment

The aforementioned principles were efficiently adapted to the SUPAIR context. Following a structured methodological approach the next step entailed the definition of a set of criteria that were used to assess the selection of candidate ‘best practice’ ports and identify the two ports to be visited. The nine criteria identified in total are being presented in Table 1 below.

Best practice principle	Adaptation to the SUPAIR context	Criteria
High effectiveness and efficiency	<ul style="list-style-type: none"> ▪ Demonstrated evidence of increased port environmental and energy performance considering port profile, role, functions and local conditions 	<ul style="list-style-type: none"> ▪ Continuous improvement of port environmental and energy performance ▪ Port hierarchy at European Union (EU) level
Wide reach	<ul style="list-style-type: none"> ▪ Diversity of implemented measures / solutions ▪ Consensus reached between port community stakeholders ▪ Wide recognition of improved performance (e.g. increased media exposure, invitations to share implementation experiences, offers to provide guidance) 	<ul style="list-style-type: none"> ▪ Coverage of intervention areas addressed in SUPAIR ▪ Stakeholder cooperation and consensus building (acceptability level) ▪ Knowledge sharing experiences
Compliance with existing standards and regulations	<ul style="list-style-type: none"> ▪ Compliance with port environmental and energy standards (e.g. Port Environmental Review System - PERS, Eco-Management and Audit Scheme - EMAS, International Organization for Standardization - ISO 14001 standard, ISO 50001 standard) 	<ul style="list-style-type: none"> ▪ Certification
Proven value	<ul style="list-style-type: none"> ▪ Comparison of implementation costs with energy and environmental cost savings 	<ul style="list-style-type: none"> ▪ Positive net financial benefits
Long period of operation (maturity)	<ul style="list-style-type: none"> ▪ Time horizon for measures / solutions implemented in the port area to demonstrate actual and consistent benefits 	<ul style="list-style-type: none"> ▪ Minimum five-year period of operation
Increased level of integration with the local context	<ul style="list-style-type: none"> ▪ Alignment with local and/or regional planning instruments 	<ul style="list-style-type: none"> ▪ Consideration of local and/or regional planning instruments in the development of low-carbon action plans

Table 1 – ‘Best practice’ criteria adapted in the SUPAIR project context

1.2 ‘Best practice’ port identification criteria

Each of the aforementioned criteria is described in more detail below facilitating, as a next step, the shortlisting of four candidate ports based on an extended review of relevant information that was freely available online. For this process, the criteria were distinguished to **primary** (P), those that candidate ports had to fulfil or otherwise they were excluded, and **secondary** ones (S) that provided a higher priority to the ports that address them. Following the presentation of the selected criteria during the 2nd project meeting and the provision of any necessary clarifications, an excel-based tool was then set-up and sent to all project partners (PPs) for making the aforementioned distinction thus weighting the secondary criteria using a 1-5 scale (1-low priority, 5-high priority) (Figure 2).

Criteria Selection

Primary

1. Continuous improvement of port environmental and energy performance
2. Port hierarchy / Category
3. Coverage of intervention areas
4. Certification
5. Minimum 5 years of operation

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Secondary

6. Positive net financial benefits
7. Knowledge sharing experiences
8. Stakeholder engagement and consensus building
9. Consideration of planning instruments in the development of action plans

Brief Instruction:

For the selected **SECONDARY** criteria the range of importance needs to be determined from 1 to 5, where 1 = unimportant & 5 = very important.
For all the **PRIMARY** criteria you selected please set the value to 0 as there is no need to determine their importance.

Value measurement

Criterion No 1

☒ 0
☐ 1
☐ 2
☐ 3
☐ 4
☐ 5

Criterion No 4

☐ 0
☐ 1
☐ 2
☐ 3
☐ 4
☐ 5

Criterion No 7

☒ 0
☐ 1
☐ 2
☐ 3
☐ 4
☐ 5

Criterion No 2

☒ 0
☐ 1
☐ 2
☐ 3
☐ 4
☐ 5

Criterion No 5

☐ 0
☐ 1
☐ 2
☐ 3
☐ 4
☐ 5

Criterion No 8

☒ 0
☐ 1
☐ 2
☐ 3
☐ 4
☐ 5

Criterion No 3

☒ 0
☐ 1
☐ 2
☐ 3
☐ 4
☐ 5

Criterion No 6

☐ 0
☐ 1
☐ 2
☐ 3
☐ 4
☐ 5

Criterion No 9

☒ 0
☐ 1
☐ 2
☐ 3
☐ 4
☐ 5

Figure 2 – Excel based tool for criteria categorization and weighting

An excel-file was distributed to the project partners containing a first classification of the nine criteria into the two categories (primary & secondary) based on the views of the leading partner of this activity, CERTH/HIT. Following the incorporated instructions, project partners were then asked to provide feedback and a weight (1-5) for each of the criteria they selected as secondary. The results of this process are being depicted in Table 2 below. It should be mentioned that for two criteria (i.e. stakeholder cooperation and minimum 5 years of operation) the views of project partners were equally divided between the two categories. For the final categorization of these criteria, the views of the port authorities participating in the project received a greater value than that of the technical partners, since the study visits are mainly designed for them in order to assist them in the successful development of their own low-carbon action plans.

Selection of criteria

No.	Criteria description	Selected as primary - P (out of 10)	Selected as secondary - S (out of 10)	Final selection
1.	Continuous improvement of environmental and energy performance	10	0	P
2.	Port hierarchy at EU level	7	3	P
3.	Coverage of intervention areas addressed in SUPAIR	9	1	P
4.	Certification	9	1	P

5.	Minimum five-year period of operation	5	5	S
6.	Positive net financial benefits	2	8	S
7.	Knowledge sharing experiences	0	10	S
8.	Stakeholder cooperation and consensus building	5	5	S
9.	Consideration of local and/or regional planning instruments in the development of low-carbon action plans	2	8	S

Table 2 – Criteria categorization into primary and secondary

According to their weighting, the secondary criteria were prioritized (Figure 3). Using the excel-based tool, project partners weighted the secondary criteria on a scale of 1 to 5 considering their added-value with regard to the development of their action plans. For the criteria listed as secondary but evaluated by some partners as primary and thus not scored, a score of 5 was assumed so as to cater for the relative importance provided. As depicted in Figure 3, criteria 9 and 8 were evaluated as the most important respectively with the remaining criteria receiving an equal score. As a result, candidate ‘best practice’ ports that meet the highly ranked criteria will receive a better ranking than the ones that meet secondary criteria with a lower priority. The same procedure followed for the rest of the secondary criteria. To this end, candidate ‘best practice’ ports that meet the highly ranked criteria will receive a better score than the ones that meet criteria with a lower priority.

Weighting of secondary criteria

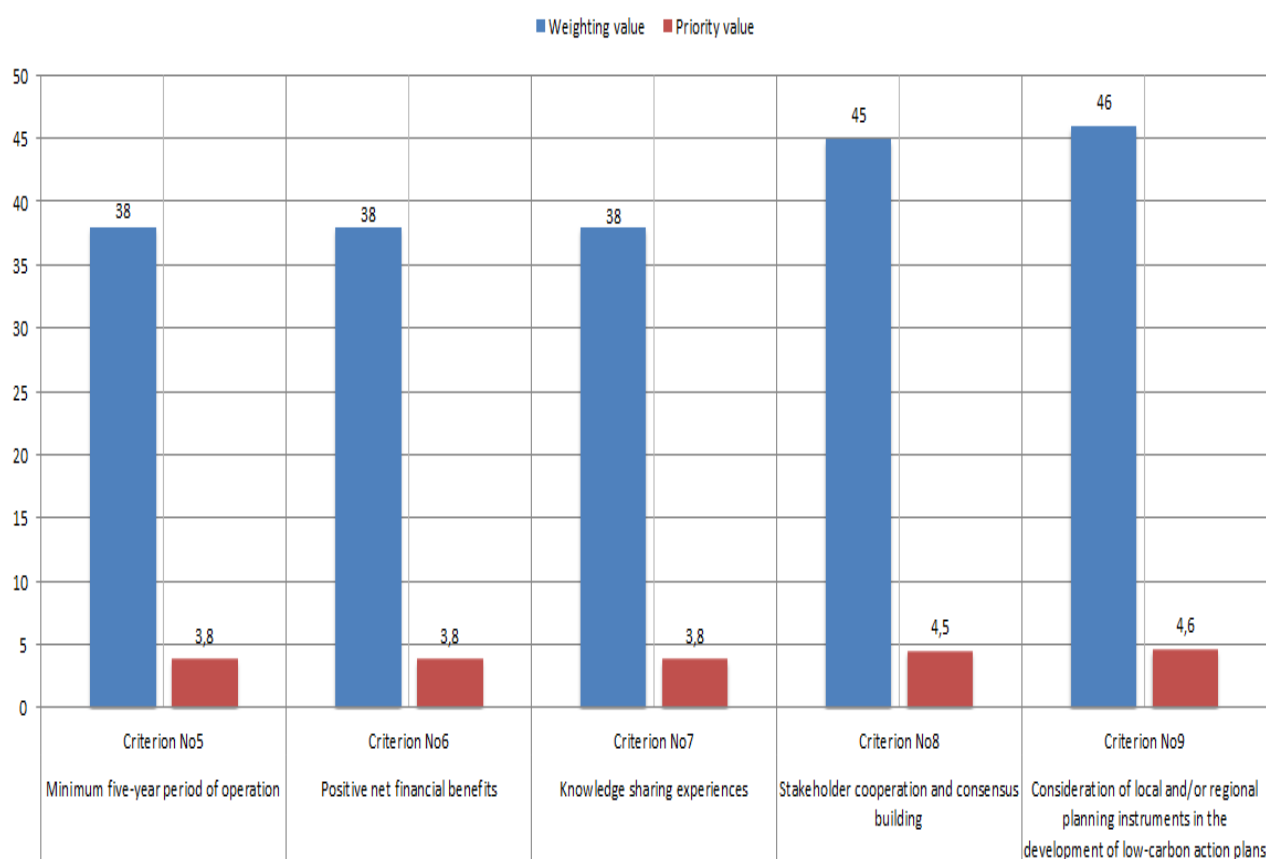


Figure 3 – Weighting of secondary criteria

1.2.1 Primary criteria description

Continuous improvement of port environmental and energy performance

‘Best practice’ candidate ports should demonstrate significant, over time, and continuous improvement of their environmental and energy performance, leading in that way the progress towards port sustainability. At European level, the EcoPorts network, fully integrated in the European Sea Ports Organization (ESPO) since 2011, provides to its port members (94 in total) appropriate tools to assess their environmental and energy performance, and compares it with the European benchmark for identifying performance gaps and areas for improvement. The EcoPorts network has created in this way a level playing field on port environmental and energy performance, with participating ports expressing their commitment to share their environmental data and experiences thus getting in return a wide recognition of their continuous efforts towards port sustainability. The founding principle of the EcoPorts network such as port cooperation and knowledge sharing on environmental and energy issues, proves therefore to be fully in line with the scope of the study visits that are to be performed within the framework of the SUPAIR project, and to this end it is proposed that candidate ports to be selected must be members of the network.

Port hierarchy / category at EU level

In 1992, the European Commission introduced the Trans-European Transport Network (TEN-T) with the aim to ensure the accessibility and connectivity of all EU regions, which features a dual layer structure, comprising of a comprehensive and a core network. As the multi-modal basic layer of the TEN-T, the comprehensive network includes components of all transport modes and their connecting points and corresponding traffic information and management systems. The core network is a subset of the comprehensive network, overlaying it to present the strategically most important nodes and links of TEN-T.

With regard to seaports, based on a volume threshold as well as other criteria that have been set, out of the total 329 ports that comprise the comprehensive network, 104 ports are being acknowledged as of strategic importance and thus constitute the core port network. All five SUPAIR ports that are located in three of the four EU Member States participating in the ADRIAN Programme (i.e. Italy, Greece and Slovenia) are part of the TEN-T core network, while the remaining two (i.e. port of Durres in Albania and port of Bar in Montenegro) comply with all the prerequisite conditions to be included in the core network should the joining process of those countries in the EU is concluded.

This strategic role and the combined or separate impact those ports can generate at EU and local level respectively is of great importance and relevant to the SUPAIR context. Thus, focus will be placed on the TEN-T core network ports for selecting the two to be visited.

Certification

This criterion goes fully in line with the aforementioned continuous improvement. For supporting the improvement of their environmental and energy performance, almost all port members of the EcoPorts network have set-up appropriate and certified Environmental Management Systems (EMS) and processes. The relevant standards include: (a) the Port Environmental Review System (PERS), (b) the ISO 14001 standard, and (c) the Eco-Management and Audit Scheme (EMAS). Candidate ‘best-practice’ ports should

have been certified with any of the aforementioned standards while ports with more than one certificate will have a higher ranking on the preference list.

Coverage of the intervention areas addressed in the SUPAIR ports' action plans

The intervention areas where the seven SUPAIR ports will be focusing for developing their low-carbon action plans are being efficiently synthesized and summarized in the following table (Table 3). Candidate 'best-practice' ports that have implemented targeted actions for addressing most or even more (if possible) of these areas will receive a higher preference during the shortlisting and ranking process.

Intervention areas	SUPAIR Ports
Environmental and energy management, measuring and monitoring	6 ports
▪ Set-up of environmental and energy management plans	Trieste, Piraeus, Thessaloniki
▪ Pollution measurement (air emissions, noise, water quality)	Piraeus, Koper
▪ Enlightenment of port area	Venice, Bar
Infrastructure and equipment modernization	4 ports
▪ Modernization of terminal infrastructure and equipment	Bar, Durres
▪ On-shore power installation	Trieste, Bar
Landside access and connectivity	3 ports
▪ Traffic management	Venice, Thessaloniki
▪ Improved connection with port-city	Durres

Table 3 - Intervention areas of SUPAIR ports' low-carbon action plans

1.2.2 Secondary criteria description

Knowledge sharing experiences

The 'best practice' ports in order to be selected and to be able to offer a good study visit experience for the participants will need to demonstrate specific characteristics such as. Specifically, they should demonstrate the ability to share knowledge and experience regarding the initiatives that they have undertaken for improving their environmental and energy performance while also being able to provide details, critical issues, problems they might have encountered, solutions given and lessons learnt. The demonstration of such efforts is also of significant importance for building a sustainable business profile that largely shapes competitiveness in today's business environment, and thus supports continuous growth and further development.

The sharing of relevant information online (e.g. sustainability reports, new projects planned, etc.) or via media including social ones, as well as the participation in targeted seminars, public events and discussions, collaborative research projects etc. are of real-added value and can assist interested followers to learn as much as possible from a best practice case and exploit a study visit to the best possible extent. Moreover, a more structured approach that some ports have undertaken, such as the establishment of training organizations/centres (i.e. Escola Europea at Port of Barcelona), is particularly appropriate for facilitating a wider knowledge sharing and the development of capacity building activities.

Consideration of planning instruments in the development of the action plans

In several cases within the European context, and especially in the Mediterranean region, ports have been developed in very close proximity to urban regions. As a result an intricate relationship exists between ports and cities since the respective impacts cannot be confined at each end but rather affect each other. Therefore, port authorities (and respectively local authorities at the other end) when setting their green policy and devising their sustainability planning, should carefully consider any relevant planning instruments established at the local or regional level (e.g. SUMPs, SULPs, etc.) since the effective alignment of the two can generate a substantial combined impact thus significantly exceeding the individual impact that isolated planning can generate, which in several cases can be considerably fragmented by contradictory measures. To this end, the effective communication and careful consideration of planning instruments at both ends was considered as an important criterion for the port authorities to participate in the study visits presenting an increased interest to learn of the strategies and means candidate 'best practice' ports have employed for establishing such efficient communication channels.

Positive net financial benefit

Ports development depends on the demand/supply principle with core objective being the financial revenues but also the social value generated from port activities. However, ports nowadays, given also their rapid growth, generate substantial environmental impacts which they need to efficiently tackle in order to sustain their development and competitiveness in today's business environment. Therefore, ports are facing the challenge of striking an optimum balance between socioeconomic benefits and a "greener" development of their activities. To this end, given each port characteristics and targets that have been set, it's of utmost importance that ports select appropriate sustainability measures that generate the expected environmental benefits that ensure reasonable returns of investments so that the aforementioned balance can be properly sustained. Access to such data is often unavailable publicly so the payback period was mostly taken into consideration with regard to certain intervention areas addressed by the SUPAIR ports' action plans.

Stakeholder cooperation and consensus building (acceptability level)

Besides local authorities mentioned above, in respect to the alignment with their planning instruments, there are several other port community stakeholders undertaking an important role in improving port environmental and energy performance. To this end, and in order to successfully achieve the targets set in green port policies, stakeholder cooperation and consensus building proves to be an important prerequisite that can ensure the successful implementation and operation of commonly agreed actions generating substantial benefits for a variety of different stakeholders. Therefore, it is important for the SUPAIR partners participating in the study visits to learn about the approaches candidate 'best practice' ports have followed for ensuring extended stakeholder participation, community engagement and consensus building regarding the sustainability measures that have been implemented.

Minimum five-year period of operation

In order for a measure/solution to reveal its true impact that will retain an acceptable level of consistency over time, a certain period of time is required following its pilot and full-scale testing. The measures/solutions under investigation should demonstrate the expected results when a certain level of maturity has been reached, within which problems and inconsistencies have been recognised and tackled

properly and more realistic long term targets can be set. A period of 5 years of operations is being generally regarded as sufficient for a certain measure/solution reaching the aforementioned maturity level.

1.3 Shortlisting and brief overview of final four ‘best practice’ candidate ports

For shortlisting the candidate ‘best practice’ ports across the European context, the primary criteria were applied first. When combining criterion 1 (EcoPorts network - 94 ports) with criterion 2 (TEN-T core network ports – 104 ports) and certification (at least one certificate), a final list of **36 candidate ‘best practice’ ports** can be generated (Table 4). The latter were then reviewed in more detail (public information) for identifying which intervention areas they have addressed over the past, narrowing down the list to 10 candidate best practice ports as depicted in the following table.

No	TEN-T core ports & Ecoports members		Environmental and energy management, measuring, monitoring			Modernization of infrastructure and equipment		Landside access and connectivity		Environmental certificates
	Country	Candidate ports	Management plans and systems	Pollution measurement	Lighting systems	Green upgrade of terminal infrastructure & equipment	OPS installations	Traffic Management	Port-city connections	
1	DK	Copenhagen	X		X	X				ISO
2	DE	Bremen-Bremerhaven	X		X	X			X	PERS
3	DE	Wilhelmshaven	X			X	X		X	PERS
4	EST	Tallinn	X	X		X		X		ISO
5	IRL	Cork	X	X	X	X				ISO
6	IRL	Dublin	X	X	X	X				PERS & ISO
7	IRL	Limerick / Shannon	X		X				X	PERS
8	GR	Ilgoumenitsa	X	X			X			PERS, ISO & EMAS
9	ESP	A Coruna	X	X					X	EMAS
10	ESP	Algeciras	X						X	PERS & ISO
11	ESP	Barcelona	X	X		X			X	PERS, ISO & EMAS
12	ESP	Cartagena	X							PERS, ISO & EMAS
13	ESP	Huelva	X	X					X	PERS
14	ESP	Valencia	X	X						ISO & EMAS
15	FR	Calais	X	X	X			X	X	PERS
16	FR	Dunkerque	X			X				PERS
17	FR	Le Havre	X						X	PERS
18	FR	Nantes Saint-Nazaire	X			X				PERS & ISO
19	FR	Rouen	X						X	ISO
20	CRO	Rijeka	X	X				X	X	ISO
21	IT	Genova	X		X				X	ISO
22	LAT	Riga	X	X					X	ISO
23	LIT	Klaipeda	X			X			X	ISO
24	NL	Moerdijk	X		X					PERS
25	NL	Rotterdam	X	X	X	X	X	X	X	PERS
26	PT	Sines	X							ISO
27	RO	Constanta	X			X			X	ISO
28	FI	Helsinki	X	X						ISO
29	FI	Turku	X						X	ISO
30	SE	Goteborg	X	X		X	X		X	ISO
31	SE	Malmo	X		X	X				ISO
32	SE	Stockholm	X			X	X			ISO
33	SE	Trelleborg	X	X		X	X			ISO
34	UK	Felixstowe	X	X		X			X	ISO
35	UK	Harwich	X					X	X	ISO
36	UK	London	X			X				ISO

Table 4 - Thirty six (36) potential study visit port and their coverability level

The selection of the final 4 (2 main and 2 alternatives) ‘best practice’ ports occur through the combination of the above described primary criteria investigation (if a port does not fulfil them, it is automatically excluded from the research) and the level of coverability of the secondary criteria in each of the 10 candidate ‘best practice’ ports.

After an extended overview of the 10 candidate ports, judging by the relevant priority values of the secondary criteria provided by the project partners selection and weighting procedure, the ports that meet the highly ranked criteria present greater potential to become study visit ports rather than the ones that meet criteria with a lower priority, thus, identifying the final four ‘best practice’ ports with the highest potential to be visited.

1.3.1 Potential study visits ports

From the potential thirty six ports investigated, the four ports with the highest potentials were included in this assessment with the aim to decide which two will eventually be the study visit ports. The ports presenting the highest potentials, to the SUPAIR program context, can be seen in green color in **Error! Reference source not found..** These ports are Port of Rotterdam, Port of Barcelona and Port of Gothenburg. Additionally, the seven follow up ports with high potential to become study visits ports can be seen in the same table (Table 4), in orange.

1.3.2 Port of Rotterdam

From the shortlisting of the candidate ‘best practice’ ports, Port of Rotterdam was considered to be the port with the highest potential for a study visit. Port of Rotterdam owns environmental certification (PERS), it is a core TEN-T port as well as a member of the EcoPorts society. In the intervention areas related to the SUPAIR context, the Port of Rotterdam presents increased environmental and energy performance, mature monitoring system, modernization of the machinery equipment with ‘greener’ technology , OPS technology installation as well as one of the Europe’s best traffic managements systems which provides intermodal connectivity between the port and the city.

Port of Rotterdam provides high range of knowledge and experiences to be shared through a variety of promoting actions (e.g. STC International, World Port Days, etc.), involving actively strategic partners from local level (e.g. Municipality of Rotterdam) in the sustainable development strategy of the port (Port Vision 2030) thus creating favourable conditions for the secure and stable growth not only for the port but for the city as well. Additionally, Port of Rotterdam attracts and facilitates local and international companies related to maritime activities (e.g. BP, ExxonMobil etc.), strengthening the engagement of international companies with the port and its sustainable development. The benefits of the implemented low-carbon strategy Port of Rotterdam has chosen to follow, creates an actual and consistent benefit for the port (increased revenues +4.6% in 2017) as well as for the local community (the port employs 1,100 people).

Although, the Port of Rotterdam was selected as the first study visit port, it could not host the SUPAIR project partners due to increased demand in that season.

1.3.3 Port of Barcelona

Port of Barcelona has been selected as the second study visit port due to its high level of environmental activity. Port of Barcelona was considered due to being fully certified from an environmental and quality perspective since it has already obtained EMAS, ISO and PERS certificates. It is a core TEN-T port and a member of the EcoPorts society. It has presented increased development and investment intentions in the

intervention areas related to the SUPAIR context. Specifically, it was shortlisted due to the promotion and usage of alternative fuels, sharp reduction of CO₂ emission as well as its shift towards a more sustainable transport system (using Short Sea Shipping (SSS) and rail combination), making it capable to share useful know-how and experiences with the consortium's Port Authorities.

The Port of Barcelona has an increased knowledge sharing activity, not only with the sharing of information publically (e.g. social media, website etc.) and the organization of targeted events (e.g. boat tours) but mainly through the official establishment of Escola Europea- Intermodal transport; a mean for training and experience sharing.

The Port of Barcelona and the city of Barcelona interact and cooperate in a daily basis. Leisure and business areas (e.g. Port Vell) located in the Port of Barcelona premises to benefit (economically and socially) the local community, building a stable consensus between the port activities and the citizens. Moreover, Port of Barcelona share multiple cooperative projects (e.g. wastewater treatment, Carbon Neutral Port) with the city of Barcelona, increasing the level of integration of the port's developing plans with the local community's. Port of Barcelona stakeholders' participation in the development of a 'greener' port is strengthened by the direct involvement of a high caliber player of the maritime industry (e.g. Hutschison BEST) in the operational activities of the port. The establishment of such partnerships also attracts high investments in the port (e.g. semi-automated terminals, cruise terminals etc.) thus generating financial and social benefits for the port and the city as well.

Port of Barcelona shows positive financial benefits with +7% increase in the total net turnover in 2017, serving nearly 3 million TEU, representing a +32.3% increase in the port's traffic in 2017 as at the same time it has set a highly optimistic target to become a Carbon Neutral port by 2025-30.

Port of Barcelona was visited by project representatives on 18th December 2018. Further details regarding the visit are provided in later sections of the report.

1.3.4 Port of Gothenburg

Port of Gothenburg was considered as the first alternative study visit port based on the criteria selection from the consortium partners. Same as all the previously selected ports, it is a member of the EcoPorts society, a core TEN-T port as well as it holds ISO certification. Focusing in the intervention areas identified by the SUPAIR context, it presents increased development mainly in the area of sustainable intermodal transportation (ship to rail), alternative fuels promotion and usage as well as in the environmental and biodiversity conservation.

The Port of Gothenburg presents a highly extroverted profile regarding not only the sustainable development of the port but port/city activities as well. It is highly active in the media (including social), willing to host any interested entities (e.g. guided boat trips, schools, SUPAIR representatives etc.) and share useful knowledge and information regarding the operation, development and the future vision of the port. Port of Gothenburg is a part of the city of Gothenburg that develops, maintains and promotes the port in its entirety hence ensuring close collaboration and the simultaneously development both of the port and the city. From 2015, Gothenburg Port Authority is a climate-neutral company by investing heavily on renewable energy and other environmental measures such as solar panels, biogas and district heating which pushed the emissions to be reduced to a minimum. At the same time, Port of Gothenburg is constantly growing while during 2018, container and rail traffic showed an increasing trend.

There is also increased level of maturity in specific operations and systems at Port of Gothenburg, related to the SUPAIR context (e.g. 'cold-ironing' technology used since early 2000) thus establishing the Port as a 'good example' of experience and knowhow in this specific field of action.

Port of Gothenburg was at first an alternative study visit port, but due to inability of Port of Rotterdam to host the project consortium it was selected as a main study visit port. The consortium visited Gothenburg, Sweden on 28th November 2018. A detailed summary of the study visit at Port of Gothenburg is presented in the next chapter of the report.

1.3.5 Port of Bremen-Bremerhaven

Port of Bremen-Bremerhaven was selected to be the final candidate study visit port, based on the criteria selection from the consortium. Bremen –Bremerhaven had already obtained a PERS certification, it is a member of EcoPorts society and a core TEN-T port. Regarding the intervention areas of the SUPAIR project, it presents an active environmental profile focusing on biodiversity conservation (flora and fauna), environmental friendly transportation (inland shipping) and ‘green’ modernization of the operation of the port (e.g. dredging).

Port of Bremen-Bremerhaven has an active participation in the media and shares information publicly regarding its environmental performance. Bremen ports efficiently communicate and interact with the local and international stakeholders in a number of cooperation networks both on national and international scale. At a national level, partnerships are mainly related to the environmental measures (e.g. ecologic compensation) and exist in close collaboration with various natural and environment protection associations (e.g. Wissenschaftliche Beratung for Naturschutz and Landschaftsplanung - WBNL). To that end, the environment experts of the port maintain close communication with partners in local and international level for the evaluation of the impact on the environment and the development plans that the port may have. In a global level, Port of Bremen-Bremerhaven is a part, among others, of associations dealing with environmental and climate issues (e.g. PIANC). In that way the port establishes strategic cooperation which raises mutual trust with the local and international community.

From an environmental perspective, the Port of Bremen-Bremerhaven showed massive reduction in their emission cutting efforts (70% since 2011), due to a structured strategy that involves a variety of different initiatives, but mainly due to the consequent purchase of renewable electricity. This demonstrates evidence that the port was highly capable to efficiently covering the intervention areas identified by the SUPAIR project.

Following an environmental friendly strategy Port of Bremen-Bremerhaven business is flourishing and that is depicted in the increase traffic at the port.

2. Summary of study visit to the Port of Gothenburg

Port of Gothenburg was selected by the PPs of SUPAIR project, as one of the two best practice ports in EU, as previously described. Within the context of Activity T2.2 – “Study visits to best practice port cities” included in the Second Technical Work Package WPT2 –“Accruing knowledge and sharing results: capacity building and mutual learning”. CERTH, who is the leader of this activity, coordinated and organized the visit to the Port of Gothenburg after getting in touch with the Port’s Authority representatives and specifically Mr. Edvard Molitor who is the port’s Senior Environmental Manager. Representatives of the consortium visited the Port of Gothenburg on the 28th of November 2018 in order to gain knowledge about the solutions adopted by the hosting port authority. In the one day visit that took place, representatives of port authorities had the opportunity to take a boat tour inside the premises of Port of Gothenburg, learn about the sustainability strategy and environmental initiatives developed and implemented on the port, as well as

gain useful knowledge of the problems, obstacles and available solutions that would potentially occur during the organization, development and implementation of their own respective action plans.

2.1 Organization, agenda and brief description of activities

In the first study visit 5 PPs participated, (4 port authorities and a technical partner). A total of 10 representatives from different project partners participated:

- Port of Piraeus (GR) - Mr. Dimitris Spyrou and Ms. Chrysanthi Kontogiorgi
- Port of Thessaloniki (GR) - Mr. Panagiotis Theodosiou
- Port of Koper (SI) – Mr. Roberto Richter and Mr. Boštjan Pavlič
- Port of Venice (IT) - Mr. Andrea Bucella, Ms. Federica Barison and Ms. Marina Minardi
- CERTH / HIT (GR) - Mr. Nikos Anastasiadis and Mr. Alkiviadis Tromaras



Figure 4 - SUPAIR project partners and study visit participants at Port of Gothenburg



Figure 5 - Host Edvard Molitor -Senior Environmental Manager

Table 5 presents the study visit agenda.

TIME	PLACE	ACTIVITY
9:45 - 10:00	Emigrantvägen 2B, Amerikaskjulet building	Meeting at port premises
10:00 - 11:30	Emigrantvägen 2B, Amerikaskjulet building	Presentation of the Port of Gothenburg, with emphasis on sustainability work
11:30 - 13:00	Port of Gothenburg premises	Boat tour of the port with lunch provided onboard
13:00 - 14:30	Port of Gothenburg premises	Presentation of Harbour Masters Office and visit to Port Control (TBC)
14:30 - 15:00	Emigrantvägen 2B, Amerikaskjulet building	Remaining questions and closing

Table 5 – Port of Gothenburg agenda

As the agenda indicates the study visit consisted of 3 parts:

1. An introductory presentation of the Port of Gothenburg with emphasis on sustainable development and ecology initiatives by Mr. Edvard Molitor- Senior Environmental Manager;
2. Boat tour around the Port premises by Mr. Edvard Molitor-Senior Environmental Manager;
3. Presentation about the Sea Traffic Management System (STM) at the port and visit to the Port's Control Center by Mr. Erik Waller Deputy Harbor Master and Mrs. Cajsa Jersler Fransson- Maritime Sustainability Coordinator.



Figure 6 - Tour Boat Vessel

The visit began with the host Mr. Edvard Molitor giving a brief presentation regarding the Port of Gothenburg and the sustainability initiatives and projects that have been implemented or that are ongoing. The presentation began with an introduction on general information about the host port and as well the city of Gothenburg. The Port of Gothenburg since the beginning of its activities in 1620, has established direct routes to China for exporting mainly raw materials (steel, paper etc.) and importing electronics and products that can be refined. Nowadays, the Port of Gothenburg consists of 5 terminals car, energy, cruise, container and Ro-Ro. The port, which is considered to be the largest in Scandinavia and the main freight hub for the region, serves on annual basis various commodities:

- 644.000 TEU of containers (800.000 containers a year)
- 40.8 million tons of freight
- 300.000 cars handled per year
- 346.000 TEU of rail volumes
- 23.5 million tons of energy products handled per year
- 1.7 million passengers served per year
- 65 Ro-Ro departures every week (590.000 per year)
- 70 trains per day and 100 ship calls per week
- 40-80 cruise ship calls (every other year demand goes up)

Due to its constant development and volumes that are currently being handled, the port has faced increased pollution, compared to what used to be handled in 1620. The environmental issues, especially in the latest years, have grown rapidly thus meeting a balance between the port activities and the local residents, human or wildlife and fauna, was of paramount importance. Although, the port's position on the global market is not significant, especially in terms of container traffic, their environmental and sustainability initiatives have established the port in the top 3 position for such issues.

In 2017, the Port of Gothenburg experienced massive labour strikes, causing the port to become unable to serve incoming ship traffic and container volumes to drop drastically. Hence, container ships operators turned to the nearby ports in the surrounding area to cover their needs. However, the competitor ports did

not have the same capacity, to handle such large volumes of containers, as the Port of Gothenburg thus establishing the strong position that the port has in the Scandinavian Peninsula.

A presentation was given regarding the overview of current operations and provided details for the ownership of each terminal. Amongst the five terminals, the energy terminal seems to be of the most significant importance. Specifically, three out of five refineries located in Sweden are located within the Port of Gothenburg's premises. Therefore, the energy terminal plays a huge role not only for the development of the port but the city as well. Another interesting point was regarding the transportation of goods. Fifty percent of the container goods are transferred via train as the presenter indicated which mainly operated by Rail Port Scandinavia. Specifically, the Port of Gothenburg is trying to shift container traffic from road to a combination of ship and train transportation. The goods are moved by train, to inland terminals, located 30 to 100 km away from the port premises that work as logistics warehouses close to the port area.



Figure 7 - Port of Gothenburg Energy terminal

The presentation proceeded with the ongoing projects that were designed and implemented by the port (creation of a new queue and 5 logistics parks etc.), the strong connection and collaboration of the city and the port (22.000 jobs provided by the port through 320 different companies) and the development of the port's ongoing sustainability strategy. Although, the port's position on the global market is not significant, especially in terms of container traffic, their environmental and sustainability initiatives have established the port on the top 3 position for such issues. In addition, the Port's development and growth is always carried out with sustainability in mind, taking into account the surrounding habitats and keeping a low carbon footprint as low as possible in order to maintain their position at an international level. Within this context a number of green development and sustainability initiatives have been carried out.

Management of dredged material: A past practice of the Port was to dispose dredged material in a specific area. A project has been created where the material will be contained with clay and other materials and will be used to create small islands for bird habitats. A study was carried out in order to identify potential areas of how far from the shore these small islands would have to be placed in order to create the best natural environment for the birds. The decision of the installation location was largely based on potential dangers for the birds and their nests such as the local fox population and how far they can swim in the water. The research concluded that the appropriate distance to place these islands was more than 15 meters from the shore since 10 to 12 meters is the longest distance a fox can swim.

Biodiversity issues: Another biodiversity initiative was about woodpeckers and soft snakes located in a logistics warehouse built area. The Port needed to create more deadwoods for the woodpeckers to peck on, while the snakes had to be moved one by one to a safe location where they could live. Additional

examples were given regarding the creation of a Salamander hotel, a lobster house and eel grass transplant.

The last example of the eel grass transplant was the toughest to cope with. The eel grass is considered to be important for biodiversity reasons and covers an area of 1.7 hectares at the port, which had to be moved to another location in order to compensate for the damage done by the development planned on the area. Divers were hired in order to transplant the eel grass in a specific area where the conditions for the growth of the plant are appropriate (right temperature and lighting etc.). Currently, tests are conducted in order to find this “special” area to transplant the eel grass straw by straw.

For these types of projects the port uses project based teams while certain problems require the help of local institutions (universities, research centers, the municipality of Gothenburg, etc.) and stakeholders. An interesting example was also given where sometimes environmental compensation measures are not always as beneficial. The case was about a group of toads in Malmö (Norway) that lived in a specific area in the port premises. Environmental permits of that area demanded to surround the toads with a fence and restrict the area so not to interfere with the toads’ habitat. However, the area looked like an industrial waste yard, with piles of old tires, which created visual nuisance but the toads lived there so no intervention could be done. Instead a new location should have been chosen to move the local species.

Furthermore, the example of habitat banks as done in America was discussed which the best case was not necessarily. Habitat banks work in the same manner as normal banks. A fee is paid for the damage you create. Thus, the compensation solely depends on the budget each port possess and not to the actual harm done to the environment. Compensation projects can be carried out by the polluter/developer in another area or even country. Thus, the compensation measures should be implemented in the local area really close to the damaged area so to be realistic.

Emissions: Reducing air emissions is of great importance at the Port of Gothenburg. One of the main problems is ships that use high sulfur content fuel. For this reason the port developed a monitoring system which measures CO₂ and SO₂ while also using meteorological and Geographic Information System (GIS) data to accurately identify the location of where the gases are emitted from and thus indicate ships that are emitting above the permitted limited. The “sniffer” device works by continuously drawing air from a pipe located in the Alvsborgs Nya Fort-island at the port’s entrance (Figure 8). The “sniffer” system may only capture 30% of the incoming ships at the port but it works as a speeding camera. The Port Authority does not charge the ship owners but provides the data to the traffic authority who then undertakes the task to resolve the matter accordingly. The fact that there is a system which monitors the emission pushes ship operators to comply with the set limits. Furthermore, the Port of Gothenburg provides initiatives by giving a 10% discount for port charges (like a bonus malus system) to low emitters. An example was given where a ship claimed to use low sulfur content fuel while the “sniffer” results indicated otherwise. This resulted to the ship lowering its emissions the next day. In addition the port does not have any issues with PM10 due to the absence of dry bulk cargo.



Figure 8 - Monitoring system at Alvsborgs Nya Fort island -Port of Gothenburg, sniffer location

“Green” fuel incentives: The Port of Gothenburg has adopted the use of Environmental Ship indexes. Specifically, financial benefits derive from the compliance to the indexes. The Port of Gothenburg offers a 10 % discount in the port tariff for vessels with:

- more than 30 points in Environmental Ship Index
- more than 4 stars in Clean Shipping Index

A 20 % discount is given to vessels that use Liquefied Natural Gas (LNG) as a fuel. In total 37% of all port calls received a discount in 2017. Port Authority visitors were interested to learn about the type and amount of ships that use LNG as a fuel. Only 8 ships (mainly tankers and 1 cruise ship) made 130-150 calls in 2017 at the port. The uses of scrubbers as well as the refueling ways for ships that used LNG as a fuel were also a matter of discussion. The port was not aware of how many ships used scrubbers either open or closed loop. Hence, the Port of Gothenburg offers three possible LNG refueling possibilities: ship to ship refueling, bunkering with truck from the landside or pipeline system (with available infrastructure). Port of Venice was highly interested in the bunkering of LNG and asked for further communication with Port of Gothenburg. According to the discussions about the use of LNG it was stated that in the future its usage will change. The port has stated that in the near future incentives for LNG will be withdrawn and will be replaced by those for Liquefied Bio Gas (LBG) instead. Although, the port does not have an LNG terminal it believes that regulations are of great importance to create momentum in the industry to start using LNG. Thus, if the regulations for LNG or LBG exist, the ships will follow naturally.

Electrification: The last part of the presentation focused on the “cold ironing” technology. The aim of the port is to use On-shore Power Supply (OPS) as a battery system at start, then move to connecting the auxiliary engine with it and eventually go fully electric. OPS initiated in 2000 as a test/project phase at the port, which eventually included also in the permits. The current situation is that 35% of all port calls can connect to OPS, offering tax free electricity. The final point of the presentation was that all core ports in the TEN-T shall offer OPS from 2025. A study was carried out by the port to identify the benefits of using OPS,

taking in consideration the amount and types of ship that berth at the port every year, the infrastructure required and the cost of CO₂ savings in each case compared to using conventional fuels. The study concluded that the cost of OPS outweighed the environmental benefits. Regardless, the port is pursuing the use of this technology for environmental reasons.



Figure 9 - Cold-ironing facility at the Port of Gothenburg

Another electrification initiative also existed in the port where the Port Authority has purchased electric vehicles and installed charging points for both their own vehicles and their employees.

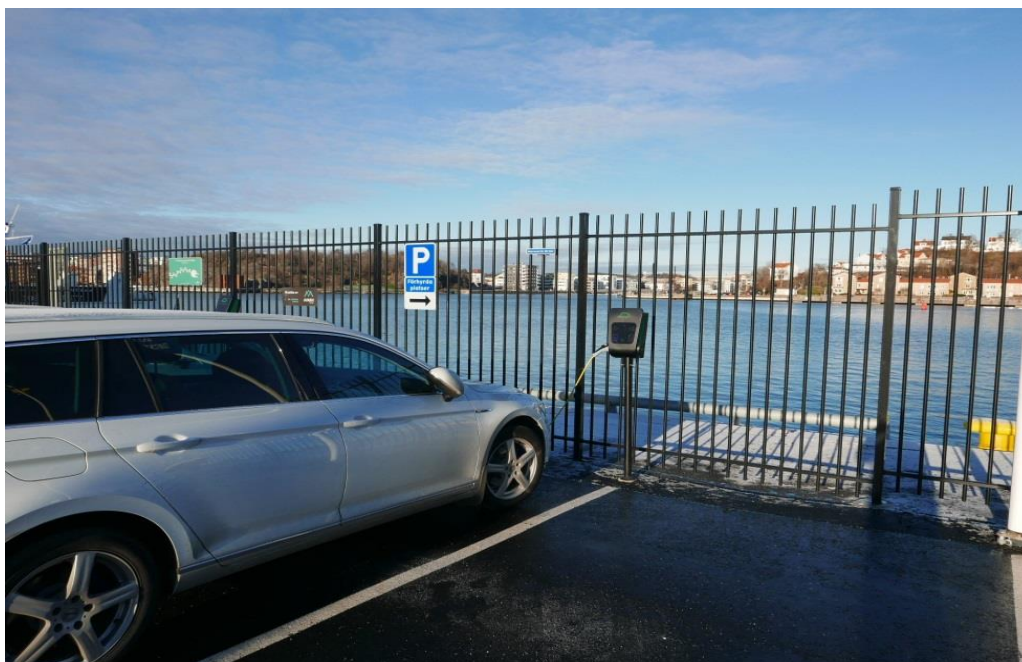


Figure 10 - Charging point for electric vehicles

The rest of the presentation took place onboard a boat where the consortium participants were given a tour of the port's five terminals and had the chance to experience in first-hand the previously described projects and developments. A proactive conversation with the host also took place. The boat tour lasted almost an hour. Pictures from the boat tour can be seen below.



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the Port of Gothenburg, called Gothenburg Approach was presented. The aim of this initiative was to create faster, simpler arrival of vessels to the port, to benefit customers and to promote safe, sustainable shipping through the adoption of effective processes working in an innovative mode of operation.

The central aspect of cooperation was all units relevant for Vessel Traffic Services (VTS) to be brought together in the same location. The three traffic services operating at the port are:

1. VTS Gothenburg, which is responsible for the supervision of the ships and the fairways
2. Pilot Request Center, which is in charge for planning for vessels in need of pilot
3. Port of Gothenburg Support Control, which manages ships in the port territory

Since all the traffic services share the same workspace and systems, improvement in the communication between the services were observed. The Port Control Center aims to facilitate the work of all operators in the port during a ship's call at the port. When the latter occurs the Gothenburg Approach participants use different operational procedures and a great volume of information is exchanged between the different parties more accurately and in the most efficient way possible to the appropriate ship. Throughout a ship's call at a port, several unforeseen events may occur which may cause delays and effect the availability of mooring space, pilots, tugs and boat man. In such cases, the Port's Control Center comes to assist by continuous supervision of port activities that enables fast coordination of all parties involved. PPs had the opportunity to experience the Port Control Center under working conditions, to discuss with the operators about details of each of the service and understand the purpose of such a beneficial collaborative initiative. Figure 13 presents the Port Control Center at Port of Gothenburg.



Figure 13 - Port Control Center, Port of Gothenburg

The main outcome of the visit at Port Control Center was the collection of all relevant information of a ship's transit in an out of the port. With the information obtained and exchanged in an uninterrupted, efficient way, the Traffic Control Services at the port can predict, control and pave the path a ship is

following, the specific needs that may require, the time spent in the port premises, the economic impact will have on the port, the environmental footprint leaving behind etc. It provides the port with a complete system of information and communication services which enable the supervision of the wholesome of the traffic within the port premises.

Port of Gothenburg also participates in the Sea Traffic Management (STM) EU project. STM control center is also located in the same area with the Vessel Traffic Services of Port of Gothenburg. Sea Traffic Management connects and updates the maritime industry in real time, with efficient information exchange. It creates a bidirectional communication between the participants (port to port, ship to ship, port to ship communication) with a variety of services provided such as route optimization services, ship to ship route exchange, enhanced monitoring, port call synchronization etc. The main aim of the project is to optimize the navigation and communication between ports and ships, create a secure, environmentally friendly maritime sector, through efficient data exchange and to develop a new digital transparent infrastructure for shipping. Currently the efficient use of STM services along with route optimization provides on average a saving of 12% of the bunkering on the sea voyage.

2.2 Lessons learnt and insights for the successful action plan implementation

The study visit core target was to foster practical learning and receive “tips and hints” on how to solve problems that SUPAIR port authorities will have to face (bureaucracy, national law, technical problems, etc.), to deepen Port Authorities knowledge on the activities undertaken by the Port of Gothenburg to increase its sustainability and to provide the participating Port Authorities with a first-hand experience on the potential problems that may be encountered during the implementation of specific solutions as well as how they can be overcome.

During the visit the participants had the opportunity to observe the port’s current operating conditions, the sustainable development projects, to understand the importance and the benefits deriving from them and participate in a proactive discussion regarding the obstacles/problems that the Port of Gothenburg faced throughout the implementation of their sustainable strategy. In such way useful knowledge obtained regarding the sustainable development plans of the participant ports which will eventually help them in the design, development and deployment of their own Action Plan. The main points of interest were:

- The difficulties experienced in the process of balancing port development and environmental compensation
- Depending on their environmental permits ports are required to carry out extensive planning and create environmental management projects, that will compensate the environment for their growth
- The consideration of the local habitat and the conservation of biodiversity requires careful environmental and scientific planning in order to make sure that no loss of local wildlife occurs
- The port of Gothenburg has demonstrated the importance of shifting traffic from road to rail or sea in order to reduce the carbon footprint of its logistics operations
- Small ports can still excel in environmental management initiatives
- Appropriate regulations could set a momentum for the use of more environmentally friendly fuels such as LNG or LBG by ships
- LNG bunkering operations seemed of interest for the visiting port authorities

- Ports can provide financial incentives in the form of relaxing port tariffs which in turn the shipping companies can use to adopt more environmental friendly technologies on their ships
- Monitoring of emission on the port area can act as a deterrent for polluters at port premises. The use of the sniffer system at the port of Gothenburg has acted in many ways as both a deterrent for using high sulfur content fuels by the ships as well as method for identifying whether a ship is eligible for lower port tariff
- Cold ironing might not always be financially profitable compared to its environmental benefits. Studies need to be undertaken to identify its viability for each port individually
- The promotion of efficient communication and information exchange for vessel traffic which could provide positive impact not only from economic but also from environmental perspective
- The port's vision of connecting into a greater digital maritime world where information regarding ports could be exchanged efficiently, fast and securely

3. Summary of study visit to the Port of Barcelona

The Port of Barcelona was selected by the PPs of SUPAIR project as one of the two best practice ports in EU, as previously described. Within the context of Activity T2.2 – “Study visits to best practice port cities” included in the Second Technical Work Package WPT2 – “Accruing knowledge and sharing results: capacity building and mutual learning” CERTH, being the leader of this activity, coordinated and organized the visit to the Port of Barcelona after contacting Escola Europea - Intermodal Transport (training center - <https://www.escolaeuropea.eu/>) representatives and specifically Ms. Marta Miquel, Chief Business Officer, Ms. Concha Palacios, Chief Financial & Projects Officer and Mr. Eduard Rodés, Director of Escola Europea. Representatives of the consortium visited the Port of Barcelona on the 18th of December 2018 in order to gain knowledge about the solutions adopted by the hosting port authority, as well as to increase their own port's sustainability and to gain a first-hand experience on the potential problems that the Port of Barcelona has faced during the implementation of their environmental initiatives. During the one day visit, representatives of the visiting port authorities had the opportunity to participate in a maritime and inland tour inside the premises of Port of Barcelona. Furthermore, they had the opportunity to learn about the port's development and implementation of their sustainability strategy, as well as gain useful knowledge of the problems, obstacles and available solutions that would potentially occur during the organization, development and implementation of their own respective low-carbon action plans.

3.1 Organization, agenda and brief description of activities

In the Port of Barcelona study visit 7 PPs participated, 6 port authorities and a technical partner (CERTH). A total of 12 representatives from different project partners participated. Table 6 presents the attendants in the study visit at Port of Barcelona.

No	NAME & SURNAME	ORGANIZATION
1	Mr. Dimitris Spyrou	Port of Piraeus (GR)
2	Mr. Ioannis Ioannidis	Port of Thessaloniki (GR)

No	NAME & SURNAME	ORGANIZATION
3	Mr. Dejan Novović & Mr. Dejan Đurđević	Port of Bar (ME)
4	Ms. Afroviti Goge & Ms. Serena Kovaci	Port of Durres (AL)
5	Ms. Elisabetta Scala	Port of Trieste (IT)
6	Ms. Laura Chiereghin, Ms. Erika Rizzo & Mr. Leonardo Cortiana	Port of Venice (IT)
7	Mr. Alkiviadis Tromaras & Mr. Nikos Anastasiadis	CERTH-HIT (GR)

Table 6 - SUPAIR participants at the study visit at Port of Barcelona

Table 7 presents the study visit agenda.

TIME	PLACE	ACTIVITY
8:30	Escola Europea Headquarters	Meeting at Escola Europea Headquarters
9:00	Port of Barcelona premises	Visit to tugs & break
11:00	Port of Barcelona premises	Visit to pilots corporation
12:30	Port of Barcelona premises	Visit to MARPOL plan
14:00	Port of Barcelona premises	Lunch break
15:30	Port of Barcelona premises	Maritime visit of port of Barcelona
17:00	Escola Europea Headquarters	Presentation of the Port of Barcelona
18:00	Port of Barcelona premises	End of the visit

Table 7 - Port of Barcelona agenda



Figure 14 - SUPAIR representative at Port of Barcelona. Visit at Pilots Centre

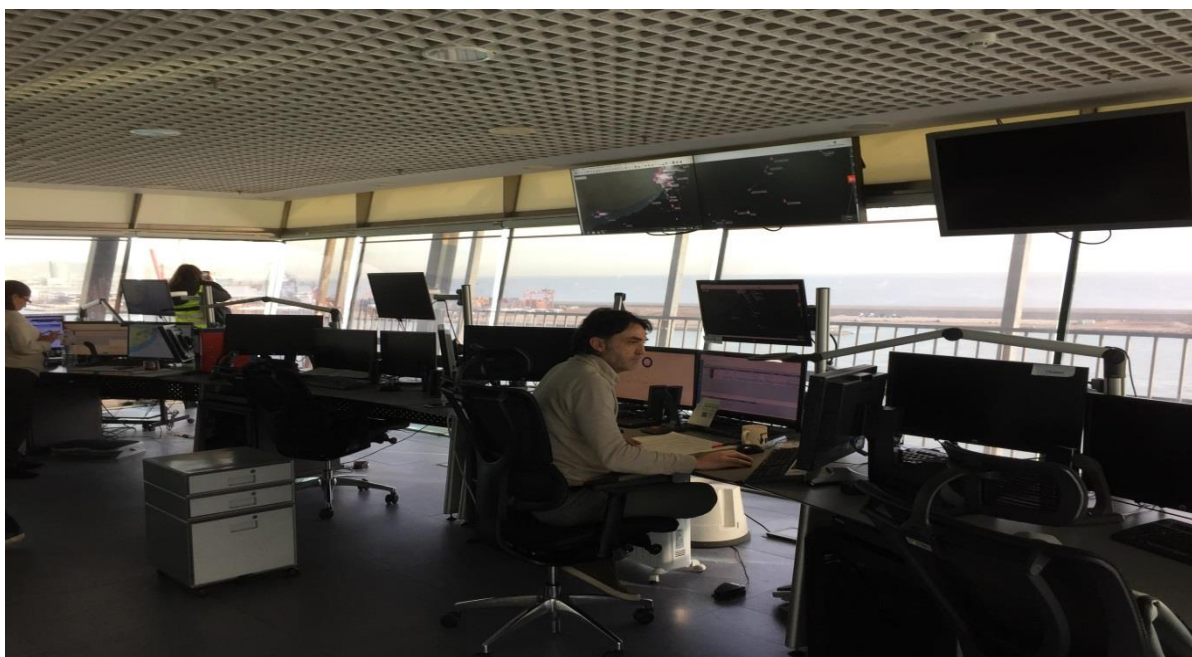


Figure 15 - Pilot Center at Port of Barcelona

The study visit consisted of 3 main parts:

1. A four hour inland tour by bus where the Project representatives visited the tugs and break port services, the pilots' command center and one of the three waste management plants (MARPOL) located inside Port of Barcelona premises. The host and guide was mainly Ms. Marta Miquel, Chief Business Officer at Escola Europea – Intermodal Transport as well executives of each of the site visits (tugs & break, pilots and MARPOL) who explained in thorough detail the current operation of their facilities.
2. An hour maritime tour around the different terminals of Port of Barcelona. Again Ms. Marta Miquel, acting as the guide of the visit, described the past, present and future operational conditions of the terminals as well as the strategic plans for the further development of the Port.
3. The study visit concluded with two presentations held at the Escola Europea Headquarters. The first presentation was held by Mr. Carles Rua Costa, Head of Strategic and Innovation projects at Port of Barcelona. Specifically, the presentation was related to the Port's development strategy and how the latter had to align with global socioeconomic trends and developments in order for the Port to increase its position in the global maritime industry. The second presentation focused on the sustainable commitment of the Port of Barcelona. The presenter was Mr. Jordi Vila, Head of Environmental Department at Port of Barcelona. The presentations lasted around one and a half hour.

The inland tour started with the visit at the tugs and break where the project's representatives had the opportunity to learn about the operation conditions and equipment used at the Port of Barcelona tugs and break boats. Separated into two groups the project partners, boarded a tug boat where a thorough presentation for its operation took place. The groups visited the bridge of the boat where the navigation system and the operator of the boat were located and the guide explained how the efficient handling /maneuvering (provided by the boat's unique propeller placement diagonally at the front and the back) of the tug boat could prove beneficial from an environmental perspective. During the presentation it was pointed out that the use of electric motors in the tugs would not be beneficial or efficient due these boats operating around the clock, over 12 hours of continuous maneuvering at pick days, which leaves with no time for recharging. Thus, the efficient usage, the maturity of the technology used in the boats (engine, PV for electrifying the boat's systems etc.) considered to be the "greener" solution in this specific operation of the Port. A cold ironing facility was also available for the tug boats at berth, in the dock where the study visit was conducted. The tug boat that was presented, was equipped with a dynamic positioning system in an effort to have less people on board. Regardless of the innovative system that could calculate automatically the position of the tug and bring it to the position where it needed to be near the boat that it would help maneuver, the system was not as good as manual operation.



Figure 16 - Cold-ironing facility for tug boat while at berth

The bridge visit continued with a tour at the engine room of the tug boat where the representatives had the opportunity to participate in a technical discussion about the efficiency of the engine, the type of the engine, its operation details etc.

Local permits at Barcelona Port also assist the maintenance of the high efficiency of the tugs and break boats, by setting a 15-year limit of an operation time of a tug boat. After the 15 years expired, the boat should be renovated or a new one should be bought. The harbor master is responsible for the monitoring of the emissions produced by the tugs and break boat which are checked every year.

Moreover, the presenter indicated that all waste produced from the tugs and breaks were collected, recycled or treated by the waste management plants located inside the port premises. Specifically, the wastewaters (black and white) generated from the boats are inserted in the city's sewage system where they are treated along with the rest of the city's wastewater. Any waste produced in the tugs and break area collected in special bins for which the Municipality of Barcelona is responsible to collect and recycle accordingly.

The tour continued with the visit to the pilot's center. The latter is located in a tower at the port's south entrance. Its location is beneficial as far as its responsibilities are concerned. The pilot's center has a twofold operation responsibility:

- Port services coordination - to control the access of the ships inside and outside of the port
- Pilot services – responsible for safety and environment issues

Thus, the pilot service coordination at the Port of Barcelona manages the traffic of the ships in coordination with the harbor master. Port of Barcelona is one of the busiest ports in EU dealing with over 30% of the cargo passing through the Mediterranean Sea. In 2017, the total traffic at the Port of Barcelona reached a record number of 61 Mt (million tons) showing an impressive increase of 26% since the previous year. The total traffic amount consists of 3 million TEU containers, 840 million vehicles, 395 million UTI in Ro-Ro traffic and 4,1 million Pax passengers. In order to control such a great amount of traffic, the efficient and uninterrupted communication between all the involved parties in the traffic management procedure is of paramount importance. Vessel traffic information is exchanged at the Port through a private information technology system managed by the pilot center which allows bidirectional communication with the Port Authority in order to efficiently manage the traffic of the ships in the port's premises. The future vision of Port of Barcelona is the creation a "common Mediterranean port" where information between all involved parties in the transportation procedure (the ship operators, Port Authorities, pilots etc.) could be

exchanged efficiently and accurately acting as one big port with different terminals around the Mediterranean Sea.

From an environmental and safety perspective, the pilots centre organizes and submits all the appropriate documentation for the quality, safety and environmental documentation. Currently, Barcelona Port holds EMAS, ISO 140001 and PERS certifications that set it among the top ports regarding sustainability, health and safety certifications. Additionally, pilots are responsible for the practical safety within the port premises. Hence, in case of an emergence event (i.e. oil spillage etc.) the pilots are responsible to inform the harbour master and to contain the source of pollution until the appropriate authority responsible to deal with emergency situations arrives at the spot.

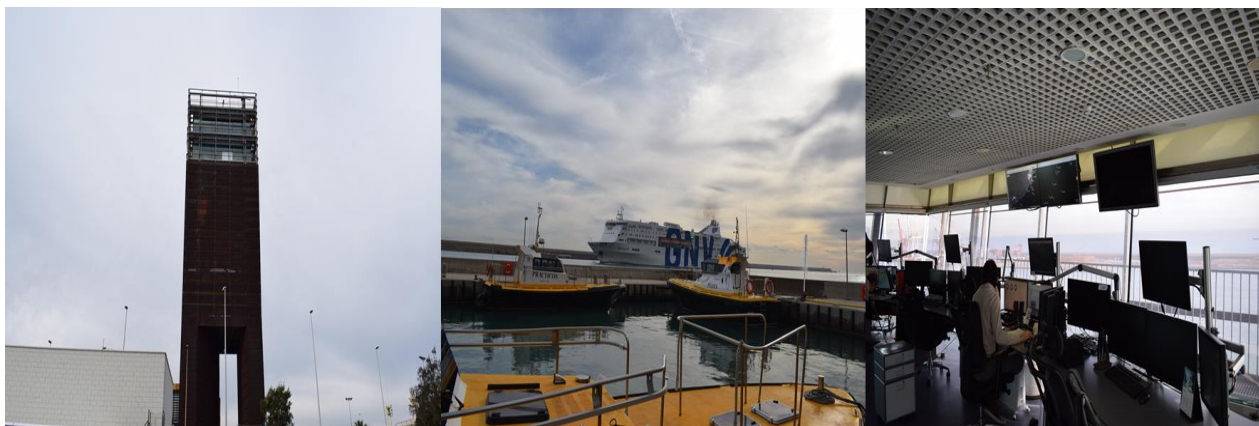


Figure 17 - Pilot center tower (left), pilot boats (middle), pilot center control room (right)

Waste management: One of the most important environmental operations taking place at the Port of Barcelona's premises is the waste management system. The existence of appropriate reception and treatment of waste generated on ships calling at the port is the most effective way of preventing such waste from being thrown overboard. Port of Barcelona can treat a variety of waste such as oil, liquid substances in bulk, sewage and solid waste in the three MARPOL waste management plants located in the premises of the energy terminal at Port of Barcelona. Any waste produced in the port is collected by truck and transferred to the local treatment plants in order to be treated accordingly. As far as the sea wastes are concerned, these are collected by two special MARPOL I and MARPOL V ships which feed the production line of the plant. Part of the inland tour contained a visit to one of the waste treatment facilities. The consortium representatives were guided through every stage of the waste treatment which provides services with 5 hazardous and non-hazardous waste management lines, with a treatment capacity of 165.000 tm/year. The visit of the representatives in the MARPOL plant was the last part of the inland tour of the study visit.



Figure 18 - Visit at the waste treatment plant

Maritime tour: After a short lunch break the study visit continued with the maritime tour at Port of Barcelona terminals, which lasted around an hour. Figure 19 presents the various terminals at the Port of Barcelona. The representatives had the opportunity to tour around the Port's terminals beginning from the cruises and ferries terminals, to the solid bulk and container terminals and ending in the energy terminals (liquid bulk).

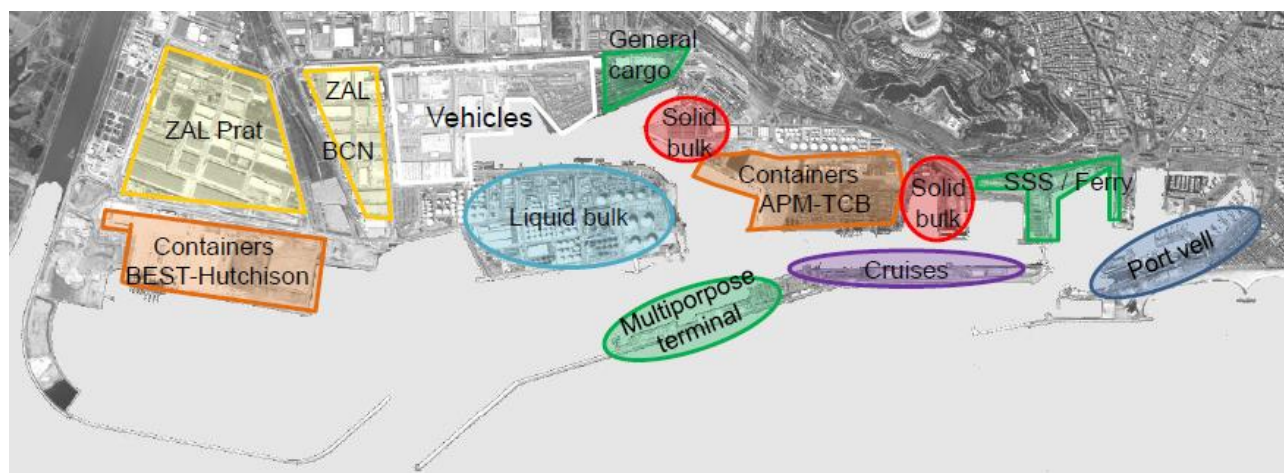


Figure 19 - Port of Barcelona terminals

During the tour the visiting port representatives were given an overview and the opportunity to discuss about the operation conditions and the development plants of each for each terminal. The main subject of the discussion was the investment done in the port and the areas in which the strategy of the port indicated to expand. As such Port of Barcelona has as a core of its investment plan to increase its cruise terminal capacity as well the upgrade of the container terminals with more efficient and automated machinery. Specifically, the Port is investigating the opportunity to use cranes fully operating with LNG as a fuel rather than the diesel that is currently used.

Presentations about the Port of Barcelona

The last part of the study visit included two presentations regarding the strategy for the future of the Port of Barcelona and the sustainability commitment at Port of Barcelona.

Presentation: The strategy for the future

Mr. Carles Rua Costa, Head of Strategic and Innovation projects at Port of Barcelona presented the Port of Barcelona strategic plan regarding the development & growth strategy of the port. The Port of Barcelona currently, employs in total 238.000 people with 32.000 jobs directly generated from the port. It consists of 82% of the Catalan and 22% of the Spanish maritime trade in value, producing 11.300€ million of the total Gross Annual Value (GAV). The total traffic has risen to 61 Mt (million tons) in 2017 of which 41% were containerized cargo, 26% liquid bulk, 23% representing general cargo and the rest 10% solid bulk. The relocation of the majority of the maritime activities from Europe to Asia and the alteration of the flow of goods currently directing from East to West, highlights the need for further development of the European port in order to present competitiveness and maintain their shares within the newly created maritime trend. That requires bold actions and high investment to be taken. Port of Barcelona's strategic location (southern range port) has proven to be beneficial as it is located in the main maritime corridors connecting Europe and Asia. The position of the Port of Barcelona has proven beneficial in many ways such as the need of 4-5 less navigation days travelling from Asia to Europe, less use of fuel and thus less CO₂ emissions

generation. The route from Asia to Europe through the Suez Canal into the Mediterranean and then to the Gibraltar Canal, is the only competitive route a ship could follow, in order to reach the biggest European ports located mainly in the Northern part of EU (Rotterdam, Antwerp etc.), thus strengthening the Port of Barcelona's position in the global maritime market. The presentation continued with the port's growth strategy, its ongoing and completed projects, as well as the amount paid in private investments from 2000-2015 reaching a total number of 2.000€ million. One of the biggest and ongoing investments is the enlargement of the port's logistics area. Hutschison Ports BEST, invested around 500€ million to develop a new semi-automated terminal with a total capacity of 2.25€ million TEUs covering an area of 79 hectares. Furthermore, the presentation also covered the port's connectivity network. Port of Barcelona customers are located fairly close to the port area (300km – 1.000km away). Barcelona wants to improve the hinterland connectivity of the port, mainly by rail, combined with the usage of Short Sea Shipping instead of using highly emitting trucks for the transportation of the goods. The Port is currently developing a strategy that does not only focus on economic benefits but is also inseparably connected with sustainable growth and expansion of the port.

The port sustainability plan was also part of the first presentation although it was only briefly discussed in the last part of the presentation as a more elaborating presentation on the sustainable commitment of Port of Barcelona followed.

Presentation: Sustainability commitment of the Port of Barcelona

The presentation on the sustainability commitment of the Port of Barcelona was held by Mr. Jordi Vila, Head of Environmental Department at Port of Barcelona. The Port of Barcelona follows a strategy for the sustainable development of the port which is structured upon four basic pillars:

- Improvement of air
- Improvement of water quality
- Efficient usage of resources
- Prevention of soil contamination

In order to increase the sustainability of the supply chain, the Port of Barcelona promotes more sustainable forms of transport and the usage of alternative fuels combined with the reduction of the carbon footprint of port related activities.

Air quality: Regarding air quality the total emissions deriving from Port of Barcelona activity are estimated to be 5.545 tons/year of NO_x and 505.68 tons/year of Particulate Matter (PM-10). The biggest producers of such emissions are the cargo ships 35%, followed by the container ships 30% and the cruises and ferries with 14% respectively. The aforementioned emissions are estimates which are calculated by inspecting the most frequent ships that call at the port, along with weather stations statistics and an emissions sensors network located at the port's premises. In addition, the Port has investigated and compared its contribution to the city's total emissions of NO₂ and PM-10 which has been estimated to be relatively low compared to car traffic emissions. Specifically, the Port of Barcelona contributes to only 7.6% NO₂ and 1.5% of PM-10 emissions to the city of Barcelona. The bigger emitters are considered to be cars with 59.8% NO₂ emissions and regional contribution with 71% PM-10 emissions. The Port is also considering of creating incentives for low emissions ships through lower port tariffs. Port of Barcelona focuses in the reduction of vessels emissions which is the greater source of pollutants by promoting alternative fuels (natural gas), creating environmental incentives for vessels and studying the feasibility of cold ironing technology in certain docks. There are also a number of initiatives in which Port of Barcelona is getting involved regarding

infrastructure development, promotion of alternative fuels in ships and truck and electrification of the port's car fleet.

Infrastructures development: The Port is participating in an initiative with FLOTA SUARDIAZ for the modification of the existing barge to incorporate LNG tanks (1,200 m³ capacity) and for creating supply mechanisms to other ships. Moreover, another initiative with ENAGAS TRANSPORTE S.A.U. is to create an LNG berth for supply small vessels and barges in order to reduce the usage of highly emitting fuels such as diesel.

Promotion of alternative fuels: The promotion of alternative fuels is one of the main activities the Port of Barcelona is dedicated to as a way to increase its sustainability. An example is the initiative of BALEARIA and GAS NATURAL FENOSA to incorporate an auxiliary NG engine and LNG storage tank of 30 m³ on board that is being investigated along with the initiative of FLOTA SUARDIAZ in collaboration with ports of Vigo, Tenerife and Barcelona for the construction and installation of a natural gas engine on the wharf to supply electricity to the vessels. Furthermore, a new concession for a gas station to supply LNG and CNG fuels to trucks has already initiated as well as the transformation of 25 dual-fuel trucks, a project supported by ECOMOBILITAT. The port has also investigated the use of alternative fuels for terminals' machinery. Currently, the port is carrying out two gasification pilots for straddle carriers within the framework of the European project CORE LNG. In case these pilots for the machinery modification are proven successful, the Port plans to further expand the initiative to the rest of the machinery (the total 76 diesel and 21 diesel electric units) located in its container terminals (APM & BEST). Furthermore, the port offers incentives for the ship operators to use alternative fuels on their ships by providing a total discount of 80% in port fares (50% by national law and an extra 30% by the port) if the vessel uses natural gas for propulsion or cold ironing while docked in the port. A number of environmental indexes also exist at Port of Barcelona (Environmental ship index, Clean shipping index, etc.) supporting even more the transition from the highly polluting fuels to the alternative ones.

Electrification: The feasibility of using old "ironing" technology is currently being investigated at Port of Barcelona. As described in the presentation, OPS technology at Port of Barcelona is an expensive investment as the cost of electricity and the infrastructure required to support such an initiative, are not considered financially beneficial. The OPS legal and technical aspects are being under thorough consideration, with the best solution being estimated to be the creation of a smart grid in the port premises using renewable energy sources for generating electricity. In the electrification perspective, Port of Barcelona has already incorporated a fleet of around 25 electric vehicles (15-17 electric cars, 5 electric vans and 6 motorbikes) which are being used for transportation purposes in the port area. Five charging stations have already been installed in the port premises with further plans to increase the public charging points to 28 by 2023 in order to promote the further expansion of the electric fleet of the port, as well as give an incentive to the people working at the port to invest in an electric car in the years to come. The Port of Barcelona aims to be carbon neutral in terms of its vehicles by the year 2023-25.



Figure 20 - Charging station at Port of Barcelona

Water quality: The presentation also covered the issue of water quality. Specifically, Mr. Vila presented the main pressures for better water quality, the improvement actions that were taken and the results of the latter. The direct discharge (estimated annual volume of 600.00 m³) from port activities at the dock was an issue for the port at the beginning of 2000, which was fixed with the construction of a 16 pumping station sewerage system, an investment of around 30€ million, that prevents the direct discharges from the docks to port waters since 2002. Moreover, the issue of massive discharges from the city's unitary sewerage system in case of high rainfall through 10 spillways, was effectively treated with improvements to prevent flooding in the city's unitary sewerage system (PECLAB 97), improvements to prevent discharges into port waters (PECLAB 97) and improvements to prevent flooding and discharges into port waters (PECLAB 2003) having as a result a reduction of 75% in discharges during rainfall times. In 2004 the diversion of the Llobregat river occurred along with the start of the Llobregat Wastewater Treatment Plan in order to improve the coastal water quality and to reduce the external inputs in the ports waters. In addition, with the opening of the new mouth (Nova Bocana Nord) at the port, the time it took to renew the port's water was reduced to 7 from 17 days that it used to take in the past, thus improving the water quality in the port premises. Finally, in the case of an accidental discharge of waste water or hydrocarbons in the sea or shore from terminals, a specific emergency preparedness procedure has been developed. A collection of liquid and floating waste procedure is in place and the Contingency Plan against accidental marine pollution is applied in such cases.

Intermodality: The port's sustainability commitment extends beyond the port and incorporates the various multimodal supply chains with the aim to minimize the impact related to goods and contribute to the improvement of the European logistics system. In its effort to become a Carbon neutral port for goods, the Port of Barcelona has included in its sustainability agenda, the promotion of cleaner alternative fuels for all modes of freight transport, as well as the facilitation of more sustainable supply chains.

The Port of Barcelona has increased its market share in the container and car cargo traffic that has been transported by rail in 2016. Containers transported by rail showed an increase of 5.9% from 2017 while rail traffic for cars increased by 2.9% respectively. In 2016 the Port of Barcelona held a share of 12.5% of the total container rail market with the Port of Rotterdam (~12%) and Hamburg-Bremen (~30%) holding around 50% of the market. The objective of the port is to increase its share in the container rail market to 25%. In addition, the Port of Barcelona rail traffic services 73% of Iberian corridor, 10% of South corridor and 13% of North Spain corridor, including rail transportation from Barcelona to Zaragoza, Madrid, Lisbon, Tarragona, Valencia Pamplona and Burgos as well. The benefit deriving from the steady abundance of truck transportation to be replaced by rail and SSS are massive. From 2006 until 2016 the Port of Barcelona has saved 139.4€ millions of externalities (congestion, accidents, climate change etc.) costs.

Barcelona's Carbon neutral port vision is based on a three-milestone strategy to reduce the Greenhouse Gas emissions (GHG) caused by its activities: ECOCALCULATOR, BCN ZERO CARBON project and an internal scope called CORPORATE FOOTPRINT. In that perspective, Barcelona Port Authority has signed a voluntary agreement to reduce GHG emissions promoted by the Catalan Government through the Catalan Climate Change Office. ECOCALCULATOR (www.portdebarcelona.cat), is a web tool which provides a calculation of the emissions of CO₂ associated to a transport route. The BCN ZERO CARBON project is a shared project between port terminals which aims to neutralise CO₂ emission generated by the passage of the goods through the port in different ways, by quantifying the emissions generated by the different categories of pollutants, implement emissions reductions actions and create incentives for the unreduced emissions.



Figure 21 - Presentation of Port of Barcelona growth and sustainable strategy

3.2 Lessons learnt and insights for the successful action plan implementation

The organization of the study visit at Port of Barcelona had as a core concept to extract useful lessons and insights deriving from the implementation procedure (including organization, planning and development) of sustainable measures/solutions in the port, in order to increase its environmental performance in specific fields of interest as those identified by the PPs in their focus group sections. To that extent, PPs

(Port Authorities) participating in the study visit recognized and questioned issues of their personal interest, learned ‘hints and tips’ as to how to encounter such issues and participated in discussions related to the similar problems they may experience, in the future development of their action plans.

During the visit the participants had the opportunity to observe the port’s current operating conditions, the sustainable development projects, to understand the environmental and financial importance of altering the transportation means of goods from highly polluting trucks to a combination of rail and SSS. Additionally, the promotion and usage of alternative fuels are a core step in the direction of the development of a sustainable port community. Useful knowledge was obtained regarding the sustainability development plans for the participant ports which will eventually help them in the design, development and deployment of their own action plan. The main points of interest were:

- The Port of Barcelona is promoting the usage of alternative fuels such as LNG and electric energy (cold ironing) either as primary fuel or while at berth. In addition the port as well as the Spanish government offers up to 80% reduction in port tariffs for the usage of such fuels at the port
- The Port of Barcelona has created an initiative of renewing their tug boats every 15 years in order to minimize their carbon footprint as well as for operational reasons
- The port is in the process of electrifying or changing into alternative fuels its terminal equipment. Specific pilot project will evaluate the operational capability of the use of alternative fuels in such equipment
- Alternative fuels will play a significant role in reducing environmental emissions of the transportation means of the goods
- Appropriate regulatory and infrastructure support can help the promotion of alternative fuels
- The Port of Barcelona uses a combination of estimations for calculating ship emissions based on ships that call frequently at the port as well as the use of an emissions monitoring sensor network
- Cold ironing has proven to be a capital intensive investment with the cost outweighing the environmental benefits. It has proven to be more applicable to cases where it can be used for specific ships that call regularly at the port as well as the use of renewable energies for electricity generation
- The Carbon neutral vision of the Port of Barcelona is opting to be achieved through the various initiatives and measures that have been carried out or are taking place (e.g. electrification of the terminal equipment and fleet, use of renewable energies)
- The importance of waste management and recycling on port premises and the creation of circular economies based on port waste
- The efficient, accurate and secure information exchange thorough a common Mediterranean platform to facilitate such communication
- Ports need to consider in parallel, financial and environmental development and create sustainability strategies that will reduce their impact to the environment and the community
- Ports require tailored solutions that will help them combat their environmental impact

4. Conclusion

This report aims to provide the SUPAIR project partners with practical knowledge and deepen their experience on sustainability measures that the ‘best practice’ ports have adopted and implemented, and the difficulties that these ports encountered during the implementation of such measures. The current

report will help the SUPAIR Port Authorities to tackle potential issues that might occur while undertaking their own initiatives for improving their environmental performance and will assist them in the development of their strategic plans. The report is based on the two study visits at the Port of Gothenburg and Port of Barcelona.

The identification of the 2 'best practice' ports occurred by the development of a methodological framework which distinguishes a 'best practice' measure/action from an emerging, promising or leading one through an effective adaptation of the principles which governs a 'best practice' into the SUPAIR project's context, thus generating 9 criteria. This procedure was used to create a shortlist of the potential study visit ports in Europe.

The selection procedure for the 'best practice' ports was based upon the above identified 9 criteria which project partners classified into primary and secondary. A 'best practice' port had to cover the primary criteria otherwise it was excluded from the selection process. Secondary criteria were more relevant to the fields of interest that project partners identified.

Primary criteria characterized those with higher importance to the areas of intervention project that partners identified in their focus groups sessions and were based on the participation of the candidate study visit port in environmental societies (e.g. EcoPorts), the existence of environmental and quality certifications as well as the candidate port's strategic importance by being located in the main corridors of TEN-T network thus being a part of the core EU ports. For a port to be recognized as a 'best practice', based on the secondary criteria identified and weighted by the PPs, it should demonstrate: 1) significant efforts to exchange experience and expertise, 2) increased interest in developing communication channels and cooperative relations with local authorities, 3) community engagement and consensus building between the port and the relevant stakeholders in sustainable related matters, 4) positive net financial benefit deriving from 'green' activities and 5) an increased level of maturity in the implemented solutions related to sustainability.

The aforementioned criteria structured the analysis and identification of the potential study visit ports resulting in a list of 36 candidate 'best practice' ports. A thorough literature review of all relevant information that was freely available was carried out, thus narrowing down the candidate ports into a list with the final 4 best practice ports; 2 main ports, Port of Rotterdam and Port of Barcelona and 2 alternative ports, Port of Gothenburg and Port of Bremen-Bremerhaven.

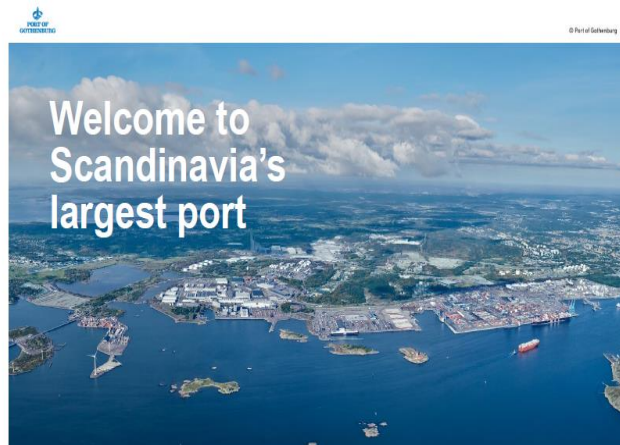
Representatives of Port Authorities visited Port of Gothenburg and Port of Barcelona, on 28th November and 18th December 2018 respectively, with the aim of boosting their sustainability know-how by the useful knowledge, insights and experiences obtained in those visits.

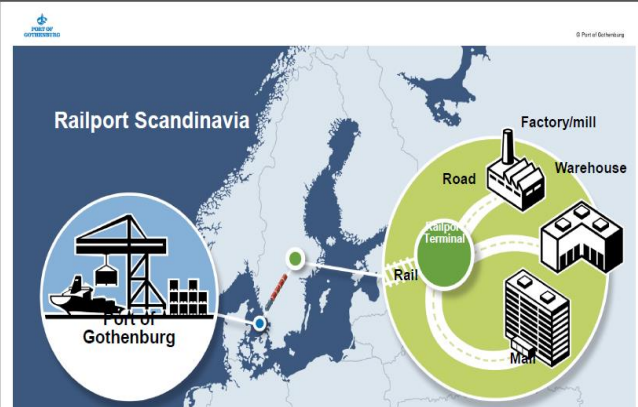
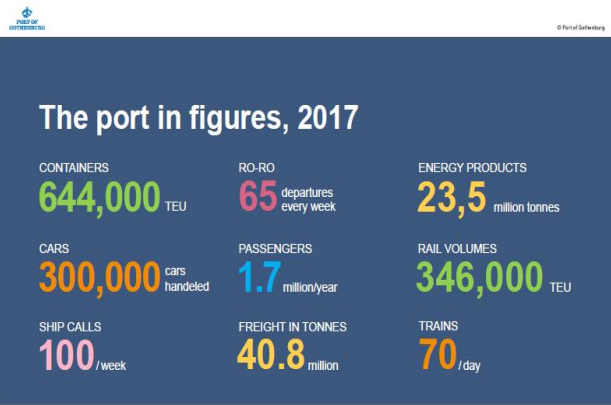
Project representatives learned how the Port of Gothenburg uses as leverage for its growth, competitiveness and development, its high profile on environmental and sustainability activities. The port is committed to protect and preserve the local biodiversity and to mitigate to the minimum the damage done to the environment. Specifically, the entire development plans must comply with strict environmental regulations before being implemented where a balanced approach needs to be taken for compensating the potential environmental damage that the development plans might cause. Moreover, project partners

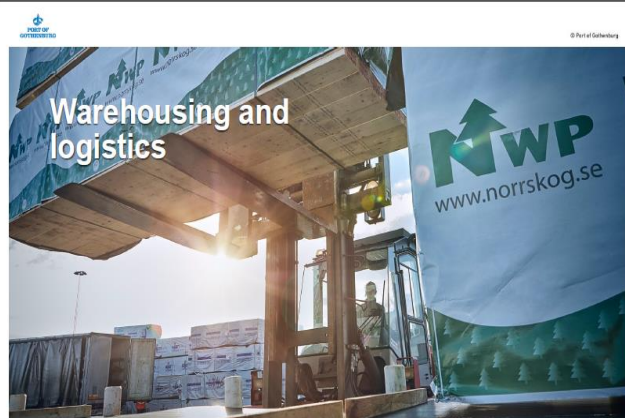
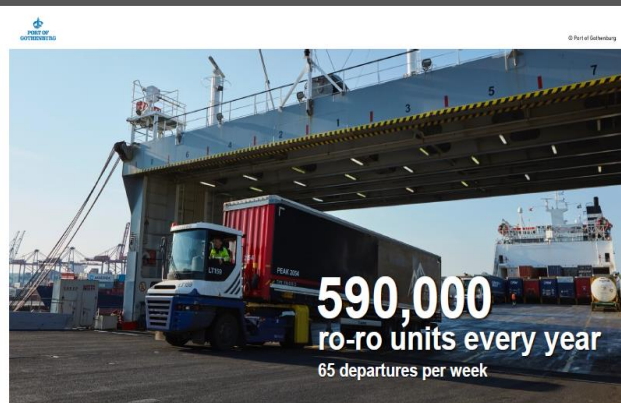
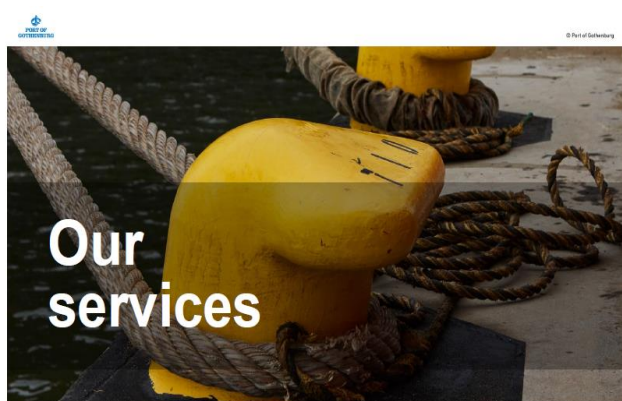
were informed about the various environmental initiatives that the Port of Gothenburg has undertaken. The Port encourages the usage of alternative fuels (e.g. LNG) and attracts such vessels (using alternative fuels) with incentives (e.g. reduction of port tariffs). In addition it has taken initiatives that promote the use of rail and ship transportation instead of road (trucks). Furthermore, emissions monitoring systems, 'cold-ironing' technology usage and efficient communication between the cooperating entities of the ports activities synthesize an environment with reduced emissions and less pollution.

Port of Barcelona as one of the biggest Mediterranean ports wants to be a pioneer in the environmental and sustainability matters. Project representatives obtained information and insights regarding the actions/measures implemented by the port in order to achieve its goals. Hence, Port of Barcelona has already developed and started implementing a Carbon Neutral Vision with an outlook of becoming Neutral Carbon Port by 2025-30, following a clear sustainability strategy, combining the simultaneous growth of the port's business with sustainable development. In order to achieve that, a number of initiatives, activities and measures have already been implemented or/and will be initiated in the future. Such initiatives include the promotion and use of alternative fuels in vessels; electrification of the entire port car fleet; investments in 'greener', more efficient infrastructure; minimization of water and air pollution (e.g. monitoring and waste management); generation of almost zero waste with efficient recycling (e.g. MARPOL) and the modal shift from road to a combination of rails and Short Sea Shipping. Port of Barcelona also highlighted, the significant benefits deriving from a more efficient, accurate and secure information exchange between the Mediterranean ports as a measure for mitigating climate change with the optimization of transportation chain heavily benefiting not only the environment (e.g. reducing the time a ship spends in port premises, less emissions) but the revenues of the wholesome maritime industry (e.g. less fuels used, less money spend).

ANNEX I – Sustainable presentation at Port of Gothenburg









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The port grows



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Intermodal terminal

Trains arrive at quayside



© Port of Gothenburg

New terminal in Arendal

220,000 m²



© Port of Gothenburg



© Port of Gothenburg

New cruise-liner quay

America Cruise Terminal



© Port of Gothenburg

We provide jobs for 22,000 people

- 320 companies
- 8000 directly employed in the Port of Gothenburg
- 14,000 indirectly employed



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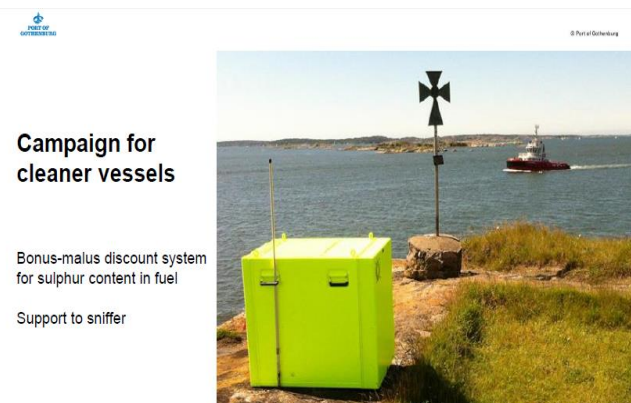
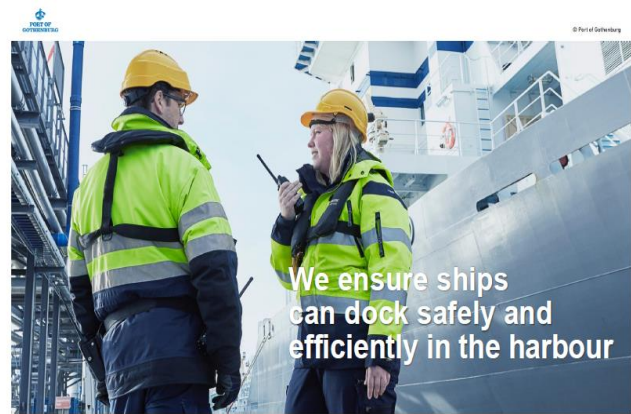
More than 320 actors in the port network

Swedish Maritime Administration
Construction companies
Terminal operators
Tugboat operators
Coastguard
Container depots
Warehousing firms
Shipping agencies
Customs office
Rail operators
Bunker operators
Security firms



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The Gothenburg Port Authority



GÖTEBORGS HAMN

Differentiated Port Dues

- 10 % discount in the port tariff for vessels with:
 - More than 30 points in Environmental Ship Index
 - More than 4 stars in Clean Shipping Index
- 20 % discount for vessels using LNG as fuel
- 37 % of all port calls received a discount in 2017





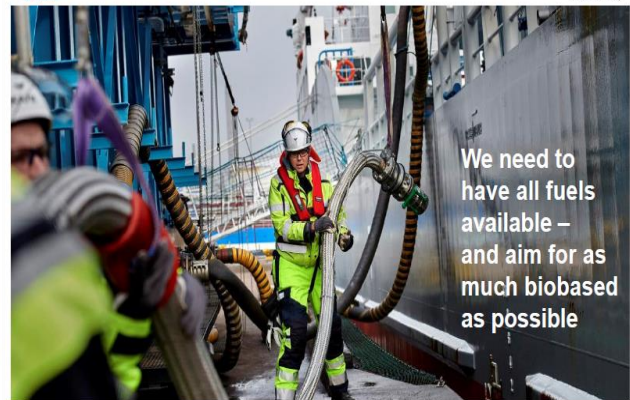
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Methanol as maritime fuel



© Port of Gothenburg



We need to have all fuels available – and aim for as much biobased as possible

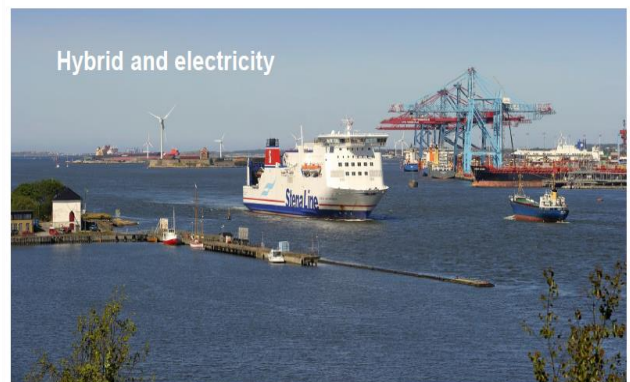


Scrubber waste disposal

- Large quantities?
- Classified as dangerous goods?
- Content depends on several factors



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Hybrid and electricity



© Port of Gothenburg



Onshore power supply

Reduced emissions and a quieter port environment



Onshore Power Supply

- Initiated in 2000
- Initially a project/test phase
- Eventually included also in permits
- Funding from national, regional and local level



Current situation

- 35% of all port calls can connect to OPS
- All new quays are prepared
- Taxfree electricity
- Core ports in the *Trans-European Network for Transport* of the European Union shall offer OPS from 2025

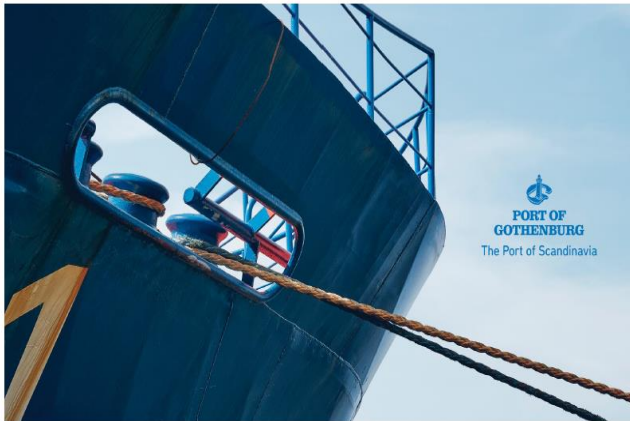


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Trains save the environment

- Reduce emissions of carbon dioxide by 60,000 tonnes
- 50 per cent of all containers are transported into the country by train
- Reduce road congestion

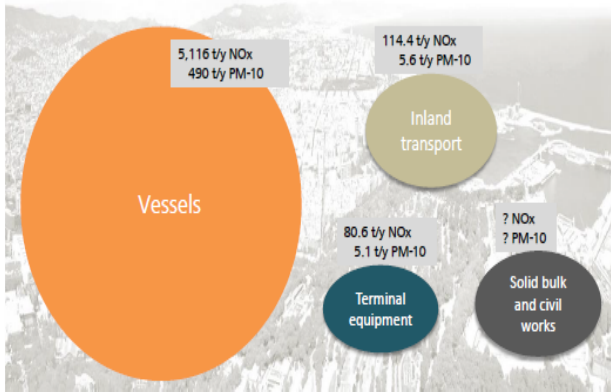


ANNEX II – Sustainable presentation at Port of Barcelona

 <p>Port de Barcelona</p> <h1>Sustainable commitment of Port de Barcelona</h1> <p>Escola Europea (Project SUPAIR)</p> <p>Jordi Vila Head of Environmental Department</p>	 <p>Port de Barcelona</p> <ol style="list-style-type: none"> 1. Objectives of environmental sustainability of the Port 2. The improvement of air quality 3. The improvement of water quality 4. The contribution to the sustainability of the supply chain
 <p>Port de Barcelona</p> <h3>1. Objectives of environmental sustainability of the Port</h3> <div>  <p>Reduce the environmental impact of port activity in the Port area and its vicinity</p> <ul style="list-style-type: none"> • Improve air quality • Improve the quality of port waters • Make efficient use of resources • Prevent soil contamination </div> <div>  <p>Increase the sustainability of the supply chain that uses the port</p> <ul style="list-style-type: none"> • Promote more sustainable forms of transport • Reduce the carbon footprint of port activities • Promote the use of alternative fuels for the different forms of transport </div>	 <p>Port de Barcelona</p> <ol style="list-style-type: none"> 1. Objectives of environmental sustainability of the Port 2. The improvement of air quality 3. The improvement of water quality 4. The contribution to the sustainability of the supply chain

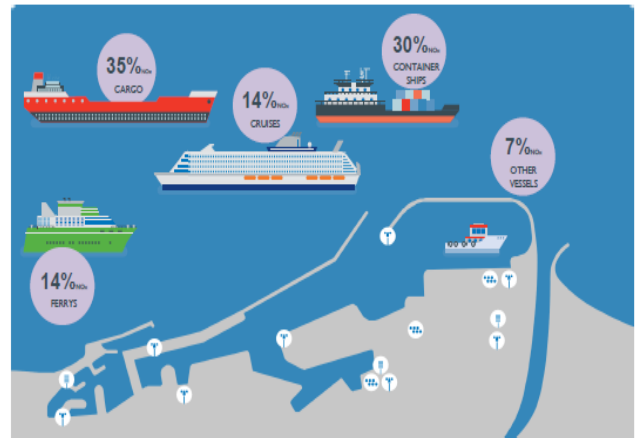
2. The improvement of air quality

Emissions from Barcelona Port Activity are estimated to be 5,545.8 t/y of NO_x and 505.68 t/y of PM-10.



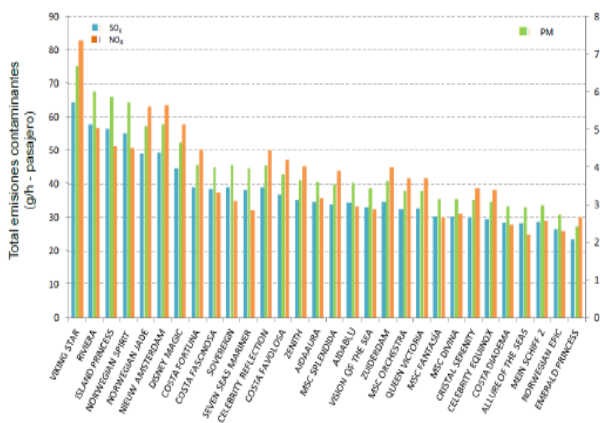
2. The improvement of air quality

Percentage of emissions of NO_x from each typology of vessels



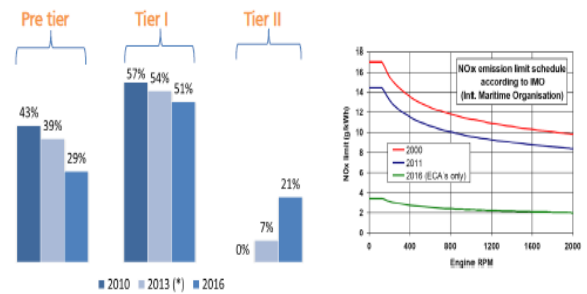
2. The improvement of air quality

Estimated emissions of SO_x, NO_x and PM of the 30 most usual cruises in the Port.
Estimations in g/hour of stay and per passenger



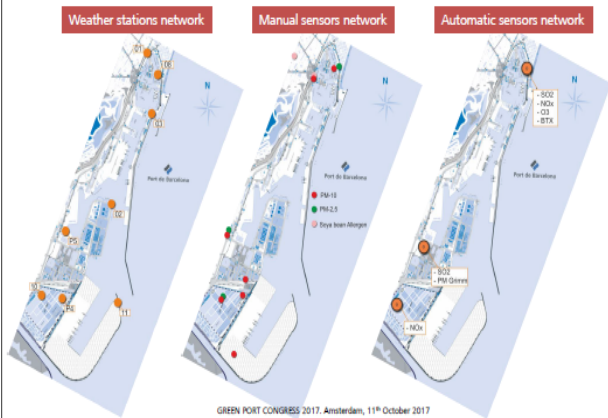
2. The improvement of air quality

NO_x emissions from cruises: percentage of cruise ships that called in Barcelona (2016) built before 2000 (pre-tier), between 2000 and 2010 (tier I) and after 2011 (tier II)



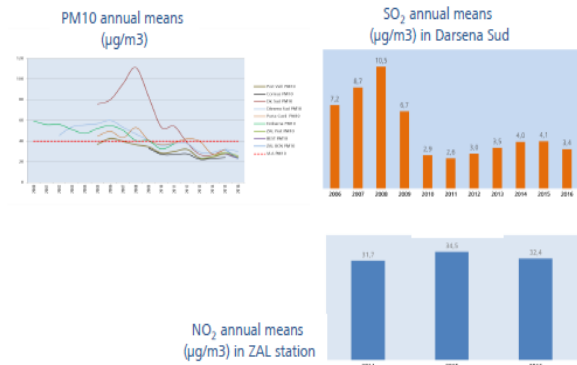
2. The improvement of air quality

Control and monitor of the air quality in the port area



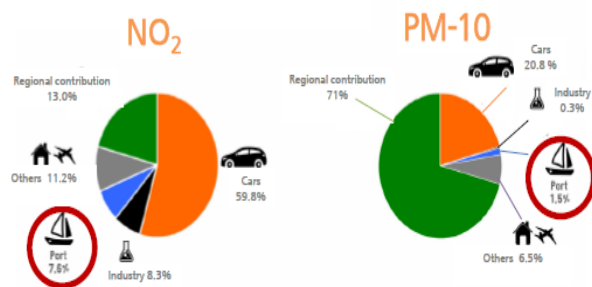
2. The improvement of air quality

The concentration of the main pollutants in port area



2. The improvement of air quality

The relative contribution played by emissions from the port to air quality in the city of Barcelona



2. The improvement of air quality

Actions to improve the port air quality



2. The improvement of air quality

Port actions to reduce emissions for vessels



2. The improvement of air quality

The response of the ports will be different in function of the type of vessels

Promoting new LNG vessels	Cold ironing	Filters SCR & DPF
Supply infrastructures	Dock supply infrastructures	In NECA
Only for new vessels	Non from de national grid	Port incentives
Long term	Cooperation between ports	Cooperation between ports
	Medium term	Short term

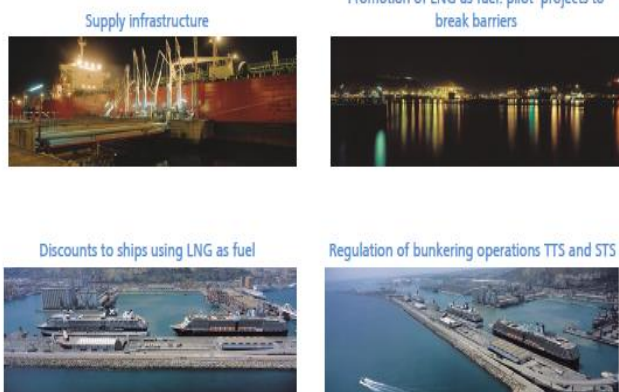
2. The improvement of air quality

Promoting new LNG vessels Cold ironing Filters SCR & DPF

Container		
Cruise		
Ferris		
Ro ro		
Car carriers		
General cargo		
Yatch		
		Bulk carriers
		Tankers

2. The improvement of air quality

Main actions to promote LNG as a fuel for mobility





2. The improvement of air quality

Basic supply infrastructure

Modification of the existing barge to incorporate LNG tanks, 1,200 m3 capacity, and supply mechanisms to ships
Initiative of FLOTA SUARDIAZ



Dedicated LNG berth to supply small vessels and barges

Initiative of ENAGAS TRANSPORTE S.A.U.



2. The improvement of air quality

Promotion of LNG as a fuel for vessels

Incorporation of an auxiliary NG engine and LNG storage tank of 30 m3 on board

Initiative of BALEARIA and GAS NATURAL FENOSA



Construction and installation of NG engine on the wharf to supply electricity to the vessel

Initiative of FLOTA SUARDIAZ in collaboration with ports of Vigo, Tenerife and Barcelona



2. The improvement of air quality

To promote natural gas as an alternative fuel for trucks

Promotion of a LNG and CNG filling station



New concession for a gas station to supply LNG and CNG.

Transformation of 25 dual-fuel trucks



Transformation of 25 dual-fuel trucks
Projecte ECOMOBILITAT (RIS3CAT)
Lideratge projecte de R+D+I



2. The improvement of air quality

To promote natural gas as an alternative fuel for machinery terminal

Two pilot gasification Straddle Carriers



TCB: 76 diesel units, of which 55 operate normally.

BEST: 21 diesel-electric units (stage IIIa).

European project CORE LNGas hive
IDIADA + HAM + terminals + GNF + APB

To show our experience to the others

Intention to extend the machines gasification if the pilot works.



2. The improvement of air quality

Discounts to ships using LNG as a fuel

- ✓ 70% reduction in port dues if vessels uses natural gas for propulsion or while docked in port



2. The improvement of air quality

Regulation of bunkering operations TTS and STS in Port

Identification of risks for other terrestrial and maritime operations in the port



Operational requirements (docks, timetables, berthing of barge, BOF return,...)



Regulation of operations in port

Expected LNG penetration of new buildings in the future - Basic scenario
(DNV GL in-house library)

Vessel segment	Basic scenario				
	2016-20	2021-25	2026-30	2031-35	2036-50
1) Container ships	4%	7%	12%	15%	20%
2) Tankers	4%	8%	13%	16%	19%
3) Bulk carriers	4%	7%	12%	15%	19%
4) General cargo	4%	7%	12%	15%	20%
5) Car carriers	4%	7%	12%	15%	20%
6) Passenger ship	10%	25%	30%	35%	40%
7) Ro-Ro	10%	25%	30%	35%	40%
8) Ro-Pax	10%	25%	30%	35%	40%
9) Other	4%	7%	12%	15%	19%

Expected LNG penetration of new buildings in the future - Low scenario
(DNV GL in-house library)

Vessel segment	Low scenario				
	2016-20	2021-25	2026-30	2031-35	2036-50
1) Container ships	2%	4%	7%	10%	15%
2) Tankers	2%	4%	7%	10%	15%
3) Bulk carriers	2%	4%	7%	10%	15%
4) General cargo	2%	4%	7%	10%	15%
5) Car carriers	2%	4%	7%	10%	15%
6) Passenger ship	5%	10%	15%	20%	25%
7) Ro-Ro	5%	10%	15%	20%	25%
8) Ro-Pax	5%	10%	15%	20%	25%
9) Other	2%	4%	7%	10%	15%

Expected LNG penetration of new buildings in the future - High scenario
(DNV GL in-house library)

Vessel segment	High scenario				
	2016-20	2021-25	2026-30	2031-35	2036-50
1) Container ships	6%	11%	15%	18%	24%
2) Tankers	6%	11%	15%	18%	24%
3) Bulk carriers	6%	11%	15%	18%	24%
4) General cargo	6%	11%	15%	18%	24%
5) Car carriers	6%	11%	15%	18%	24%
6) Passenger ship	15%	30%	40%	45%	55%
7) Ro-Ro	15%	30%	40%	45%	55%
8) Ro-Pax	15%	30%	40%	45%	55%
9) Other	6%	11%	15%	18%	24%

2. The improvement of air quality

To bonus ships propelled with cleaner fuels

Bonus schemes have currently joined worldwide renowned for a 10% bonus rate ships

Rethinking ship bonuses considering environmental criteria

ENVIRONMENTAL SHIP INDEX (2011)



CLEAN SHIPPING INDEX (2007)



GREEN AWARD (2000)



To promote amending the law in order to environmentally bonus above 5% fixed the ships

Layover: 8000
Total of Ships: 1.639

Exhibition and audience

New bonus scheme application

2. The improvement of air quality

OPS

OPS from grid



- Cost of taxes and power disposition

"Línea directa" from CCC



- Legal and technical aspects
- Grid management (smart grid)

OPS from renewable or Natural gas



- Flexible solutions
- Limited capacity for responding to high demand
- Additional investments
- Batteries

2. The improvement of air quality

Electrify the internal car fleet

Incorporating electric vehicle in 2017



To have supply infrastructure in car parks.



To have 15 - 17 electric vehicles, 5 electric vans and 6 motorbikes.

- Objectives of environmental sustainability of the Port
- The improvement of air quality
- The improvement of water quality**
- The contribution to the sustainability of the supply chain

3. The improvement of water quality

Main pressures	Improvement actions	Result
Direct discharge from Port activities at the docks. Estimated annual volume: 600,000 m3	2000 and 2001: Construction of the Port's sewerage system. Investment of €30m. 36 km of network and 16 pumping stations	No direct discharges from docks to port waters since 2002
Downloads from the city's unitary sewerage system in case of high rainfall through 10 spillways. Estimated annual volume: 8m m3	1999. Improvements to prevent flooding in the city's unitary sewerage system (PECLAB 97) 2001. Improvements to prevent discharges into port waters (PECLAB 97) 2005. Improvements to prevent flooding and discharges into port waters (PECLAB 2003)	75% reduction in discharges during rainfall times
Mouth of the Llobregat river and collectors outside the port. Not estimable volume	2002 Start up Llobregat Wastewater Treatment Plant 2004 Diversion of Llobregat river	Improvement of coastal water quality and reduction in external inputs into port waters
Lower rate of water renewal in port area (about 17 days)	2003. Opening the new mouth (Nova Bocana Nord)	Improvement of port water renewal time from 17 to 7 days
Accidental discharge of wastewater or hydrocarbon from ship or shore terminals	Contingency Plan against accidental marine pollution Liquid waste collection from ships (Marpol service) Floating waste collection service on water's surface	Reduction in accidental discharge into port waters

3. The improvement of water quality

Contingency Plan against accidental marine pollution

Liquid waste collection from ships (Marpol service)

1999. Improvements to prevent flooding in the city's unitary sewerage system (PECLAB 97)

2001. Improvements to prevent discharges into port waters (PECLAB 97)

2005. Improvements to prevent flooding and discharges into port waters (PECLAB 2003)



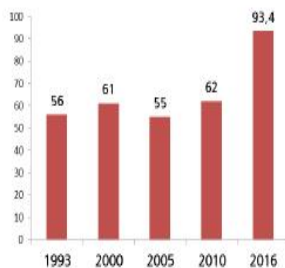
2002. Start up Uobregat Wastewater Treatment Plant

2000 and 2001. Construction of the Port's sewerage system. Investment of €30m. 36 km of network and 16 pumping stations

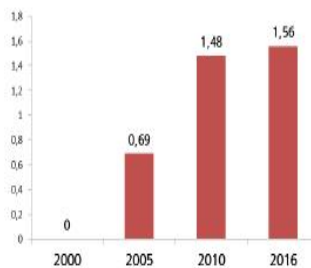
2003. Opening the new mouth (Nova Bocana Nord)

3. The improvement of water quality

Dissolved oxygen expressed in % of saturation
(Annual average Port Vell station, bottom water)

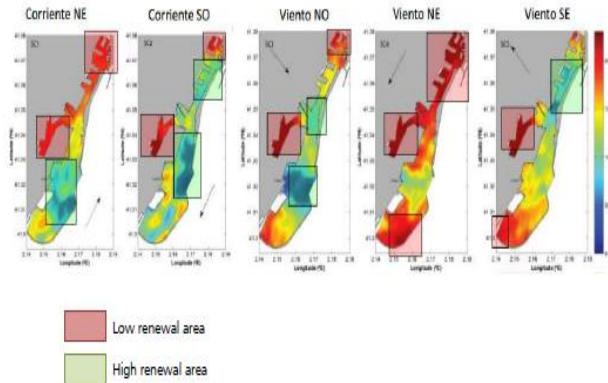


Benthic colony on sediments Poblacions bentòniques als sediments (Specific diversity in summer season, Port Vell station)



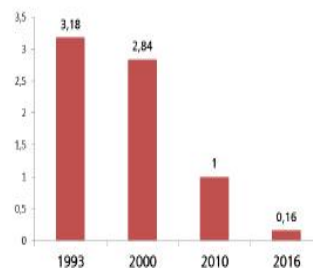
3. The improvement of water quality

With the new Mouth the renewal time of Port Vell water has gone from 17 days to 7 days



3. The improvement of water quality



Organic matter as DBO₅ (en mg/l)
(on surface water from Port Vell inside station, summer season)



1. Objectives of environmental sustainability of the Port
2. The improvement of air quality
3. The improvement of water quality
4. **The contribution to the sustainability of the supply chain**

4. The contribution to the sustainability of the supply chain

The Port sustainability commitment extends beyond the port and considers the multimodal supply chains in order to:

-  Minimize the impact related to goods
-  Contribute to the improvement of European logistics system



Promote and facilitate the change of supply chain into a more sustainable mode of transport of goods



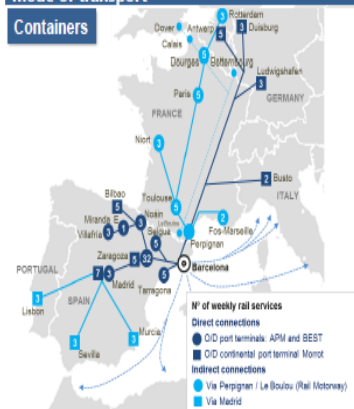
Commitment to become a Carbon neutral Port for goods



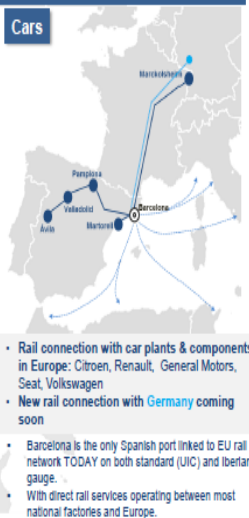
Encourage and promote cleaner alternative fuels for all modes of transport of goods

4. The contribution to the sustainability of the supply chain: more sustainable mode of transport

Containers



Cars



Bulk

Potash from Barcelona area (Súria and Sallent)
Caustic soda and ethylene dichloride from Barcelona area (Martorell)
Grain of corn from Tarragona

4. The contribution to the sustainability of the supply chain: more sustainable mode of transport

Rail port traffic 2016			
Cargo	Rail traffic	% var. 2015	% market share
Containers	225,996 TEU	+5.9%	12.5%
Cars	271,669 Un.	+2.9%	33.5 %

Spanish rail market share

5%

Container rail market share of other European ports. Containers	
Rotterdam	12%
Hamburg-Bremen	30%

50%
considering inland navigation



Port of Barcelona, rail port traffic by corridors :

73% Iberian corridor: Barcelona- Zaragoza-Madrid-Lisbon
10% South corridor: Barcelona- Tarragona- Valencia
13% North of Spain: Barcelona- Pamplona-Burgos



4. The contribution to the sustainability of the supply chain: more sustainable mode of transport

Savings in externalities from the Intermodal strategy of the Port of Barcelona in favour of rail traffic and SSS Services

Externalities generated by the volumes of cargo transported (M€)

Mode of transport	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016
Rail	7.52	7.18	3.09	3.45	5.61	7.52	7.18	7.53	9.31	11.93	12.37
Road (same cargo volume)	17.55	16.75	9.08	8.04	13.09	17.55	16.75	17.56	21.71	27.84	28.86
SSS	17.01	19.14	20.74	20.00	21.77	22.63	17.35	19.31	22.67	28.31	26.69
Road (same cargo volume)	93.50	105.08	113.90	112.54	122.34	126.97	97.93	108.66	127.12	157.54	149.60
Savings (M€)	86.52	95.52	98.35	97.13	108.05	114.36	90.14	99.38	116.85	145.14	139.4
Savings (%)	77.91%	78.40%	79.97%	80.55%	79.78%	79.14%	78.61%	78.73%	78.51%	78.29%	78.11%

Calculation made with the figures from the Handbook on external costs by DG MOVE.

Externalities: congestion, accidents, noise, air pollution, climate change, infrastructure..



4. The contribution to the sustainability of the supply chain: Carbon neutral Port

The GHG emissions are:

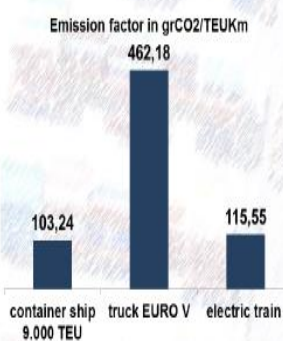
- ✓ GLOBAL: The effect of GHG is felt globally therefore it does not matter where emissions take place
- ✓ UNIVERSAL OR GENERAL: Almost all industrial, mobility and service activities have GHG emissions associated to them

The carbon footprint has therefore become a good indicator of environmental performance in relation to climate impact:

- Comparable for activities within the same sector and between sectors
- The scope can be established for each case according to the own aim
- It is broadly accepted

4. The contribution to the sustainability of the supply chain: Carbon neutral Port

Freight customers are increasingly concerned about the carbon footprint life cycle of their products



4. The contribution to the sustainability of the supply chain: Carbon neutral Port

Ports: Adopting strategies to reduce GHG emissions

Ports are links in most goods supply chains and therefore contribute to a higher or lower extension of the transport carbon footprint



Ports are nodal points of the network, with which it is possible to influence the modal choice of the chain



4. The contribution to the sustainability of the supply chain: Carbon neutral Port

Ports: Approach to the strategies of GHG emissions reduction

A territorial approach:
Inventorying all the GHGs emitted by all port activities

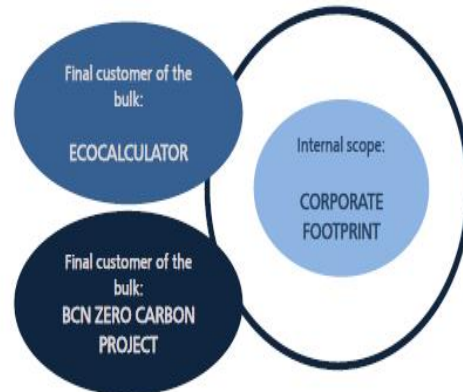


A supply chain approach:
Inventorying only activities related to the passage of goods through the port



4. The contribution to the sustainability of the supply chain: Carbon neutral Port

Port of Barcelona: A three-milestone strategy to reduce the GHG emissions caused by its activities

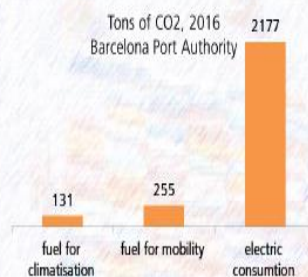


4. The contribution to the sustainability of the supply chain: Carbon neutral Port

Barcelona Port Authority has signed a voluntary agreement to reduce GHG emissions promoted by the Catalan Government through the Catalan Climate Change Office



Oficina Catalana
del Canvi Climàtic

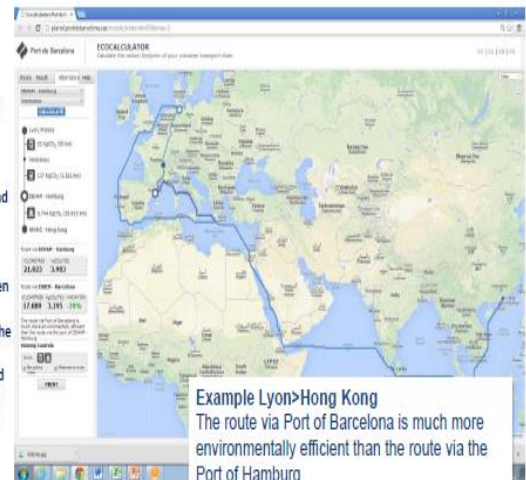


4. The contribution to the sustainability of the supply chain: Carbon neutral Port

Web tool for calculating emissions of CO₂ associated to a route of transport

- Maritime leg between the foreland port and hinterland localisation
- Land leg between the port of Barcelona and the hinterland location, by road or rail (last mile always by road)

Possibility to compare with a different European port of call



Try out on www.portdebarcelona.cat



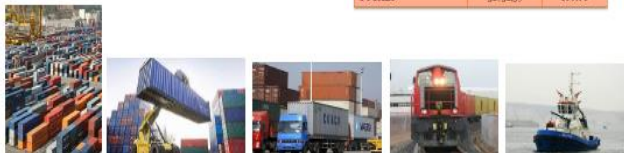
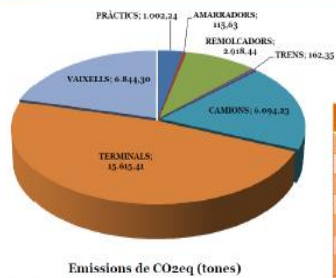
4. The contribution to the sustainability of the supply chain: Barcelona zero carbon

The BCN ZERO CARBON Programme:

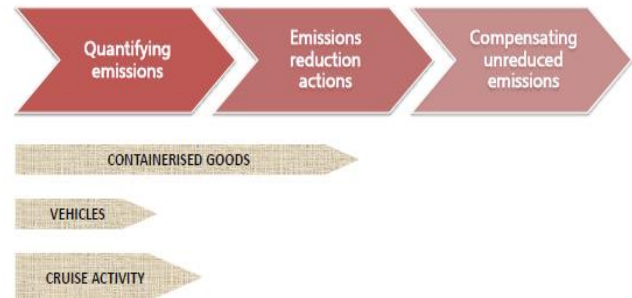
- ✓ A shared project between port terminals
- ✓ The aim: to neutralise CO₂ emissions generated as goods pass through the port in different ways



4. The contribution to the sustainability of the supply chain: Barcelona zero carbon

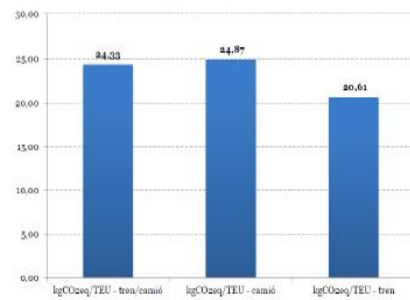


4. The contribution to the sustainability of the supply chain: Barcelona zero carbon



4. The contribution to the sustainability of the supply chain: Barcelona zero carbon

Emissions per TEU transported, considering current train/truck mix, transport by truck only or by train only



www.portdebarcelona.es

Thank you

