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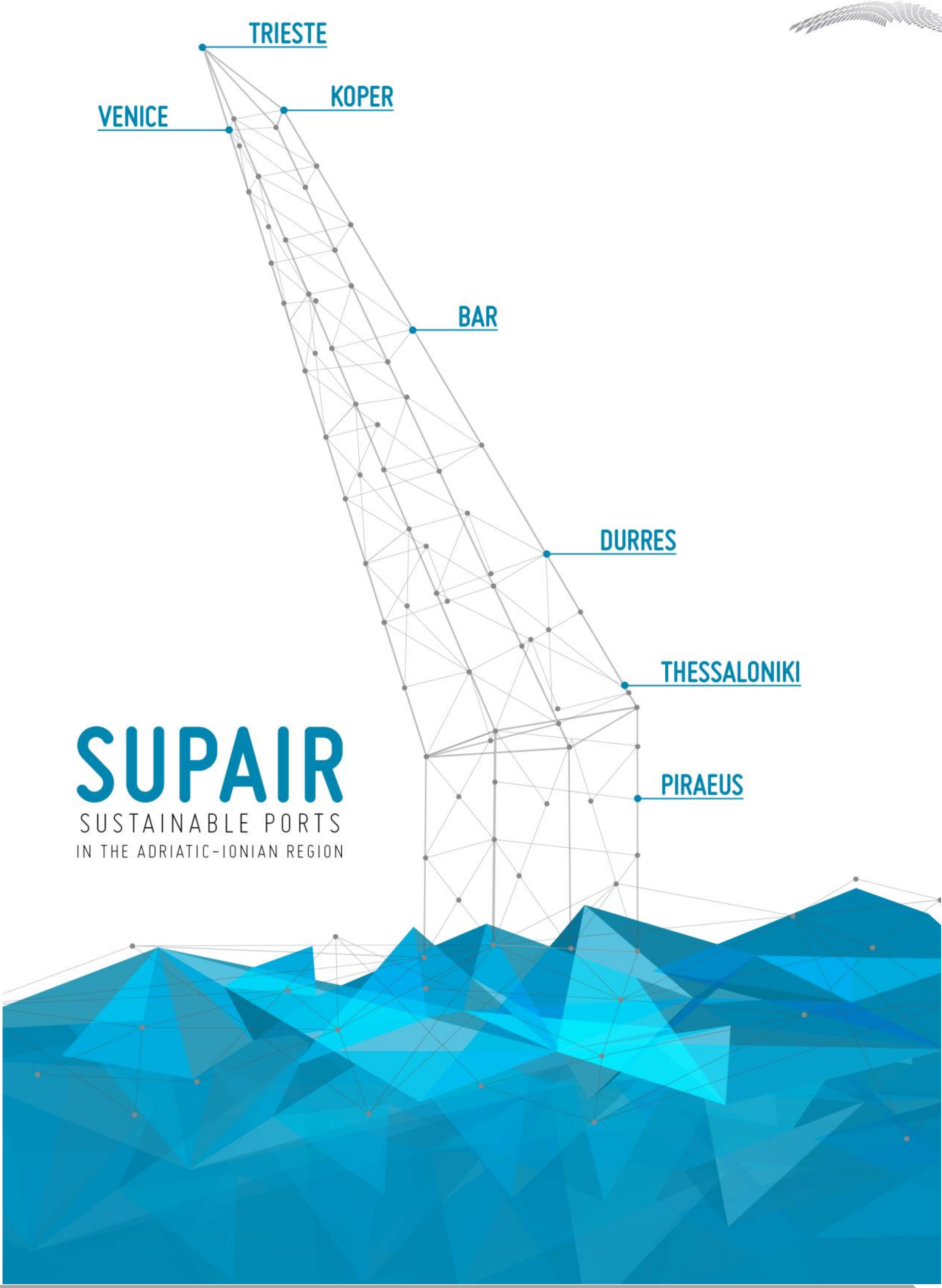

Sustainable and Low carbon Port Action Plan

AUTHOR/INSTITUTION: PPA

WPT1

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Description: The Action Plan provides the proper setting for the detailed description of the two interventions on which PPA will focus. For both interventions, a detailed mapping of existing port activities will be undertaken in order to assess existing inefficiencies and gaps and following a carbon footprint and energy assessment, the selected measures and technologies will be presented taking into consideration all available planning instruments at the local and regional level.

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Index

1. Definition of "sustainable port as a key element of wider low carbon strategies"

In recent years, the concept of "sustainability" is widespread and is applied in many sectors with primary objective to maintain change in a balanced trend, in which the exploitation of resources, the direction of investments, the orientation of technological development and institutional change are all in harmony and enhance both current and future potential with respect to human needs and the environment.

Seaports provide a variety of services which are mostly related to passenger and cargo transport. As trade and cargo volumes continue to grow internationally, ports around the globe are looking to new technologies to help manage resources in a more sustainable and cost-effective manner. Shipping is responsible for approximately 20% of global discharges of wastes and residues into the sea. The busiest the port is, the higher are the risks for suffering from pollution at the local level. That means, they represent a danger to environmental protection, as port is a conventional word which includes conflict between human act and the environment. Therefore, Directives of the European Union are directed to the "green" development of seaports, which implies a special attention to the energy efficiency and environmental protection. It can be said that the concept of a "green" and sustainable development is identified as of mutual dependence. Furthermore, transportation is closely related to the concept of "green" development and sustainability as seaports serve as key transport nodes.

In 2017 the port of Rotterdam launched a campaign called "Building a Sustainable Port" highlighting how sustainability in ports does not mean focusing on environmental issues only, rather it should aim at making the port safe, healthy and attractive. In particular, sustainability should be directed towards the creation of economic and social value. Three major features of port sustainability are envisaged, namely: Safe & Health Environment, Climate & Energy and People & Employment. Consequently, the port should focus on areas such as water safety, solar power and port welfare. In the port of Rotterdam, a Sustainability Day is celebrated on October 10th.

Based on the above analysis, the Port of Piraeus realised a Focus Group with the aim to discuss the concept of sustainable port at national and international level related to the priorities of PPA, as set in the SUPAIR project. The stakeholders of the Focus Group attempted to form a definition of a sustainable port which shows clearly the parameters of their needs:

"Ports are the main pillars of supply chain; therefore they should apply the principles of sustainable development with particular emphasis on environmental protection, which is now directly linked to the economic viability and growth of each activity"

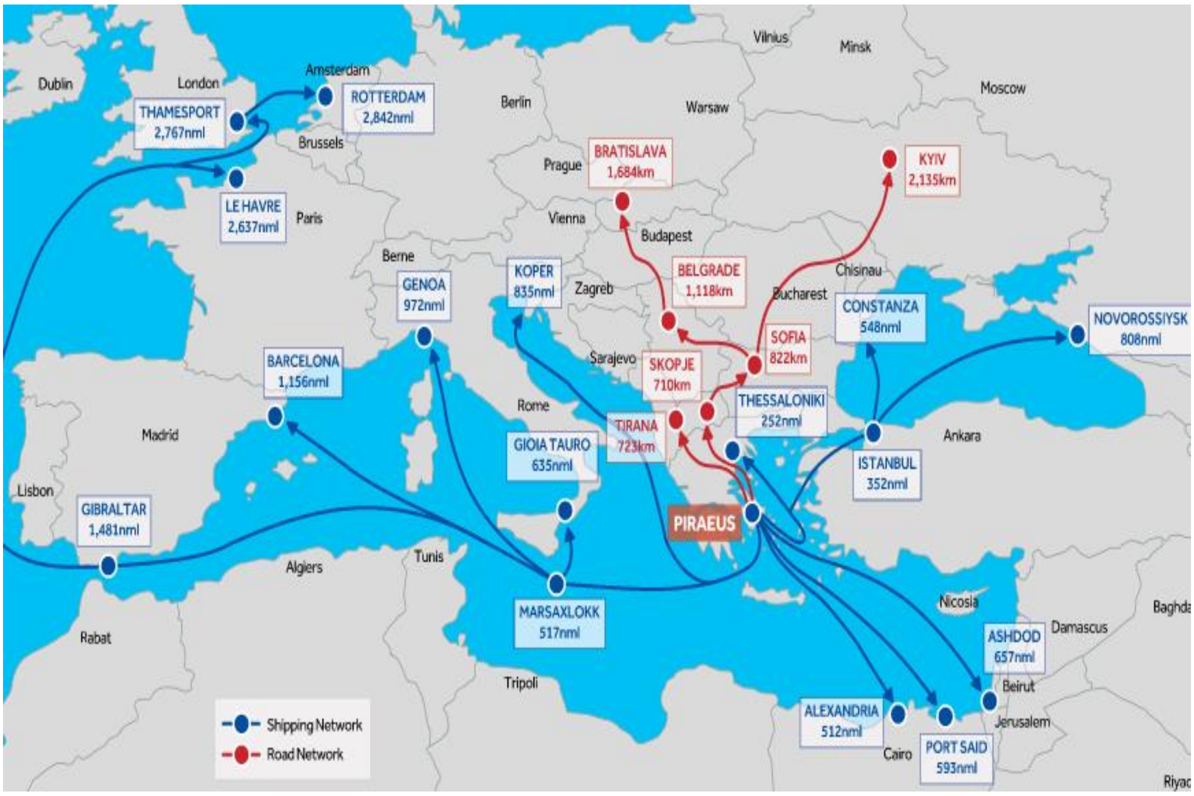
Deriving from the above definition, the concept of "Sustainable Port" requires an efficient organization and leadership, coherent policies and regulations, innovations and a management system of environmental protection, energy efficiency and sustainable development. Greek seaports should adopt a "greener" strategy and upgrade the existing operating system in order to minimize and eliminate the potential effects on environment. Therefore, Greek ports should aim to develop waste management and energy efficiency plans in order to protect the port area of waste from ships and daily port operations. However, the implementation of the aforementioned plans is not possible without establishing efficient cooperation between public bodies and private companies who are the key stakeholders for achieving sustainable operations and green development of the ports. Finally, the introduction of the concept of "Sustainable Port" is not only the protection of the environment but also includes achieving better working conditions considering the complexity characterizing port operations. It provides a clear definition of responsibilities and training of internal staff, who will work in a more environmental friendly area and with more environmental friendly equipment.

2. Understanding current port operations and management models

2.1 Overview of Piraeus Port Operations

Piraeus is the largest port in Greece and one of the largest ports in the Mediterranean and plays a crucial role in the development of international trade as well as the local and national economy. The port today has a range of activities concerning the Commercial and Central Ports, ship services and real estate development. It connects continental Greece with the islands and is an international cruise center and a commercial hub for the Mediterranean, providing services to ships of any type and size.

Piraeus is considered the natural port of Athens, just 10Km away from the capital, and it is the country's main gateway for imports and exports. It is the first European port after the Suez Canal with the necessary infrastructure to serve transit trade and overland transport. Situated near international trade routes, the port is a hub of international trade being the only European port in the East Mediterranean with the necessary infrastructure for the accommodation of transshipment cargo. The map, below, shows the strategic position of PPA and its distance from important international ports and road nodes.



Picture 2.1: Main connections of Piraeus Port

PPA SA serves all types of cargo (conventional and unitized) from all origins to all destinations (import-export and transshipment), passenger traffic in relation to both coastal and cruise lines, and also hosts vessel repair activities. In a glance, the port serves nearly 18 million passengers per annum, more than 2.0 million cruise passengers, approximately 0.5 million cars with more than 70% destined to other Mediterranean countries, and

2.7 million containers (TEU) per annum at two terminals. Its main comparative advantages are summarized in the following:

- Strategic geographical position at the crossroads of Asia - Africa – Europe.
- Infrastructure and natural depths for the accommodation of even the largest modern container ships.
- Operation under a free zone type II status.
- 24 hour - 365 day operation of the Container and Car Terminals.
- Scale of tariffs based on the volume of transshipment containers and cars.
- Competitive storage fees.
- Extended feeder services connecting the port with almost all main ports in the Mediterranean.
- Integrated information system supporting port operations.
- Operational and safety standards according to international regulations.
- Operating conditions and safety on the basis of international standards and regulations (ISPS).
- Certification by AEO - Authorized Economic Operator.
- Qualified and experienced staff for accommodating all port functions.
- Among the first ports in the Mediterranean to apply an Environmental Management System certified by PERS and ISO 14001.

2.1.1 PPA Facilities

The port facilities, in relation to the nature of activities conducted, include:

- the operation of four domestic passenger terminals and two cruise terminals,
- the operation of three container terminals (Piers I, II, III), including loading-unloading, transshipment and storage facilities of containerized cargo, as well as designated area for temporary storage of containerized dangerous goods,
- the operation of two car terminals, including storage facilities,
- the premises and land exploitation,
- the exploitation of the ship repair zone and four dry docks (two floating and two stationary).

The first four types of the aforementioned activities are under the direct operational responsibility of PPA SA. The management of the ship repair-zone and the dry docks is performed by subsidiary companies of PPA SA, while the relevant works and services on ships, are provided by private ships' repairing and building companies.

2.1.2 Coastal Shipping and Cruise

The Passenger Port is divided into areas that serve coast shipping and cruising. Regarding coastal shipping, the port has a throughput volume of about 20 million passengers per annum (including the ferry traffic between Salamis and Perama, which has a throughput volume of about 8 million passengers per year) and it serves as the main link between the mainland and the Aegean islands and Crete, while also being the main sea gate of the European Union at its southeastern edge.

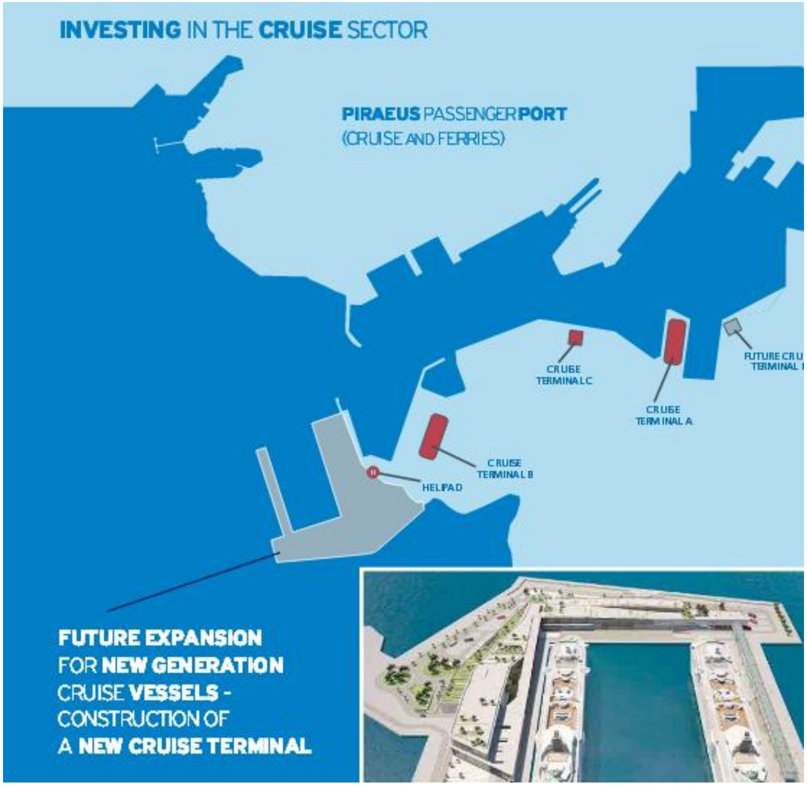
The anthropocentric nature of the services of the central port is a basic choice of PPA SA and in this context, an attempt is made to continuously upgrade services:

- Digital information displays for passengers, indoors and outdoors
- Pedestrian bridge

- Electric signs and free transport service within the port
- Improvement of passenger terminals- renovation of the passenger terminal at Tzelepis coast (approved).
- Construction of waiting areas with air conditioning and water coolers
- 3 km path for the disabled
- Reconstruction of a 350m^2 area at Kononos street
- 130 parking spaces
- 13 taxi stations
- 2 vehicle control points
- Alignment and boundary settings for traffic control

Concerning the cruise sector, the Port of Piraeus is an important destination for cruise ships in the Mediterranean Sea. It has 11 places for the simultaneous berthing of vessels and can accommodate even the largest cruise ships. For the purpose of servicing cruise passengers, the Port operates three Passenger Terminals which host duty free shops, Tourist Police, Customs office and other essential services for the passengers. Nearby, there is an open parking area for tourist coaches, while the transportation of passengers from the anchoring areas to the Passenger Terminal is provided for free by PPA SA transportation means. PPA SA objective is to attract a larger market share in the cruise field, in order to yield considerable benefits for the National Economy by creating new employment opportunities and increasing the income from tourist exchange currency.

PPA has designed the expansion of the cruise pier in order to expand its cruise services. The map below shows this planned extension.



Picture 2.2: Future Expansion of PPA’s Cruise Terminal

2.1.3 Container Terminals

The Container Terminal of the Piraeus Port Authority began its operation in June 2010. With a projected annual capacity of 1.000.000 TEUs, it constitutes the main pier for freight activities of PPA SA. The personnel of the Station have experience and expertise of more than twenty years, thus ensuring the provision of high quality port services. Both the technical staff and administrative staff are highly trained with expertise in both the operation of container terminals and the demands and peculiarities of the Greek market scene.

Container Terminal has facilities and equipment of high standards and has the ability to offer advanced services in loading & unloading containers. The mechanical equipment is of the latest technology, compiled of 7 gantry cranes (4 SPP), one (1) Mobile Crane and 8 RMGs. There are three berths; the East1 with 500m length and 18m depth, the East2 with 330m length and 11m depth, as well as the West one with 320m length and 12m depth.

2.1.4 General Cargo Terminal - Logistics Center

The Piraeus Port Authority serves the general cargo goods transported by truck T.I.R. lorries, as well as those moving through containers, but also train wagons, special features, or via the terminal with warehouse complex at Keratsini of Piraeus (former ODDY area).

The competitive advantages of the Logistics Center of PPA are:

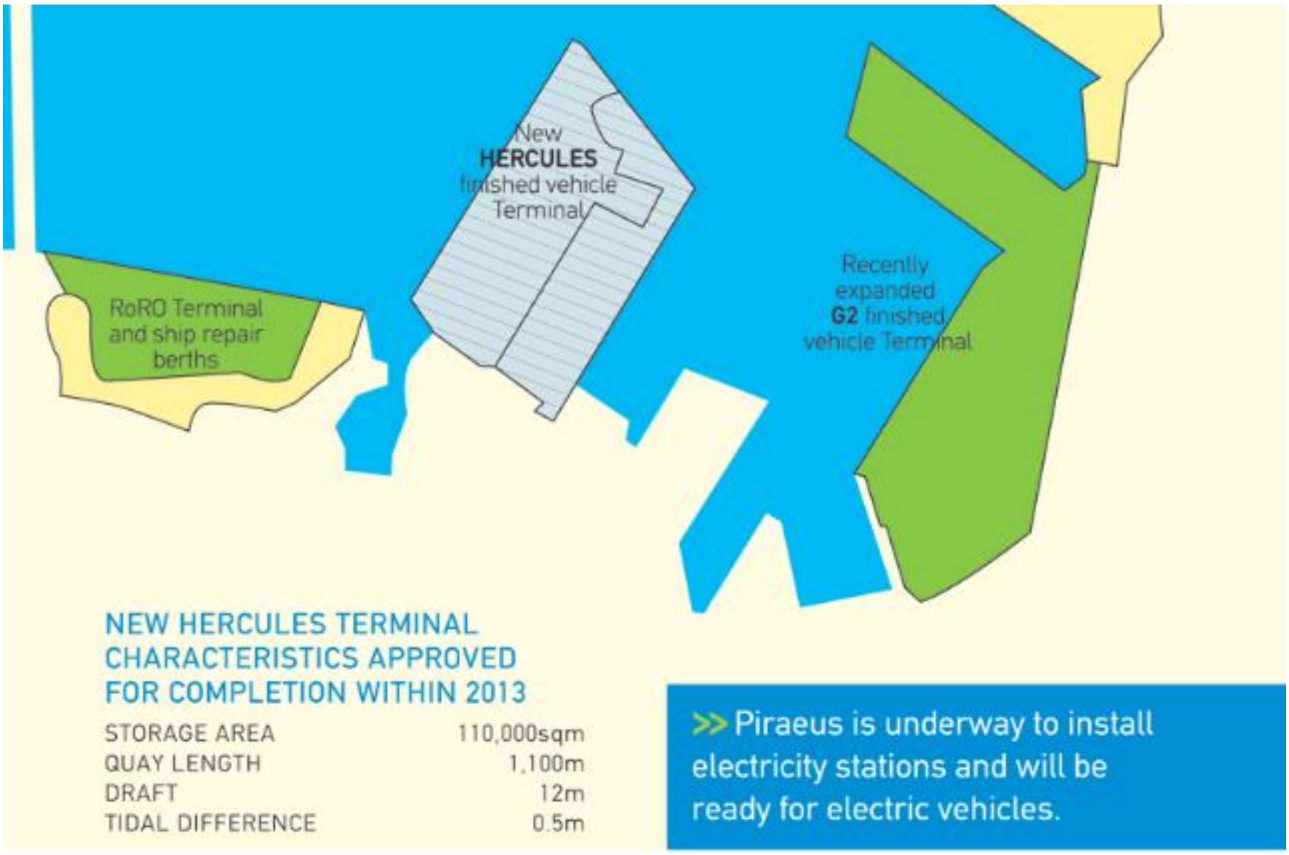
- The link of the facility space of warehouses with the National road network, whether the Nat. Road Athens - Corinth and consequently the Nat. Highway Corinth - Patras, either Nat. Road Athens - Lamia, able to facilitate all the business project forwarding.
- The easy connection with the urban fabric of the whole of the Attica region through the following avenues: Andreas Papandreou (from Piraeus to Keratsini), Republic (from Piraeus to Perama), Salamis - P.Ralli (from Keratsini to Nice), Gr. (From Keratsini up nat. Road Athens - Lamia) Schistou (from Keratsini to nat. Road Athens - Corinth), which facilitates the work and cost of receivers - importers in terms of rapid delivery and / or distribution of the goods to processors and / and retail sale of Attica.
- The comfort and traffic safety within the area of warehouses due to the large outdoor fenced area, able to facilitate the work of TIR drivers.
- The ease of transport, storage and distribution of goods coming from or destined for ships, railway or airport, enhancing capabilities of combined transport and intermodal transport chain, as well as reducing the time and cost of imports and exports.
- The direct vicinity of the Customs Services, G.CH.K., S.Y.K.E. etc., able to facilitate the work of customs officers and customs agents, which also reduces the time and costs of customs procedures and the receipt of goods.

2.1.5 Car Terminal

The operation of the car terminal in Piraeus was launched in 1995, in Drapetsona under G1 car terminal, along with the introduction of other conventional cargo in the warehouse of the region. With the demolition of the warehouse (2002), the entire area of 69.000m^2 was granted for the movement –storage of cars only, providing a storage capacity of 4.500 cars. From 1999, at N. Ikonio, under G2 car terminal, the first Car Carriers are served and the first cars are stored in 2.300 slots, in an area of 17.150m^2.

In 2005 the new Car Terminal, with an area of 74.000 m^2, begins operation, which resulted from sand - filling the port area of Karvounoskala. In 2009 the complex G8, 9 and 10 is demolished and the space is reserved for the Car Terminal. During the first half of 2011, with the modern requirements imposed by the international standards of car terminals, a new space of approximately 24.000 m^2 is created for the movement and storage of cars.

In 2011 the parking space of G1 terminal stood at 45.980 m^2, with capacity of 2.300 slots, after the grant of 21.860 m^2, for the interior Ro-Ro traffic, while in 2013 the construction of OSE's (Hellenic railway agency) port-side train station and its connection with the car terminal (G2) was completed.



Picture 2.3: Characteristics of Car Terminal of Piraeus Port

Additionally, the picture below shows the allocation of transshipment destinations for the Piraeus Car terminal.

Picture 2.4: Current transshipment operation in Piraeus Port Car Terminal

2.1.6 Utilization of land areas

PPA SA has areas and buildings in the portal region and non-portal regions which are available for concession. The usual concessions are as follows:

- Warehouses for food-supplies and general usage. Facilities: unrestricted 24hour loading and handling of goods. WC. Controlled entrance. Electricity supply.
- Outdoor areas for canteens.
- Cafes and Canteens.
- Outdoor areas for ticket kiosks / Ticket kiosks.
- Outdoor areas for kiosks, isoboxes and ATMs.
- Outdoor areas for various usage / Indoor areas / Offices / Stores.
- Plots of land and buildings for lease.

2.1.7 Ship Repair Zone

During the last 50 years, major infrastructure has been developed in the Ship Repairing Zone of Piraeus, leading to the continuous use of floating and drydocks and the establishment of around 475 relevant companies (200 steel and piping, 80 mechanical works, 70 painting & sandblasting, 50 electrical works, 20 wood works, 30 other, 25 yacht and mega-yacht shipyards), totaling around 5,000 employees, with about 500 million euros annual turnover in 2011.

The Ship Repairing Zone of Piraeus provides shipping tradition, history and expertise, excellent quality of work, skilled personnel, innovative products/special projects implementation, green technology products, European Union standards, solid infrastructure, safe environment (ISPS), effective time management, and average cost project delivery with high-value end-products.

2.2 Piraeus Port Environmental Management

2.2.1 Overall Environmental Management and Operations

PPA SA, being a leader in the Mediterranean area and having a beneficial geographical position in Europe, is in continuous development, according to the principles of sustainability and environmental protection. PPA SA applies an Integrated Quality & Environmental Management System in compliance with the requirements of the ISO 9001:2015 and ISO 14001:2015 standards.

The port's complex activities may result in the emergence of environmental issues, related to port-area water, noise and air quality. PPA recognizes that port activities and its commitment on providing cost-effective and competitive facilities and services could have impact on the environment. In this framework, PPA seeks to achieve long-term sustainable development by minimizing adverse emissions on the natural (air, land and water) and social environment, in all of its operations, activities and facilities. As such, PPA acknowledges the significance of environmental issues related to air, soil, noise and water quality and resources consumption. In this respect, priorities of PPA policy are the effective management of waste generated from port installations and ships, monitoring noise quality, in the entire port area, Passenger and Commercial terminals and monitoring air quality at the Passenger and Cruise Terminals. PPA is also environmentally sensitive and aware of all the environmental issues related to the development/expansion plans and works (current and future), the coastal resources and the need to monitor the adverse effects in the environment from ships, private companies and contractors that are facilitated and activated within the port area.

PPA SA has elaborated and implements an Environmental Policy, considering the European and National Environmental Legislation, as well as the International Environmental Regulations, whilst it has designed a specific mechanism for the evaluation of the environmental performance of port activities. PPA SA implements a well-advanced level of organization and environmental management, by means of the following actions:

- Environmental Management Standard
- Environmental Quality monitoring programs
- Ship-generated Waste Management Plan
- Marine Pollution Preparedness and Response Contingency Plan

1) <u>ECOPORT status – Environmental Management Standard Pers</u>

PPA SA has achieved an ''EcoPorts port'' status and has joined the Ecoports network since 2011. The Ecoports network consists of European ports that have self-assessed their environmental performance, according to the ESPO (European Sea Ports Organization) methodology, i.e. the Ecoport Self Diagnosis Method (SDM). The assessment criteria have been established by ESPO, based on the European port sector benchmark of environmental performance and the main requirements of international environmental standards, such as ISO 14001 and PERS (Port Environmental Review System).

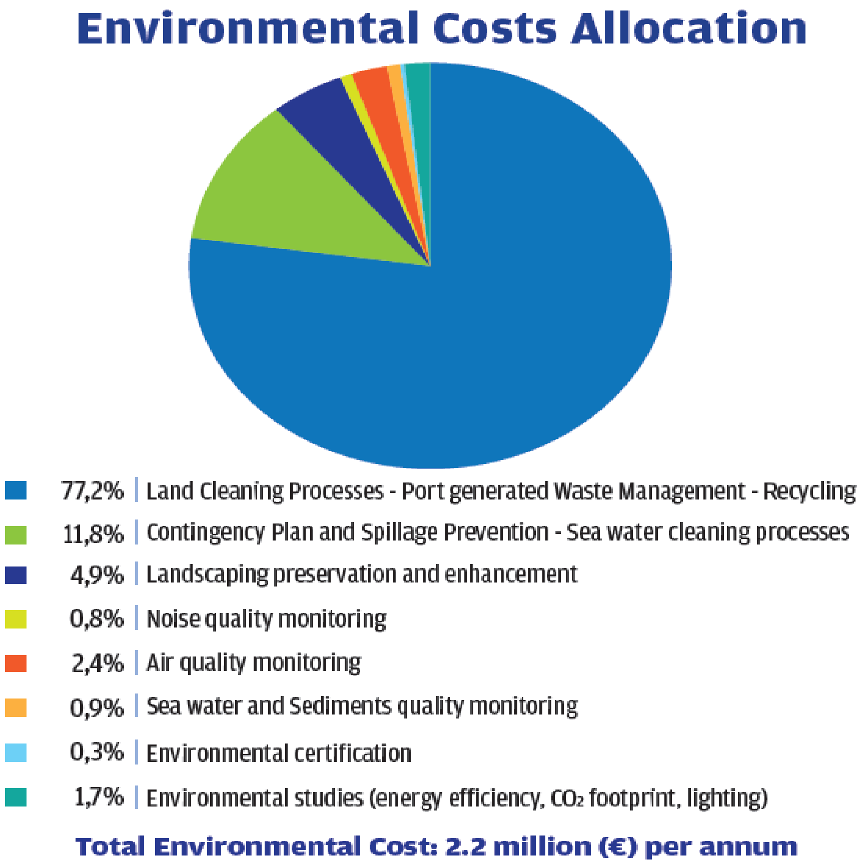
The Environmental Management Standard that PPA SA implements, has been certified since 2004, according to the European Environmental Management System PERS (Port Environmental Review System) of ESPO. Being developed by ESPO for ports, PERS is a well-established Environmental Management Standard within the

European port sector, designed to deliver effective port environmental management, whereas the organization of the environmental management system according to the PERS requirements is certified by the independent certification authority of Lloyd's Register.

In 2017, PPA has been recertified (for the fifth time since 2004) for the implementation of the Environmental Management System in line with the principles and the requirements of the revised edition of PERS (version 5). In the framework of PERS, PPA has elaborated and implements a specific Environmental Policy, whereas is in a continuous process for the registration of the environmental aspects related to its port activities and seeks for the continuous improvement of its environmental performance, according to European and international standards, in order to protect the environment and preserve the natural resources for future generations. Below, the picture shows the main environmental issues of Piraeus Port.

Picture 2.5: Piraeus Port Environmental Management

Additionally, Picture 2.6 below, presents the environmental cost allocation of the port showing which sectors face greater problems and which are priorities that the Port has set.



Picture 2.6: Piraeus Port Environmental Costs Allocation

2) <u>Environmental Quality Monitoring Programs</u>

PPA SA implements environmental quality monitoring programs in collaboration with universities and external experts. Monitoring results may indicate special areas and issues of concern, needing improvement. Thus, PPA SA can evaluate its environmental performance and take proper corrective measures when necessary. The table, below, summarizes the two recent research programs of the Port and identifies their expenditures.

Table 2.1: Research Environmental Programs of PPA

Research program	***COST (€)***	
	2017	***2016***
Acoustic Environment monitoring program for the total of PPA area	6.300	6.300
Station Installation, Measurement, Air Quality Monitoring and Measurements' Assessment in Port Area of PPA PIRAEUS_ ATMOSPHERIC ENVIRONMENT QUALITY MONITORING PROGRAMME	36.000	36.000

Specifically, PPA SA focuses on the following environment issues:

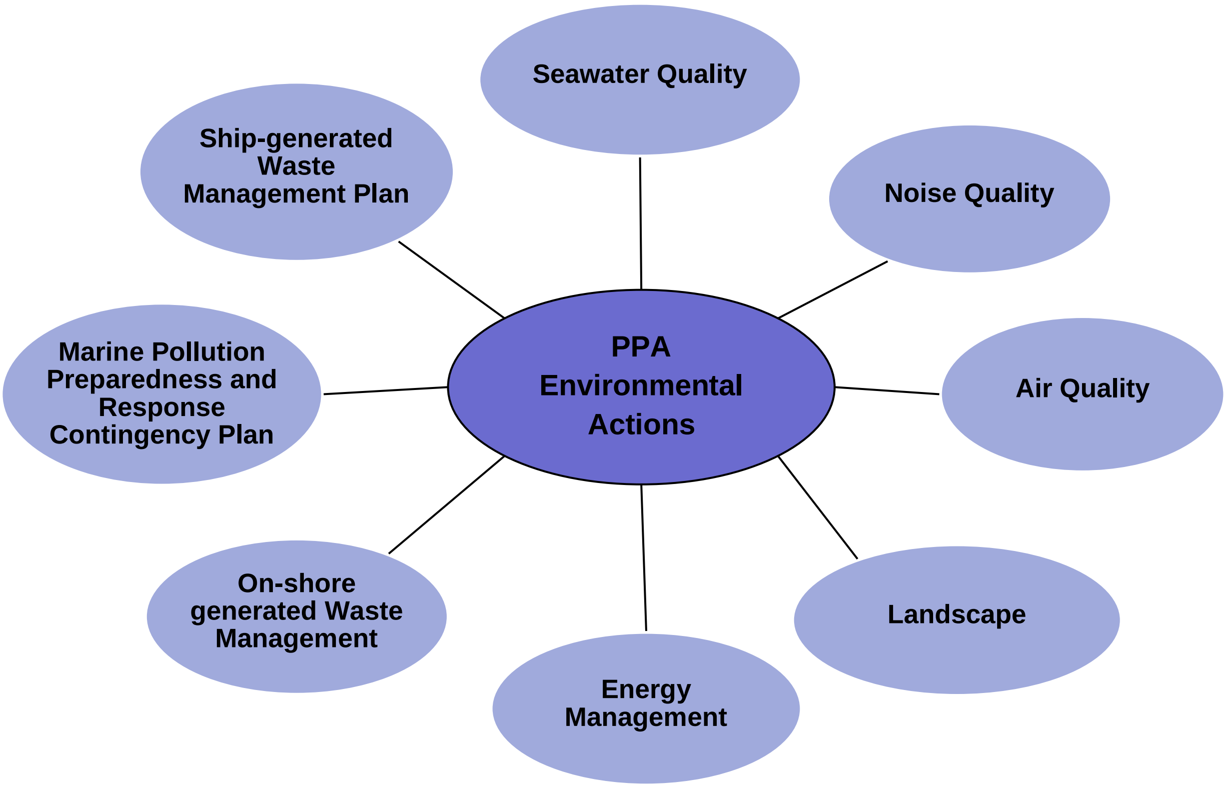


Figure 2.1: Piraeus Port Environmental Operations

3) Seawater Quality

In collaboration with University of Piraeus (Greece) and Cardiff University (UK), PPA SA implements a seawater quality monitoring program each year. Twice a year, seawater and sediment sampling take place within the entire PPA SA port area and collected samples are tested for marine pathogens and physical and chemical parameters. During dredging works within the port area of the Central Port (Passenger and Cruise Terminals), a special technical study was elaborated regarding the sound management of the dredged materials.

Picture 2.7: Surface seawater samples collected for testing

Picture 2.8: Sediment sample is collected from the seabed using a special grab

Additionally, PPA is reporting any pollution incidents that occurred both in the sea water and on the land.

Table 2.2: Annual Pollution Incidents in PPA

	2017	2016
Pollution incidents in the sea water (no of incidents)	18	14
Pollution incidents on the land (no of incidents)	1	5

The above data show that the last two years the number of pollution incidents remained constant (19 incidents). All incidents were small and local and were dealt without any problems, by implementing the contingency plan of PPA SA.

4) Noise Quality

PPA SA implements an acoustic environment quality monitoring program covering its entire port area. PPA SA has undertaken corrective actions after evaluating the results of noise level measurements and relevant noise studies.

Picture 2.9: Noise measurements at PPA SA container stevedoring area

The following table presents the locations and results of the noise measurements for the years 2016 and 2017. It is noted that the locations of the measurements are at the boundary of the ownership of PPA SA and are usually affected by road traffic outside the port. It is noticed that the noise level remains constant without significant variations per position in the last four semesters. It is also noted that in the yard of the 1st EPAL of Perama (position Θ05) PPA SA has placed sound panels. Measurements prove that the sound panels ensure the noise protection of the school [the noise is reduced by 10-15 dB (A)].

Table 2.3: Piraeus Port Indicative Noise Measurements

		A HALF 2017	B HALF 2017	A HALF 2016	B HALF 2016
a/a	**POSITION**	**Leq [dB(A]**	**Leq [dB(A]**	**Leq [dB(A]**	**Leq [dB(A]**
P01	Entrance-Exit Pier I Container Terminal (PPA)	68.4	67.4	68.9	67.0
P04	Property boundary close to the pubic road transit for trucks within Pier II (PCT)	75.6	69.7	72.5	72.2
P05a	PPA property boundary close to school	72.7	73.1	76.2	72.5
P05b	Behind screen in the courtyard of the school	59.9	61.0	60.0	62.4
P06a	Dimokratias Avenue close to Aegean petrol station	72.5	73.6	70.0	69.6
P06b	Dimokratias Avenue close to Jetoil facilities	74.7	72.5	74.6	72.7
P07	Nikolaidis Street (area ODDY)	73.4	75.7	72.3	74.2
P09	Akti Vasiliadi Street – Gate E1	59.5	58.2	59.6	70.4
P10	Akti Vasiliadi – Gate E2	68.8	69.3	70.2	61.3
P11	Akti Kallimasioti Street, PPA pedestrians' bridge (opposite HSAP)	69.8	66.0	64.4	64.7
P12	Akti Vasiliadi Street – Ministry of Shipping (under the bridge)	66.3	61.5	61.9	63.0
P13	Cruise Pier (gate)	64.2	60.5	63.5	74.2
P14	Property boundary close to the entrance for Container Terminal II (PCT)	64.4	63.6	65.4	71.7
P15	Property boundary close to the small harbor of Armos area	56.6	57.0	55.4	58.4
P16	Property boundary on entrance gate to Container Terminal II (PCT)	74.2	74.5	71.8	74.4
P17	Property boundary at Car Terminal	58.0	57.5	57.3	56.7
P20	Property boundary close to PCT entrance	64.3	64.0	68.7	68.6

In parallel, the enhancement of the plantation which takes place in the port's surrounding area, not only improves the area's aesthetics, but also contributes to noise absorption, even in places that are indirectly affected by noise caused by port activities.

5) Landscape

PPA SA has elaborated a Technical Study concerning the enhancement of the plantation in collaboration with the Agricultural University of Athens for the entire port land area, aiming at enhancing the area's aesthetics, improving the micro-climate through the removal of certain pollutants from the air and optimizing the plants' maintenance conditions, such as water saving, sound use of pesticides etc. PPA SA enhances the existing landscape by planting new local species of trees and bushes, such as Cercis silliquastrum, Ceratonia siliqua, Elaeagnus angustifolius, Rosmarinus officinallis, Nerium oleander etc., according to the Technical Study outcomes. Thus, PPA SA contributes to the improvement of the micro-climate and the aesthetics of the surrounding urban area and achieves a better quality of life in the entire area.

Picture 2.10: New plantings in the Ikonio-Perama area, near the new PPA SA Container Terminal (Pier I)

6) <u>On-shore Generated Waste Management</u>

PPA SA has organized and implements an on-shore generated Waste Management System for the on-shore generated waste (in offices, workshops, passenger terminals, warehouses etc.), according to which, waste segregation and recycling takes place.

Office-generated waste is:

- Paper –Glass – Packages
- Empty ink cartridges & toners
- Portable batteries and accumulators
- Waste Electrical and Electronic Equipment (WEEE)

Workshop and in other areas-generated waste is:

- Used Lubricating Oils
- Vehicles and other industrial type accumulators
- Waste Electrical and Electronic Equipment (WEEE)
- Vehicle and machinery tires
- Timber
- Workshop operational waste
- Dry docks (stationary and floating) operational waste
- Scrap
- Excavation, construction and demolition waste

For the implementation of the PPA SA on-shore generated Waste Management System, PPA SA collaborates with Alternative Waste Management Systems and private waste collection companies, authorized by the relevant competent authorities, ensuring high cleanliness standards at the waste collection spots, where proper waste collection bins have been placed, the avoidance of overflowing waste and the constant awareness of employees and port users.

Picture 2.11: Waste collection bins placed within the PPA SA port area

The following table presents the waste produced from port facilities operation showing the waste with the higher value and importance.

Table 2.4: Measurements of waste production in Piraeus Port

	2017	2016	2017	2016
	ton	ton	% Total Year Waste	% Total Year Waste
Quantity of non-hazardous waste	1,022	1,248	**76.10**	**76.33**
Quantity of hazardous waste	57	123	**4.24**	**7.52**
Operational waste of PPA plants driven to recovery	158	179	**11.76**	**10.95**
Recyclable packaging (paper, plastic, glass, metal)	106	85	**7.89**	**5.20**
Year Total	**1,343**	**1,635**	**100.00**	**100.00**

As shown by the above data on waste, there are not significant differences between 2017 and 2016. There is, however, a slight improvement in waste management for 2017. Thus, in 2017, the quantity of hazardous waste produced at PPA has slightly decreased, which is an environmental progress. Also, in 2017, the quantities of packaging waste (blue bins) that were recycled had a small increase.

Additionally, the table below shows the waste quantities delivered to alternative management systems in years 2016 and 2017 (and are included in the "Operational waste of PPA plants driven to recovery" referred to in the above table).

Table 2.5: Comparison analysis of waste quantities in the last two years in Piraeus Port

	2017	2016	2017	2016
	ton	ton	% total waste quantities, produced by workshops, driven to alternative management systems	
Used Tires	0	5.02	0.00%	31.14%
Electrical & Electronic Eq. Waste	0.12	4.44	3.51%	27.52%
Used Batteries	2.05	2.24	62.05%	13.92%
Used Accumulators	0.02	0.07	0.07%	0.42%
Used Lubricants Oils	1.12	4.36	33.75%	27.01%
TOTAL	**3.31**	**16.13**	**100.00%**	**100.00%**

It should be noted that the quantities of alternative management waste produced in 2017 are lower than in 2016, which is attributed to the following factors:

- No need for used tires delivery. Has to be note that during the year there was production of used tires but in limited quantities and the further management will take place when adequate quantities of tires will be generated.
- For the waste of Electrical and Electronic Alternative Equipment, a management system that is including temporary storage in container has been implemented. After the filling of the container follows the delivery for further management, in the year 2017 there was need for further management, except for the category of lighting equipment waste.
- The used batteries were of limited production, with the consequent reduced quantities for further management.

7) <u>Ship-Generated Waste Management Plan</u>

PPA SA has elaborated and implements a Ship-generated Waste Management Plan, in line with the European Directive 2000/59/EC on port reception facilities for ship-generated waste and cargo residues, as embodied in Greek Legislation, as well as according to the International Convention Marpol 73/78 for the Prevention of Pollution from Ships. Through the implementation of this Plan, PPA SA aims at the reduction of discharges into the sea and especially of illegal discharges of ship-generated waste and cargo residues from ships calling at the port, by improving the availability and use of port reception facilities, thereby enhancing the protection of the marine environment. PPA SA Ship-generated Waste Management Plan applies to all ships, calling at PPA SA port area, irrespective of the flag they fly. According to this Plan, PPA SA provides port reception facilities, adequate to meet the needs of all kind of ships that normally call at PPA SA port area, without causing them undue delay. PPA SA, while designing its port reception facilities, takes into consideration the type of ships that normally call

at its port area, their operating needs and estimates both the type and amount of waste and cargo residues they generate, in order to ensure the adequacy of the PPA SA port reception facilities.
In the PPA SA Ship-generated Waste Management Plan, waste and cargo residues are categorized according to the International Convention Marpol 73/78, as follows:

- Annex I: Oily waste
- Annex II: Noxious liquid substances carried in bulk
- Annex III: Harmful substances carried in packaged form
- Annex IV: Sewage
- Annex V: Garbage
- Annex VI: Ozone-depleting substances

PPA SA provides port reception facilities for all the above-mentioned types of waste and cargo residues, according to the PPA SA Ship-generated Waste Management Plan.

According to this Plan, the ship-generated waste management is divided in:

- Liquid waste management
- Solid waste management

Liquid waste is:

- Oily waste (Annex I), including crude oil, fuel oil, sludge and oil refined products, other than petrochemicals, vegetable and animal oil. Oily waste can also be divided in:
- Oily waste generated in the engine department of any type of ship, including used lubricating oil, fuel residues, sludge and oily bilge water,
- Oily waste generated in ship tanks, including oil cargo residues, oily tank washings, dirty ballast water etc.
- Noxious liquid substances carried in bulk (Annex II), including noxious liquid cargo residues, tank washings and dirty ballast water.
- Harmful liquid substances carried in packaged form (Annex III)
- Sewage (Annex IV), generated from ship lavatories, kitchen areas etc.

Solid waste is:

- Domestic waste (Annex V): food waste, packaging materials (plastic, cans etc.), medical wastes, bottles, paper, glass, plastic etc.
- Operational waste (Annex V), including maintenance waste (machinery maintenance remains, broken parts, rust, oily rags, paint, packaging materials, cargo residues etc.), cargo-associated waste (pallets etc.) and other harmful solid waste (ash of onboard garbage incineration etc.)
- Harmful solid substances carried in packaged form (Annex III)

PPA SA has also organized the Port Reception Facilities Department in order to ensure the effective operation of the PPA SA port reception facilities. An innovative technology on the sewage reception services is applied in the Cruise area. More specific, a permanent sewage network is operated in this area and the cruise ships calling at PPA SA Cruise Terminal may discharge their sewage by connecting to this permanent network, which connects to the urban sewage network with final recipient the Wastewater Treatment Plant of Athens in Psittallia. This permanent port sewage reception network was constructed to meet the increased needs of cruise ships visiting the port during the Olympic Games ''Athens 2004'' and since then many cruise ships have benefitted saving discharge time. Saving of energy and fuel, reduction of air emissions and traffic congestion avoidance are also achieved, compared to the delivery of cruise ship-generated sewage on tanker trucks.

8) Marine Pollution Preparedness and Response Contingency Plan

The International Convention for the Prevention of Pollution from Ships, 1973 as modified by the Protocol of 1978, known as Marpol 73/78, specifies the Mediterranean Sea as 'special area' within which any discharge of oil, chemical substances or other solid and liquid waste is forbidden. Each year, million tons of oil and general cargo are shipped via the Mediterranean Sea. Although preventive measures are taken, during those shipments, accidents do occur (e.g. collision, grounding, cargo transfer failure etc.) causing marine pollution, known also as accidental pollution. This kind of pollution is usually caused when large quantities of oil or chemical substances are spilled into the marine environment and therefore the effective management of these incidents is crucial for the impact caused on both the marine environment and the society. Response from the authorities must be immediate and effective.

PPA SA, operating according to the provisions of the Protocol on Preparedness, Response and Co-operation to pollution incidents by Hazardous and Noxious Substances, as to the OPRC Convention and to the Greek legislation, has adopted and implements a Marine Pollution Contingency Plan for oil, hazardous and noxious substances, approved by the local Port State for the preparedness and response to oil, hazardous and noxious substances marine pollution incidents from shipping and offshore installations within the PPA SA port area. This Plan is in line with the National Legislation and compatible with the Local Contingency Plan of the local Port State and the National Contingency Plan, as well.

Picture 2.12: Response to an oil pollution incident by using absorbents and floating barriers within the PPA SA port area

Finally, PPA, as a high developed company, takes into consideration the social impacts of port operations and it investigates any submitted complaint by residents. Two complaints about noise nuisance in year 2016 and 1 complaint about noise nuisance in the year 2017, focused on the adjacent Container Terminal area. Regarding the complaints submitted by residents of the area neighboring to the Container Stations, they were thoroughly investigated by PPA SA. In relation with the complaints submitted targeted night measurements were carried out in similar operating conditions with those that were described, which confirmed the results of the main monitoring program and in particular, the following results were obtained:

a) The measurements' results are directly influenced by the traffic of the Dimokratias Avenue, which is very close to the houses.
b) While in particular during the night hours the operation of the port (loading, stowage, Straddle Carriers' movement etc.) becomes audibly perceived to the houses in a lower degree comparatively to the neighboring street.

2.2.2 Air Quality

Climate change and greenhouse effect are major issues that concern our society. Anthropogenic activities are regarded as the main source of carbon emissions, which contribute to the greenhouse effect and solutions that will lead to the effective mitigation of this problem, are sought. PPA SA, acknowledging the severity of this issue and although its activities do not relate directly to it, has initiated and implements a pilot quality monitoring program of the atmospheric environment in the port area, taking into consideration both direct and indirect port activities. In order to implement this monitoring program, an Air Quality Monitoring Station has been installed in the N-NW area of the Central Piraeus Port (Passenger and Cruise Terminals), in collaboration with the National Technical University of Athens (NTUA – School of Chemical Engineers), fully equipped for the inventory of air pollutants' concentrations on 24 hour basis. The aim is, by assessing the monitoring station inventories, to provide useful information about the levels and distribution of air pollutants in the atmosphere, as well as to identify the main air pollutant sources.

Picture 2.13: The Air Quality Monitoring Station in PPA SA port area.

Picture 2.14: Inventory instruments in the PPA SA Air Pollutants Monitoring Station.

The following table shows the results of the measurements of the main air pollutants for the years 2016 and 2017. It is noted that there are no significant variations between these two years.

Table 2.6: Measurements of air pollutants in Piraeus Port

Atmospheric pollutant	Average annual rate **2017**	Average annual rate **2016**
	µg m-3	µg m-3
CO	1.30	1.02
NO	77.00	75.00
NO2	48.00	45.00
SO2	26.00	20.70
PM10	34.00	35.00
O3	48.00	43.00

2.2.3 Energy Management

PPA SA recognizes that the resources consumption must be used in an efficient way across the port sector. Port of Piraeus' nature and size favors a high amount of daily energy consumed (e.g. ship-to-shore cranes, terminals lighting, reefer containers, administration buildings, workshops). PPA raises awareness on the subject by promoting initiatives and behaviors to improve the balance of the demand and supply of energy and to reduce energy consumption. Firstly, PPA SA raises the awareness of its employees regarding good practices for energy saving, while PPA SA implements energy saving measures by means of:

- purchasing electrical equipment depending on the energy class and certification
- scheduled and frequent maintenance of cooling and heating infrastructures
- replacement of incandescent lamps with energy saving ones
- Improvement of buildings' energy efficiency

In parallel, PPA SA seeks ways of deriving energy savings in buildings and therefore has constructed a green roof on the top of the new office building at the PPA SA Container Terminal (Pier I), where plant species, such as Levandula, Rosmarinus officinallis etc., have been planted. Thus, PPA SA achieves reduction of the building's energy demands, for both heating in the winter and cooling in the summer. The green roof consists also an aesthetics element of the building, improving the view of the residents in the upwards Perama area.

Picture 2.15: Green roof on the top of the new office building at PPA SA Container Terminal (Pier I)

PPA SA also schedules actions for the evaluation of its buildings' energy efficiency, whilst at the moment is studying the implementation of Renewable Energy Resources (RES) projects. In this scope, PPA's first photovoltaic station generating energy using solar panels has been put into operation since July 2016, generating up to 430 kWp. The photovoltaic Station is linked up to the Public Power Corporation electricity grid.

Below, the table shows the energy production of renewable energy sources (Container terminal 430KWp photovoltaic power station) for the last two years.

Table 2.7: Production of renewable energy (Container terminal 430KWp photovoltaic power station)

	2017	**2016 (8th -12th)**
Total energy efficiency (kWh)	757,672	265,861
Emissions' Reduction CO_2 (tn)	644	226

2.3 SWOT Analysis

The above presentation of Port of Piraeus provides a general view of both PPA dynamics and problems in order to underline the main needs and opportunities of the port in relation with current international and national socio-economic and technological status. Two SWOT analyses are presented below with the aim to diagnose the benefits and constraints of the port operations and the two environmental interventions selected by PPA for its action plan respectively. The first SWOT focuses on the overall port operations and strategies as defined by PPA S.A. and the second focuses on the two environmental interventions selected by PPA for its action plan.

Strengths:

- Geographical position centrally located in the eastern Mediterranean.
- Providing all port services.
- Range of activities.
- Big natural depths and access channels.
- Proximity to Athens, the largest consumer center in Greece.
- Longtime experience executives and staff.
- Longtime profitable management.

Weaknesses:

- Border with cities with limited availability of new land areas.
- Significant dependence on a small number of customers in certain activities.
- Inability for staff renewal.
- Weaknesses arising from the dual nature of the company in relation to goal setting, strategic direction and operation.

Opportunities:

- High international fuel price.
- Stable political environment.
- Expected recovery in international trade following address of the European and national crisis.
- Funds provided from NSRF.
- New rail connection with the Balkans and Central Europe.
- Increase of the ships size.

Threats:

- Port intensifying competition with infrastructure development outside the EU.
- Competition from low-wage countries outside the EU.
- Standing competition cities - port to use land areas.
- Increase of the international market concentration in a small number of potential and existing customers.

Figure 2.2: SWOT analysis of Piraeus Port on operations and strategic development

STRENGTHS	WEAKNESSES
• Existing strong environmental sustainability through the Integrated Quality & Environmental Management System in compliance with the requirements of the ISO 9001:2015 and ISO 14001:2015 standards. • Contribution to a sustainable port image (from a commercial and marketing point of view). • Reduction of negative environmental externalities inside and outside the port area; • Contribution to reaching emission reduction in the port area and/or port city area - compliance with air quality targets. • Increase of environmental awareness inside the port managing body in a cross-functional way (finance, marketing, environmental departments are all involved – in principle).	• Selection of most appropriate method for monitoring the impact of the two interventions – wide range of solutions not always adaptable from all bodies. • Administrative complexity: Requirement of additional human resources to monitor closely the developed mitigation system. • Adapting additional operations into the global tariff of port services. • Increase in investment costs due to the inclusion of environmental measures in charging schemes.
OPPORTUNITIES	**THREATS**
• Development of new services and products linked to environmental performance, thereby increasing port competitiveness • Foster partnerships and dialogue between stakeholders (operators, managing bodies, shipping lines, local communities) to develop further research and development to limit environmental externalities; • Complement and possibly reduce the need or intensity of regulatory initiatives at IMO or EU level to reduce pollution and/or carbon emissions from shipping. • Raise the environmental profile of short sea shipping as an alternative to congested land transport corridors.	• Lack of autonomy in tariff setting preventing both the development of such schemes and/or changes / learning from results. • No universally accepted system to determine the environmental impacts in port. • Increase of transport costs of the European industry / economy (if badly implemented) and/or loss of connectivity.

Figure 2.3: SWOT analysis for two environmental interventions covering carbon footprint and energy management

3. Stakeholder consultation

In the framework of the first activity of the SUPAIR project, the first meeting between operators and PPA SA was held on April 23, 2018 at the premises of the latter. The main subject of the meeting was the challenges and opportunities associated with taking measures for sustainable, less carbonized ports. The meeting was moderated by Mr. Elias Bellos, a journalist from a national newspaper, with extensive expertise in the field and real competence in coordinating round tables and interactive conferences.

The Agenda of the Focus Group was designed taking into consideration the main objectives to be achieved related to the development of a carbon footprint system and energy management in the port area. More specifically, it consisted of four separate sessions covering carbon footprint and energy management through a 5-step approach: 1) identify and present the impact of port environmental issues to stakeholders directly or indirectly related and/or affected by them, 2) assist in the management of environmental issues and needs as part of a corporate responsibility commitment, 3) gain support and enhance cooperation introducing common measures of actions with stakeholders, 4) provide greater understanding of the effects of environmental performance on a port, local, regional and national level, 5) potentially improve port environmental measures and adapt new ones taking into account additional external impacts. The Sessions presented were the following:

- Session I - SUPAIR Project: Presentation of the SUPAIR project and the strategies and priorities of PPA towards a more environmental friendly management system
- Session II - Development of a carbon footprint system: Presentation of exisitng practices within PPA and future planning strategies, analysis of optimised applicaitons and techniques
- Session III - Development of an energy management action plan: Presentation of exisitng practices within PPA and future planning strategies, analysis of optimised applicaitons and techniques
- Session IV - Concluding discussions: Discussion on the main items presented and comparative analysis of the various techniques in the two sectors.

An english overall translation of the detailed agenda is provided herewith:

Thematic Session I: Information about the project SUPAIR • Presentation of SUPAIR and its main targets • Presentation of the Focus Group's objective • Presentation of PPA's priorities - Identification of port harmonization issues and strategic plans • Presentation of participants
Thematic Session II: Development of Carbon footprint system • Presentation of environmental port activities - Port-Ships • Applied practices for the reduction of pollution - Deficits and Prospects • Investigation of best practices to reduce pollutants • Environmental objectives and solutions of modern port organization, operation and development • Discussion – Challenges and opportunities
Thematic Session III: Development of Energy Management Plan

• Existing energy management of PPA • Energy management at regional level • Energy management of ports • Implementation of technologies for the improvement of energy efficiency – electricity • Implementation of technologies for the improvement of energy efficiency – renewable forms of energy • Discussion – Challenges and Opportunities
<u>Conclusions</u> • Presentation of meeting results • Planning of next steps

The results of the Focus Group Meeting supported the development of the "Guidelines for Sustainable and Low-carbon Ports" (Deliverable T1.2.1). The meeting involved a wide spectrum of actors, all of them being active in the fields of carbon footprint and energy management, who managed to cover different aspects of the implementation of strategies and activities related to the priorities of the port. The Action Plan to be developed for the Port of Piraeus will focus on 2 key interventions:

1. Development of a system for the detailed calculation and assessment of the carbon footprint of port activities, with the aim to define existing inefficiencies and gaps and investigate, through a best practice review, appropriate measures for addressing them. Special attention will be paid to equipment fuel consumption and alternative fuels (e.g. CNG, LNG, etc.) while for the selected measures, the technical feasibility and financial sustainability will be assessed.

2. Establishment of an energy management plan, with the framework of which an energy mapping and consumption assessment process will be undertaken, enabling to identify the port's main energy consumers and define and prioritize, as a next step, promising technologies that can be implemented for improving the port's energy efficiency. Special attention will be paid to electrification (e.g. use of electric vehicles serving passengers from the cruise terminal) and the wider exploitation of RES (e.g. solar covering the energy requirements of port activities / buildings, etc.).

Different points of views were pointed out during the meeting when discussing challenges and opportunities for sustainable and low-carbon ports, as well as the coordination of port strategies with relevant local strategic plans such as regional transport plans, SEAPs, SECAPs and SUMPs (existing or under preparation). The dynamics of PPA were undelined during the meeting both for the passenger and container sectors showing that there is great need for sustainable interventions, actions and strategies for the port.

Additionally, a main parameter affecting environemntal perfomance at the port as an overall, is the absence of reliable recording data, upon which future port actions and strategies can be based. As far as the carbon footprint system is concerned, there is a need of a hybrid system that combines pollutant measurements and calculations to solve this issue of lack of accurate data .

PPA's identified needs towards an efficient carbon footprint system and an effective energy management plan following the discussion that was undertaken. More specifically, the following aspects were stressed out:

- efficient traffic management
- accessibility to the hinterland including rail connection
- sufficient parking areas
- renovation of diesel equipment in the port
- improvement of the quality of conventional fuels
- reduction of nitrogen oxides from ships as in Piraeus there is high concentration of NOx
- supply of electricity to the berths, specifying that these practices can reduce pollutants up to 90% but do not reduce the energy footprint of the port unless the port produces electricity from alternative sources
- use of alternative fuels such as LNG and promotion of natural gas, specifying that these practices can reduce sulfur by 90-100%, carbon dioxide by 25% and particulates by 70%
- use of scrubbers which extract SO_2 from fuel

As far as the carbon energy management is concerned, the mapping of energy consumption is considered by detailing the necessary data to be recorded for the development of the energy management action plan of a port. Within the meeting, various best practices and future actions were mentioned and analysed that can also be applied in PPA practices such as the concept of the port as an energy hub, energy bunkering where the port will have the space to store energy in the evening and provide it in the morning, Smart Grids, battery management system, and the concept of energy clouding, which is a solution when there is not enough energy storage space in ports.

Additionally, significant steps towards ship electrification are a) the reduction of electricity generation costs, a) the increase of use of renewable forms of energy and combination with energy storage (at local level), c) co-generation of electricity from clean fuels (eg LNG) and d) the development of focused solutions for the needs of the port such as mobile cold ironing, which can significantly reduce costs. To this point, a required significant action is the identification of the interest groups for the development of the required infrastructure and the provision of finacial incentives.

All above issues require the participation of various organisations and experts in order to achieve the expected outputs, therefore all participants pointed out the necessity for correct coordination and collaboration amongst involved bodies.

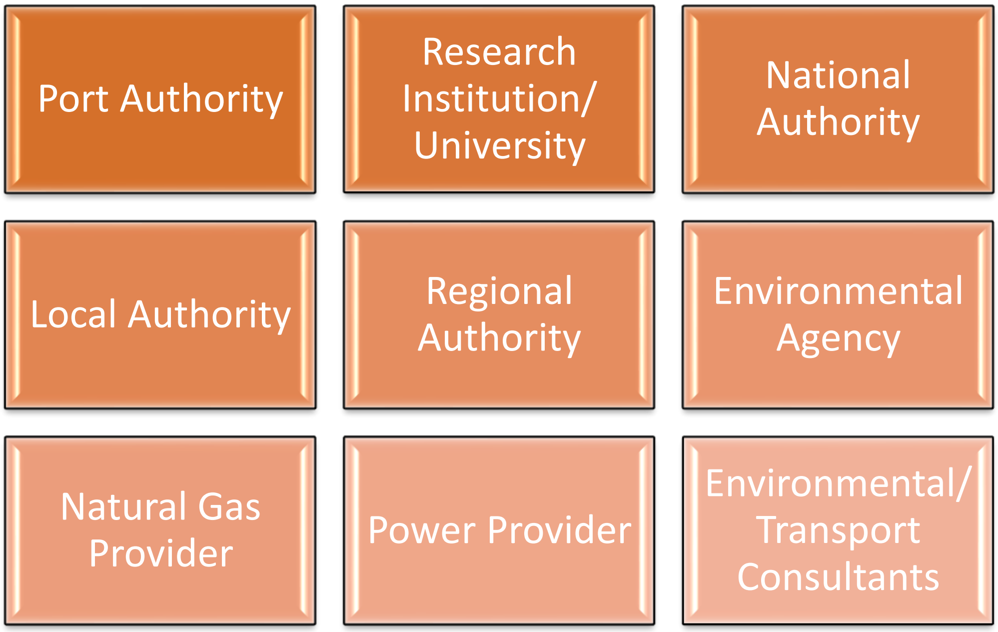


Figure 3.1: Stakeholder categories participating in Focus Group

The table, below, presents the stakeholders and identifies their contribution into the Focus Froup Meeting.

Table 3.1: Involvement of Focus Group stakeholders

STAKEHOLDER CATEGORY (i.e Privates: Shipper; Logistics operator; Forwarders; Carrier (road/rail/shipping); Terminal operator i.e. Public: Regional authority, Transport agency, etc.)	RELEVANT STAKEHOLDERS (Name of the Organization)	INVOLVED IN THE FOCUS GROUP (Yes or not)	Contribution of the Sustainable and Low-carbon Port	
			NEEDS (list 2/3 of the main relevant needs)	INVOLVEMENT IMPACT (Involvement: indicate if easy, medium, difficult Impact on the sector: indicate if small, medium, large)
PORT AUTHORITY	Piraeus Port Authority, Department of Environment	YES	- Sustainable port - Energy management/ monitoring system - Relationship with local community	Involvement: LARGE Impact: LARGE
RESEARCH INSTITUTION	CERTH	YES	- Sustainable ports - Energy management/consumption - Port development	Involvement: LARGE Impact: LARGE

NATIONAL AUTHORITY/MINISTRY	Ministry of Shipping and Island Policy	YES	- Sustainable ports - Air quality - Energy management/consumption	Involvement: MEDIUM Impact: MEDIUM
REGIONAL AUTHORITY	Region of Attica	YES	- Climate change - Air quality - Energy management/consumption	Involvement: MEDIUM Impact: MEDIUM
LOCAL AUTHORITY	Municipality of Piraeus	YES	- Relationship with local port authority - Air quality - Energy management/consumption	Involvement: MEDIUM Impact: LARGE
ENVIROMENTAL AGENCY	CRES	YES	- Energy Management - Air quality - Climate change	Involvement: MEDIUM Impact: MEDIUM
UNIVERSITY	NTUA	YES	- New technologies - Port development - Energy management/consumption	Involvement: LARGE Impact: LARGE
NATURAL GAS PROVIDER	DEPA	YES	- Energy management/consumption - Air quality	Involvement: MEDIUM Impact: LARGE
POWER PROVIDER	Public Power Corporation S.A.	YES	- Electrification of port operations - Energy management/consumption	Involvement: MEDIUM Impact: LARGE
ENVIRONMENTAL AND TRANSPORT CONSULTANT S	PPA CONSULTANTS	YES	- Energy management/consumption - Air quality - Port Development	Involvement: LARGE Impact: MEDIUM

4. Evaluation framework

The proposed evaluation framework is based on three principles, monitoring, review and evaluation, which are essential in order to measure the degree to which the developed Action Plan by the Piraeus Port Authority S.A. has realized its objectives and outputs and to observe its long-term effects. The evaluation framework provides the basis for accurate reporting and allows for the identification of best practices and bottlenecks, which can be used to devise new Action Plans as well as to adjust and tailor existing Action plans and strategies. The evaluation framework is a valuable planning and management tool supporting the design and review of objectives that have been set and the process of continuous learning which should be shared with the port staff and externally with relevant stakeholders and policy-decision makers. Therefore, it allows PPA to identify where they may have failed to have an impact or even where they have had an unintended negative impact.

Following the principles of results-based monitoring and evaluation, the evaluation framework provides step by step the methodology of effective structures and procedures for results-based monitoring, review, evaluation and report on Piraeus' Action Plans for becoming a low carbon port. More specifically, this chapter builds on section 3.4 of the Guidelines for Sustainable and Low-carbon Ports and describes in detail how, when and by whom effective review, monitoring and evaluation should be carried out. The proposed evaluation framework takes into consideration the national and international good practices and it promotes the concepts of a multi-disciplinary approach as a prerequisite for a sustainable and comprehensive port sustainability response.

The proposed evaluation framework consists of seven basic steps as they are presented below:

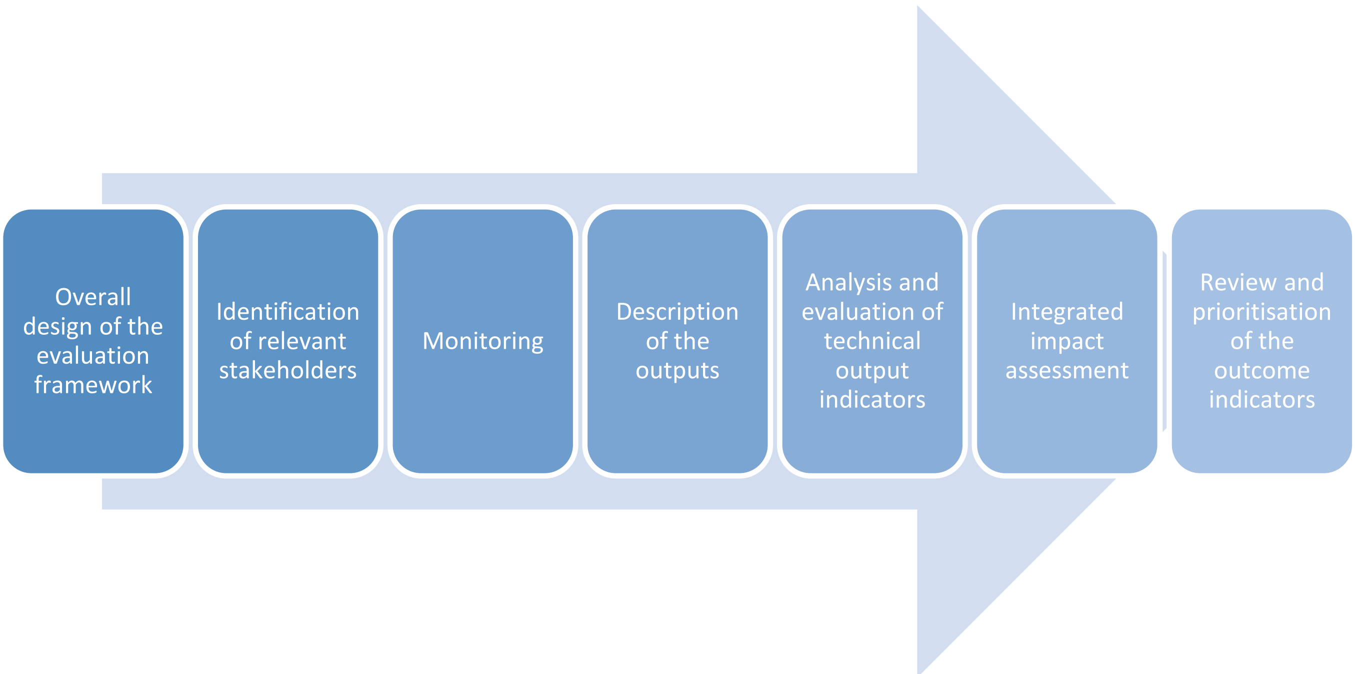


Figure 4.1: Evaluation Framework Methodology

The above evaluation framework of is divided in three different phases in order to ensure its efficient application:

- Preparatory Phase, which consists of the overall design of the evaluation framework and the planning of monitoring and evaluation tools, introducing what has to be done, how, when and by whom. In this phase, the identification of relevant stakeholders and their needs is significant for underlying the main desired outputs of the implementation of Action Plan.

- Implementation Phase, which consists of the monitoring and the collection of the required data for the further development of the actions proposed by the Action Plan.
- Reporting Phase, which consists of the description of the outputs, the analysis and evaluation of output indicators and the review and prioritization of the outcome indicators. The results of the reporting phase will lead to the development of the financial, socio-economic and environmental impact assessment which will show clearly the expected impact of the Action Plan implementation.

4.1. Overall design of the evaluation framework

The overall design of the evaluation framework and the identification of the required activities and tools within, is the first step of the proposed methodology and it is essential for the efficient monitoring and evaluation of the developed Action Plan.

The overall design is the identification of the target after the implementation of the evaluation framework. The main target is the development of financial, socio-economic and environment impact assessment for the proposed action plan for showing the effectiveness of it and underlining the best practices and difficulties which have been exploited and faced respectively. Then, the output indicators should be identified which will be used for the evaluation and assessment process. The output indicators should present the following characteristics:

- Be directly linked to the activities or actions proposed in the Action Plan.
- Describe clearly the actions (e.g. carbon footprint, energy efficiency (carbon footprint/output), emissions, etc.).
- Be responsive to port's intervention and should reflect the intervention logic behind the specific objective.
- Have a baseline, which is the situation at the start of (or just before) the intervention.
- There should be a target value for the action plan to achieve.

To this point, for the conduction of an efficient evaluation process after the implementation of the Action Plan, the baseline values of the output indicators should be fulfilled in order to describe the pre-existing situation that the Action Plan intends to change. Below, it is presented the list of the selected output indicators:

Table 4.1: First phase indicators for Action Plan

Action Plan	Sustainable Issues	Indicators
1) Clean Energy Investments **2) Decarbonisation Strategies**	**1) Energy Management** **2) Carbon Footprint**	Net purchases of energy
		Electricity consumption kW in buildings
		Electricity consumption kW on site
		Energy consumption on site
		Energy cost
		Fuel consumption
		Fuel cost
		Use of fossil primary source of energy
		Use of biogenic energy source
		Usage of renewable forms of energy

		Contribution of renewable forms of energy to electricity generation
		Energy savings
		Installed Photovoltaic
		Fuel efficiency
		CO emissions
		Carbon Footprint
		NOx emissions
		PM10 emissions
		SO_2 emissions
		Informed staff about energy management

Afterwards, to facilitate monitoring of the progress of the Action Plan during its implementation, it is also possible to define one or more milestones. A milestone is an expected intermediate value of an indicator at a pre-defined moment during the implementation of the monitoring and evaluation process. The milestones will be set quarterly and annually, according to the nature of the indicators. Indicators with intensive change will be measured every three months, while indicators with slow change and supportive role will be measured annually.

4.2. Identification of relevant stakeholders

An important part of the evaluation framework is the identification of relevant stakeholders so that the satisfaction of their needs and expectations will be checked by the application of the Action Plan. The primary stakeholders for the implementation of the Piraeus Port's Action Plan are listed below:

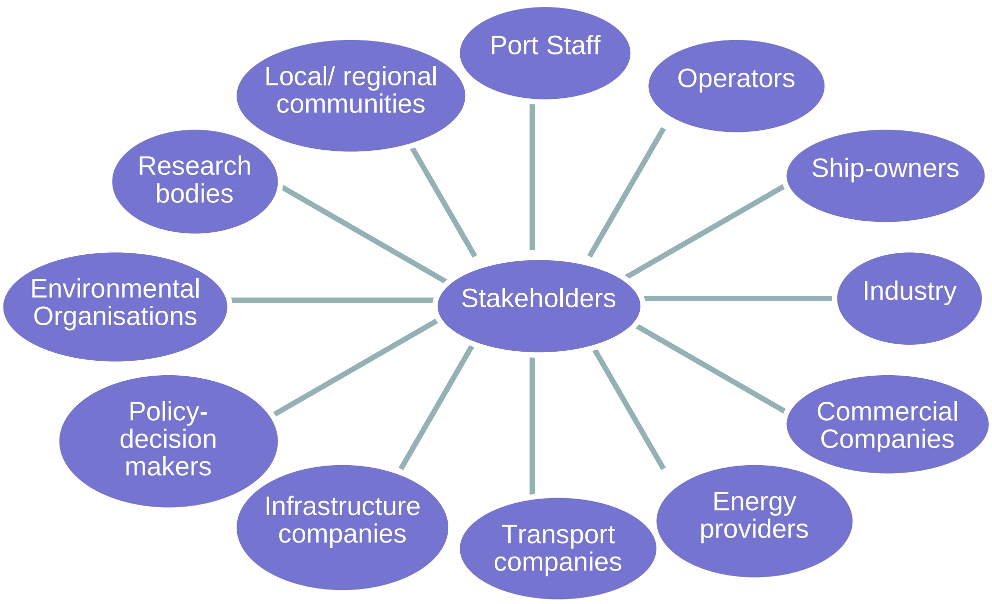


Figure 4.2: Relevant stakeholders for the implementation of the Piraeus Port's Action Plan

4.3. Monitoring

Monitoring is the continuous, regular, systematic and purposeful observation, gathering of information, and recording of actions proposed within the Action Plan. The monitoring process is needed to check on how planned actions are progressing, to identify operational difficulties and to adjust your activities as needed to reach your objectives. Monitoring is aimed at improving the efficiency and effectiveness of the Action Plan and at ensuring that proposed actions are transformed into results/outputs. The monitoring process will be undertaken during the implementation of the Action Plan.

The frequency of monitoring and reporting for Piraeus Port' Action Plan will be every 4 months and it will monitor the progress of the proposed actions responsible for the efficient energy management and reduction of carbon footprint within the Port of Piraeus.

4.4. Description of the outputs

This step of the evaluation framework is undertaken after the entire implementation of the Action Plan and it includes the detailed description of the outputs derived from the proposed actions. The identification of the outputs is the most important step of the evaluation framework as it gives a first indication of the efficiency of the Action Plan. The description of the outputs includes all qualitative and quantitative data selected on the last monitoring process, which takes place at the end of the Action Plan's implementation.

4.5. Analysis and technical evaluation of output indicators

The evaluation of the output indicators is the independent analysis and reflection on the performance of the Action Plan. It is meant to collect independent feedback on the achievements, scope and quality of outputs and results. Evaluation also aims to investigate what changes the Action Plan has really brought about. It involves assessing the strengths and weaknesses of the proposed actions in order to improve their effectiveness. To this point, the identification and fulfillment of the output indicators is the greatest tool for the successful analysis and evaluation of the outputs, taking into consideration their baseline values.

Three main methods of analysis and evaluation will be used in this step of the evaluation framework for the conduction of satisfactorily results:

- Multi-criteria analysis for concluding to the degree of success of the Action Plan based on all output indicators and criteria setting on the beginning of the evaluation.
- SWOT Analysis for further development of PPA after the implementation of the Action Plan. SWOT analysis is important for the next step of the evaluation framework which is the prioritarisation of the output indicators.
- Benchmarking for identifying which targets have been achieved and putting new ones.

4.6. Integrated Impact Assessment

In this step of the evaluation framework, the effects of the Action Plan are investigated on financial, socio-economic and environmental side. The objective of the Impact Assessment is to provide a set of quantitative and qualitative variables that will guide and support PPA in taking further decisions after the implementation of the Action Plan. Although, the proposed actions within the Action Plan will be implemented within the port area on specific technical issues, their outcomes will influence different domains and therefore, there is the need for Integrated Impact Assessment. The Integrated Impact Assessment of the PPA Action Plan includes analytical methods and it is based on model analysis, cost-benefit analysis and risk analysis. For the Financial, socio-economic and environmental impact assessment, a set of additional indicators will be taken into consideration in combination with the already output indicators identified in previous step of the evaluation framework.

4.7. Review and prioritisation of the output indicators

The review and prioritarisation of the output indicators are the step which leads to the further analysis and usage of the Action Plan's results. This step is, on the one hand, important for additional actions in case the output indicators do not satisfy the desired outcomes. On the other hand, the prioritarisation of the output indicators can be a useful tool for investment actions as it shows the current needs of port and its relevant stakeholders.

5. Actions and solutions deployment

5.1 Action plan solutions design

The Action Plan was formed taking into consideration the following 3 main pillars:

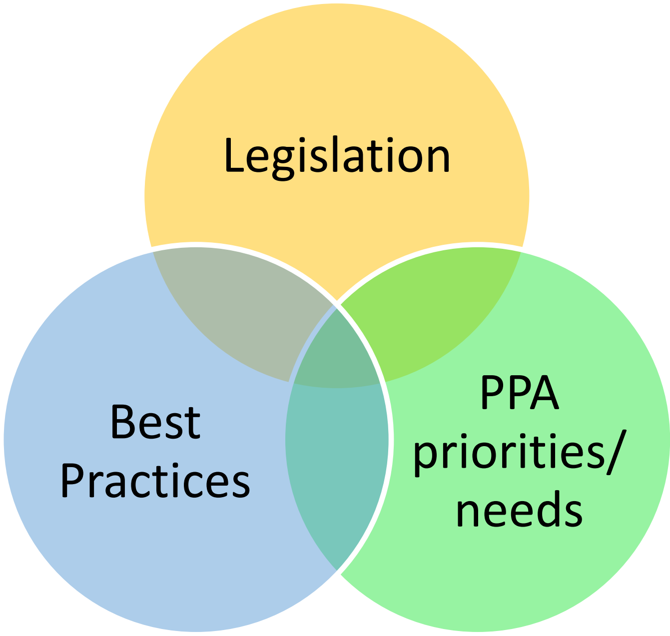


Figure 5.1: Three main pillars for Action Plan development

Pillar 1: With regard to the "Legislation" pillar, the Action Plan is formulated taking into consideration energy, environmental, transport and other related legislation. The table below presents them divided into International, European and National Regulatory framework.

Table 5.1: Legislation Framework

International Regulatory Framework
Paris Agreement (Agreement on taking urgent actions to fight climate change and its impacts.)
IMO 2020 Sulphur Regulation (2020 global Sulphur limit will be 0,50% m/m (from 3,50%) for marine fuels.)
European Regulatory Framework
Directive (EU) 2018/2001 (European Union 2030 target for the share of renewable energy consumed in the Union should be at least 32 %.)
Regulation (EU) 2018/1999 (Ensures the achievement of the 2030 and long-term objectives and targets of the Energy Union in line with the 2015 Paris Agreement on climate change)
Regulation (EU) 2018/842 (At least 40% reduction of greenhouse gas emissions in European Union (from 1990 levels).)
Directive 2018/844 (EU) (On energy performance and efficiency of the buildings in EU.)
Directive 2014/94 (EU) (On the deployment of alternative fuels infrastructure.)
DIRECTIVE 2009/28/EC (European Union 2020 target for the share of renewable energy consumed in the Union should be at least 20 % and 20% reduction of greenhouse gas emissions.)

National Regulatory Framework
Greek Law 3855/2010 (Measures to improve energy efficiency in end use, energy services and other provisions.)
Greek Law 3851/2010 (National Target of Renewable energy resources for 2020: 20% on final the energy consumption and 20% reduction of greenhouse gas emissions (from 1990 levels).)
KENAK Regulation (On energy performance and efficiency of the buildings in Greece.)

Pillar 2: As regards priorities and needs, PPA is an international leading port with intense freight and passenger activity and a significant degree of development. In the second chapter of this report, an extensive analysis has been presented showing PPA's activities and how they burden the environment and influence the life quality of local community. Specifically, the graph below shows clearly how the port activities pollute the air environment, underlining in that way the importance for the introduction of environmentally friendly technologies.

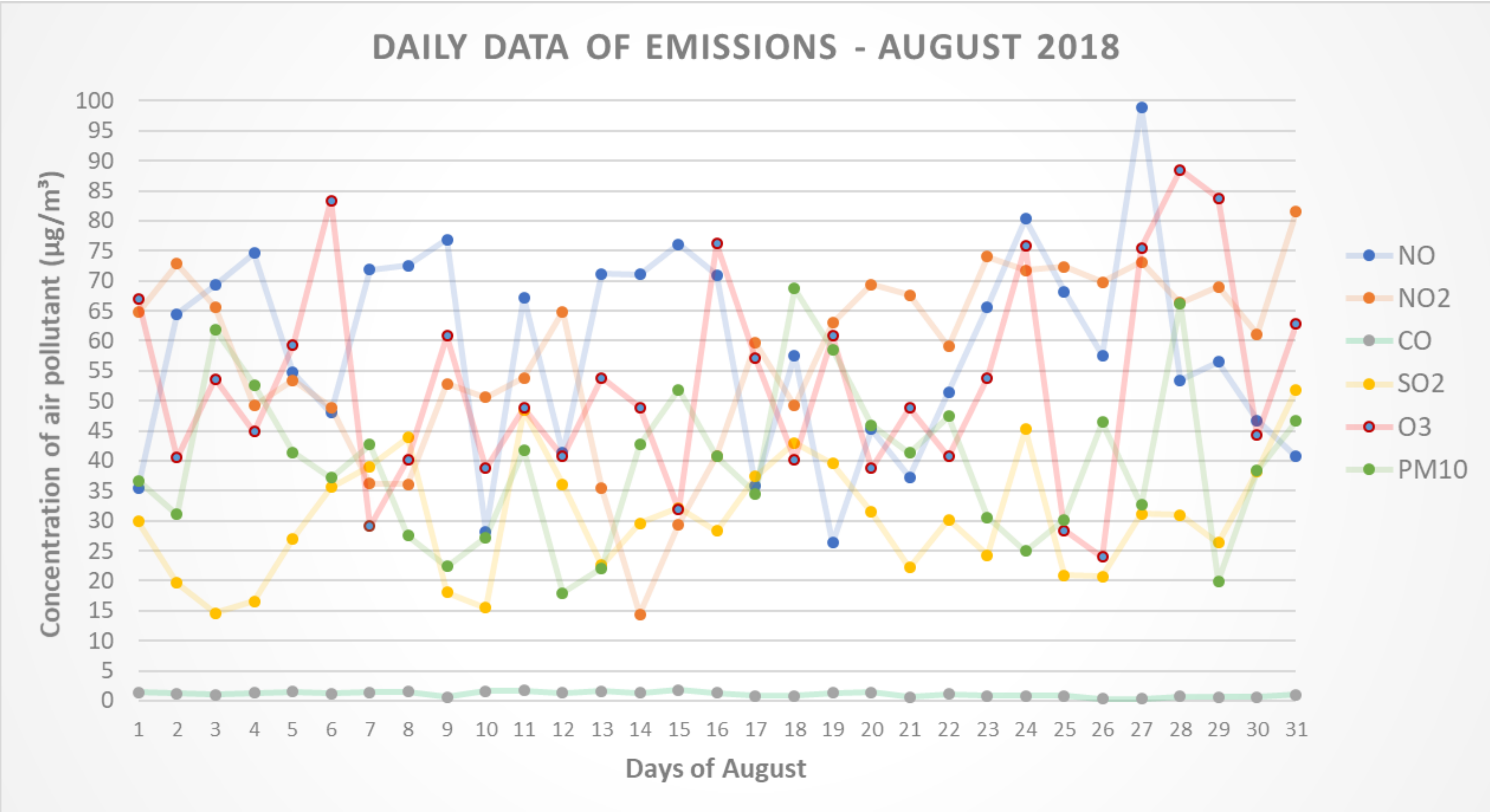


Figure 5.2: Daily data of the emissions of air pollutants within port area in August 2018

Pillar 3: With regard to the "Best Practices" pillar, PPA follows the development of other ports and remains updated about new technologies and practices towards "low emissions" ports through business collaborations and communication and participation into national, European and international seminars, conferences and fora. The most appropriate best practices have been analysed, assessed and incorporated into the needs and priorities of PPA. To this point it should be mentioned that, the communication with relevant stakeholders and experts was very helpful for providing important feedback about existing practices and upcoming solutions.

Based on these three main pillars, the Action Plan of PPA was developed focusing in the introduction of low carbon technologies in port activities and the reduction of carbon footprint based on two key interventions:

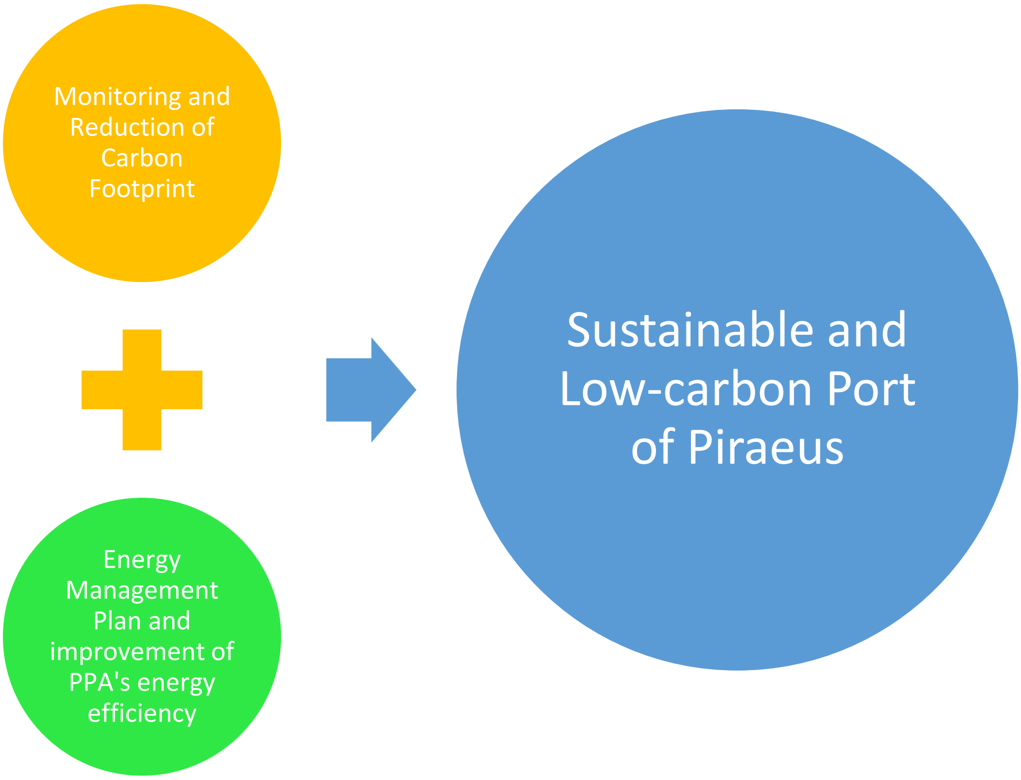


Figure 5.3: Two key interventions of Action Plan

The picture below summarizes the selected measures of the Action Plan, following the steps of the above methodology, adhering successfully to the expectations of the Port of Piraeus.

Figure 5.4: Overview of Action Plan Measures

The measures of the Action Plan, presented above, do not have the same degree of difficulty for their implementation while their impact is also different. Therefore, they have been distinguished in short- and long-term measures according to the immediacy of their implementation.

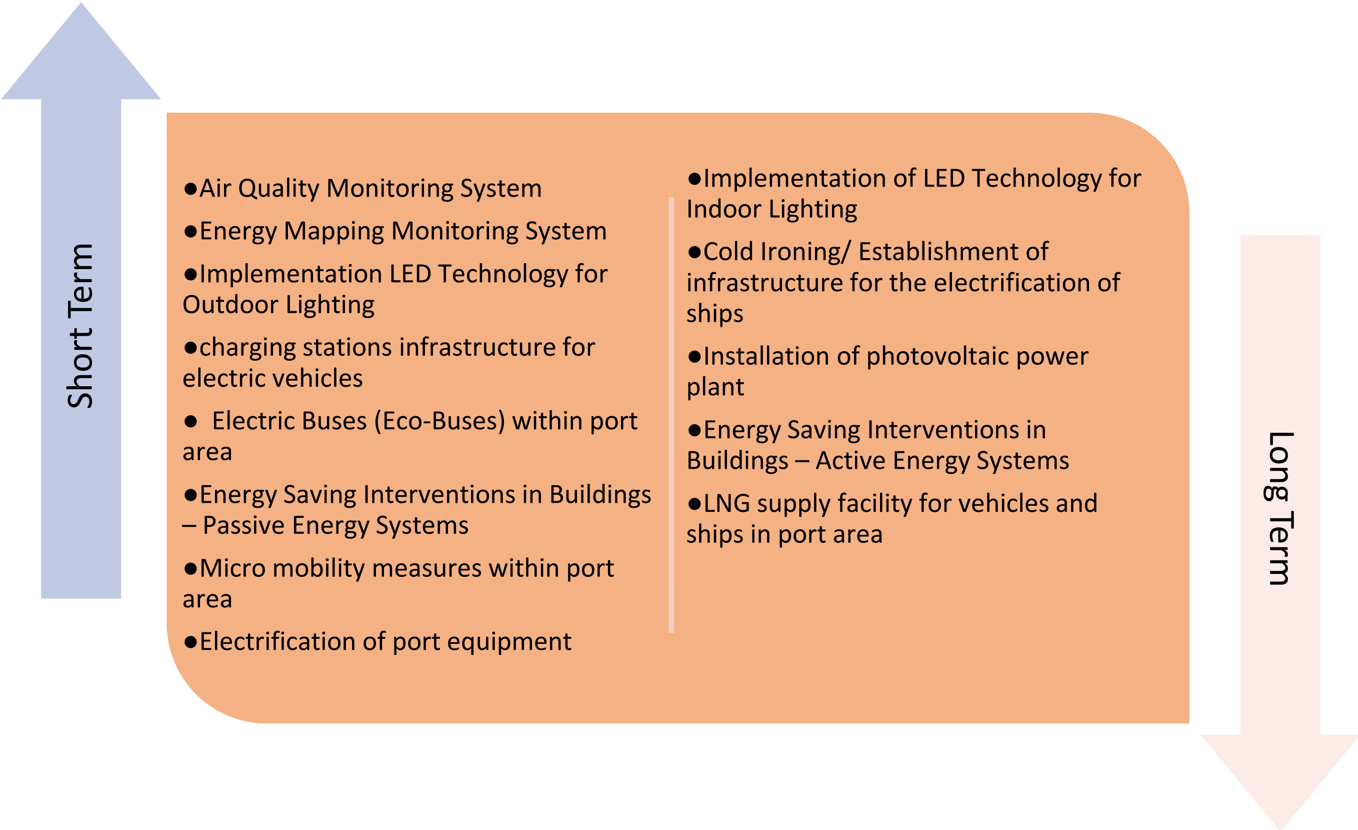


Figure 5.5: Categorisation of the measures into short term and long term

5.2 Detailed presentation of Action plan measures

Following, the overview of the Action Plan, the measures will be presented analytically with reference on their impacts, technical requirements, budget, duration of implementation and mitigating risks.

5.2.1. Monitoring and reduction of carbon footprint

The monitoring of carbon footprint and other pollutants of port activities is a main priority, aiming at obtaining real-time data of the emissions in port and surrounding area. Many emission-producing sources are directly and indirectly related to port operations. These emission sources include port administration vehicles, power plants providing power for administration offices, tenant buildings, electrified cargo handling equipment, fuel-powered cargo handling equipment, ships, harbor craft, trucks, rail locomotives, etc. These sources produce greenhouse gases, notably carbon dioxide (CO_2), methane (CH_4), and nitrous oxide (N_2O), and other pollutants of concern, such as oxides of nitrogen (NOx), particulate matter (PM), and sulfur oxides (SOx). In developing carbon footprint inventories, GHG quantification protocols delineate that the emission-producing activities for ports should be grouped into the following three scopes:

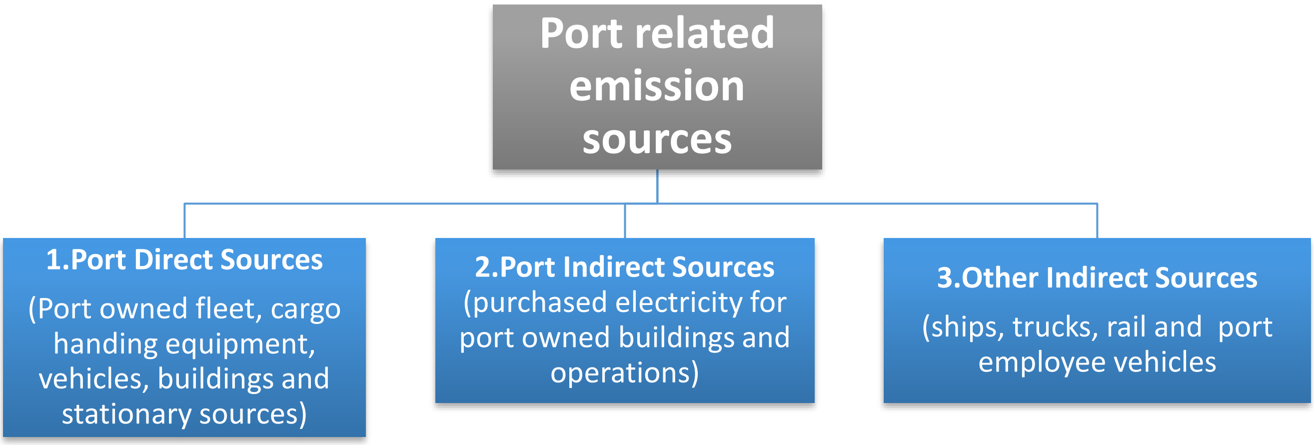


Figure 5.6: Port related emission sources

After identifying and categorizing port related carbon emissions, the first priority is the adoption of air quality monitoring system with installed sensors in the appropriate positions, in order to obtain real-time data of the carbon and air pollutants emissions. The system will collect and process the relevant data of the greenhouse gas emissions, in order to produce estimated values of the carbon footprint in the port area. According to the categorization of port related emissions sources, the appropriate positioning of the sensors in port area was evaluated, considering both compact and mobile stations with the latter offering greater flexibility allowing to monitor other areas as well. Essentially, the air quality monitoring system will be the assessment tool of the recommended measures, which will evaluate the impact to the reduction of carbon footprint emissions and improvement of air quality in the port area.

Table 5.2: Monitoring and reduction of carbon footprint measures

Measure #1.1	**Air Quality Monitoring System**
Description	Port industry characterised often of high carbon footprint and dangerous air pollutants. Most emissions are generated from the movement of ships, the traffic from the vehicles along the port area and the various port operations. The carbon emissions are responsible for global warming and climate change and the air pollutants can cause serious health issues to people. It's essential to have an Air quality monitoring system to obtain data of the carbon footprint and pollutants of atmospheric air in port area. The aim of this installation is, by assessing the monitoring system inventories, to result in useful information about the levels and distribution of air pollutants in the atmosphere and carbon footprint, as well as to identify the main sources of the emissions. A sensor-based system with compact and mobile stations will monitor the air quality, obtaining real-time data of the emissions in port area. Compact air quality monitoring stations measure real-time emissions of carbon and air pollutants, with a remote data acquisition system. Broadly, mobile air quality monitoring involves deploying instruments for a short period at a temporary location, before moving them to another location. These deployments may be as short as a few hours or a few days. Often instruments are mounted in or

	on a vehicle, in a trailer or mounted temporarily. Regardless of the deployment, the site is treated as temporary, and the instrument is moved after a short period. Also, mobile air quality monitoring is useful for assessing new site locations and plugging gaps in the existing compact monitoring network.
Technical Requirements	• The expansion of the current Air quality monitoring system will include: 3 compact stations with air quality sets of sensors, 11 mobile air quality sensor sets (4 in coaches, 4 in trucks, 2 extra sets as back up and 1 sensor set to be used for field tests). • Technical requirements of compact stations: 1)The station should be able to measure the follow emissions: CH_4, NOX, SO_2, CO, O_3, VOC, PM). 2) Evaluation of the relevant measures for the estimation of carbon footprint in the port area. 3)The station should be in the form of a lockable compact cabin integrating all sets of sensors with minimum protection level IP65. 4)The station should provide for efficient outdoor operation in at least the range of temperatures -35°C to +50°C and include a thermal management system. 5)The station should provide a homogenized way to remotely configure it and access the measurements by providing an Application Programming Interface (API). The measurement period should be no longer than 10 minutes. 6)The station should provide for WI-FI, Ethernet and Mobile connection to the Internet. 7) The station should be capable embedding and supporting necessary add-ons for permitting auto- calibration of all sensors as an option. • Technical requirements for mobile stations: 1)In order to have near real time data, the measurements should be taken every, no longer than, 10 minutes. 2)To prolong their effective lifetime and to avoid any kind of technical malfunctions sensor sets must be able to operate under the conditions that manufacturer has provided. 3)The post-deployment calibration must follow a regular repetition for ensuring the measurements consistency and accuracy. 4)The rechargeable battery of the set can be charged by using a USB cable and/or an external solar panel. 5)This communication module is specially oriented to work with Internet servers, in order to make the data transfer easier. • Installation of IT platform to manage the exported data from the sensor network. • Procurement procedures • Impact assessment

Target	Monitoring air pollutants emissions (CH_4, NO_X, SO_2, CO, O_3 VOC, PM) and estimating carbon footprint.
Impact	• Identifying the relevant sources of carbon and air pollutants emissions in port area. • Real-time data of the emissions in different locations of port operations. • Exportation of measure results from emission reduction measures. • IT platform with the selected data and user friendly interface. • Reduces lifecycle cost by fewer fuel consumption and maintenance cost. • Provides better onboard comfort while in port.
Estimated Budget	100.000 €
Duration of measure implementation	12 months
Measurable Results	• Carbon Footprint (ppm) • CH_4 Emissions (ppm) • CO Emissions (ppm) • NO_X Emissions (ppm) • SO_2 Emissions (ppm) • O_3 Emissions (ppm) • VOC Emissions (ppm) • PM Emissions (ppm)
Mitigation Measures	• Ensuring for efficient operation of the digital system and sensor sets that will provide real time data for emissions in port area. • Flexible network with mobile sensors to identify possible gaps of monitoring cover area of the stable stations. • Establishment of development of periodic reports of the exported data. • Making adjustments based on reporting feedback.

Measure #1.2	**Cold Ironing/ Establishment of infrastructure for the electrification of ships**
Description	Cold Ironing is an anti-pollution measure which helps in reducing air pollution generated from diesel generators by using shore electric power as a substitute. It is used when the ship is halting at a port so that the engines of the ship (working on diesel) do not need to be used unnecessarily. This, in turn, helps in reducing the emissions from ships by a great margin. Cold ironing permits emergency equipment, refrigeration, cooling, heating, lighting and other equipment to receive continuous electrical power while the ship loads or unloads its cargo. It makes sense for ports to include cold ironing in their investment plans, and it also helps to meet the

	demand by ships for lower energy costs in order to comply with international regulations. Indeed, the International Maritime Organisation (IMO) acknowledges the importance of reducing the emissions from ships with the establishment of IMO 2020 about limiting the Sulphur content in marine fuels. The Marpol Annex VI Regulation has already set a timeframe to progressively reduce the content of NOx and SOx in fuels. Ships will have no other choice but to use fuel with an increasing lower Sulphur level or to choose for alternative technologies. Shore connection has been officially noted as a way for ships to comply with the Marpol VI requirement.
Technical Requirements	• Feasibility study setting the systems' characteristics. • Final design of the installation which will include electrical power and transformer connection infrastructure and the appropriate power needs for each terminal and ensure adaptability. • Construction based on technical specifications indicated in final design, including: one substation/ power transformer, frequency convertors 50/60 Hz and also switchboards and panels/energy management system. • For the implementation of cold ironing installation is considered necessary the upgrading and maintenance of the existing electrical network and substations, which is already in progress with time horizon for completion up to 2021. (Estimated budget: 20.000.000 €) • Procurement procedures • Impact assessment
Target	Reduction of carbon footprint and other air pollutants emissions (NO_X, SO_X and PM) - less emission to the city interface
Impact	• Reduction of carbon footprint up to 30%. • Reduction of NO_X, SO_X and PM up to 95%. • Reduction of noise pollution. • Reduces ship lifecycle cost by fewer fuel consumption and maintenance cost. • Provides better onboard comfort while in port.
Estimated Budget	1.000.000 €/MW
Duration of measure implementation	24 months
Measurable Results	• Fuel consumption (t) • Electricity consumption (kWh) • Energy cost of electricity (€/kWh) • Carbon Footprint (ppm)

	• NO_X Emissions (ppm) • PM Emissions (ppm) • SO_X Emissions (ppm)
Mitigation Measures	• Ensuring the compatibility of electricity parameters, specifically some ships use 220 Volts at 50 Hz, some at 60 Hz and some others use 110 Volts. • Installation of connectors and cables that are internationally standardised. • Ensuring wide variations of load requirements for serving different types of ships. • Infrastructure related with the Public Power Corporation S.A - Hellas (DEI)

Measure #1.3	**Deployment and operation of charging stations infrastructure for electric vehicles of port administration and employees**
Description	Electric-drive vehicle technologies are essential to fully decarbonize the transport sector. Electric vehicles are cars and other forms of mobility that use an electric motor as their main source of propulsion, rather than a conventional engine. An electric vehicle charging station, also called EV charging station, is an element in an infrastructure that supplies electric energy for the recharging of plug-in electric vehicles—including electric cars, neighborhood electric vehicles and plug-in hybrids. The charging time depends on the battery capacity and the charging power. In simple terms, the time rate of charge depends on the charging level used, and the charging level depends on the voltage handling of the batteries and charger electronics in the car. A charging station is usually accessible to multiple electric vehicles and has additional current or connection sensing mechanisms to disconnect the power when the vehicle is not charging. The replacement of vehicles which use conventional fuels with ones which are electric can result in significant reduction of carbon emissions because of the less fossil fuel consumption for their operation. The deployment and operation of charging infrastructure for electric vehicles in the port will service: a) the electric vehicles of the passengers of coastal shipping, b) electric taxis, c) electric shuttle buses, transferring passengers to and from the port and d) the vehicles of the crews and of the employees of the Port. The project will contribute to the sustainability of the Port, by encouraging and enabling the use of Electric Vehicles in the port, will enhance the quality of air in the wider area of Piraeus, will reduce the levels of noise and will improve the environmental footprint of the Port.
Technical Requirements	• Feasibility study • The foreseen infrastructure will include: a) Installation of three (3) AC double charging stations (2 x 22 kW) and set up of six (6) parking spaces dedicated to electric cars in each Gate of the Port for Coastal Shipping and for Cruises (8 gates in total) (24) AC charging stations in total / 48 parking spots for electric vehicles,

	b) Installation of 3 DC double Chargers of 100 kW (two in the Taxis ranks of Coastal shipping) and one in the stop of Shuttle Buses • c) Load management system to efficiently balance loads for EV charging • Procurement Procedures • Impact Assessment
Target	Reduction of energy consumption and carbon footprint.
Impact	• Reduction of carbon footprint up to 30%. • Reduction of NO_X, CO, O_3 and PM up to 100%. • Reduction of noise pollution (electric vehicles are quitter than the diesel/petrol ones). • Reduces lifecycle cost by fewer fuel consumption and maintenance cost.
Estimated Budget	2.500.000 €
Duration of measure implementation	36 months
Measurable Results	• Electricity Consumption on site (kWh) • Energy cost of electricity on site (€/kWh) • Carbon Footprint (ppm) • NO_X Emissions (ppm) • PM Emissions (ppm) • SO_X Emissions (ppm) • CO Emissions (ppm)
Mitigation Measures	• Ensuring the installation of both AC and DC charging stations to cover electric vehicles energy demands. • Installation of the appropriate number of charging points and parking space to cover the expected number of vehicles. • Ensuring wide variations of load requirements and equipment for serving different types of vehicles.

Measure #1.4	**Electric Buses (Eco-Buses) for transportation in port area**

Description	Electric buses have engines, which operate with electricity supply and not conventional fuels, which leads to zero emissions to the environment. Electric buses can store the electricity on board, or can be fed continuously from an external source. Buses storing electricity are majorly battery electric buses, in which the electric motor obtains energy from an on-board battery, although examples of other storage modes do exist, which uses flywheel energy storage. When electricity is not stored on board, it is supplied by contact with outside power sources. Battery electric city buses have developed rapidly in recent years. There are several different manufacturers in the market and also the big bus manufacturers have shown interest in developing them. There are several different operating methods for electric buses due to the different options in charging methods. The battery can be charged overnight at the depot, it can be charged during operation at the end stations, or during the route in the dedicated bus stops. The replacement of the current bus fleet with electric buses with zero emissions will have significant impact to the reduction of emissions in port area. The purchase of one electric bus and pilot application to monitor the reduction of carbon emissions in port transport.
Technical Requirements	• Feasibility Study • Selection of the appropriate model and size of electric bus for pilot application. • Definition of technical requirements and system set up: Vehicle energy calculation, driving route data, vehicle charging requirements, auxiliary system, life cycle and propulsion. • Procurement Procedures • Impact Assessment
Target	Reduction of carbon footprint and other air pollutants emissions (NOx, SOx, CO, O_3 and PM).
Impact	• Reduction of carbon footprint. • Reduction of NOX, CO, O_3 and PM emissions up to 95%. • Reduction of noise pollution (electric vehicles are quitter than the diesel/petrol ones). • Reduces lifecycle cost by fewer fuel consumption and maintenance cost.
Estimated Budget	600.000 €
Duration of measure implementation	12 months
	• Electricity consumption for electric mobility (kWh) • Fuel Consumption (t) • Energy cost of electric mobility (€/kWh)

Measurable Results	• Carbon Footprint (ppm) • CO Emissions (ppm) • NO_X Emissions (ppm) • O_3 Emissions (ppm) • PM Emissions (ppm)
Mitigation Measures	• Implementation of sufficient charging points infrastructure in port area to serve the charge of the electric busses. • Appropriate planning of the electric busses timetable for serving the maximum number of passengers.

Measure #1.5	**Micromobility in Port Area with Electric Scooters and Bicycles**
Description	Micromobility is a category of modes of transport that includes very light vehicles such as electric scooters and bicycles (e-bikes). This measure will enhance the more sustainable mobility in the port area, aiming at reducing the use of conventional transport vehicles (cars, taxis, buses and other), which cause significant amounts of emissions of carbon dioxide and air pollutants in port and neighboring area being reduced. The implementation of this measure targets the transportation of port employees between port premises and also the transportation of cruise passengers from cruise terminal to access the city of Piraeus. The electric scooters and bicycles will be charged by multifunctional solar charging stations, which will have roof with photovoltaic panels for renewable energy production. If the solar generated energy which is provided by the station isn’t enough for charging the vehicles, the station will be connected with the main power grid of the port. The charging stations will have the size of an average car park and the roofs will be covered by photovoltaic panels. Through multiple maximum power point traces with integrated DC-DC converter, the solar produced DC electricity is directly used to charge multiple type of voltages of electric vehicles. Furthermore, the installation of DC-AC inverter can put back energy in the main power grid when there are no vehicles to be charged, aiming at maximum exploitation of solar generated energy. It is examined the pilot application of 20 electric scooters and 20 electric bicycles. The station of electric bicycles (e-bikes) will be located at cruise terminal to serve the transportation of passengers to the city of Piraeus. The station of electric scooters will be installed closely to main premises of the port to serve the needs of transportation of employees in port area.
Technical Requirements	• Feasibility Study • Selection of the appropriate models of electric scooters and bicycles. • Siting of the solar charging parking stations for the vehicles in port area.

	• Final design of the solar charging stations and electromechanical equipment. • Procurement procedures • Impact assessment
Target	Reduction of carbon footprint and air pollutants emissions in port area.
Impact	• Integration of environment-friendly mobility options in the port and neighbouring area. • Reduction of use of conventional vehicles in the port area (cars, buses, taxis). • Reduction of carbon footprint. • Reduction of air pollutants emissions (NOx, SOx, PM, CO, O_3).
Estimated Budget	250.000 €
Duration of measure implementation	24 months
Measurable Results	• Carbon Footprint (ppm) • CO Emissions (ppm) • NO_X Emissions (ppm) • SO_2 Emissions (ppm) • O_3 Emissions (ppm) • PM Emissions (ppm)
Mitigation Measures	• Implementation of raising awareness campaigns to inform passengers and port employees about the concept of micromobility. • Dedicated staff to inform and give instructions about the proper and safe use of the vehicles. • Planning of the maintenance of the solar charging parking stations for their efficient operation.

Measure #1.6	**LNG supply facility for ships in port area**
Description	Liquefied Natural Gas (LNG) is natural gas that has been cooled down to liquid form for ease and safety of non-pressurized storage or transport. The liquefaction process involves cooling the gas to around −162 °C and removing certain impurities, such as dust and carbon dioxide. As a liquid, LNG takes up around 600 times less volume than gas at standard atmospheric pressure. Despite the high-quality insulation, a small amount of heat still penetrates the LNG tanks. This causes slight evaporation

	of the product. The resulting boil-off gas is captured and fed back into the LNG flow using compressor and recondensing systems. This process prevents the occurrence of venting natural gas from the terminal under normal operating conditions. This makes it possible to transport the gas over long distances, without the need of pipelines, typically in specially designed ships or road tankers. LNG is the only marine fuel with almost zero SO_2 emissions that can comply with IMO's sulphur 2020 regulation. Also, LNG can deliver reduction of carbon emissions up to 30%, PM and NOX and emissions reduction. For Port of Piraeus the transport of LNG from Revithoussa LNG Terminal via tank ships is examined to supply directly ships and vehicles that use LNG as fuel. This process of suppling LNG does not require the installation of LNG storage station with special tanks in port. These tanks for LNG storage are very complex installations with many technical specifications and requirements, with which the port wouldn't be able to comply with some of them. LNG fueled ships will have bunker stations allowing the ship to refuel through hoses from either a shoreside facility, truck or a small LNG bunker vessel or barge. An advantage of using an LNG bunker vessel moored on the offshore side of the receiving ship or at anchorage is that this isolates the bunkering operation from the pier area, which should reduce LNG bunkering's impact on cargo operations and can reduce the consequences of an LNG incident. LNG supply network is examined to serve the energy demands of ships in the Cruise and Passenger Terminals.
Technical Requirements	• Feasibility study • Planning of the transportation of LNG from Revithoussa LNG Terminal with tank ships (LNG carriers) and the appropriate equipment for suppling LNG to ships in the port area. • Business cooperation with relevant bodies and LNG providers (DEPA, DESFA). • Definition of technical characteristics of LNG supply facility's components: low pressure pumps, high pressure pumps, open rack vaporizers (ORV), submerged combustion vaporizers (SCV), cryogenic bail-off gas compressors, sea water pumps and electromechanical equipment. • Procurement procedures • Impact assessment
Target	Reduction of carbon footprint, SO_2, NO_X, and PM emissions and fossil fuel consumption.
Impact	• Reduction up to 30 % of carbon footprint. • Reduction up to 80% of NO_X emissions. • Reduction of 99% of SO_2 emissions. • Reduction up to 70% GHG emissions. • Reduction up to 99% of PM emissions. • Vehicles and ships that use LNG as fuel produce less noise. • Less fossil fuel consumption.

	• Increase of energy efficiency.
Estimated Budget	1.500.000 €
Duration of measure implementation	60 months
Measurable Results	• Carbon Footprint (ppm) • NO_X Emissions (ppm) • SO_2 Emissions (ppm) • PM Emissions (ppm) • LNG consumption (ppm) • Fossil fuel consumption (ppm)
Mitigation Measures	• The supplying of LNG to Port of Piraeus will be implemented via tank ships from Revithoussa LNG Terminal and the construction of LNG station in port won't be needed, which requires specifications that the Piraeus couldn't comply with. • Port of Piraeus participates in implementation of many European Projects about using LNG as marine fuel.

5.2.2. Energy Management Plan and improvement of PPA's energy efficient

The Energy Management System will assist PPA to integrate energy management into its business structures, with a purpose to save energy, save costs and improve their energy, environmental and business performance. The main target is to:

- reduce costs,
- reduce the impact of rising costs,
- meet legislative or self-imposed carbon targets,
- reduce reliance on fossil fuels, and
- enhance the entity's reputation as a socially responsible port.

The implementation of an Energy Management System, based on ISO 50001, focuses on a continual improvement process to achieve the objectives related to the environmental performance of the port. The process follows a plan – do – check – act approach.

Figure 5.7: Plan-do-check-act approach

The main important step for the implementation of an Energy Management Plan is the establishment an integrated energy consumption monitoring system with sensors, which will monitor energy and fuel consumption of port buildings and activities. The above system will identify the main energy sources in port, provide real-time data of consumption and assess the energy savings potential of proposed measures. Afterwards, the Action Plan will introduce measures for the improvement of the PPA's energy efficiency including the use of LED lighting for indoor and outdoor lighting with control system (as mentioned in proposed measures for reducing the carbon footprint), exploitation of renewable energy resources to cover partially the energy demand, electrification of port equipment and energy saving interventions in buildings, both active and passive energy systems.

Table 5.3: Energy Management Plan and improvement of PPA's energy efficiency measures

Measure #2.1	**Energy Mapping Monitoring System**
Description	Knowing your consumption is a prerequisite for conserving energy and preserving the environment. This is the first step in professional energy management and forms the basis for estimating savings potential and verifying the results of promising initiatives once implemented.Important step is mapping energy consumption in the port area, identifying sources, which demand the highest amount of energy and defining the electricity and fuel consumption of buildings and port activities. Energy Management Systems (EMS) are based on Smart devices, Wireless Sensor Networks and a centralized platform for data presentation and management. The implementation of a network with sensors measuring the consumed energy in the port area can be achieved with establishing a system for

	detailed monitoring of electricity use and of fuel consumption (buildings, operations and transport). The methodology and criteria used to develop the energy review shall be documented. In particular the port shall analyse current energy sources and evaluate past and present energy use and consumption. Based on the analysis of energy use and consumption, the system will identify the facilities, equipment, systems, processes, personnel and other relevant variables that significantly affect the energy consumption. The monitoring system will take advantage of the requirements and procedures of the International Standard ISO 50001 about energy management systems. Energy Management System (EMS) helps to integrate energy and management into the business structures, with a purpose to save energy, save costs and improve energy, environmental and business performance. The standard specifies the requirements for establishing, implementing, maintaining and improving an energy management system, whose purpose is to enable an organization to follow a systematic approach in achieving continual improvement of energy performance, including energy efficiency, energy security, energy use and consumption.
Technical Requirements	• Feasibility study • To be applied in parts of the port area (buildings, terminals etc.). • Development of a plan for integrating an Energy Consumption Monitoring System in port facilities. • Definition of technical requirements of the equipment such as the type and number of sensors, IT installations and systems. • Procurement procedures • Pilot application of a monitoring system according to ISO 50001 for energy management systems. • Impact Assessment
Target	Monitoring and reduction of energy consumption.
Impact	• Identifying the main sources of energy consumption in port area. • These monitoring systems help to achieve annual energy savings up to 20%. • Exportation of results from energy reduction measures and identification of cost saving opportunities. • Digitalization of energy systems and operations in port area. • Reduction of energy consumption leads to lower carbon emissions.
Estimated Budget	65.000 €/per installation
Duration of measure implementation	36 months

Measurable Results	• Net purchases of energy (kWh). • Electricity consumption in buildings (kWh). • Electricity consumption on site (kWh) • Fuel Consumption (t) • Use of energy from renewable forms (%) • Annual Energy Savings (kWh) • Annual Energy Cost Savings (€) • Carbon Footprint (ppm)
Mitigation Measures	• Ensuring for efficient operation of the digital system that will provide real time data for energy consumption. • Establishment of development of periodic reports of the exported data. • Making adjustments based on reporting feedback.

Measure #2.2	**Implementation of LED Technology for Indoor Lighting**
Description	The implementation of LED lighting technology in the buildings of port area is a very simple and efficient solution to reduce the consumed energy which means reduction of carbon emissions. Light-emitting diodes (LED) are semiconductors. As electrons pass through this type of semiconductor, it turns into light. Compared to incandescent and CFL lamps, LED lights are more efficient at turning energy into light. Therefore, less of the energy radiates from the lamp as heat. This is why LED bulbs are cooler during operation than incandescent and CFL bulbs. LED lights are up to 80% more efficient than traditional lighting, they also draw much less power than traditional lighting. A typical 84-Watt fluorescent can be replaced by a 36-Watt LED to give the same level of light and harmonic distortion. Also LED lighting allows for simple integration of lighting control system. A lighting control system is an intelligent network-based lighting control solution that incorporates communication between various system inputs and outputs related to lighting control with the use of one or more central computing devices. Lighting control systems are widely used on both indoor and outdoor lighting of commercial, industrial, and residential spaces. Lighting control systems serve to provide the right amount of light where and when it is needed.
Technical Requirements	• Feasibility Study • Buildings of port area to be applied. • Definition of requirements such as type of the light lamp, appropriate power of the light lamp, selection of light colours (cold or warm) and minimum level of lux (lumen/m^2). • Development of integrated smart lighting system that can optimize the light efficiency versus the cost of energy. • Disposal Requirements • Procurement Procedures • Application and replacement in the current infrastructure.

	• Impact Assessment
Target	Reduction of energy consumption and carbon footprint.
Impact	• Energy savings up to 80%. • Reduction of carbon footprint up to 50%. • LED light lamps have longer lifespan which leads to lower maintenance cost. • No special disposal requirements (LED light lamps do not contain hazardous material).
Estimated Budget	1.000.000 €
Duration of measure implementation	24 months
Measurable Results	• Electricity Consumption in buildings (kWh) • Energy cost of electricity in buildings (€/kWh) • Carbon Footprint (ppm)
Mitigation Measures	• Maintaining sufficient and uniform light levels. • Managing thermal properties to maximize light engine life.

Measure #2.3	**Implementation of LED Technology for Outdoor Lighting**
Description	Similarly to the implementation of LED Technology for Indoor Lighting, the implementation of LED lighting technology in the outdoor parts of port area is a very simple and efficient solution to reduce the consumed energy which means reduction of carbon emissions. Outdoor lighting requires daily a large amount of electricity; therefore, the introduction of friendly environmental solutions will lead to significant impacts. LED lights are up to 80% more efficient than traditional lighting, they also draw much less power than traditional lighting.

Technical Requirements	• Feasibility Study • Parts of the port area to be applied. • Definition of requirements such as type of the light lamp, appropriate power of the light lamp, selection of light colours (cold or warm) and minimum level of lux (lumen/m^2). • Development of integrated smart lighting system that can optimize the light efficiency versus the cost of energy. • Disposal Requirements • Procurement Procedures • Application and replacement in the current infrastructure. • Impact Assessment
Target	Reduction of energy consumption and carbon emissions.
Impact	• Energy savings up to 80%. • Reduction of carbon footprint up to 50%. • LED light lamps have longer lifespan which leads to lower maintenance cost. • No special disposal requirements (LED light lamps do not contain hazardous material).
Estimated Budget	3.500.000 €
Duration of measure implementation	36 months
Measurable Results	• Electricity Consumption on site (kWh) • Energy cost of electricity on site (€/kWh) • Carbon Footprint (ppm)
Mitigation Measures	• Maintaining sufficient and uniform light levels. • Managing thermal properties to maximize light engine life. • Ensuring the longevity of the light bulb in a marine environment.

Measure #2.4	Energy Saving Interventions in Buildings – Active Energy Systems
Description	Energy saving interventions in buildings are a very efficient way to improve the energy class of the buildings, aiming at reducing energy consumption and carbon emissions. Furthermore, the increase of energy efficiency allows individuals and organisations to reduce their capital and operational costs. The interventions of active energy systems include the following: upgrading the heating and cooling systems with high energy heat pumps and installation of solar energy collectors. Heat pumps use electricity to move heat from a cool space to a warm space, making the cool space cooler and the warm space warmer. As heat pumps only move heat and not generate it, they have very high ratio of heat output to energy output. This heating energy efficiency is expressed as a coefficient of performance (COP), while cooling energy efficiency is expressed as an energy efficiency ratio (EER). These ratios are typically around 2-4.5 times, which means heat pumps produce 2 – 4,5 as much as heating/cooling power as the electricity they use. Solar energy collectors are special kinds of heat exchangers that transform solar radiation energy to internal energy of the transport medium. The major component of any solar system is the solar collector, which is a device that absorbs the incoming solar radiation, converts it into heat and transfers the heat to a fluid (usually air, water, or oil) flowing through the collector. The solar energy collected is carried from the circulating fluid either directly to the space conditioning equipment or to a thermal energy storage tank. Also, the establishment of Building Energy Management System to monitor and control the heating and cooling systems of the buildings depending on energy needs, can result in less energy consumption and carbon emissions.
Technical Requirements	• Feasibility study • Definition of the appropriate interventions for every building depending on inveteracy, current infrastructure and needs of each building. • Development of the plan for integrating Building Energy Management System. • Procurement procedures • Impact assessment
Target	Reduction of energy consumption and carbon emissions.
Impact	• Reduction of energy consumption at a very significant rate, which is depending on the selected intervention. • Reduction of carbon emissions. • Increase energy efficiency. • Digitalization of building's energy system.
	Estimated cost for each intervention: • Installation of heat pumps: 50 €/m²

Estimated Budget	• Installation of solar energy collectors and system: 100 €/m²
Duration of measure implementation	36 months
Measurable Results	• Net purchases of energy (kWh) • Electricity consumption in buildings (kWh) • Fuel Consumption (t) • Use of energy from renewable forms (%) • Annual Energy Savings (kWh) • Annual Energy Cost Savings (€) • Carbon Emissions (ppm)
Mitigation Measures	• Different intervention plan for each building depending on current infrastructure. • Energy savings interventions can be easily applied in buildings because there is already the appropriate know-how. • These interventions are very efficient for reducing energy consumption of buildings and it's possible to receive public funding for their implementation.

Measure #2.5	**Energy Saving Interventions in Buildings – Passive Energy Systems**
Description	Energy saving interventions in buildings are a very efficient way to improve the energy class of the buildings, aiming at reducing energy consumption and GHG emissions. Furthermore, the increasing of energy efficiency allows individuals and organisations to reduce their capital and operational cost. The interventions are consisted of passive energy systems, specifically insulation of buildings, installation of insulated window frames and green roofs. The thermal insulation of external walls and roof of buildings with insulation materials, which designed to frustrate the transfer of heat through the material itself, contributes to less energy consumption for covering heating and cooling energy needs of the buildings. Thermal windows are a type of window with energy efficient features. Thermal replacement windows, sometimes called thermal pane windows, are windows that are made up of multiple panes of high-performance energy efficient glass - making them more energy efficient than standard single pane windows. By incorporating two or three panes of glass with insulating gas between each pane, energy consumption is reduced because the transfer out heat is significantly diminished. Planting the rooftops of urbanized areas brings many benefits to public, private, economic and social sectors, as well as to the local and global environments. Green roofs reduce the heat flux through the roof, and less energy for cooling or heating can lead to significant cost savings. Shading the outer surface of the building envelope has been shown to be

	more effective than internal insulation. In summer, the green roof protects the building from direct solar heat. In winter, the green roof minimizes heat loss through added insulation on the roof. Energy conservation translates into fewer greenhouse gas emissions to the environment.
Technical Requirements	• Feasibility study • Definition of the appropriate interventions for every building depending on inveteracy, current infrastructure and needs of each building. • Procurement procedures • Impact assessment
Target	Reduction of energy consumption and carbon emissions.
Impact	• Reduction of energy consumption at a very significant rate, which is depending on the selected intervention. • Reduction of carbon emissions. • Increase energy efficiency.
Estimated Budget	Estimated cost for each intervention: • Thermal insultation of external walls of buildings: 70 €/m² • Thermal insultation of roof of buildings: 50 €/m² • Installation of thermal windows: 40 €/m² • Green roof on buildings: 60 €/m²
Duration of measure implementation	36 months
Measurable Results	• Net purchases of energy (kWh) • Electricity consumption in buildings (kWh) • Fuel Consumption (t) • Energy consumption for heating and cooling (kWh) • Annual Energy Savings (kWh) • Annual Energy Cost Savings (€) • Carbon Emissions (ppm)
Mitigation Measures	• Different intervention plan for each building depending on current infrastructure. • Energy savings interventions can be easily applied in buildings because there is already the appropriate know-how. • These interventions are very efficient for reducing energy consumption of buildings and it's possible to receive public funding for their implementation.

Measure #2.6	Installation of photovoltaic power plant
Description	Solar power is the conversion of sunlight into electricity, either directly using photovoltaics (PV), or indirectly using concentrated solar power (CSP). Solar energy is primarily collected in one of two ways: photovoltaic solar cells and solar thermal. A photovoltaic cell is basically a semi-conductor connected to two electrical contacts. Photons from the sun are absorbed into the semi-conductor (usually a silicon alloy) and knock loose a few electrons. The electrons then travel through the semi-conductor creating an electrical current. Photovoltaic power stations use large areas of photovoltaic cells, known as PV or solar cells, to directly convert sunlight into usable electricity. The solar panels can be installed on roofs of the existing buildings or on site. The energy production from solar panels and the reduction of use of fossil fuels can contribute to reduction of carbon footprint, specifically life cycle carbon dioxide equivalent from electricity supply technology for coal is 740-910 gCO_2e/kWh and for solar is 26-180 gCO_2e/kWh. In 2016, Port of Piraeus started the operation of a photovoltaic power plant with installed power capacity 430 kWp.
Technical Requirements	• Feasibility study • Siting of the new photovoltaic power plant (430kWp) and finding of the proper orientation for maximum exploitation of the plant in port area. • License for connection of the plant to the Public Power Corporation S.A. • Definition of technical requirements of equipment such as installed power capacity, type of solar panels the appropriate transformers to DC/AC, monitoring system and other electromechanical equipment. • Procurement procedures • Impact assessment
Target	Reduction of carbon footprint and production of renewable energy.
Impact	• Reduction of carbon footprint. • Using a renewable energy source for electricity production. • Reduction of conventional energy sources for covering energy demand.
Estimated Budget	800.000 €
Duration of measure implementation	36 months
Measurable Results	• Net purchases of energy (kWh) • Electricity production from photovoltaic power plant (kWh) • Use of energy from renewable forms (%) • Carbon Footprint (ppm)

Mitigation Measures	• There is already another photovoltaic power plant in port area, which will make the construction of this one easier because port staff have the know-how of similar installations and appropriate procedures. • Monitoring system to export data of the produced energy from the solar plant.

Measure #2.7	**Electrification of Port Equipment**
Description	Port operations include the handling and transfer of cargo in the port area and account for significant sources of energy consumption and carbon emissions. Electrification of port equipment is main priority for ports for integrating an energy management system and controlling efficiently the energy consumption in the port area. The main port equipment consists of cranes, quay cranes, rail-mounted gantry cranes (RMG Cranes), telescopic cranes, empty container handlers (ECH), mobile cranes forklift trucks, straddle carriers and luggage towing tractors. The above vehicles and machines use mainly diesel or gasoline engines and consume large amounts of fossil fuels for their operation. The concept of electrification focuses on the replacement of the diesel engines of the available equipment with electric or hybrid ones. Electric engines improve the performance of the equipment, smooth and make operation more efficient, lower maintenance and energy costs and offer more flexibility in automatization and operation. Port of Piraeus has already installed electric port equipment, specifically there are 7 electric quay cranes, 8 electric RMG cranes and 2 electric forklift trucks. The rest of PPA's equipment is consisted of 22 straddle carriers, 1 harbor mobile crane, 5 empty container handlers, 49 forklift trucks, 8 telescopic cranes and 7 luggage towing tractors, all of them are using diesel for their operation. For this Action Plan, it was examined the replacement part of the diesel-operated port fleet with electric-operated or hybrid ones, a high investment like this requires careful planning, funding solutions and forecasting of future needs of the port. Furthermore, depending on the technical characteristics of the engines of the current diesel-operated vehicles, it's also recommended the investigation of possible integration of electric or hybrid engines and the appropriate electromechanical equipment to the existing diesel-operated ones.
Technical Requirements	• Feasibility Study • Selection of the appropriate electric models of the equipment according to the needs of the port operations. • Definition of technical requirements and system set up: Vehicle energy calculation, driving route data, vehicle charging requirements, auxiliary system, life cycle and propulsion. • Procurement procedures • Impact assessment

Target	Reduction of energy consumption, carbon footprint and other air pollutants in port
Impact	• Integration of energy management system in port equipment • Optimisation of the port operations. • Reduction of use of conventional fuel's consumption. • Reduction of carbon footprint. • Reduction of air pollutants emissions (NOx, SOx, PM, O_3).
Estimated Budget	Electric forklift truck: 30.000 €/truck Electric telescopic crane: 35.000 €/crane Electric towing tractor: 10.000 €/vehicle Electric empty container handlers: 30.000 €/vehicle Electric straddle carriers: 250.000 €/carrier
Duration of measure implementation	48 months
Measurable Results	• Electricity consumption for electric port equipment (kWh) • Fuel Consumption (t) • Energy cost of operation of electric equipment (€/kWh) • Carbon Footprint (ppm) • NO_X Emissions (ppm) • O_3 Emissions (ppm) • PM Emissions (ppm)
Mitigation Measures	• Training of the staff of the port equipment to get familiar with the operation of the new electric equipment. • Electric equipment has lower operational and maintenance cost, offers flexibility and efficiency, optimize port operations and integrates an energy management system.

6. Strategies for actions deployment

The designation and implementation of the Action Plan measures will take place under the Deployment Strategy so that PPA can achieve the successful implementation of the measures and the maximization of their expected impacts. The picture below presents the necessary steps towards the implementation of the selected measures.

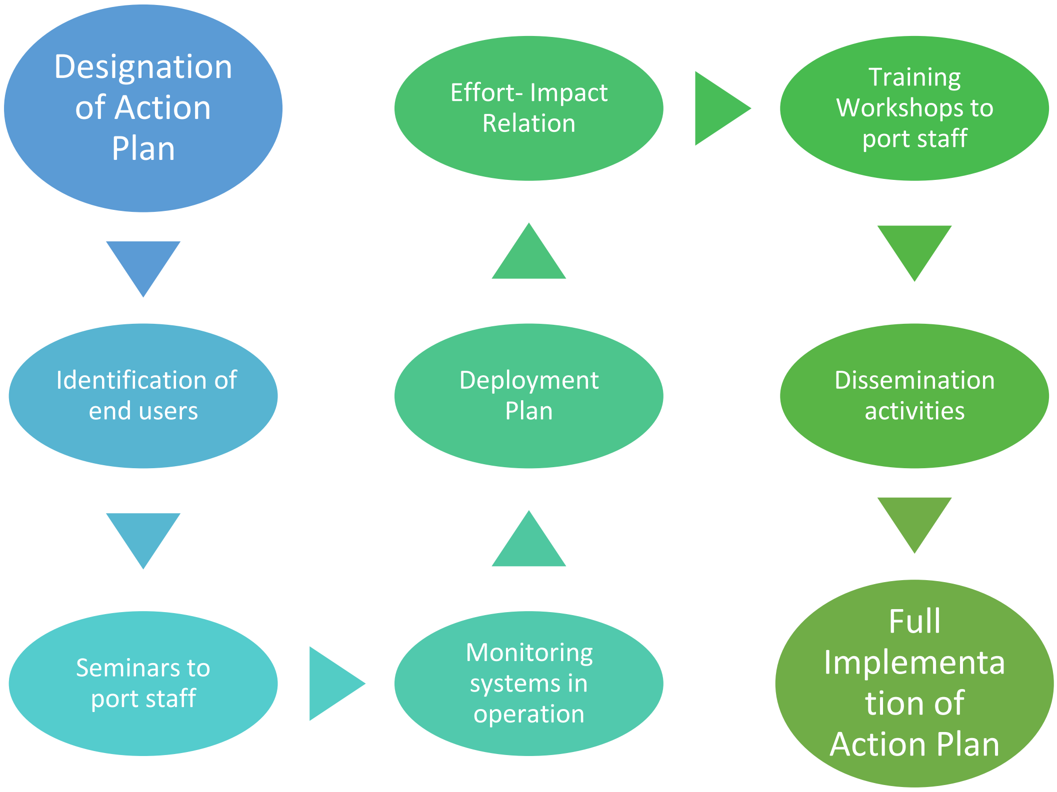


Figure 6.1: Deployment Strategy for the Action Plan

6.1 Identification of end users

PPA Action Plan will be deployed within the port area, therefore the end users are mainly the port staff. However, there are measures to which other groups will also have access and receive the benefits of them such as the local community and shipping companies. The table below indicates the end users of each measure.

Table 6.1: End Users of Action Plan measures

SUPAIR Action	End Users
Cold Ironing/ Establishment of infrastructure for the electrification for ships	Port Staff, Shipping Companies, Passengers
Deployment and operation of charging stations infrastructure for electric vehicles	Port Staff, Local community/ residents, SMEs
Electric Buses (Eco-Buses) for transportation in port area	Port Staff, Passengers

Micro mobility measures within port area	Port staff, Passengers, Residents of local community
LNG supply facility for ships in port area	Port staff, Shipping Companies
Energy Saving Interventions in Buildings – Active Energy Systems	Port staff, Local community
Energy Saving Interventions in Buildings – Passive Energy Systems	Port staff, passengers
Implementation of LED Technology for Indoor Lighting	Port staff, Local community
Implementation of LED Technology for Outdoor Lighting	Port staff, Local community, Transport companies, SMEs
Installation of photovoltaic power plant	Port staff, Public Power Corporation
Electrification of port equipment	Port staff, Shipping Companies, SMEs

6.2 Seminars and training courses for personnel

For maximizing the expected impacts from the interventions and minimizing the effort scale, the organization of appropriate seminars for the port staff is required. The seminars organized before the implementation of each measure, the external experts and the corresponding PPA directors will meet with the corresponding port staff for presenting the structure and the significance of the measures. Port staff will get informed about what the measures will be implemented and how these are expected to influence port operations in line with relevant policies and specific EU goals that will be outlined.

6.3 Effort – Impact Relation

The selected measures have been analysed and assessed before their final selection in order to answer successfully to the needs and priorities of PPA and the local community, adhering to the legislation framework and considering the possibilities of existing and upcoming technologies. However, each measure contributes differently into the final goal of the Action Plan and requests a different degree of effort according to its maturity, the budget and the duration of implementation.

In more details, for the weighting of the relation between effort and impact was taken into account the following criteria:

- Criteria for Effort:
    - Estimated cost for the implementation of each measure.
    - Duration for the efficient implementation of each measure.
    - Prioritization according to the current needs of Port of Piraeus and future planned extensions of its port infrastructure.
    - Technical specifications of PPA's port infrastructure to integrate adequately and efficiently the required installations of each measure.

- Criteria for Impact:
    - Potential reduction of carbon footprint of the implementation of each measure.
    - Potential reduction of energy consumption of the implementation of each measure.
    - Potential reduction of fossil fuel consumption of the implementation of each measure.
    - Potential reduction of air pollutants emissions of the implementation of each measure.
    - Requirements for alignment with National and European environmental, transport, energy and climate change legislation.

Therefore, the required effort and the expected impact of each measure have been analysed according to the above criteria and the table below presents the weighting of the relation between Effort-Impact for each of the recommended interventions.

Table 6.2: Weight values of Effort-Impact of each proposed measure

Energy Management	Effort	Impact
Energy Mapping Monitoring System	7	10
Implementation of LED Technology for Indoor Lighting	3	4
Implementation of LED Technology for Outdoor Lighting	4	6
Energy Saving Interventions in Buildings – Active Energy Systems	4	4
Energy Saving Interventions in Buildings – Passive Energy Systems	4	7
Installation of photovoltaic power plant	7	4
Electrification of Port Equipment	5	8
Carbon Footprint		
Air Quality Monitoring System	7	10
Cold Ironing/ Establishment of infrastructure for the electrification of ships	9	8
Deployment and operation of charging stations infrastructure for electric vehicles	8	7
Electric Buses (Eco-Buses) for transportation in port area	3	6
LNG supply facility for vehicles and ships in port area	9	8
Micromobility in Port Area with Electric Scooters and Bicycles	5	7

Table 6.3: Scale of the weight values

1	2	3	4	5	6	7	8	9	10
Low					High				

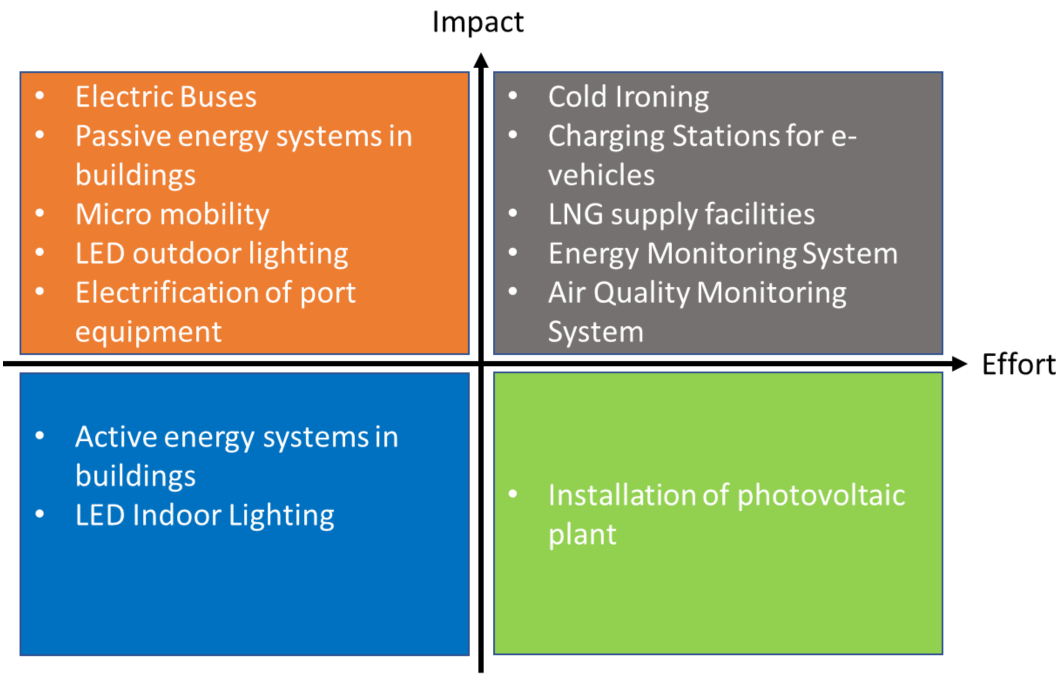


Figure 6.2: Effort- Impact relation for Action Plan measures

6.4 Deployment Plans

Following the analysis of the measures for the "Monitoring and reduction of carbon footprint" and the "Energy Management Plan and improvement of PPA's energy efficiency" and taking into consideration the effort-impact assessment, two deployment plans have been designed identifying the sequence to be followed in implementing the measures.

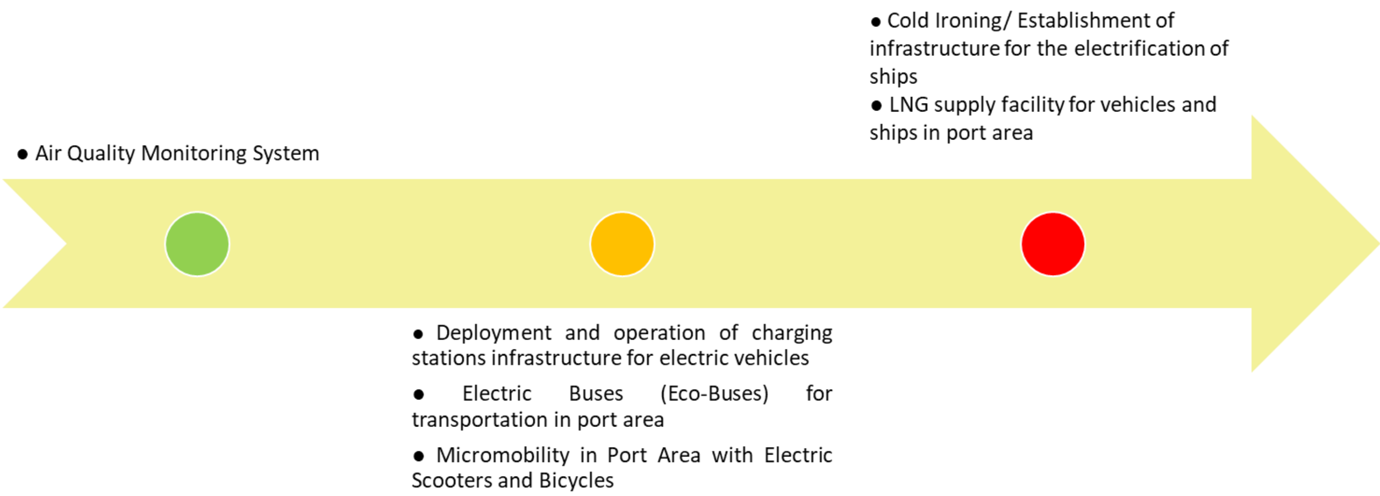


Figure 6.3a: Deployment plan for monitoring and reduction carbon footprint measures

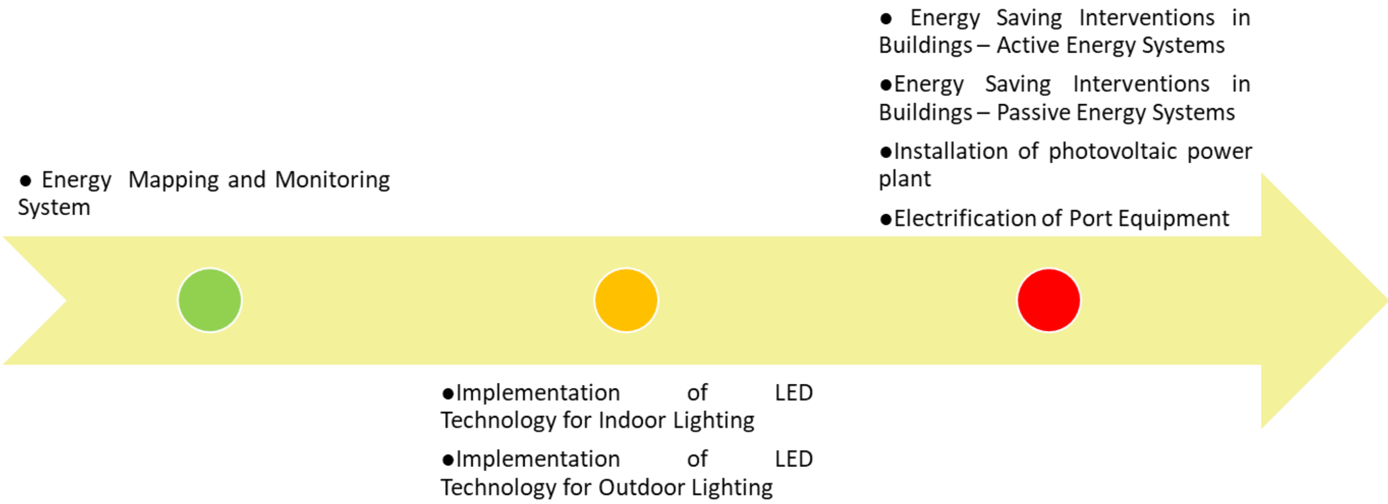


Figure 6.3b: Deployment plan for the Energy Management Plan and improvement of PPA's energy efficiency measures

6.5 Monitoring Systems in Operation

The first part of the Action Plan involves the development and operation of the two main Monitoring Systems:

- Air Quality Monitoring System
- Energy Mapping Monitoring System

These systems are mandatory for PPA for the successful selection of all required data, air pollutants and energy consumption. PPA will collect the data at regular intervals for having a clear view about the environmental impact of its daily activities and designing appropriate actions towards a sustainable and low carbon port.

6.6 Training workshops to port staff

The training workshops will take place after the implementation of the measures and port staff will have the chance through interactive practices to get familiar with them. External experts and the corresponding PPA directors will be there for answering any query of the staff and to create a better learning environment by guiding trainees to know what to look for and what to remember.

6.7 Dissemination activities

Dissemination activities are very important for two reasons:

- PPA to become a good paradigm for other ports within the country and beyond with regard to their transformation into sustainable and low carbon ports
- Demonstrate PPA to relevant stakeholders and the local community PPA's environmental character and attracting them for using part of the recommended measures such as charging stations, cold ironing, etc.

7. Coordination with relevant plans

7.1 Overall Vision of Relevant Plans

The city – port complex of Piraeus has the vision of promoting "Piraeus" as a Business, Tourist, Cultural, Maritime and Commercial Destination of International Recognition and Scope, with Energy, Environmental and Social added values for citizens, and visitors. This vision highlights Piraeus as:

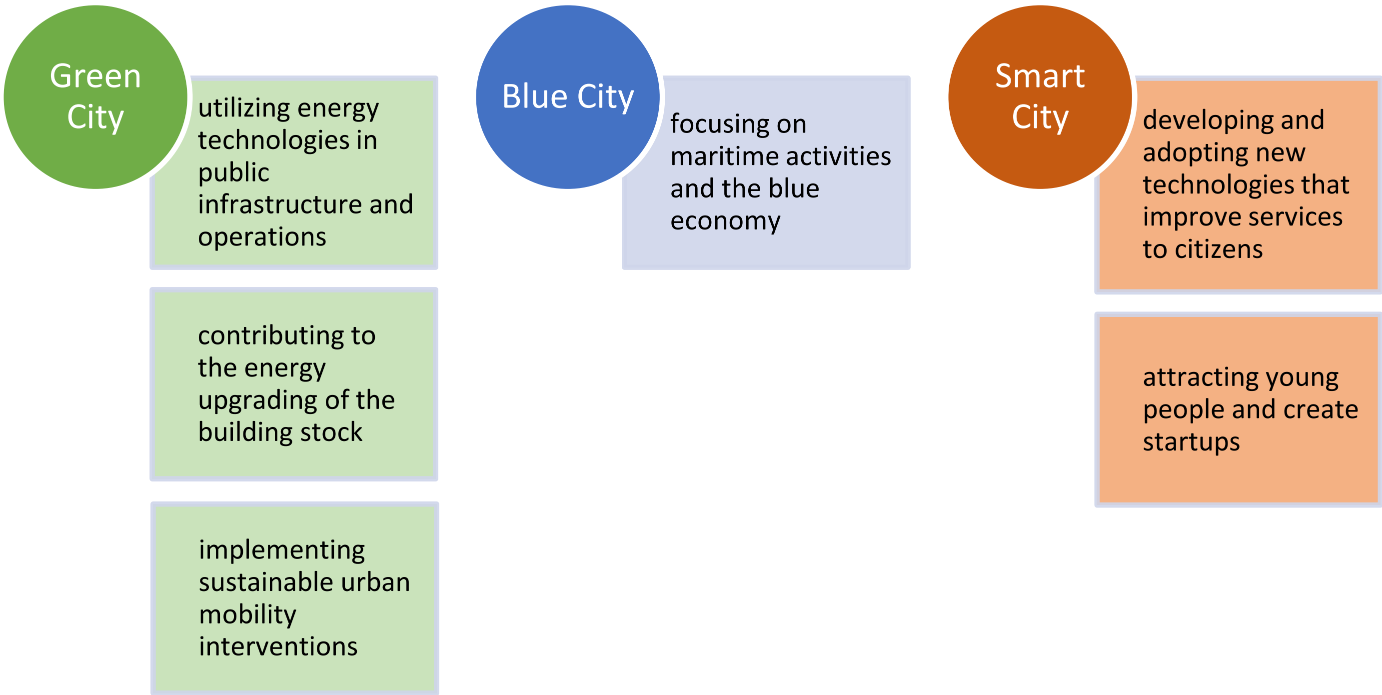


Figure 7.1: The vision of Piraeus

Following this vision, a series of Development Plans have been conducted according to local, national and international principles for identifying, analyzing and designing interventions for the city – port of Piraeus which aim to increase attractiveness of Piraeus and improve life quality. All plans recognizing that the port of Piraeus is located within the city, have taken into consideration the functions that define the City's interface and interoperability with the neighboring Municipalities and Port functions (e.g. traffic infrastructure and flows, repair and manufacturing activities, logistics, supplies, development and management of the "maritime cluster", utilization and reuse of industrial zones and large public real estate, etc.).

Within the SUPAIR Action Plan, the existing Development Plans in the area of Piraeus were analyzed and an alignment with their scope has been ensured, thus the plans' priorities have been carefully considered in the proposed measures to the extent of course that the needs of the port are also fully met. The figure below shows the different Development Plans at local level that were taken into consideration in the development of the SUPAIR Action Plan.

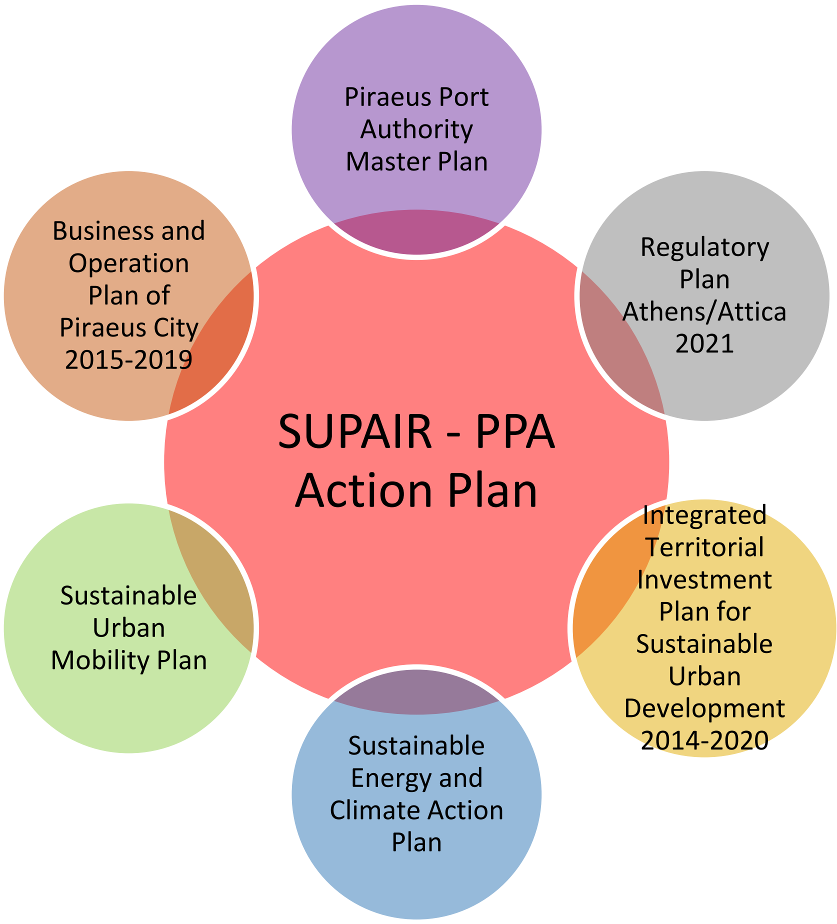


Figure 7.2: Development Plans for the Piraeus

7.2 Piraeus Port Authority Master Plan

PPA Master Plan has been developed with a detailed architectural vision on the possible future layout of the port focusing on the future market demands and the potential of the area. The main target of the PPA Master Plan is the development of PPA into a modern and dynamic company that provides high quality services, keeps investors satisfied, ensures long-term employment and serves commercial transactions in Greece in favor of the national economy and the consumers in the most efficient way and within the context of the global port industry.

The proposed PPA Master Plan projects include 11 Mandatory Investments and 9 Additional Investments and are classified into the following 4 basic types:

- Port Projects
- Infrastructure Projects
- Building Construction Projects
- Ancient and Culture Projects

All PPA Master Plan projects aim to allow the active development of new business areas while enhancing the operation of the existing ones.

Regarding the environmental sector, PPA gives great importance on the protection of the environment and the promotion of sustainable solutions which meet the general vision of the port to be transformed into a "green" port. The PPA master plan includes environmental infrastructure projects and upgrading environmental actions which cover the following sectors:

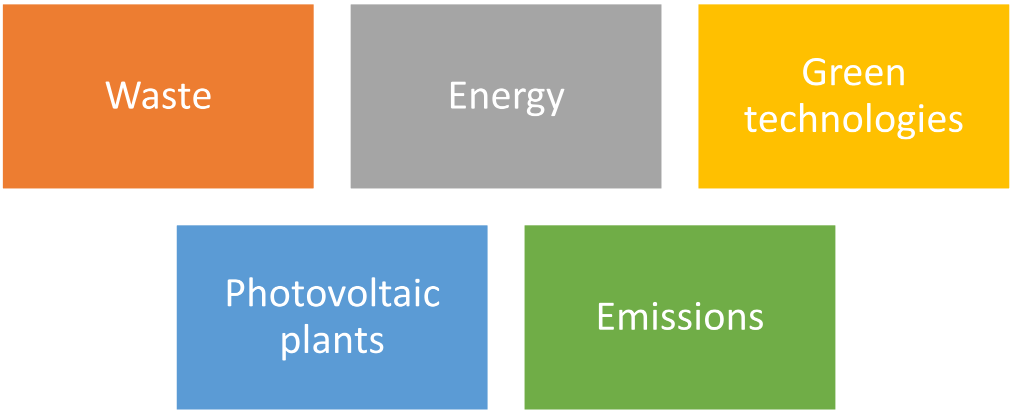


Figure 7.3: Sectors including into PPA Master Plan Projects

7.3 Regulatory Plan Athens/Attica 2021

The Regulatory Plan Athens/Attica 2021 is a strategic plan of directions for the organization of the space for the city of Athens and for the entire Attica Region. The main milestones of the Regulatory Plan are listed below:

- The production and support of entrepreneurship, as a key driver and a prerequisite for economic growth and social sustainability
- The environment, as an important resource for the future of society and as a pillar for sustainable development
- Social and spatial cohesion, as the most important concepts in times of crisis
- Culture as a concept that permeates and encompasses all the individual expressions and components of society
- Urban revitalization, with integrated interventions and urban renewal

Regarding the sector of environment and energy, a key strategic direction of the Regulatory Plan is to address and adapt to climate change, primarily through the following actions:

1) Implementing a coherent urban development model.

2) Limiting greenhouse gas emissions by reducing mainly vehicle use.

3) Protecting natural resources.

4) Developing an integrated energy saving program (at least 20% saving).

5) Promoting bioclimatic design.

6) Improving energy efficiency of buildings and infrastructures.

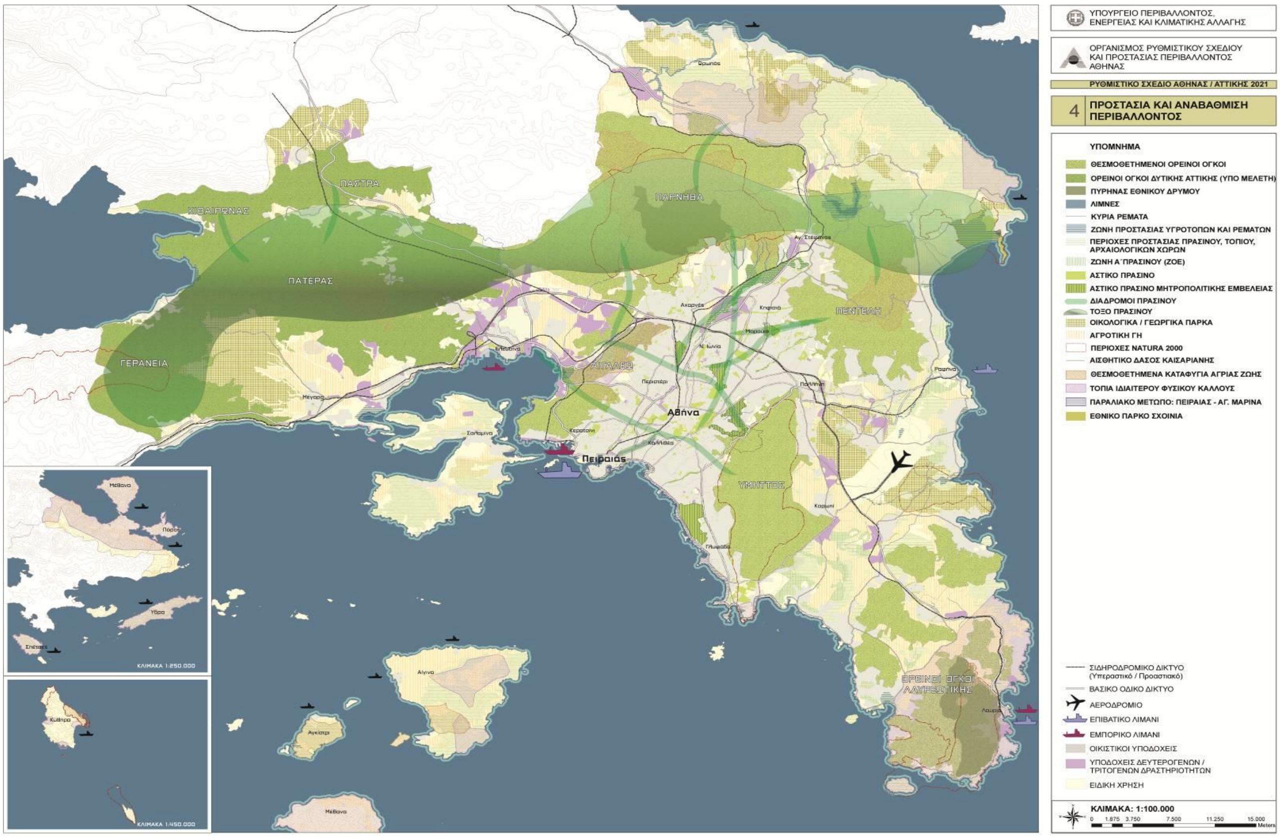
7) Increasing production and use of renewable energy.

8) Implementing an integrated environmental management system.

9) Developing a noise mapping program.

Figure 7.4: Main action of Regulatory Plan Athens/Attica 2021

The map, below, shows the protection and enhancement of environment according to Regulatory Plan.



Picture 7.1: Protection and enhancement of environment according to Regulatory Plan

7.4 Integrated Territorial Investment Plan for Sustainable Urban Development 2014-2020

The Integrated Territorial Investment Plan is an integrated spatial development tool for the implementation of development strategies in spatial units that encounter specific problems and are distinguished by significant development opportunities. The main goals of OED are to improve the attractiveness and competitiveness of the city of Piraeus, implement urban upgrading actions, as well as initiatives to enhance social cohesion.

In more details, the main priorities of Integrated Territorial Investment Plan are listed below:

1) Improving attractiveness and competitiveness of the city of Piraeus.

2) Promoting the City of Piraeus as a Recognized and Intercultural Destination of tourism and cultural flows.

3) Upgrading and revitalizing traditional commerce and the business center of Piraeus City.

4) Improving the life quality and the effectiveness of urban functions.

5) Creating appropriate conditions and supporting new job creation.

6) Developing and implementing 'smart' solutions in urban and social innovation.

7) Consistent utilization of public, municipal and private Properties.

8) Developing of partnerships – Promoting Piraeus abroad.

9) Management, Implementation and Evaluation of development interventions.

Figure 7.5: Main priorities of Integrated Territorial Investment Plan

Resulting from the above OED priorities, the sector of environment and energy are included mainly in each OED intervention as a horizontal principle for improving the quality life, increasing Piraeus attractiveness and transforming the city of Piraeus to an eco-city.

7.5 Sustainable Energy and Climate Action Plan

In 2016, the Municipality of Piraeus joined the Covenant of Mayors for Climate and Energy, adopting the EU 2030 targets for climate change mitigation and adaptation.

1) Reducing greenhouse gas emissions by at least 40% by 2030

2) Increasing the city's resilience by adapting to the effects of climate change and assessing risks and vulnerability

Figure 7.6: EU 2030 targets for climate change mitigation and adaptation

The Covenant of Mayors is the world's largest movement for local climate and energy actions and brings together thousands of local governments voluntarily committing to implementing EU climate and energy objectives. The Covenant of Mayors was launched in 2008 in Europe with the ambition to gather local governments voluntarily committing to achieve and even exceed the EU climate and energy targets. The initiative now gathers 9,000+ local and regional authorities across 57 countries drawing on the strengths of a worldwide multi-stakeholder movement and the technical and methodological support offered by dedicated offices.

7.6 Sustainable Urban Mobility Plan

Piraeus of City is developing this period its Sustainable Urban Mobility Plan (SUMP) for improving the accessibility of the city areas and providing high-quality and sustainable mobility and transport. The Piraeus SUMP fosters a balanced development of all relevant modes, while encouraging a shift towards more sustainable modes. The Plan is built on a careful assessment of the present and future performance of the urban transport system by reviewing the current situation, establishing a baseline against which future progress can be measured, as well as defining performance objectives and related targets to guide the implementation of the plan.

The plan puts forward an integrated set of technical, infrastructure, policy-based, and soft measures to improve performance and cost-effectiveness with regard to the declared goal and specific objectives. It would typically address the following topics:

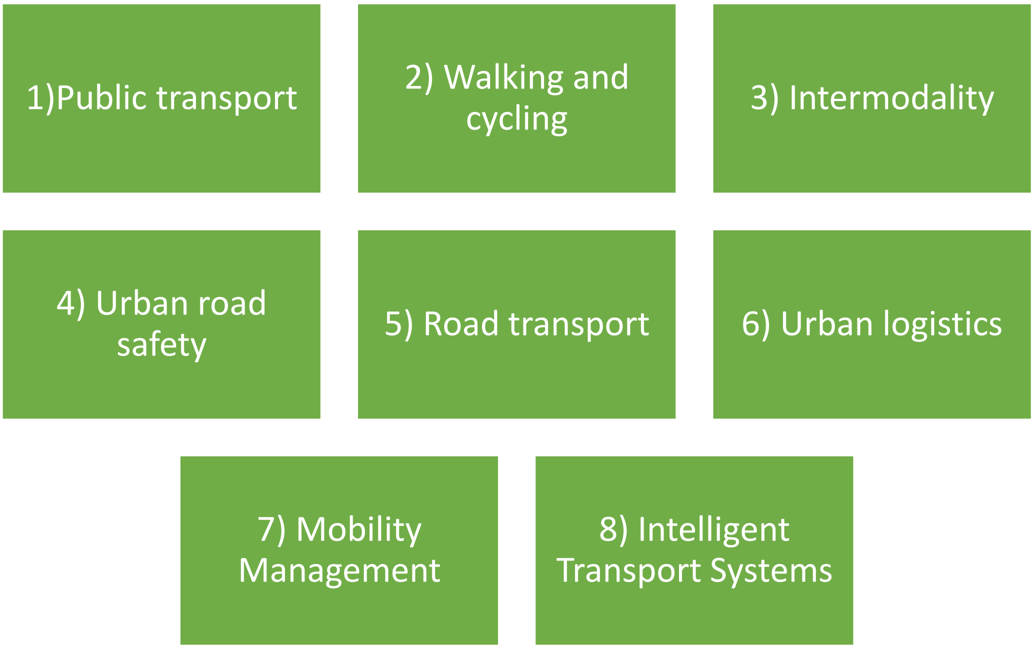


Figure 7.7: Topics involved in a Sustainable Urban Mobility Plan

To this point, taking into consideration that the city of Piraeus is directly connected with the port of Piraeus, the plan follows a transparent and participatory approach as relevant actors, citizens and economic actors are involved in developing and implementing the plan from the outset and throughout the process to ensure a high level of acceptance and support.

7.7 Business and Operation Plan of Piraeus City 2015-2019

The Business and Operation Plan of Piraeus City is a comprehensive plan of local and organizational - operational development for the period 2015-2019, in alignment with the development planning directions at regional and national level. The main priorities of the business and operation plan of Piraeus City are listed below:

Figure 7.8: Main priorities of the business and operation plan of Piraeus City

Focusing on Priority 1, the Business and Operation Plan of Piraeus City includes specific goals and actions on the environment and energy sectors which are:

Priority 1:

- Sustainable Environmental Management
- Monitoring of emissions and environment standards
- Prevention of risks and natural disasters
- Energy upgrading and energy saving in schools, public spaces and municipal buildings / Green roofs
- Quality upgrading of heating systems in schools and public buildings
- Use of RES in schools and public buildings
- Raising awareness of the population on energy saving issues

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7.8 Coordination among relevant Plans

Resulting from the above, which are in force for the further development of the Piraeus Port Authority and Piraeus city, it is clear that the sectors of environment and energy are main priorities at local, national and international level. The developed Action Plan within the SUPAIR Project has taken into consideration the directions of existing plans in order to recommend and design actions which are fully aligned with the general priorities of the port and the city. The table, below, presents the connection of the SUPAIR Action Plan with the existing Development Plans.

Table 7.1: Connection of SUPAIR Action Plan with the existing Development Plans

Development Plan	Priority	SUPAIR Action Plan Intervention
PPA Master Plan	Green technologies	Eco Buses
	Energy saving	
	Reduction of emissions	
Regulatory Plan Athens/Attica 2021	Energy saving	Led Technology
		Energy mapping
		Energy Saving Interventions in Buildings
		Installation of photovoltaic power plant
	Environmental management	Air quality monitoring system
	Reduction of greenhouse gas emissions	Charging stations for electric vehicles
		Cold Ironing
		Electric Buses
		LNG supply facility
Integrated Territorial Investment Plan for Sustainable Urban Development 2014-2020	Improving life quality	Cold Ironing
		Charging stations for electric vehicles
		Electric Buses
		LNG supply facility
		Installation of photovoltaic power plant
		Energy Saving Interventions in Buildings
Sustainable Energy and Climate Action Plan	Reducing CO_2 Footprint	Air quality monitoring system
		Cold Ironing
		Electric Buses
		Charging stations for electric vehicles
		LNG supply facility
Sustainable Urban Mobility Plan	Mode Shift	Electric Buses
	Reduction of greenhouse gas emissions	Electric Buses
		Charging stations for electric vehicles
Business and Operation Plan of Piraeus City 2015-2019	Environment	Air quality monitoring system
		Cold Ironing
		Electric Buses
		Charging stations for electric vehicles
		LNG supply facility
	Energy Saving	Led technology
		Energy mapping
		Energy Saving Interventions in Buildings
		Installation of photovoltaic power plant

8. Assessment design

This chapter aims to support PPA and policy makers to increase their understanding of the recommended PPA Action Plan. Sustainability Impact Assessment (SIAs) will provide stakeholders with an in-depth analysis of the potential economic, social and environmental impacts of the SUPAIR Action Plan interventions. In more detail, SIAs have several purposes, including:

- Providing information for the recommended actions.
- Assessing the actions from an economic, social and environmental view.
- Providing sollutions for possible negative results.
- Ensuring that the related policy choices are optimised.

The concept of 'sustainability' has become widespread and has been applied in many areas with the main aim of maintaining change in a balanced trend, where resource utilization, investment direction, technology development orientation and institutional change they are all harmoniously developed and respect both human needs and the environment. In this context, Piraeus Port, as one of the largest developing companies at European level, applies the principles of sustainability in all its development steps with the main aim of protecting the environment from potential negative impacts and promoting the well-being of the local community. For this reason, PPA developed within the SUPAIR Project, the Action Plan focusing on the reduction of carbon footprint including specific actions covering reduction of air pollutants and efficient energy management.

PPA in collaboration with the Focus Group operated within the SUPAIR project, attempted to form a definition of sustainable port which shows clearly the parameters of their needs. The main parts of the definition are:

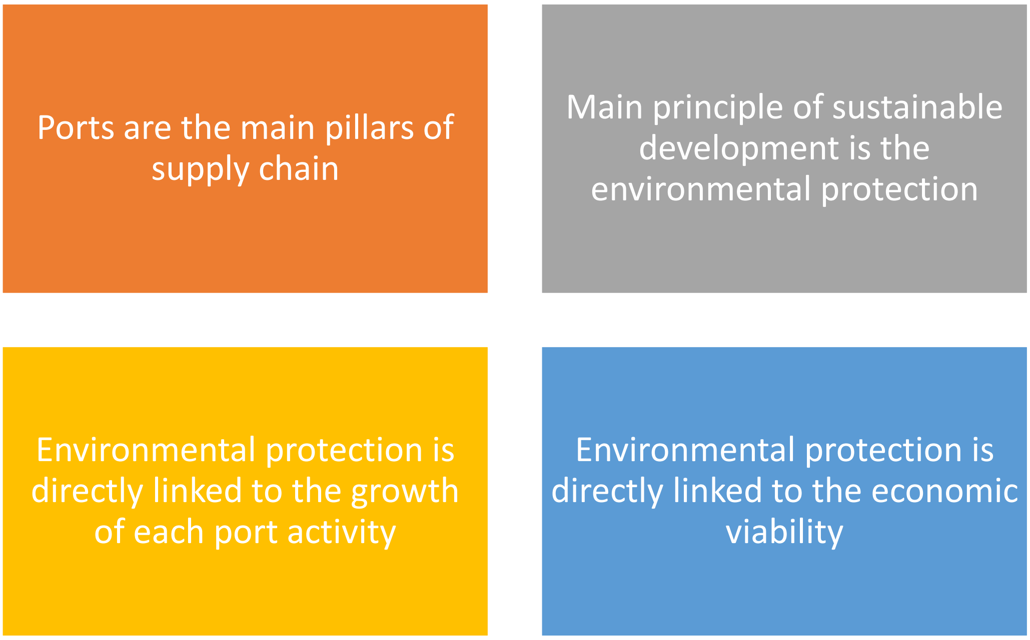

Figure 8.1: Main parts of SUPAIR definition for “sustainable port”

Deriving from the above analysis, the concept of "Sustainable Port" requires an efficient organization and leadership, coherent policies and regulations, innovations and a management system of environmental protection, energy efficiency and sustainable development.

Resulting from the above, PPA has designed an efficient Sustainable Impact Assessment (SIA) for exploring the combined economic, environmental and social impacts of the developed Action Plan. The main principles of designed SIA are:

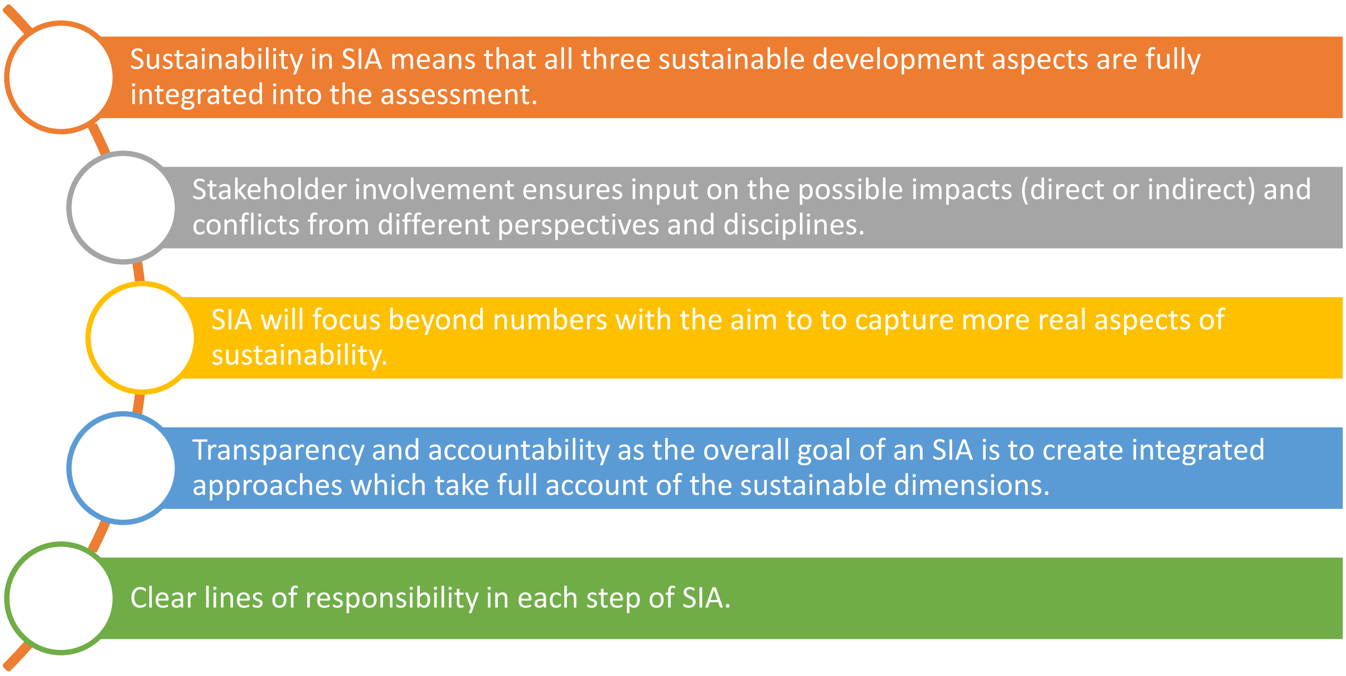

Figure 8.2: Main principles of designed Sustainable Impact Assessment (SIA)

Based on the above principles, the steps of SIA are clearly designed for achieving the main scopes of SIA and contributing to the successulf implementaion of PPA actions towards the reduction of carbon footprint. The steps of the SIA, listed below, cover four main type of analysis; a) relevance analysis, b) delineation analysis, c) Impact analysis and d) optimisation.

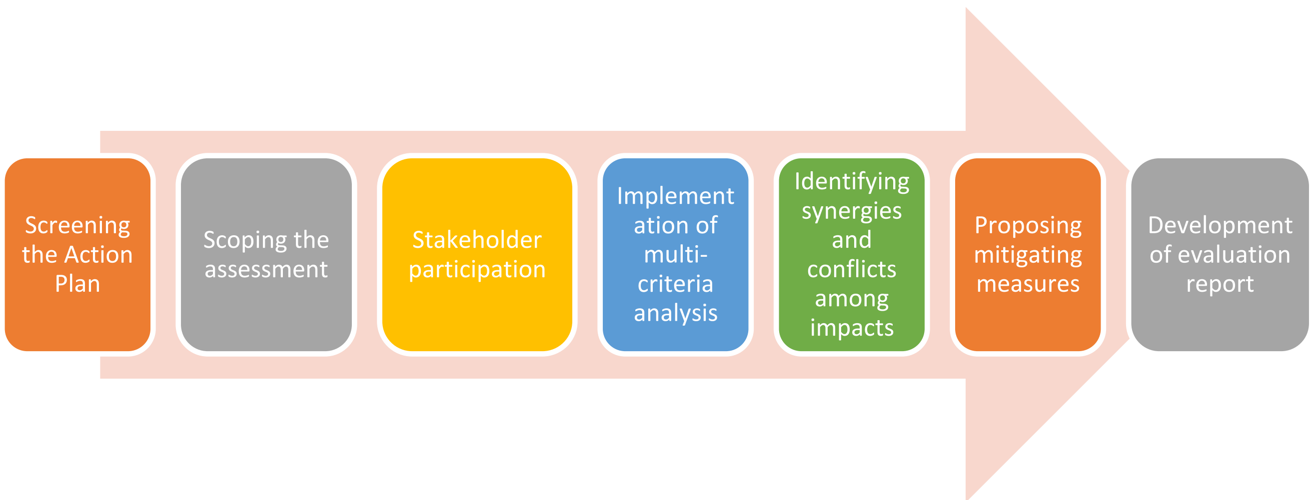

Figure 8.3: The steps of Sustainable Impact Assessment (SIA)

8.1 Screening the Action Plan

This step is the first part of "relevance analysis" and refers to a clear description of the PPA actions for understanding each action and their significance. This quick scan of the actions will identify a first view of significant synergies and conflicts across economic, environmental and social dimensions. Within this framework, PPA Action Plan includes measures promoting the concept of sustainability and circular economy in terms of port infrastructure:

Figure 8.4: The measures of PPA Action Plan

<u>Scoping the assessment:</u>

This step is the second part of "relevance analysis" and aims to specify the depth and extent of the assessment as proportionate to the importance of the Action Plan and the potential impacts. The PPA actions have been selected since Port of Piraeus acknowledges the need for reducing the carbon footprint in port area and it expects the following results from the adoption of the Action Plan measures until 2030.

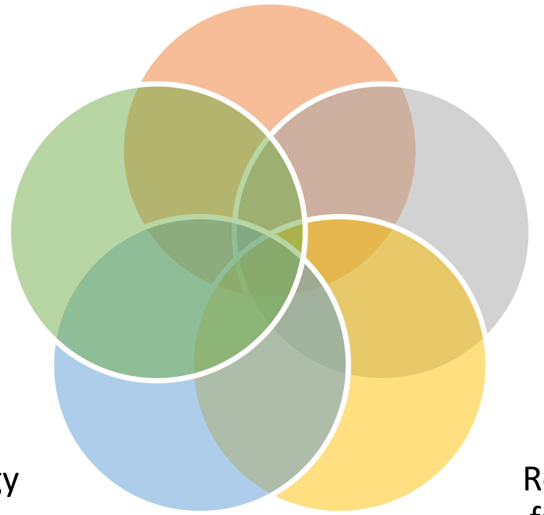

Figure 8.5: The goals of PPA Action Plan

8.2 Stakeholder participation

This step belongs to the "delineation analysis"and refers to the involvement of stakeholders through various means in different stages of the sustainability impact assessment. In more details, stakeholders will be involved as the graph shows below through three main methods;

a) interviews
b) questionnairies
c) focus group meetings

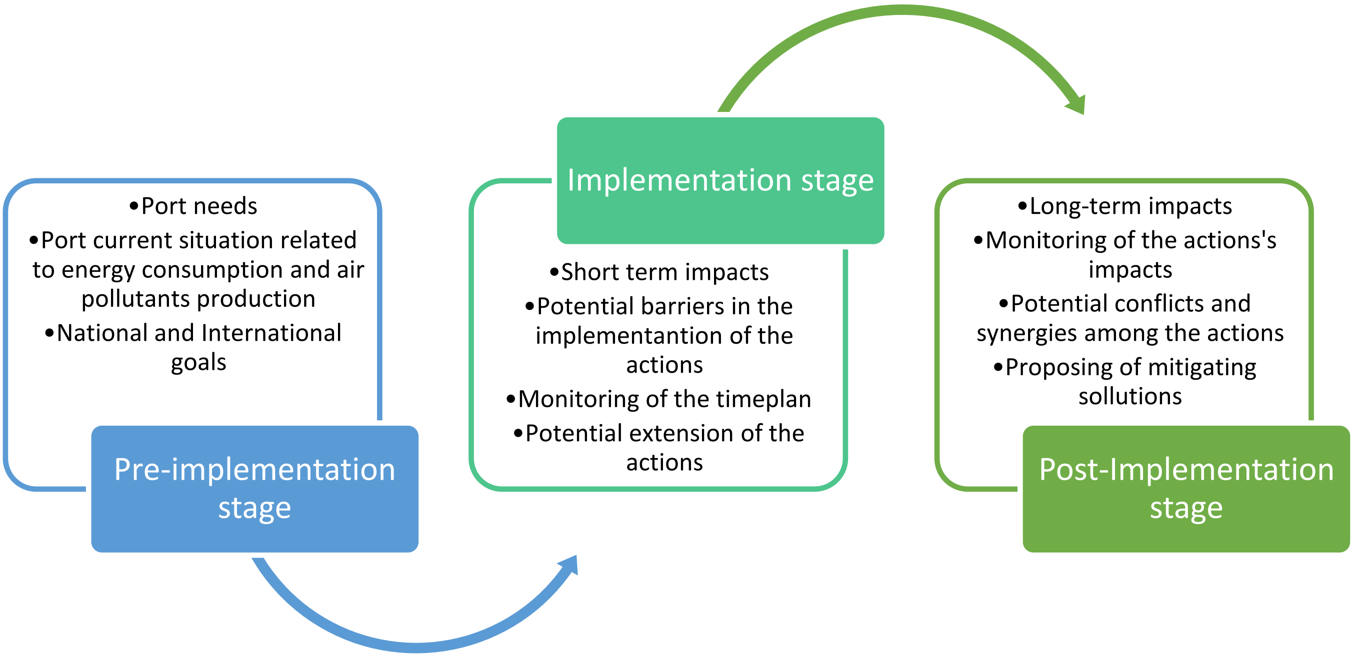

Figure 8.6: Stakeholder participation in all Action Plan implementation

8.3 Implementation of multi-criteria analysis

This step is the first part of the "impact analysis" and refers to the assessment of the economic, environmental and social impacts of the proposed actions. For this step, multi-criteria analysis has been selected for analysing proposed actions from three main aspects: a) economic, b) social and c) environmental. The selected multi-criteria analysis is based on multi-actor process since stakeholder engagement is envisaged in the next steps. The multi-criteria analyis will be divided into two time zones; pre-implementaion stage ("as is" scenario) and post-implementation stage ("to be"scenario). For both time zones, a set of impact indicators has been developed and should be fulfilled in order to achieve a clear view of how proposed actions influence PPA and round places from an economic, environmental and social view.

Table 8.1: Outcome indicators for each measure

SUPAIR Action	Type of Indicator	Outcome Indicator
Cold Ironing/ Establishment of infrastructure for the electrification for ships	Environmental	Fuel consumption
		Electricity consumption kW on site
		Energy cost of electricity
		Carbon Footprint
		NO_X Emissions
		PM Emissions
	Social	Employment rate
		Life satisfaction

	Economic	Implementation Cost/ PPA Profit
Deployment and operation of charging stations infrastructure for electric vehicles	Environmental	Electricity Consumption on site
		Carbon Footprint
		Energy cost of electricity in buildings
	Social	Employment rate
		Life satisfaction
	Economic	Implementation Cost/ PPA Profit
Electric Buses (Eco-Buses) for transportation in port area	Environmental	Electricity consumption for electric mobility
		Fuel Consumption
		Energy cost of electric mobility
		Carbon Footprint
		CO Emissions
		NO_X Emissions
		O_3 Emissions
		PM Emissions
	Social	Employment rate
		Life satisfaction
	Economic	Implementation Cost/ PPA Profit
Micro mobility measures within port area	Environmental	Carbon Footprint
		CO Emissions
		NOX Emissions
		SO_2 Emissions
		O_3 Emissions
		PM Emissions
	Social	Employment rate
		Life satisfaction
	Economic	Implementation Cost/ PPA Profit
LNG supply facility for vehicles and ships in port area	Environmental	Carbon Footprint
		GHG Emissions
		NO_X Emissions
		SO_2 Emissions
		PM Emissions
		LNG consumption
		Fossil fuel consumption
	Social	Employment rate
		Life satisfaction
	Economic	Implementation Cost/ PPA Profit

Energy Saving Interventions in Buildings – Active Energy Systems	Environmental	Net purchases of energy
		Electricity consumption in buildings
		Fuel Consumption
		Use of energy from renewable forms
		Annual Energy Savings
		Annual Energy Cost Savings
		Carbon Footprint
	Social	Employment rate
		Life satisfaction
	Economic	Implementation Cost/ PPA Profit
Energy Saving Interventions in Buildings – Passive Energy Systems	Environmental	Net purchases of energy
		Electricity consumption in buildings
		Fuel Consumption
		Energy consumption for heating and cooling
		Energy consumption for heating and cooling
		Annual Energy Savings
		Annual Energy Cost Savings
		Carbon Footprint
	Social	Employment rate
		Life satisfaction
	Economic	Implementation Cost/ PPA Profit
Implementation of LED Technology for Indoor Lighting	Environmental	Electricity consumption in buildings
		Carbon Footprint
		Number of lamps
	Social	Employment rate
		Life satisfaction
	Economic	Implementation Cost/ PPA Profit
Implementation of LED Technology for Outdoor Lighting	Environmental	Electricity consumption on site
		Carbon Footprint
	Social	Employment rate
		Life satisfaction

	Economic	Implementation Cost/ PPA Profit
Installation of photovoltaic power plant	Environmental	Net purchases of energy
		Electricity production from photovoltaic power plant
		Use of energy from renewable forms
		Carbon Footprint
	Social	Employment rate
		Life satisfaction
	Economic	Implementation Cost/ PPA Profit
Electrification of port equipment	Environmental	Fuel Consumption
		Carbon Footprint
		NO_X Emissions
		SO_2 Emissions
		PM Emissions
	Social	Employment rate
		Life satisfaction
	Economic	Implementation Cost/ PPA Profit

8.4 Identifying synergies and conflicts among impacts

This step refers to the identification of synergies and conflicts across identified economic, environmental and social impacts of the proposed actions. The concept of sustainablity is consisted of three major pillars, the economic, environmental and social factors, which have different characteristics, targets and perspectives. The environmental pillar is focused on reduction of carbon footprint, energy consumption and waste, the economic pillar includes the governance, compliance and risk management to ensure that the organistaion is profitable and the social pillar is associated with the support and approval of the employees, relevant stkaeholders and local community.

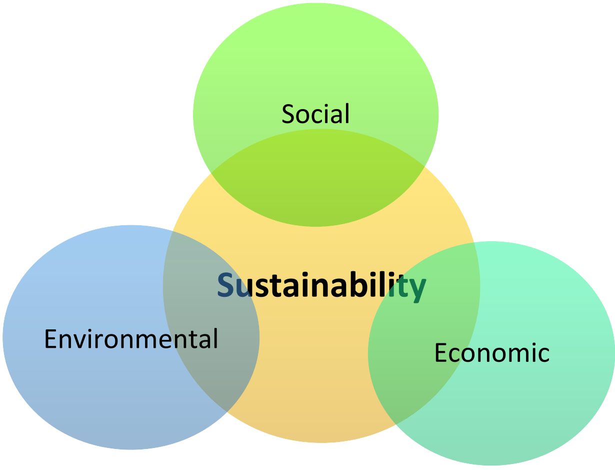

Figure 8.7: The three pillars of the Sustainability

In more details, this section is focused on identifying the synergies and conflicts among the selected indicators, in order to reach the main goal of the Action Plan, which is to transform Port of Piraeus into a sustainable port in terms of social, environmental and economic.

For example, an action may have extremely positive enviromental impact while its impementation cost is very huge. The method, that was followed to identify the measures of the Action Plan, aimed at balancing the conflicts and enhancing the synergies among economic, environmental and social factors, taking into consideration of priorities, needs and targets of PPA as were determined during the Focus Group Meeting with the relevant stakeholders.

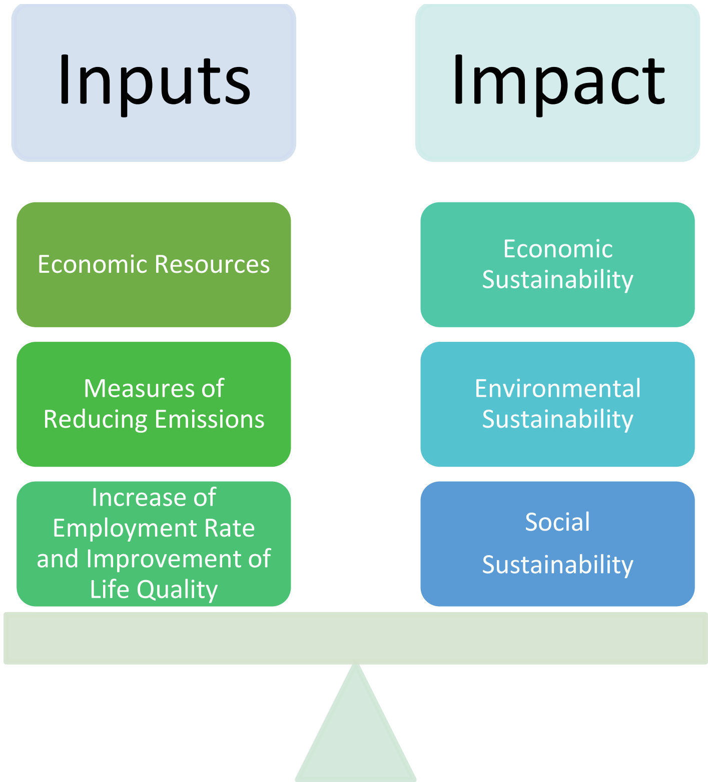

Figure 8.8: Balancing the inputs and outputs for the implementation of the Action Plan

All three factors played a major role in implementation of the Action Plan, the selection and prioritization of the proposed measures were based on constributing to the economic growth of PPA, reducing the impact of port's operations to the environment and strengthening the relationship with the community.
Therefore, in this step weight values will be given in the economic, environmental and social impact indicators in order to achieve objective results covering the needs of PPA and round places. Below, the table listed the weight values of each proposed measure taking into account the economic, environmental and social indicators, which were identified in Table 8.1.

Table 8.2: Weight values of proposed measures in terms of economic, environmental and social indicators

Proposed Measures	Indicators		
Energy Management	**Economic**	**Environmental**	**Social**
Energy Mapping Monitoring System	7	10	7
Implementation of LED Technology for Indoor Lighting	3	4	6
Implementation of LED Technology for Outdoor Lighting	4	6	6
Energy Saving Interventions in Buildings – Active Energy Systems	4	4	7
Energy Saving Interventions in Buildings – Passive Energy Systems	4	7	7
Installation of photovoltaic power plant	7	4	6
Electrification of Port Operations	5	8	8
Carbon Footprint			
Air Quality Monitoring System	7	10	10
Cold Ironing/ Establishment of infrastructure for the electrification of ships	9	8	9

Deployment and operation of charging stations infrastructure for electric vehicles	8	7	9
Electric Buses (Eco-Buses) for transportation in port area	3	6	7
LNG supply facility for vehicles and ships in port area	9	8	8
Micromobility in Port Area with Electric Scooters and Bicycles	5	7	9

Table 8.3: Scale of the weight values

1	2	3	4	5	6	7	8	9	10
Low					High				

8.5 Mitigation measures recommendations

This step is the first part of "optimization" and refers to the introduction of modifications or supplemental measures to better balance economic, environmental and social impacts of the actions. This step is based on the results of the above step and it requires the active participation of stakeholders in order to optimize positive outcomes of the proposed actions.

The implementation of the Action Plan includes mitigation measures for each proposed measure of two key interventions. Specifically, the recommended mitigation measures are focused on the following:

- Ensuring the procurement of all the appropriate equipment for the efficient implementation of each measure.
- Appropriate maintenance of the installations in terms of ensuring their efficient operation in marine environment, technical assistance and integrating IT systems to monitor and optimize the operation of each installation.
- Establishment of reporting periods for analyzing and evaluating exported data and indicators of the monitoring systems and technical installations.
- Selection of measures based on current needs, priorities and experience of PPA
- Training of staff about the specifications and operation of new installations, new established protocols and procedures.

8.6 Development of evaluation report

This step is the second part of "optimization" and refers to the presentation of results of the sustainability impact assessment to interested bodies, policy makers, including synergies and conflicts, mitigation measures and options. The evaluation report is an important output for PPA as it summarises the content of the Action Plan while it includes the overall and analytical analysis and assessment of the proposed actions. The existence of Sustainability Impact Assessment ensures that the proposed actions have been analysed from various views and have been designed in a way that optimises the positive outcomes of the actions.

9. Monitoring Plan

The Monitoring Plan is the document that helps to track and assess the results of the interventions throughout the life of the SUPAIR Action Plan. It is important to develop the Monitoring Plan before applying the interventions and beginning any monitoring activities so that there is a clear plan for what questions about the SUPAIR Action Plan will need to be answered. Therefore, the main objectives of the Monitoring Plan are:

Figure 9.1: Main objectives of the Monitoring Plan

Considering the aforementioned objectives, the Monitoring Plan is extremely useful to monitor the performance and impact of the interventions using key indicators and disseminate progress to all participating stakeholders. The Monitoring Plan of the SUPAIR Action Plan follows a clear methodology consisting of four main steps which fulfil the objectives of the Monitoring Plan and ensures the efficient monitoring of action plan progress. The four main steps of Monitoring Plan's methodology are:

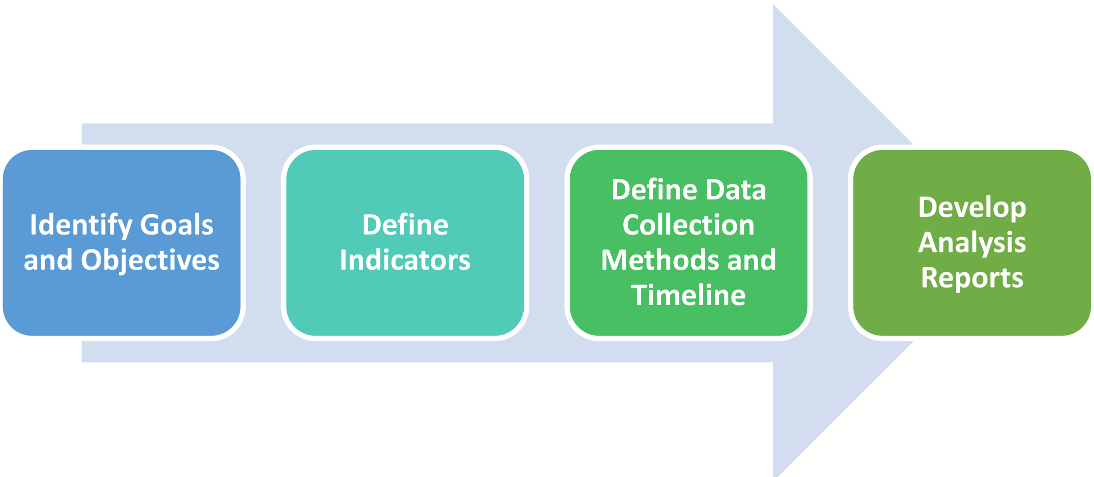

Figure 9.2: Main steps of Monitoring Plan's methodology

<u>1) Identify Goals and Objectives of the Monitoring Plan</u>

The first step to create a Monitoring Plan is to identify the goals and objectives of the implemented interventions. Defining goals starts with answering three main questions:

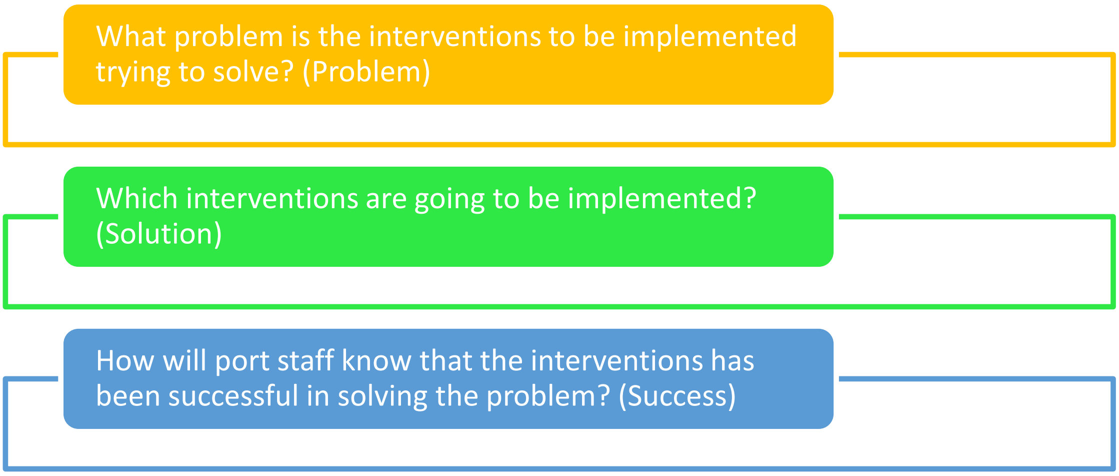

Figure 9.3: Main questions before the development of the Monitoring Plan

Answering these questions will help to identify what the interventions are expected to do, and how staff will know whether or not it worked. For PPA's Action Plan, the answers are formed like:

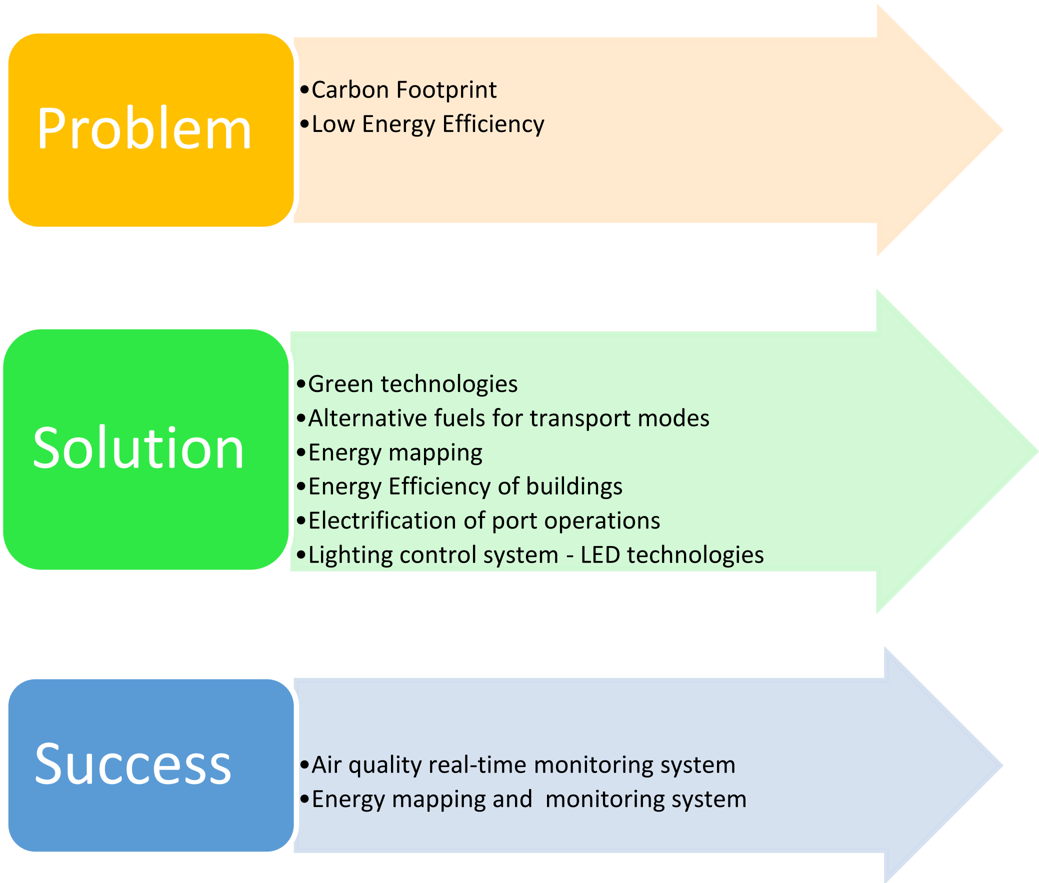

Figure 9.4: Main goals and objective of Monitoring Plan

2) Define Indicator for the Monitoring Plan

Following the identification of the goals and the objectives of the SUPAIR Action Plan, the indicators for tracking progress are further identified and analysed. The selected indicators are divided into two main categories:

Process Indicators

- Track the progress of the implemented actions

Outcome Indicators

- Track how successful implemented actions have been at achieving Action Plan objectives.

Figure 9.5: Two types of indicators for tracking the progress of Action Plan implementation

The selected indicators for the SUPAIR actions are listed below:

Table 9.1: Indicators for tracking the progress of each measure

SUPAIR Action	Process Indicator	Outcome Indicator
Cold Ironing/ Establishment of infrastructure for the electrification for ships	Feasibility study	Fuel consumption
	Design of the installation	Electricity consumption kW on site
	Procurement Procedures	Energy cost of electricity
		Carbon Footprint
		NO_x Emissions
		PM Emissions
Deployment and operation of charging stations infrastructure for electric vehicles	Feasibility study	Electricity Consumption on site
	Definition of technical requirements and system set up	Carbon Footprint
	Procurement Procedures	Energy cost of electricity in buildings
Electric Buses (Eco-Buses) for transportation in port area	Feasibility Study	Electricity consumption for electric mobility
	Definition of technical requirements and system set up	Fuel Consumption
	Procurement Procedures	Energy cost of electric mobility
		Carbon Footprint
		CO Emissions
		NO_x Emissions
		O_3 Emissions
		PM Emissions
	Feasibility Study	Carbon Footprint

Micro Mobility Measures within port area	Definition of technical requirements and system set up	CO Emissions
	Procurement Procedures	NO_X Emissions
		SO_2 Emissions
		O_3 Emissions
		PM Emissions
LNG supply facility for vehicles and ships in port area	Feasibility study	Carbon Footprint
	Definition of technical characteristics of LNG supply facility's components	Carbon Footprint
	Procurement procedures	NO_X Emissions
		SO_2 Emissions
		PM Emissions
		LNG consumption
		Fossil fuel consumption
Energy Saving Interventions in Buildings – Active Energy Systems	Feasibility study	Net purchases of energy
	Definition of the appropriate interventions for every building	Electricity consumption in buildings
	Development of the plan for integrating Building Energy Management System	Fuel Consumption
		Use of energy from renewable forms
		Annual Energy Savings
		Annual Energy Cost Savings
		Carbon Footprint
Energy Saving Interventions in Buildings – Passive Energy Systems	Feasibility study	Net purchases of energy
	Definition of the appropriate interventions for every building	Electricity consumption in buildings
	Procurement procedures	Fuel Consumption
		Energy consumption for heating and cooling
		Annual Energy Savings
		Annual Energy Cost Savings
		Carbon Footprint
Implementation of LED Technology for Indoor Lighting	Feasibility Study	Electricity consumption in buildings
	Definition of requirements	Carbon Footprint
	Procurement Procedures	
Implementation of LED Technology for Outdoor Lighting	Feasibility Study	Electricity consumption on site
	Definition of requirements	Carbon Footprint
	Procurement Procedures	

Installation of photovoltaic power plant	Feasibility study	Net purchases of energy
	License for connection of the plant to the Public Power Corporation S.A.	Electricity production from photovoltaic power plant
	Procurement procedures	Use of energy from renewable forms
		Carbon Footprint
Electrification of port equipment	Feasibility study	Fuel Consumption
	Definition of technical requirements of equipment	Carbon Footprint
	Procurement procedures	NO_x Emissions
		SO_2 Emissions
		PM Emissions

<u>3) Define Data Collection Methods and Timeline</u>

The third main step for developing an efficient monitoring plan refers to the design and development of methods for gathering data and the identification on how often various data will be recorded to track indicators. The selection of the most appropriate data collection method depends largely on what each indicator is trying to measure.

Therefore, for the PPA Action Plan indicators, two main data collection methods have been selected and have already been included in the main interventions of the PPA Action Plan:

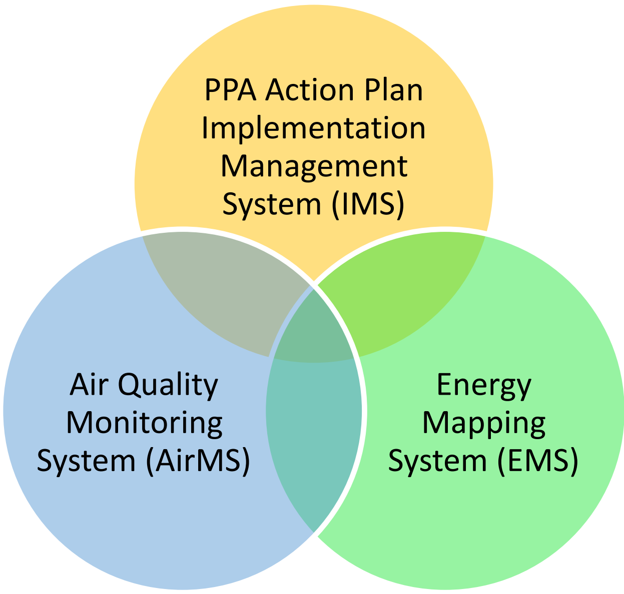

Figure 9.6: Main Monitoring Systems of Action Plan

Concerning "Process Indicators", a detailed PPA Action Plan Implementation Management System will be developed underlying the necessary milestones and deadlines for the implementation of each intervention included within PPA Action Plan. For the success of this method, the cooperation of all administrative units and stakeholders of PPA is necessary. Concerning "Outcome Indicators", the Air Quality Monitoring System will monitor the carbon footprint and pollutants of atmospheric air in the port area. The aim of this installation is to evaluate the levels and distribution of air pollutants in the atmosphere by assessing the monitoring system inventories, as well as to identify the main sources of the emissions. A sensor-based system comprised by compact and mobile stations will monitor the air quality, obtaining real-time data of the emissions in the port area. On the other hand, the Energy Mapping System will identify the sources and the demands on energy, electricity and fuel consumption on buildings and port activities.

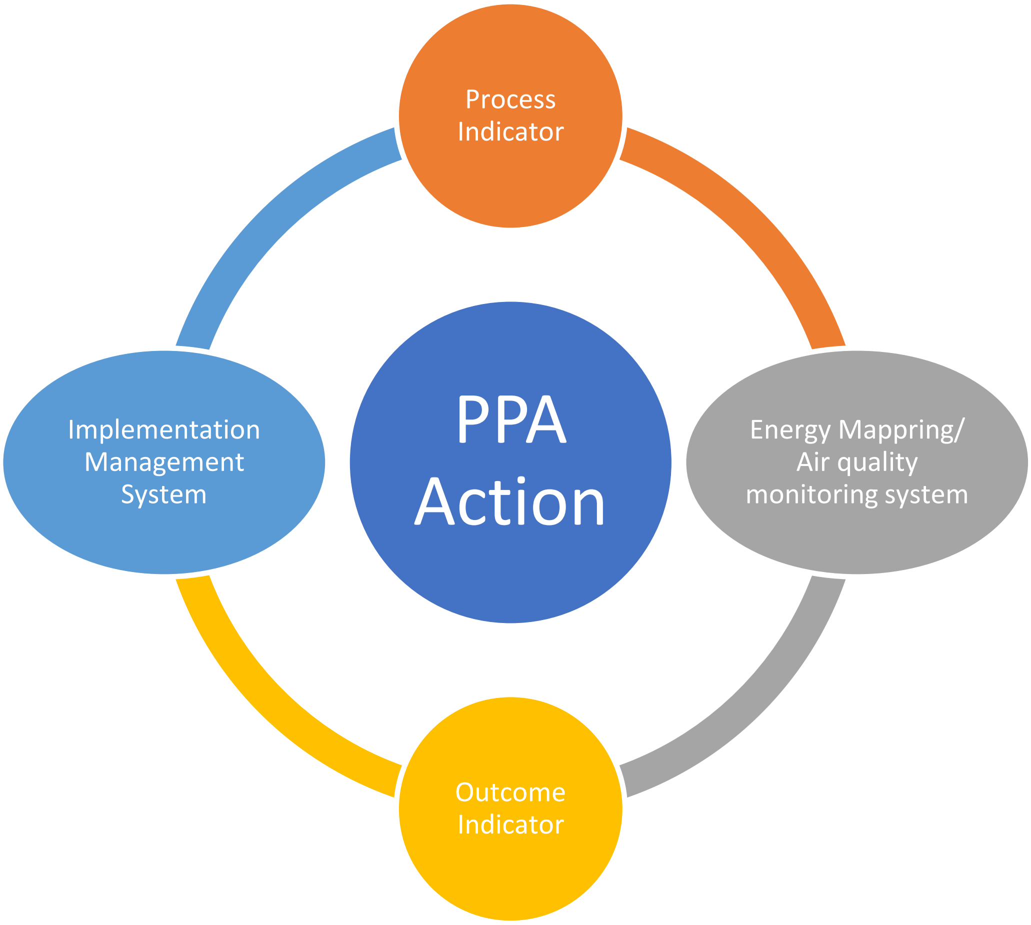

Figure 9.7: Relation among the indicators and the Monitoring systems

The table, below, shows how each PPA Action Plan indicator will be measured:

Table 9.2: Method for the data collection for each indicator

SUPAIR Action	Process Indicator		Outcome Indicator	
Cold Ironing/ Establishment of infrastructure for the electrification for ships	Feasibility study	PPA Action Plan Implementation Management System (IMS)	Fuel consumption	Energy Mapping System (EMS)
	Design of the installation	IMS	Electricity consumption kW on site	EMS
	Procurement Procedures	IMS	Energy cost of electricity	EMS
			Carbon Footprint	Air Quality Management

				System (AirMS)
			NO_X Emissions	AirMS
			PM Emissions	AirMS
Deployment and operation of charging stations infrastructure for electric vehicles	Feasibility study	IMS	Electricity Consumption on site	EMS
	Definition of technical requirements and system set up	IMS	Carbon Footprint	AirMS
	Procurement Procedures	IMS	Energy cost of electricity in buildings	EMS
Electric Buses (Eco-Buses) for transportation in port area	Feasibility Study	IMS	Electricity consumption for electric mobility	EMS
	Definition of technical requirements and system set up	IMS	Fuel Consumption	EMS
	Procurement Procedures	IMS	Energy cost of electric mobility	EMS
			Carbon Footprint	AirMS
			CO Emissions	AirMS
			NO_X Emissions	AirMS
			O_3 Emissions	AirMS
			PM Emissions	AirMS
Micro Mobility Measures within port area	Feasibility Study	IMS	Carbon Footprint	AirMS
	Definition of technical requirements and system set up	IMS	CO Emissions	AirMS
	Procurement Procedures	IMS	NOX Emissions	AirMS
			SO_2 Emissions	AirMS
			O_3 Emissions	AirMS
			PM Emissions	AirMS
LNG supply facility for vehicles and ships in port area	Feasibility study	IMS	Carbon Footprint	AirMS
	Definition of technical characteristics of LNG supply facility's components	IMS	Carbon Footprint	AirMS
	Procurement procedures	IMS	NO_X Emissions	AirMS
			SO_2 Emissions	AirMS
			PM Emissions	AirMS
			LNG consumption	EMS
			Fossil fuel consumption	EMS
Energy Saving Interventions in	Feasibility study	IMS	Net purchases of energy	EMS
	Definition of the appropriate	IMS	Electricity consumption in buildings	EMS

Buildings – Active Energy Systems	interventions for every building			
	Development of the plan for integrating Building Energy Management System	IMS	Fuel Consumption	EMS
	Procurement procedures	IMS	Fuel Consumption	EMS
			Use of energy from renewable forms	EMS
			Annual Energy Savings	EMS
			Annual Energy Cost Savings	EMS
			Carbon Footprint	AirMS
Energy Saving Interventions in Buildings – Passive Energy Systems	Feasibility study	IMS	Net purchases of energy	EMS
	Definition of the appropriate interventions for every building	IMS	Electricity consumption in buildings	EMS
	Procurement procedures	IMS	Fuel Consumption	EMS
			Energy consumption for heating and cooling	EMS
			Annual Energy Savings	EMS
			Annual Energy Cost Savings	EMS
			Carbon Footprint	AirMS
Implementation of LED Technology for Indoor Lighting	Feasibility Study	IMS	Electricity consumption in buildings	EMS
	Definition of requirements	IMS	Carbon Footprint	AirMS
	Procurement Procedures	IMS		
Implementation of LED Technology for Outdoor Lighting	Feasibility Study	IMS	Electricity consumption on site	EMS
	Definition of requirements	IMS	Carbon Footprint	AirMS
	Procurement Procedures	IMS		
Installation of photovoltaic power plant	Feasibility study	IMS	Net purchases of energy	EMS
	License for connection of the plant to the Public Power Corporation S.A.	IMS	Electricity production from photovoltaic power plant	EMS
	Procurement procedures	IMS	Use of energy from renewable forms	EMS
			Carbon Footprint	AirMS
	Feasibility study	IMS	Fuel Consumption	EMS

Electrification of port equipment	Definition of technical requirements of equipment	IMS	SO_2 Emissions	AirMS
	Procurement procedures	IMS	PM Emissions	AirMS
			Carbon Footprint	AirMS
			NO_X Emissions	AirMS

Once data collection is determined, it is also necessary to decide how often it will be collected. All data collection will be simultaneous and homogeneous to produce harmonized results. The reporting will be realized along specific intervals defined from the sensitivity, the importance and the dynamic of each set of data. The table, below, shows the reporting intervals for each indicator.

Table 9.3: Time plan for the data collection for each indicator

SUPAIR Action	Process Indicator	Reporting period	Outcome Indicator	Reporting Period
Cold Ironing/ Establishment of infrastructure for the electrification for ships	Feasibility study	Every week	Fuel consumption	Every 3 months
	Design of the installation	Every week	Electricity consumption kW on site	Every month
	Procurement Procedures	Every week	Energy cost of electricity	Every month
			Carbon Footprint	Every 3 months
			NO_X Emissions	Every 6 months
			PM Emissions	Every 6 months
Deployment and operation of charging stations infrastructure for electric vehicles	Feasibility study	Every week	Electricity Consumption on site	Every month
	Definition of technical requirements and system set up	Every week	Carbon Footprint	Every 3 months
	Procurement Procedures	Every week	Energy cost of electricity in buildings	Every month
Electric Buses (Eco-Buses) for transportation in port area	Feasibility Study	Every week	Electricity consumption for electric mobility	Every month
	Definition of technical requirements and system set up	Every week	Fuel Consumption	Every 3 month
	Procurement Procedures	Every week	Energy cost of electric mobility	Every month
			Carbon Footprint	Every 3 months
			CO Emissions	Every 3 months
			NOX Emissions	Every 6 months
			O_3 Emissions	Every 6 months

			PM Emissions	Every 6 months
Micro Mobility Measures within port area	Feasibility Study	Every week	Carbon Footprint	Every 3 months
	Definition of technical requirements and system set up	Every week	CO Emissions	Every 3 months
	Procurement Procedures	Every week	NOX Emissions	Every 6 months
			SO_2 Emissions	Every 6 months
			O_3 Emissions	Every 6 months
			PM Emissions	Every 6 months
LNG supply facility for vehicles and ships in port area	Feasibility study	Every week	Carbon Footprint	Every 3 months
	Definition of technical characteristics of LNG supply facility's components	Every week	Carbon Footprint	Every 3 months
	Procurement procedures	Every week	NO_X Emissions	Every 6 months
			SO_2 Emissions	Every 6 months
			PM Emissions	Every 6 months
			LNG consumption	Every 3 months
			Fossil fuel consumption	Every 3 months
Energy Saving Interventions in Buildings – Active Energy Systems	Feasibility study	Every week	Net purchases of energy	Every month
	Definition of the appropriate interventions for every building	Every week	Electricity consumption in buildings	Every month
	Development of the plan for integrating Building Energy Management System	Every week	Fuel Consumption	Every 3 months
			Use of energy from renewable forms	Every 3 months
			Annual Energy Savings	Annually
			Annual Energy Cost Savings	Annually
			Carbon Footprint	Every 3 months
Energy Saving Interventions in	Feasibility study	Every week	Net purchases of energy	Every month

Buildings – Passive Energy Systems	Definition of the appropriate interventions for every building	Every week	Electricity consumption in buildings	Every month
	Procurement procedures	Every week	Fuel Consumption	Every 3 months
			Energy consumption for heating and cooling	Every 3 months
			Annual Energy Savings	Annually
			Annual Energy Cost Savings	Annually
			Carbon Footprint	Every 3 months
Implementation of LED Technology for Indoor Lighting	Feasibility Study	Every week	Electricity consumption in buildings	Every month
	Definition of requirements	Every week	Carbon Footprint	Every 3 months
	Procurement Procedures	Every week		
Implementation of LED Technology for Outdoor Lighting	Feasibility Study	Every week	Electricity consumption on site	Every month
	Definition of requirements	Every week	Carbon Footprint	Every 3 months
	Procurement Procedures	Every week		
Installation of photovoltaic power plant	Feasibility study	Every week	Net purchases of energy	Every month
	License for connection of the plant to the Public Power Corporation S.A.	Every week	Electricity production from photovoltaic power plant	Every 3 months
	Procurement procedures	Every week	Use of energy from renewable forms	Every 3 months
			Carbon Emissions	Every 3 months
Electrification of port equipment	Feasibility study	Every week	Fuel consumption	Every 3 months
	Definition of technical requirements of equipment	Every week	Carbon Footprint	Every 3 months
	Procurement procedures	Every week	SO_2 Emissions	Every 6 months
			NO_X Emissions	Every 6 months
			PM Emissions	Every 6 months

<u>4) Develop Analysis Reports</u>

Following the collection of all data, PPA will assess the efficiency of the implemented actions. For this reason, a result table will be developed which will be the base for internal reviewing and external reporting. This progress assessment is proposed to be realized on a yearly basis in order to track efficiently the impacts of the implemented actions and how these achieve the general targets of the SUPAIR Action Plan. The main information to be recorded and assessed within the annual report may include:

Figure 9.8: Main parts of Action Plan annual report

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