D.T.2.5.3 ACTION PLAN ON ECO-SOLUTIONS DEPLOYMENT – TRIESTE (NAPA)

Energy efficiency solutions

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Executive Summary

Maritime transport is the most sustainable way of transporting goods from the environmental and energy point of view: a recent OECD study has calculated that, for the same amount of goods being transported, maritime transport produces three times less CO_2 than the train and ten times less than the truck. Furthermore, commercial ports, located near cities, play an essential role in the transport logistics system, as they allow the connection between the maritime and land routes, and represent an important factor for the growth of the economy and jobs.

However, port operations also have an impact on air quality and greenhouse gas emissions.

The Port of Trieste is committed to decreasing the environmental impact of port-related operations it is competent for by supporting alternative fuels use and improving its energy efficiency.

The following tables show the SWOT analysis identified by the Port of Trieste in these two domains:

SWOT	Negative	Positive
Internal	• Retrofitting a vessel to LNG poses several issues (e.g. space and stability needs); whether and when to invest is up to each ship owner • High costs of infrastructure for alternative fuels	• Average length of trips made by Ro-Ro and Ro-Pax services can be adequately covered with a full tank • Ro-Ro traffic has been progressively growing in the last years
External	• Market immaturity as most of the LNG-powered fleet is composed of ferries operating in the North Sea • No common technical specifications for the interface of vehicle to infrastructure	• Reduced emissions in terms of NO_X, CO_2 and noise • Evolution of regulation and incentives of technology = further impulse to the development of demand for LNG

Table 1 - SWOT Analysis - alternative fuels

SWOT	Negative	Positive
Internal	• The Port Electricity Grid is fragmented. • Very few energy efficiency interventions performed. • There are no local renewable energy production plants. • There are no electrical mobility infrastructures and no cold ironing.	• The port of Trieste is an important stopover • Growing interest of shipowners in relation to the energy efficiency of the port system and related activities.
External	• High costs for electrification of infrastructures. • There are no important State funds available. • Market immaturity as most of the LNG-powered fleet is composed of ferries operating in the North Sea	• There are important European funds to utilise for technology improvements.

Table 2 - SWOT Analysis - energy efficiency

Accordingly, the Port of Trieste has identified several actions to be taken as to tackle the weaknesses here above and improve the environmental performance of port-related operations in a holistic approach, the most relevant ones being the following:

1) Cold ironing installation

The Port of Trieste finalised a pre-investment study for the realisation of a cold ironing facility in one of its RoRo terminals, which will be used as a test bed for the project designs of similar facilities in the other terminals, to be realised through other EU-funded projects in the next few years

2) Replacement of the port lightning system

The current lighting system of the Port of Trieste will be completely replaced in the next few months, also through other EU-funded projects, with LED bulbs, allowing a significant reduction in energy consumption and costs.

3) eMobility

The Port of Trieste will replace all its combustion-engine cars with hybrid or full electric vehicles by June 2021, with own funds and through the NOEMIX project, co-funded by the H2020 Programme.

5. Cluster 5 - Energy efficiency solutions: overview of the needs and good practices in cooperation with stakeholders to develop the action plan

The present chapter consolidates the main lessons learnt on the needs assessment, past solutions and best practices recognition in regards to ECO-Innovation solutions deployed taking into consideration the experiences in relevant EU and international ports.
In this framework, the main need of the Port of Trieste is the identification of the best and most suitable replicable solutions in response to the needs of the Port of Trieste under the perspective of ECO-Innovation.

Needs

Process mapping within D.T2.2.2. has highlighted the following problems:

- electricity grid of the Port is fragmented;
- just few energy efficiency interventions were performed;
- there are no local renewable energy production plants for self-consumption;
- absence of cold ironing and electrical mobility infrastructures.

These problems can, in part, be overcome through the implementation of energy efficiency measures and the production of energy from renewable sources, optimizing the port electricity network adapting it to a potential future cold-ironing plant.
The Port of Trieste must define strategic guidelines for the implementation of specific actions in order to improve energy efficiency and to promote the use of renewable energy in the port area. The guidelines can be reached identifying the following points.

- The interventions and measures to implement to achieve the objectives, assessing their technical and economic feasibility, also by means of cost-benefit analysis;
- The modality of energy and environmental monitoring of the interventions performed, in order to allow an assessment of their effectiveness.

The following specific objectives must be pursued in order to guarantee the energy sustainability:

- energy consumption of vessels, both large and small ships:
    1. electrification of the quays to allow the moored ships to stop the engines (cold ironing);
    2. powering large ships to LNG, providing necessary infrastructure for supplies, and incentive measures for ship owners who wishing to adapt the ships themselves;
    3. the electrical conversion of small service vessels;
- **energy consumption of buildings and port facilities** (including cranes, refrigerated warehouses, service vehicles, etc.):
    1. civil building works (insulation of the enclosure, fixtures, efficient heating systems, shields to reduce chiller production, etc.);
    2. led lighting of the external areas;
    3. use of electric energy storage systems for the container cranes;
    4. the creation of electric charging points to encourage the use of electric vehicles inside the port;
- **actions that do not directly involve efficiency projects**:

1. incentive schemes to support operators inside the port who invest in less energy-intensive plants / equipment and / or **renewable energy sources**;

to include consumption criteria and energy efficiency criteria and good operating practices in the selection processes of authorities and in the purchasing processes.

Past solutions

Concerning energy consumption of vessels, the Port of Trieste developed two sets of actions:

1) LNG: through the COSTA II East-POSEIDON MED project, co-funded by the TEN-T Programme, the Port of Trieste developed a study on the sustainability of LNG for RoRo traffics between Turkey and Trieste, elaborating four potential scenarios:

Hypothesis 1 - Tank lorries use	
Strengths	Flexibility, low investment level, creation of synergies by using the vehicles also outside the port
Weaknesses	Low capacity of the system
Location	Porto Franco Nuovo is the area with the highest potential demand, the tank trucks can stop anywhere inside the port's perimeter
Requirements	Identify the locations of tank trucks and terminal areas dedicated to the supply, sign cooperation agreements with gas suppliers, mapping procedures for refueling and perform risk analyses
Hypothesis 2 - Bunkering station in adock	
Strengths	Maximum capacity of the system , possible exploitation in case of local and regional demand in-crease
Weaknesses	Minimum system flexibility, high level of investment, inability to meet the demand from land side
Location	Porto Franco Nuovo is the area with the highest potential demand, the station can be constructed in other terminals not congested, in a long term perspective it could be realized in new port terminal forcasted in PRP
Requirements	Identify paths for the ships , sign agreements with gas suppliers, map procedures for bunkering and perform risk analysis
Hypothesis 3 - Barge use	
Strengths	Flexibility, low investment level
Weaknesses	Low capacity of the system, impossibility to supply road demand
Location	Anywhere inside the port
Requirements	Identify paths for the ships , sign agreements with gas suppliers, map procedures for bunkering and perform risk analysis
Hypothesis 4 - Tank use	
Strengths	Flexibility, low investment level
Weaknesses	Low capacity of the system
Location	Porto Franco Nuovo is the area with the highest potential demand, the station can be constructed anywhere inside the port's perimeter
Requirements	Identify paths for the tank trucks and areas in the terminal for the supply , sign agreements with gas suppliers, map procedures for bunkering and perform risk analysis
Hypothesis 5- Bunkering station in a area close to the gates of the port	
Strengthens	Maximum capacity of the system, possibile exploitation of local and regional demand coming from maritime and road transport
Weaknesses	Minimum flexibility of the system, high investment level, planning complexity due to the pipeline system for the maritime supply
Location	Porto Franco Nuovo is the area with greater demand, the station can be constructed in other terminals not congested, in future it could be constructed in new port terminal forcasted in PRP, fundamental requirement is that the station is easly reachable by private cars
Requirements	Plan a system of cryogenic piping to connect the station with the docks , sign agreements with gas suppliers, map procedures for bunkering and perform risk analyzes

2) Cold ironing: the Port of Trieste has tendered the technical and financial feasibility study for the installation of OPS in the Pier no. VI (devoted to RoRo) within the TalkNET project. Moreover it will tender a similar deliverable thanks to the funds of the METRO project, co-funded by the Interreg Italy-Croatia Programme.

Best practices

The port of Antwerp regularly releases a Sustainability Report highlighting major sustainability issues of importance for the port and related sustainability goals (and sub-goals) to be achieved through specific action plans. The major sustainability issues and subjects are shown in the picture below.

Figure 1 - List of the different Sustainable Development Goals to which a contribution is made by the different subjects adopted by the Antwerp port community (source: Antwerp Port Authority)

According to the list of sustainability issues (or subjects), a number of Sustainable Development Goals are chosen by the port among those identified by the United Nations in 2015, namely:

1. Affordable and clean energy;
2. Decent work and economic growth
3. Industry innovation and infrastructure;
4. Climate action;
5. Partnership for the goals.

Accessibility to/from the port is another sustainability issue, particularly in terms of modal shift. The port regularly monitors such a parameter and a target of road traffic reduction of 43% (to be achieved by means of a number of strategies and action plans) has been set by 2030 (currently it is 56%). At the same time, improving road accessibility is of concern for the port. Traffic is constantly monitored by the port authority and related information are provided to port users, thus allowing them to better plan their trips. Moreover, trucks accessing the port are monitored in terms of their environmental performance. Despite a downward trend in recent years, the port is largely the biggest employer in the region, accounting to some 140,000 jobs – more important than the city itself. As such, employment and safety at work ("people") is a relevant sustainability issue in terms of commuting trips, safety and career development (education and training, late retirement). Port workforce commutes from a large surrounding area, thus worsening road congestion around the port

A safe working environment is a top priority for the port and effective actions are taken to prevent accidents. The trend of accidents has been positive in recent years. Improving education and training is a major sustainability issue in the port. As a whole, the port-maritime cluster shows less people with higher level of education than the non-maritime labor market, although the demand for higher education jobs has been increasing in the last few years in the port sector.

The contribution of the port to the economic development of the region is another issue. The port should be seen as an economic "engine" and as a mean to improve the quality of life. That means that employment and added value should be the parameters to be monitored for a port aiming at being sustainable. Added value and employment together show the overall port labor productivity. For instance, the contribution of port activities to regional GDP in Antwerp is more than 8%. At the national level, the contribution of the port (around 5%) is smaller than that of the construction sector only. However, indirect added value turns out to be significantly bigger than direct valued created in the region. Moreover, by comparing various port-related economic sectors, industrial activities are those generating the biggest proportion of added value, while land transport is the one with the lowest value.

Land transport, along with shipping-related activities, is also the sector with the lowest profitability. The – strictly speaking – environment of the port areas is another major sustainability issue. For instance, the port of Antwerp employs the so-called Cleanliness Index to measure how much clean public spaces in port areas are. An app supports the measurements by stakeholders. Dock litter (including empty drink cans, wood, plastic and so on) ending up into the water is another issue.

The Port Authority is in charge of cleaning up such a kind of litter constantly by using specialized barge systems. Soil quality is constantly monitored through surveys on soil pollution and contamination and proper measures are taken to minimize the impacts. Water management is another issue and it deals with the monitoring of the quality of water in port areas (in particular, oxygen conditions). Further parameters include salinity, nutrients levels and overall chemical conditions. Emissions of metals and polyaromatic hydrocarbons are additional parameters to be monitored.

Overall, water consumption is a major sustainability issue, happily showing a decreasing trend in recent years. Air quality should be monitored looking at the various components, including SOx, NOx and particulates. Various tools can be employed here (see, for instance, the "We-nose" and "E-nose" initiatives in the port of Rotterdam and Amsterdam respectively).

Noise is another issue to be tackled by noise surveys in port areas coming up with noise level maps.

Port areas are usually home of habitats of endangered species under various EU Directives (eg, EU Bird and Habitat Directive – Natura 2000). Ecological networks should be developed to ensure long-term conservation of a good number of species. Biodiversity should be preserved.

Energy and climate change targets set by various international agreements are significant for sustainability, although such agreements do not consider the port and shipping industry. Thus, energy consumption and energy efficiency are monitored. They show a declining trend from 2011, mainly due to energy-saving measures. Attention should be paid to the monitoring and developing of sustainable forms of energy, in particular those from renewable sources. In the port of Antwerp, the proportion of renewable sources is expected to double in the coming years. Clearly, CO_2 emissions should be monitored

at the port: in the case of Antwerp a declining trend since 2012 has been in place due to the increased energy efficiency of various activities (CO2 emissions/output).
Research and innovation activities, including digitalization, automation, etc. are also fundamental to reach a sustainable economy in the port. They can be monitored through the investments in R&D made by companies within the port. In Antwerp, an upward trend is reported, especially in the petrochemical sector, while in the maritime cluster the trend is negative, despite many initiatives and projects launched by the port authority and local public bodies.
Another key issue of sustainability consists of the ways in which the port community interacts with overall local society and citizens. The port community should not be seen as an independent cluster. In Antwerp, an annual survey is carried out about how citizens perceive the activities in the port with respect to a number of sustainability variables. The port is usually perceived positively with regards to economic development and employment and in negative terms with respect to the impacts on local mobility. Initiatives of the kind of “open port” should be promoted and events (“the port as a social experience”) should be organized correspondently to improve the interaction between the local and the port community. Surveys about port perception should be conducted with respect to a wider surrounding area as well (regional, national).
The contribution of the port to the circular economy model represents another key feature of port sustainability. That means focusing on the goal of maximizing recycling and reusing activities in the port areas. Suitable parameters to be used could consist of employment and added value in the related recycling activities as well as the amount of waste produced and processed within the port.
In Antwerp, the circular economy sector has been growing in the last years. Security is another issue: the port should be a safe place for everyone. Correspondently, a number of measures and actions should be taken in the field of infrastructures, procedures and organization models. Cooperation among various organizations involved (police, customs, fire departments, etc.) in the development of security plans and emergency procedures should be fostered to create a real network. Incidents in various port sectors should be regularly recorded.

In the port of Amsterdam a number of indicators has been defined to deal with sustainability issues, namely:

SUSTAINABILITY ISSUE	INDICATOR
Sustainable supply of energy	Investments made in renewable sources
	Space (ha) allocated to innovative start-ups
Air quality and noise	Monitoring suitable parameters
Port-hinterland connections	Modal shift
Labour market	Development of low/high skill jobs
Clean shipping	Number of ships accessing the port having adopted environmental-friendly measures to deal with emissions
	Waste management and ballast water
Safety	Number of incidents and inspections
Social and stakeholder engagement	Number of regular meeting on various issues.

Table 3 - Indicators of sustainability issues (Port of Amsterdam)

Also, Swedish shipping company Terntank became the first operator to take on LNG and liquefied biogas (LBG) at the new bunkering facility at the Port of Gothenburg, on 27th November 2018. The facility also liquefied biogas, LBG.

The bunkering facility is one of a kind since it handles both LNG and LBG, which are identical when it comes to their chemical composition. In that way, the bunkering facility has a flexibility concerning the transformation of the shipping sector. Actually, on June 25th 2018, the first-ever bunkering of liquefied biogas, 'Fure Vinga', in Sweden, took place at the Port of Gothenburg and received 40 cubic metres of LBG directly from a road tanker.
Mainly, LNG reduces emissions of SOx, NOx and PM, whereas LBG is a 100% renewable fuel produced from a variety of sources, including organic waste, and net emissions of carbon dioxide are zero.

Applying the approach followed by the Port of Antwerpen could be adapted and applied in the Port of Trieste as well. The Action Plan and the Ports' Energy Master Plan could take into consideration the sections identified in Antwerpen and focus on strictly environmental domains, such as:

1. Shipping
2. Mobility
3. Nature and environment
4. Energy and climate
5. Circular economy

In particular, the latter is consistent with the experience of Gothenburg related to the use of bioLNG.
Each core port of the TEN-T networks will need to abide by the deadlines set by the Directive 94/2014 on alternative fuels.
The Port of Trieste is implementing body in the GAINN4MED project, co-funded by the CEF Programme. The Action (2016-IT-TM-0284-S) includes the pilot deployment in a real life context of a network of 6 L-CNG filling stations in Italy, along the Mediterranean and Scan- Med Corridors, supported by ISO-containers, together with a starting fleet of HDVs as mobile equipment ensuring an effective trialing and start-up of the network itself.
GAINN4MED Action is part of the GAINN-IT global project for the deployment of the alternative fuels network in Italy. The Action consists of the deployment of L/CNG filling stations, the implementation of LNG innovative solutions for the supply chain, the development of framework conditions for sustainable alternative fuels technology deployment and training. The Action will support the take up of LNG as an alternative fuel.
Within GAINN4MED, the Port of Trieste will analyse the potential supply of organic waste and materials to be used for the production of bioLNG, coherently with the principles of circular economy.

5.1 Action: Strategic planning to improve the ECO-Innovation in the Port of Trieste

Through concreate actions planning, and taking into account the replicable elements of the ports of Antwerp and Amsterdam analysed within the best practice recognition phases, the Action Plan will be developed on the coverage in all relevant different sectors connecting public as well as private stakeholders.

5.2 Main challenges tackled

The main challenges the Port of Trieste faces with regard to environmental issues are the following:

1) reclamation of contaminated areas
2) monitoring of air quality and noise
3) provide alternative fuels / cold ironing facilities (EU Directive 94/2014/EU)
4) decrease energy consumption of the port's building

5) e-mobility

Port terminals and harbor areas play important roles in the economy worldwide through the transport and storage of traded goods. However, they have several negative environmental impacts on the coastal zone, such as pollution due to the discharge of contaminants, e.g., wastewater, petroleum and its derivatives. Port activities are often associated with aquatic pollution and the spreading of contaminants through different compartments, such as water, sediments and biota. Special attention must be given to sediments, which frequently present higher concentrations of contaminants compared to the water column, and may constitute not only a sink but also a secondary source of contaminants for the water column and biota. Benthic organisms, in particular, due to their limited mobility, are exposed to accumulated contaminants and respond to stress conditions both at individual and community level through the selection of taxa, the elimination of sensitive ones and abundance changes. Many studies report on changes in abundance or diversity of micro- or macro-benthic communities in chronically polluted marine environments.

The Port of Trieste is located within a Site of National Interest (SIN). These sites are defined by the Italian State as very large contaminated areas, in need of soil, surface water and groundwater remediation. SIN are identified in relation to the characteristics of the site, the quantity and hazardous nature of pollutants, the importance of the impact on the surrounding environment, in terms of health and ecology, as well as damage to cultural and environmental heritage. The SIN of Trieste was founded by Decree of the Italian Ministry of the Environment in 2003 and covers a marine coastal area of about 12,000,000 sq.m. in the eastern part of the Gulf of Trieste. It is divided into 5 macrosites on the basis of the main activities located there and their consequent anthropogenic pressures: (1) a port area, (2) a shipbuilding area, (3) an iron foundry area with a steel plant, (4) a petroleum area where petroleum products are handled, stored and processed, and (5) a residential area/center bay, the largest among the 5 areas. Since activities such as fishing, aquaculture, swimming and urban development are restricted within the SIN, the local authorities are interested in assessing whether the entire area should continue to form part of the SIN. Updated and focused environmental assessments could allow the detection of subareas, if present, characterized by a less deteriorated environmental situation than those expected for a SIN (in terms of contamination levels and ecosystem functioning). In this way, it would be possible to exclude part of the marine space from one or more of its current legislative constraints. This can lead, subsequently, to a management scheme focused on the establishment of productive activities that could contribute to the economic development of the area. The Port Network Authority of the Eastern Adriatic Sea, which is the managing body of the SIN, adopted a strategy based on the integrated ecosystem approach in order to implement the new Environmental Characterization Plan of the SIN, as required by the most recent Italian law.

As outlined above, although maritime and intermodal transport ensure the lowest impact on the environment than fully road transport, even port operations affect the port areas, and the city where it is located.

Moreover, the new Port Master Plan, foreseeing new port infrastructures including port terminals, quays and berths, was approved in 2016 with conditions, i.e. the continuous monitoring of air quality.

Besides, since the port terminals are located within the city areas. Therefore, noise emissions originated from both port operations and ship engines is also to be monitored.

The Port of Trieste will also need to take into consideration obligations deriving from EU Directive 94/2014/EU, which:

- Requires Member States to develop national policy frameworks for the market development of alternative fuels and their infrastructure;
- Foresees the use of common technical specifications for recharging and refuelling stations;
- Paves the way for setting up appropriate consumer information on alternative fuels, including a clear and sound price comparison methodology.

More specifically, it sets the following deadlines:

- Electricity at shore-side for ports of the TEN-T core network and other ports by the end of 2025

- LNG at maritime ports for ports of the TEN-T core network by end 2025

Additionally, the premises of the Port of Trieste are located inside a historical building (the so-called "Torre del Lloyd"), in need of important restructuring to abide by the most recent energy efficiency standards, aiming to become a zero-emission building.
Finally, the Port of Trieste needs to answer the need for e-mobility infrastructures and equipment from employees and citizens alike.

5.3. Results to be achieved

The Port of Trieste aims to achieve the following goals:

1) Decrease of the impact of port operations on the environment
This goal encompasses both air quality and noise, and takes into consideration emissions at local level, impacting the quality of life of residents in the city of Trieste.
2) Increase in energy efficiency and reduction of CO_2 emissions
This goal takes into consideration emissions contributing to global warming without necessarily having an impact at local level, and the guidelines published by the Italian Ministry of Environment in mid-December 2018

5.4. Tasks to be performed

Based on the current situation analysed within D.T2.2.2 and the challenges described here above, the related actions are listed here below, clustered according to the two goals:

1) Increase in energy efficiency and reduction of CO_2 emissions:
    a. Replacement of refrigeration plant in the Torre del Lloyd
    b. Automatic temperature adjustment system in the Torre del Lloyd
    c. Replacement of heating system in the Torre del Lloyd
    d. Replacement of doors and windows in the Torre del Lloyd
    e. Installation of LED lightning in the Torre del Lloyd
    f. Installation of photovoltaic system on the rooftop of Torre del Lloyd and neighbouring buildings
    g. Energy efficiency planning for the building in via Svevo
    h. Installation of LED lightning in the port areas
    i. Installation of charging stations for electric cars
    j. Purchase of electric cars
    k. Purchase of electric boat
    l. Cold ironing facility

Some of these actions have already been described in D.T2.2.2, but it is worthwhile to include them in the present document.

Energy efficiency of the port's buildings

The Tower of Lloyd is in energy class F, the two warehouses are in energy class G instead. Considering that the three structures are heated by very old boilers fuelled by diesel, the main energy efficiency interventions to consider will be:

- extension of the gas distribution network to the Torre del Lloyd;
- replacement of old oil-fired boilers with methane-fired condensing boilers;

- internal insulation of the perimeter walls.

The combination of these interventions would make a leap in energy quality to the Tower of Lloyd as it would pass from class F to class B with a theoretical energy saving, of over 60% compared to the pre-intervention situation.

Table 1 shows a rough estimate of investment costs and economic benefits resulting from the two main interventions.

The government contribution of the “Conto Termico 2.0 (CT)” is relevant considering the two interventions as it allows to halve the return time of investment.

Action	Theoretical Consumption per year PRE	Theoretical Consumption per year POST	Energy Saving	Economic Saving (on real consumption)	Investment Cost	Return Time	Incentives CT 2.0	Return Time CT 2.0
	kWh/m^3	*kWh/m^3*	*%*	*euro/year*	*euro*	*year*	*euro*	*year*
Boiler Replacement	33,38	21,03	37%	26.506	100.000	3,77	28.392	2,7
Building Coating	33,38	16,19	52%	21.857	200.000	9,15	100.000	4,6
Boiler Replace and Coating	33,38	10,99	67%	34.11	300.000	8,80	149.039	4,4

Table 1 – Costs/benefit estimation for Torre del Lloyd

Considering warehouses 53 and 60, the main actions that can be performed are:

- replacement of old diesel-fired boilers with air-cooled heat pumps;
- replacement of circulation pumps with pumps with inverter;
- internal insulation of walls and floors towards the outside;
- new windows with high energy performance (warehouse 53).

The combination of these interventions would make a leap in energy quality to buildings that would pass from class G to class C with a theoretical energy saving of over 60%. compared to the pre-intervention situation.

Other interventions to be considered on the Torre del Lloyd, concern the redevelopment of the cooling system and the redevelopment of the internal lighting system with LEDs.

Lighting system

The external lighting system, consisting of 469 light points, has been standardized with the use of a single model of floodlight, with lamps that mainly use high pressure sodium (HPS). There are 30 light points equipped with newly installed LED lamps.

Location			Device Type	n.	Lamp Type	num	Power (W/each)	Total Power (kW)
New Free Port	Traiana shore, Dock V, Dock VI	Scattered	Lighthouse tower - 9 lights	6	HPS	54	1000	54,00
		Ausonia	Lighthouse tower - 6 lights	1	HPS	6	1000	6,00
		Wh 55, 58, 69, 71	Single Floodlight	1	HPS	29	250	7,25
		Wh 57, 53, Silo, 70, 72	Single Floodlight	1	HPS	27	1000	27,00
		Wh 57	Single Floodlight	1	LED	25	250	6,25
		Wh 57	Single Floodlight	1	LED	5	150	0,75

		Ausonia, Wh 60, weigh station	Single Floodlight	1	HPS	47	250	11,75
		Customs	Single Floodlight	1	HPS	36	125	4,50
	Highway	Crossing 4	Single Floodlight	1	HPS	61	250	15,25
		Transformer room n. 72	Single Floodlight	1	HPS	49	250	12,25
		Trasnformer room n. 60	Single Floodlight	1	HPS	67	250	16,75
		Crossing 1	Single Floodlight	1	HPS	56	250	14,00
Free Port "Scalo legnami"		"Scalo legnami"	Single Floodlight	1	HPS	7	250	1,75
Total LED						**30**		**7,0**
Total HPS						**439**		**170,5**
Total lamps						**469**		**177,5**

Table 2 – Census of lighting devices of outdoor lighting

Annual consumption is estimated to be around 940 MWh.

It is advisable to replace the HPS lamps with new lamps equipped with LED technology, considering a view of increasing the efficiency of the electricity grid. This intervention would reduce electricity consumption and maintenance time.

Table 3 and Table 4 provide a rough estimate of costs, savings and return time related to the replacement of HPS lamps with LEDs.

	Device Numbers	Device Power PRE	Total Power PRE	Device Power POST	Total Power POST	Energy Saving
	n.	*W*	*kW*	*W*	*kW*	*kWh/year*
	87	1000	87,0	800	69,6	92.090
	316	250	79,0	193	61,0	95.329
	36	125	4,5	75	2,7	9.527
TOTAL	**439**		**170,5**		**133,3**	**196.945**

Table 3 - Scenario for external lighting replacement - Energy Saving

	Cost	Investment	Economic Saving	Return Time
	€/each	*€*	*€*	*year*
	3.59	312.504	13.813	23
	805	254.380	14.299	18
	552	19.872	1.429	14
TOTAL		**586.756**	**29.542**	**20**

Table 4 - Scenario for external lighting replacement - Return Time

The reduction in installed power from 170.5 kW to 133.3 kW would allow to save around 197,000 kWh per year and to save on energy bill of about € 29,500 per year. The intervention would be repaid in about 20 years.

E-mobility

A considerable reduction in emissions of greenhouse gases, particulate matter, nitrogen oxides and other harmful emissions can be achieved through an ambitious plan for electrification of the port as well as purchasing of electric vehicles and zero emission cargo handling machines.

The aim should be the establishment of a microgrid consisting of one or more photovoltaic systems, a battery storage system, charging stations and an energy management control system. In this way the terminal can also operate off-grid whenever a blackout event occurs. It is also desirable to electrify unloading ship vehicles.

The hope is that the creation of the charging infrastructure could become port workers and companies working in port aware of the purchasing of electric vehicles in order to contribute to environmental pollution reduction.

Although the vehicles utilised by Port of Trieste cover a few kilometres a year, replacing older vehicles with electric vehicles, in addition to sensitizing all operators in the port, would still save about 30% of the cost of supply and would give a reduction in maintenance costs and in fixed costs (car tax).

By way of example, Table 5 compares the costs related to use and maintenance of vehicles with endothermic and electric engines.

Engine Type	Fuelling	Specific Consumption	Fuel Price	Cost for 10.000 km/year	Minimum Car Tax*	Cost for ordinary service** year
Endothermic	Diesel	5-7 l/100km	1,37 €/l	675 ÷ 945 €	150 €	747 €
	Gasoline		1,45 €/l	725 ÷ 1.015 €		
Electric	Electricity	2 kWh/100km	0,2 €/kWh	400 €	0 €	485 €

** It is expected that in the future the car tax will be re-updated based on the polluting impact of vehicle (more pollute more pay).*
***Source: a "Federconsumatori" study in 2012*

Table 5 - Comparison of car costs - Endothermic engine VS Electric engine

Energy production from renewable resources

To delete transmission and distribution of some energy needs, it is essential to promote the production of local electricity, favouring renewable sources and storages.

In August 2011, the Port Network Authority issued to the Meridian Parco Energia Srl a twenty-year concession for the use of the roofs of 14 state-owned warehouses located in New Free Port (almost 90,000 m2) to install photovoltaic systems, as well of replacement of asbestos roofs. The plant, in operation since 2012, consists of 44,213 modules that develop a total power of 8,622 kWp. The energy produced, equal to over 7,000 MWh per year, is fed into the distributor's network and avoids the emission of over 2,100 tCO2 per year.

It is desirable that this technology will continue to be installed for the self-production of the energy necessary to cover part of the current and future electricity needs of Port of Trieste but also of port operators. Therefore, further areas available for new photovoltaic systems should be sought.

Cold ironing

A study day was held in Trieste, in March 2018 on the solutions for the energy and environmental sustainability of the port areas that involved Port of Trieste, the Board of Public Works, the Friuli Venezia Giulia Region, the Municipality of Trieste, experts in the maritime sector and the shipowners. During the meeting the starting of a pilot project for the electrical infrastructures of a part of the quays of the port of Trieste, was evaluated. This technology is called "cold ironing" The intervention would allow ships stationed in port to connect to the electricity grid, with the consequent shutdown of the on-board generators and the reduction of atmospheric and noise pollution for the city. A study conducted by Arpa FVG showed that the ships which stop in port produce atmospheric pollution estimated at around 20% of the total.

The study performed for the implementation of cold ironing in the port of Trieste has shown beneficial benefits for the health of citizens and the environment. The project, given the considerable economic impact, requires a synergy between all stakeholders, institutions but also shipowners, whose involvement is necessary for the start of experimentation in a large area along the route Trieste-Turkey. Part of the necessary funding can potentially come from European funds and national funds.

The purpose of the port of Trieste is to start a pilot project which involves the ferries that have the characteristic of having precise schedules and routes and suitable dimensions in order to do not burden on the port electricity grid.

5.5 Key actors

As outlined in D.T2.2.2, the main actors to be involved are the following:

Stakeholders name and role	How it is important? (Low - Med - High)	Current level of support (Low - Med - High)	What do you want from stakeholders?	What is important for them?	How could stakeholders block your efforts?	What is your strategy for enhancing stakeholders support?
Electric Energy Distributor	Med	High	Electrical grid Reorganization	Foreseeable and laminated energy consumption	Not performing the modernization of the electricity grid	Ensure the reliability of end users
Ship owners	High	Med	Support for Cold Ironing and LNG system development	Cheap energy supply	Not adapting ships to cold ironing and LNG	Adopting competitive prices for LNG and cold ironing systems
Terminal operator	High	Med	Energy Efficiency Interventions on areas under management	Reliability and continuity of energy supply	Not performing any energy efficiency intervention	Providing incentives to perform the interventions
ARPA - Regional Agency for the protection of the environment	High	High	ARPA is responsible for controlling the compliance of the prescriptions of PP2	Implementation of the prescriptions	Identify non compliances	Ensuring the compliance to the prescriptions and showing a pro-active approach towards the environment

5.6. Time plan and financial resources

At present the GANTT foreseen for the actions here above is the following:

	2020	2021	2022	2023	2024	2025
Decrease of the impact of port operations on the environment						
1 fixed control unit in Muggia to monitor air quality and noise level	■	■	■	■	■	■
3 mobile control units	■	■	■	■	■	■
Monitoring of bird population	■	■	■	■	■	■
Monitoring of benthic organisms	■	■	■	■	■	■
Geo-referencing of environmental data (QGIS)	■		■		■	
Monitoring of buildings and sites containing asbestos	■					
Pollution diffusion modelling and related mooring management (SW)		■				
Installation of a sensor on a drone to identify hydrocarbons at sea			■			
LNG bunkering facility						■
Increase in energy efficiency and reduction of CO_2 emissions						
Replacement of refrigeration plant in the Torre del Lloyd			■			
Automatic temperature adjustment system in the Torre del Lloyd			■			
Replacement of heating system in the Torre del Lloyd			■			
Replacement of doors and windows in the Torre del Lloyd				■		
Installation of LED lightning in the Torre del Lloyd					■	
Installation of photovoltaic system on the rooftop of Torre del Lloyd and neighbouring buildings						■
Energy efficiency planning for the building in via Svevo			■			
Installation of LED lightning in the port areas				■		
Installation of charging stations for electric cars		■				
Purchase of electric cars		■				
Purchase of electric boat			■			
Cold ironing facility						■

From the perspective of the financial resources to be committed, please see the estimates of costs presented in the previous sub-chapter ('2.4. Tasks to be performed'), analysed along with the itemized assets showing the financial viability of the targeted measures.

5.7 Expected results

The actions described in the previous chapters encompass a wide range of tasks that PP2 will implement over the next few years.
Although they will all result in a stronger environmental performance of the Port of Trieste, it is not possible to quantify them at the present time, since the design stage has not been reached for all of them. This activity will be performed over the next few months, also thanks to the contribution of other EU projects.

Therefore, the expected results of the actions foreseen in the current document are summarised in relative terms in the table here below:

	Expected result
Decrease of the impact of port operations on the environment	
1 fixed control unit in Muggia to monitor air quality and noise level	100% and permanent monitoring of the air quality and noise level
3 mobile control units	100% and permanent monitoring of the air quality and noise level
Monitoring of bird population	100% assessment of the potential effect of port activity on the bird population
Monitoring of benthic organisms	100% assessment of the potential effect of port activity on benthic organisms
Geo-referencing of environmental data (QGIS)	100% real-time and updated geo-reference data on the environmental data
Monitoring of buildings and sites containing asbestos	100% of the buildings and sites containing absestos monitored
Pollution diffusion modelling and related mooring management (SW)	Elaboration of 1 modelling SW simulating pollution diffusion in order to direct mooring activities accordingly. Decrease of the impact of mooring on local residents
Installation of a sensor on a drone to identify hydrocarbons at sea	100% monitoring of hydrocarbon spillover in the sea
LNG bunkering facility	Improving air quality during ship navigation - reduction of NOx, SOx, PM
Increase in energy efficiency and reduction of CO_2 emissions	
Replacement of refrigeration plant in the Torre del Lloyd	Decrease of energy consumption and CO_2 emissions - 20%
Automatic temperature adjustment system in the Torre del Lloyd	Decrease of energy consumption and CO_2 emissions - 20%
Replacement of heating system in the Torre del Lloyd	Decrease of energy consumption and CO_2 emissions - 20%
Replacement of doors and windows in the Torre del Lloyd	Decrease of energy consumption and CO_2 emissions - 20%
Installation of LED lightning in the Torre del Lloyd	Decrease of energy consumption and CO_2 emissions - 20%
Installation of photovoltaic system on the rooftop of Torre del Lloyd and neighbouring buildings	Production of energy from renewable resources - +20%
Energy efficiency planning for the building in via Svevo	Decrease of energy consumption and CO_2 emissions - 20%
Installation of LED lightning in the port areas	Decrease of energy consumption and CO_2 emissions - 20%
Installation of charging stations for electric cars	10% reduction in the use of gasoline for cars belonging to PP2 (assuming 1 EV)
Purchase of electric cars	10% reduction in the use of gasoline for cars belonging to PP2 (assuming 1 EV)
Purchase of electric boat	10% reduction in the use of gasoline for cars belonging to PP2 (assuming 1 e-boat
Cold ironing facility	Improving air quality during ship stopover in Trieste - reduction of NOx, SOx, PM

5.8 References

Port of Antwerp
https://www.sustainableportofantwerp.com/en/file/sites/default/files/downloads/duurzaameidsverslag2017_en_lr_v2.pdf

Port of Amsterdam
https://www.portofamsterdam.com/en/port-amsterdam/sustainability-future-proof-port-customers-and-local-community