



D.T2.3.1 - Monitoring Report (Port of Bar) Final

Port of Bar

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Work Package T2

The goal of WP is identification of the most appropriate area and energy model in each area. In each port area intelligent LED luminaire will be installed: suitable places will be identified inside the port (with the support of an experts who knows the area perfectly) for the 23 LEDs in LP, 10 in PP3, 50 in PP4 and 20 in PP5. The energy model suitable for each area starts from the previous study and analysis carried out jointly by the partners; in addition, experts will check the value and suitability of the product identified and evaluate any applicable changes or improvements (through the systematic and continuous collection of data useful for further analysis or change). This WP is the pilot action of the project. LED lighting and the use of presence detection sensors to illuminate only areas actually used could further improve energy use. The project therefore proposes a state-of-the-art eco-sustainable lighting system for large spaces, with LED modules. It is planned to use innovative LED products characterized by an extremely long useful life and an exceptionally high efficiency, which allow the reduction of maintenance/replacement costs, resulting in an investment of considerable profitability, characterized by a "life time" guarantee, certificates for a period of twenty years, with a duration of up to 100,000 hours (12h to day). The innovative technology proposed will be characterized by an innovative remote-control system, which analyses instant information of various types from the illuminated area and is programmed to guarantee punctual attention of energy consumption and/or increasing the light intensity from the individual LED pole.

Activity A.T2.3 Development of tools for monitoring and evaluating the energy chain

The aim of this action is draw up monitoring and evaluation reports that will support and improve the design work. Responsible of action is PP3 and with support of PP4 will develop monitoring tools while all PPs involved in pilot action will provide expert for local reports.

Monitoring of pilot projects aims at supporting project management to assess and review the extent to which innovative LED system in local development is being implemented and to undertake corrective measures if necessary.

Purpose of this document

Appropriate monitoring is key for ensuring the necessary accountability in relation to the performance of a pilot project and it assesses the effectiveness of a piece of project. It can also highlight whether pilot project is moving successfully towards achieving what it is set out to do, or whether it is moving in a different direction.

Distribution of tasks for drafting the deliverable

No. partner	Partner	Involvement in the activity
LP	Port Network Authority of The Ionian Sea – Port of Taranto	Involved
PP2	Apulia Regional Agency for Environmental Prevention and Protection	Involved
PP3	Municipality of Termoli	Activity coordinator
PP4	Port of Bar	Activity coordinator
PP5	Port of Vlora	Involved

Structure of the monitoring report

The results of this monitoring report will be joint and shared within the final common deliverable as results of cooperative work of all partners. All partners are requested to provide the information about the ongoing SMARTPORT pilots that will summarize:

- State of the art prior to the implementation of the pilot
- Detailed steps in the implementation of the pilot
- Criticalities found during the implementation

With this purpose, also considering the deliverables planned for the pilot, the template to draft the monitoring report has been structured in the following chapters:

- Background
- Rationale for pilot action
- Pilot action implementation
- Monitoring data
- Stakeholders involved
- Problems and solutions found
- Additional information
- Annexes

1 BACKGROUND

City of Bar is located on the coastal western border of Montenegro on the shore of the Adriatic Sea. It is approximately 53 km from Podgorica, the capital of Montenegro. The city is located at 42 ° 6' latitude and 19 ° 6' longitude, at an elevation of 4 meters.

With the construction of the highway Bar-Boljare, the distance from the borders crossing with Serbia to Bar is approximately 170 km at the moment. Distance from the city of Bar to Albania is ~35km, to Croatia ~100km, to Bosnia and Herzegovina ~150km.

Bar is a coastal town of Montenegro and according to Census of Population, Households and Dwellings in Montenegro in 2011 Bar has 42.048 number of inhabitants which makes 6,78% of Montenegro's population which makes Bar the 4th municipality in number of inhabitants behind Podgorica (capital city), Nikšić and Bijelo Polje.

The economy of city of Bar relies upon Port of Bar in a significant extent. The port area is located west of the Town of Bar. Port of Bar, as practically the only cargo port in Montenegro, which performs almost all of maritime traffic, has capacities and development potentials (length of the operational coast, depth of the waters, connection with the railway and a large area for expansion), which gives it regional status. In addition, the Port of Bar, as a modern port, offers great opportunities for further development of combined transport and interconnection of all regions.



Figure 1: Old city of Bar

The Port of Bar is the largest and main Montenegrin port. The Town of Bar represents Montenegro's connection with the world because it is a border municipality which is connected to Italy by the Adriatic Sea.

The port area covers an area of 200 hectares and an aquatorium of approx. 90 ha. The port has a total quay length of 3,5Km, and comprises of various open storage areas and warehouses. The port is accessible by road and rail.



Figure 2: Port of Bar and the city (source: [google.com/maps](https://www.google.com/maps))

The port zone includes two units. The first unit consists of the existing waters and territory of the Port of Bar with breakwaters, operational coasts, piers, freight terminals, service and business systems. This unit covers an area of 183.54 ha and is exclusively intended for the development of a number of specialized freight terminals.

Reasons for the implementation of the pilot

LED technology implementation is one of the measures from the *Action plan for low carbon and sustainable Port of Bar*. Using LEDs instead of conventional light bulbs can reduce energy usage / emissions immediately but it can also reduce maintenance costs. While requiring greater initial investment, newer technologies tend to offer longer operational lifetime, reduced maintenance requirements, and superior performance when compared to many conventional lighting techniques. Furthermore, newer lighting technologies, such as LED, continue to evolve, suggesting that further improvements in safety, operational and environmental performance could be realized with such technologies in the years ahead.

LED terminal lighting provides a retrofit of all existing floodlights on the terminal from conventional lighting to LED lighting.

The advantages of LED compared to conventional lighting are:

- improved lifetime,
- reduced maintenance cost and
- an increased level of efficiency also resulting in less light pollution.

The increased lifetime and reduced maintenance costs are a result of two factors. First, LED luminaires are solid state light sources, therefore they contain less fragile parts like filaments, glass or moving parts. Second, lumen per watt is increased for LED luminaires (approx. 40 % higher value of lumen per watt compared to HID lights).

The risk of accidents during lighting-related maintenance should also be considered when reviewing lighting options. Older lamps typically require replacement three or four times a year. The durability of newer technologies reduces maintenance requirements. The longer lifetime of newer technologies, between 50,000 and 100,000 hours for some units, minimizes replacement requirements and keeps technicians clear of active mobile equipment zones. Furthermore, LED luminaires do not require warm-up periods as conventional lighting technologies do. Therefore, LED luminaires can be programmed and dimmed to further reduce energy consumption and light pollution.

Table 1: LED terminal lighting – Technical data and environmental data

Characteristic	HID	LED
Rated life	2,000-40,000 hours	50,000-100,000 hours
Energy usage	Up to 90% of energy not converted into light	Up to 95% less energy usage than HID
Directionality	Larger radius of light; up to 90% light loss	Control of light minimizes light pollution, light spill and glare
Colour rendering	25% colours not seen accurately	More colour accuracy
Controls	Limited ability to incorporate lighting controls	Allows for simple integration of programming and dimming

Source: PEMA (2016): Lighting Technologies in Ports and Terminals

The carbon footprint of a terminal building can be improved slightly with moderate efforts by replacing conventional light bulbs with LED luminaires. While the initial cost of installing LEDs is typically higher than conventional lighting options, energy savings and reduced maintenance can result in a return on investment (ROI), being realized in a relatively short timeframe. Real case scenarios suggest that energy savings can amount to between 55-60%; while maintenance costs can fall by up to around 90%. Ports that have introduced newer lighting technologies often report other operational benefits. For example, improved lighting tends to improve safety and result in reduced operator fatigue.

New lighting technologies also allow operators to have greater control over how light sources affect the surrounding environment in terms of light pollution, light spill, and glare. Finally, LED luminaires can be programmed and dimmed to reduce energy consumption and light pollution.

2 RATIONALE FOR PILOT ACTION

Pilot action performed in the SMARTPORT project is a very important step in satisfying safety and security standards, energy efficient and environmentally suitable transport interests of the local, governmental, and the wider interested public, as well as to stimulate the port's green operations.

Better infrastructure would create the preconditions for better business image, higher efficiency and cost reductions which are all crucial for development. Investments in the energy efficient measures must also be followed by other measurements that are foreseen with the SMARTPORT project that aim to further upgrade and green the port operations in the future. With this pilot implementation, Port of Bar has significantly improved and upgraded the terminal lighting system by installing 73 LED luminaires.

Before the implementation of the pilot project, analysis and identification of the most appropriate locations were made. The new 73 LED luminaires installed on 13 lighting poles are given in the figure 3. On each lighting pole, 4-7 LED luminaires were installed.

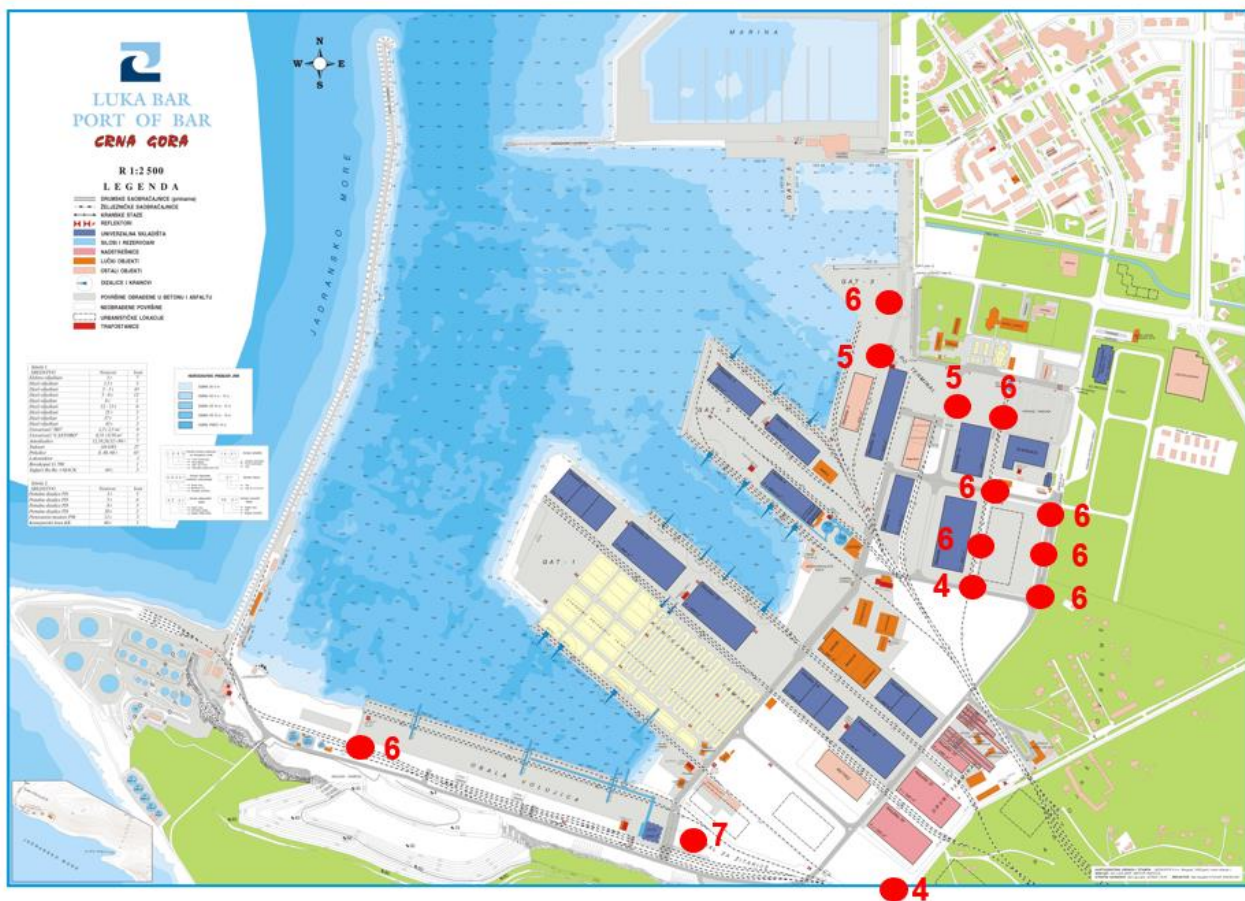


Figure 3: Locations of installed LED luminaires in the Port of Bar

In total, 102 old luminaires were changed. There are no historical data related to the consumption of energy related to the luminaires. Measurement unit was installed in one of the poles with 6 LED luminaires for monitoring purpose.



Figure 4: Old high-pressure sodium lamps prior the SMARTPORT pilot implementation

The previous luminaires were 400W high-pressure sodium lamps or mercury lamps which were installed more than 40 years ago.

3 PILOT ACTION IMPLEMENTATION

The intervention involved the replacement of 102 high-pressure sodium lamps or mercury lamps which were installed more than 40 years ago with 73 high-efficiency LED luminaires Philips BVP651 LED650.



Figure 5: LED luminaire (Philips BVP651 LED650)

The public call about the tender was published in daily newspapers Dan and Pobjeda and on the website of "Port of Bar" JSC on 30 December 2021. Two offers arrived until the agreed deadline and the evaluation team has picked the most suitable one in the predicted time. Based on the results of the conducted procedure, company La Collina ltd was selected as the most favorable bidder and a contract for the procurement and installation of 50pcs. of LED luminaires (Philips BVP651 LED650) was concluded. The contract related to 50 pieces (tender SMARTPORT2021-01) of LED luminaires was signed on 18/03/2022 and Addendum no 1 to the contract for additional 23 LED luminaires (Philips BVP651 LED650) was signed on 04/05/2022, as there were savings in budget related to the pilot project. The total value of the procurement was €76,650.00.



Figure 6: SMARTPORT pilot implementation (installation of the LED luminaires)

In the following table technical data related to the LED luminaires are given.

Table 2: Technical data of the LED equipment

General Information	
Lamp family code	LED650 [LED module 65000 lm]
Light source replaceable	Yes
Number of gear units	2
Driver included	Yes
Light source engine type	LED
Lighting Technology	LED
Light Technical	
Luminous Flux	56,100 lumens
Luminaire output flux (source):	66,000 lumens
Correlated Color Temperature (Nom)	4000 K
Color rendering index (CRI)	70
System luminous efficacy:	135 lm/W
Optical cover/lens type	Flat glass
Operating and Electrical	
Input Voltage	220 to 240 V
Input Frequency	50 to 60 Hz
Power Consumption	415 W
Connection	Connection unit 5-pole
Temperature	
Ambient temperature range	-40 to +50 °C

Mechanical and Housing	
Housing Material	Aluminum die cast
Optic material	Acrylate
Optical cover/lens material	Glass
Fixation material	Steel
Mounting device	Mounting bracket adjustable
Effective projected area	0.41 m ²
Dimensions (Height x Width x Depth)	80 x 597 x 817 mm
Approval and Application	
Ingress protection code	IP66 [Dust penetration-protected, jet-proof]
Mech. impact protection code	IK08 [5 J vandal-protected]
Surge Protection (Common/Differential)	Luminaire surge protection level until 4 kV differential mode and 4 kV common mode
Protection class IEC	Safety class I
CE mark	Yes
ENEC mark	ENEC mark
EU RoHS compliant	Yes

4 MONITORING DATA

As previously mentioned, measurement unit was installed in one of the poles with 6 LED luminaires for monitoring purposes. Data were collected in 6-month period (2022 – Aug, Sep, Oct, Nov and Dec and in 2023 – Jan).



Figure 7: Monitoring measurement unit

All luminaires in the port are switched on and switched off at the same time. The power of each installed LED luminaire is 415 W. From the monitoring data, energy consumption of 1 LED luminaire is calculated and accordingly energy consumption of 73 LED luminaires is given in the table 3.

Table 3: Energy consumption monitoring data

No	Month	Start date monitoring period	End data of monitoring period	Energy consumption for 6 LED luminaire (KWh)	Energy consumption for 73 LED luminaire (KWh)
1	August 2022	29.7.2022	2.9.2022	815,59	9.923,01
2	September 2022	2.9.2022	3.10.2022	1700,32	10.764,22
3	October 2022	3.10.2022	3.11.2022	2625,01	11.250,40
4	November 2022	3.11.2022	2.12.2022	3459,59	10.154,06
5	December 2022	2.12.2022	10.1.2023	4948,25	18.112,03
6	January 2023	10.1.2023	10.2.2023	5977,35	12.520,72
					72.724,43

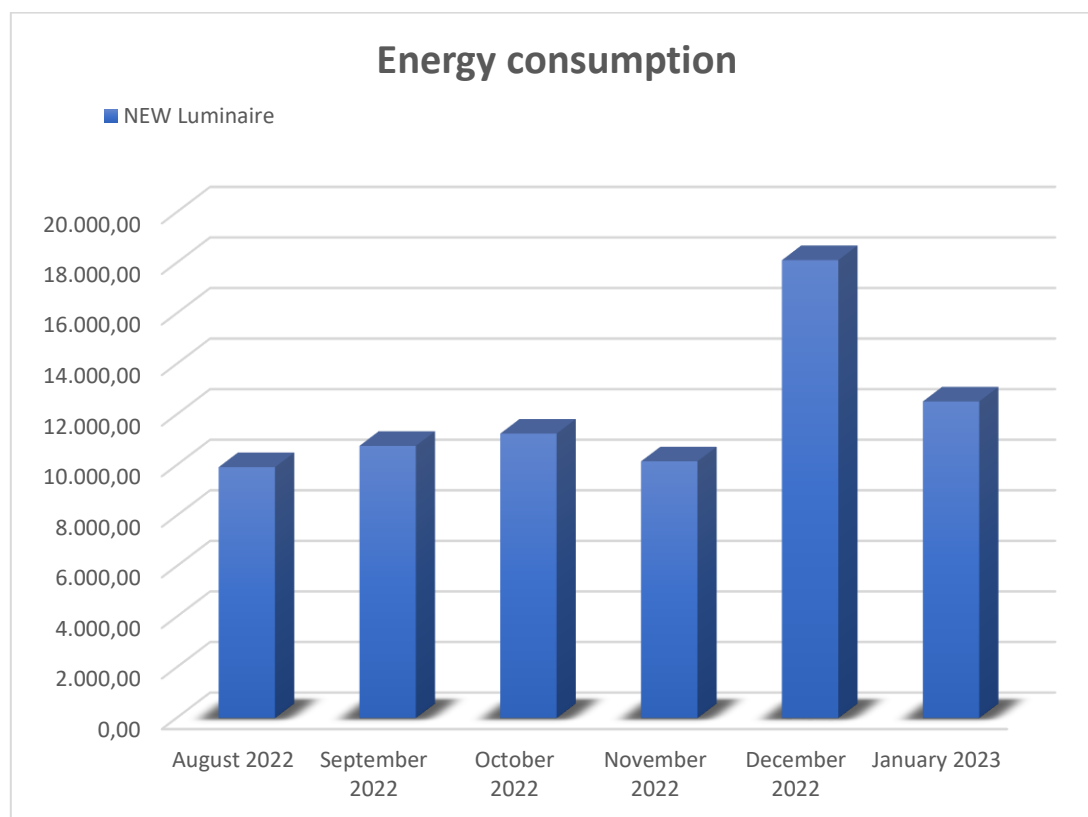


Figure 8: Monitoring data of energy consumption

As already mentioned, 102 old types of luminaires have been changed and there are no historical data related to the consumption of energy related to previous luminaires. The power of the 102 high-pressure sodium lamps or mercury lamps was 400W. According to the power of the old luminaires, provisional calculation of the energy consumption was made (assumption is that the same conditions apply like daily working time, etc.).

Table 4: Energy consumption for new and old lightning

No	Month	Energy consumption for 73 LED luminaire (KWh)	Theoretical energy consumption for 102 obsolete luminaires (KWh)
1	August 2022	9.923,01	13.363,88
2	September 2022	10.764,22	14.496,78
3	October 2022	11.250,40	15.151,55
4	November 2022	10.154,06	13.675,05
5	December 2022	18.112,03	24.392,50
6	January 2023	12.520,72	16.862,36
		72.724,43	97.942,12

In accordance with the pilot action, an estimated 6 months energy saving is approximately 25.217,69KWh, which is 34,68% less than with old luminaires. In addition, we achieved the increased lumen per watt with

LED luminaires (approx. 40 % higher value of lumen per watt) thanks to the pilot action, and it improved safety and security in the port area.



Figure 9: Old and new luminaires in the Port of Bar

In this case, the 6 months energy saving of 25.217,69 kWh, and therefore an annual saving of 50.435,38 kWh, results in environmental benefit associated with the replacement of LED luminaires of over 31,5 tons of CO₂ equivalent emissions avoided per year (source: EUROSTAT and Action plan for sustainable and low carbon Port of Bar - WTW CO₂e emission factor (kg CO₂e/kWh) = 0,623)

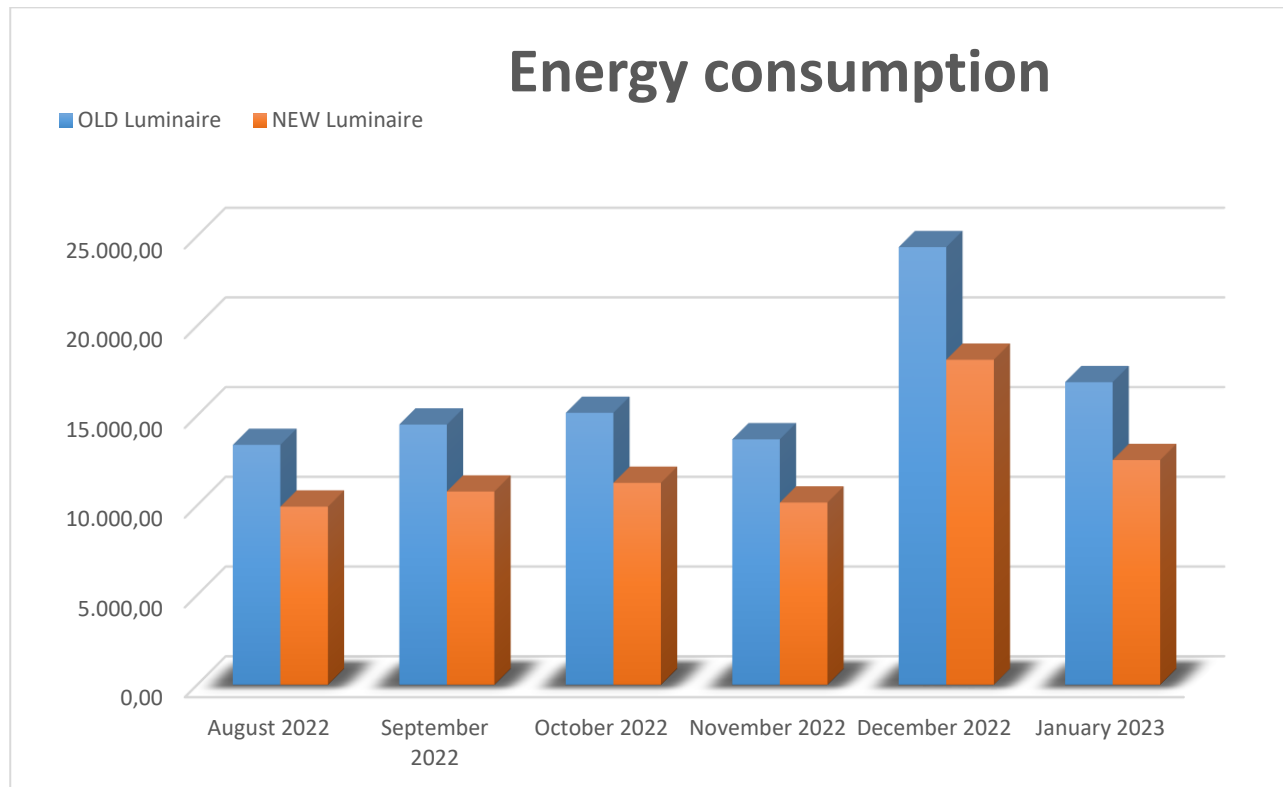


Figure 10: Monitoring data of energy consumption

5 STAKEHOLDERS INVOLVED

We had several stakeholders involved during the entire process of implementation of the SMARTPORT project. These are the main ones:

Table 5: Stakeholder involvement

Name of stakeholder	Type of stakeholder	Level of engagement	Level of impact
Transport Community	International organization	Medium	Low
Ministry of Capital investments	National authority	Medium	High
Eco Fund		High	Low
Municipality of Bar	Local authority	High	Medium

Institutional meeting and conference round table held in Bar on 20th May 2023 were a great opportunity for both stakeholders and Port of Bar to bring the issues of energy efficiency and similar green measures to the table and during this meeting Port of Bar, the Bar Municipality, and the Ministry of Capital investments decided that they will make significant efforts to jointly create conditions that support overall development with substantial efforts from Eco Fund, in line with development plans at national, regional, and local levels.



Figure 11: Institutional meeting and round table conference with main stakeholders

6 PROBLEMS AND SOLUTIONS FOUND

There were no major problems in the implementation of the SMARTPORT pilot project. The general problem is the lack of measurement of electricity consumption per consumers, including the lighting system in the Port. In the absence of data from the previous period, the theoretical consumption of old type of luminaires (high-pressure sodium or mercury lamps) was calculated and a comparison was made with the actual consumption of LED luminaires. Tender procedure for procurement of LED luminaires was organized in 2 steps. Firstly, the most favorable tenderer was selected and a contract for delivery of 50 LED luminaires was concluded. Secondly, there were savings in the budget due to the favorable tender offer and, after consultation with the LP and the JS, an annex to the contract was made, according to which 23 more LED luminaires were purchased. With this pilot project, the Port of Bar has significantly improved the lighting system at the terminals, while saving energy and reducing CO₂ emissions at the same time.



Figure 12: Obsolete luminaire removed

7 ANNEXES

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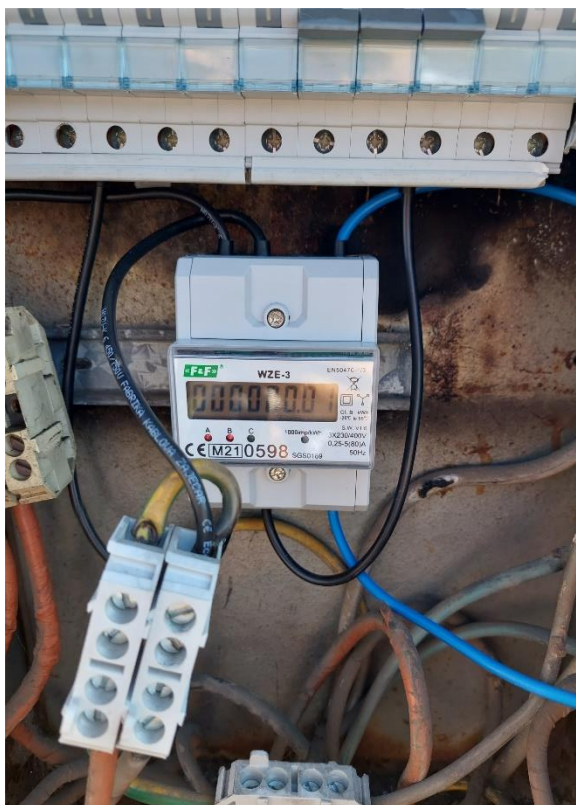
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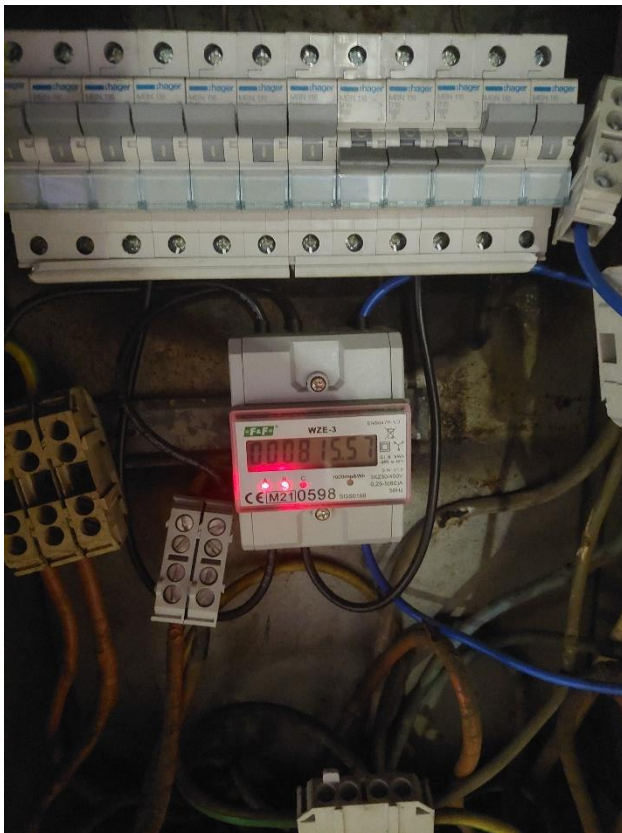
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7.1 Additional photo documentation

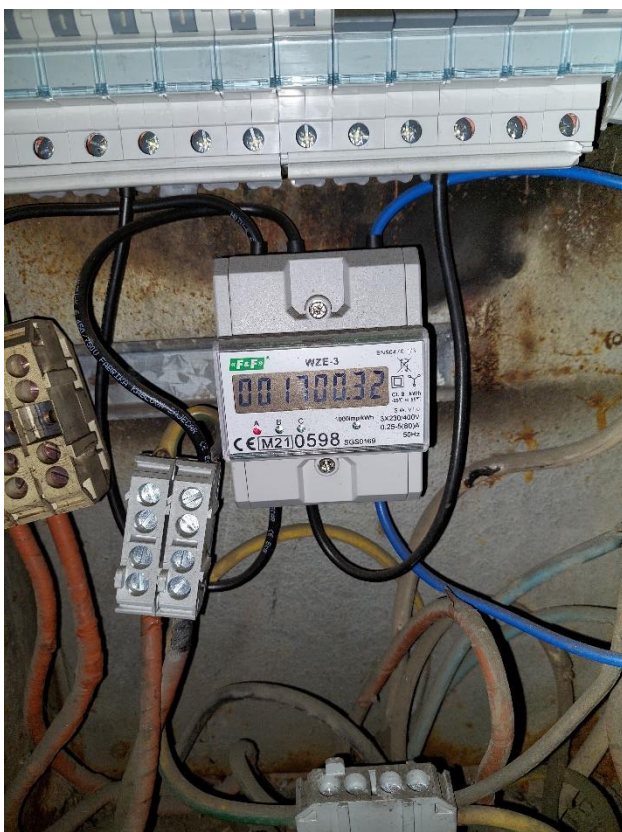
- installation of the measurement unit 29/07/2022



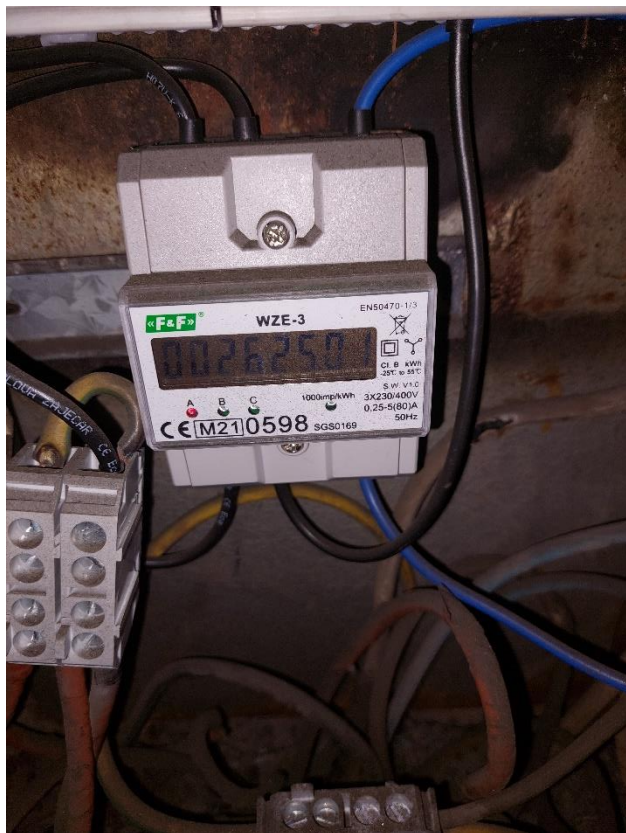
- 1st measurement on 02/09/2022



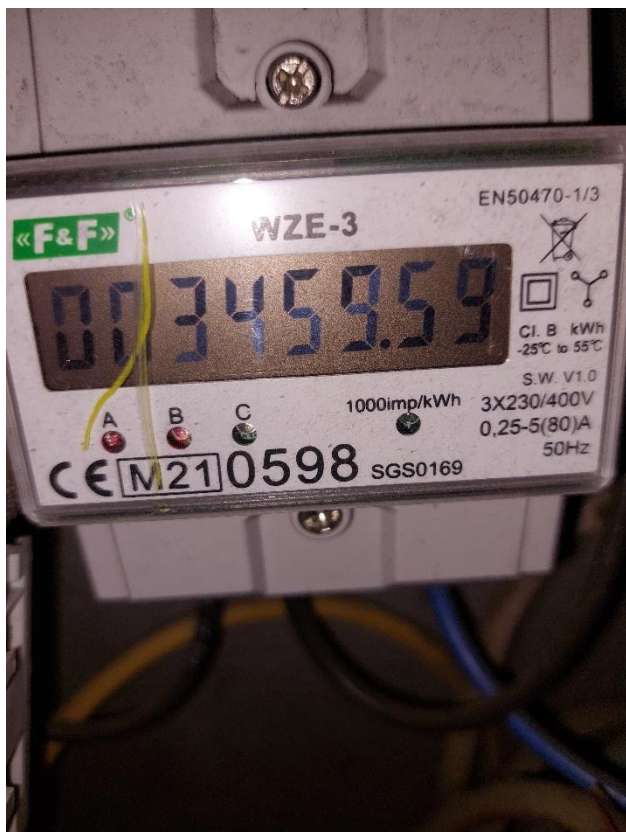
- 2nd measurement on 03/10/2022



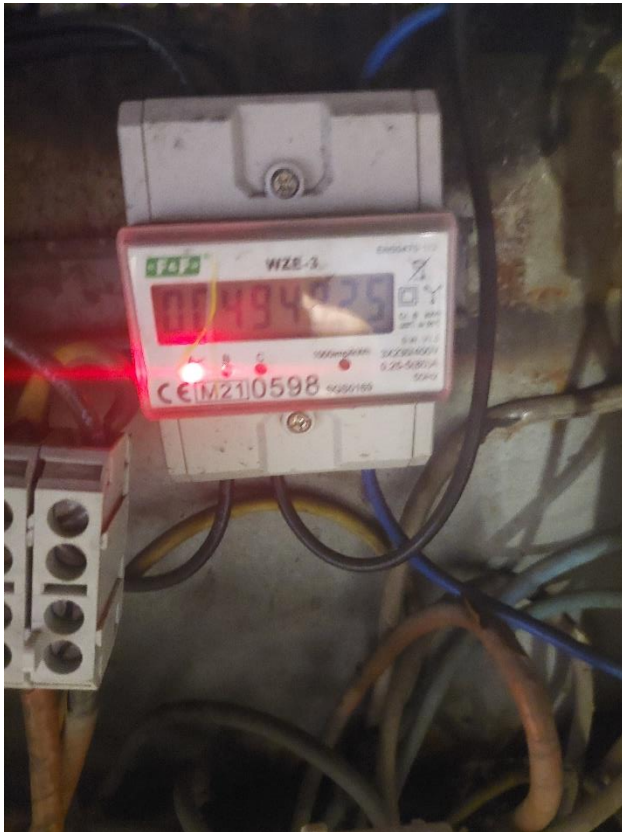
- 3rd measurement on 03/11/2022



- 4th measurement on 02/10/2022



- 5th measurement on 10/01/2023



- 6th measurement on 10/02/2023





Port Network Authority
of the Ionian Sea

Port of Taranto



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LUKA BAR

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