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SMARTPORT

D.T2.3.1 - Monitoring Report

Version n. 1

Municipality of Termoli

09/2023

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Contents

Work Package T2

The objective of the WP consists in increasing the efficiency of the port of Termoli, efficiency to be achieved by optimizing the energy needs of the port and implementing the use of renewable energy sources.

In order to begin evaluating these efficiency interventions, it was decided to carry out a constant pilot project in installing, in a previously prepared area of the port, a lighting system created through the installation of photovoltaic LED streetlights.

It is subsequently planned to extend this project to the public areas of the port by replacing the existing traditional street lights with photovoltaic LED street lights, thus guaranteeing the satisfaction of the lighting energy needs through the exploitation of renewable energy sources and the improvement of lighting performance through the use of LED lamps with optics optimized for the installation purpose.

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 PP2 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 set out to do, or whether it is moving in a different direction.

Distribution of tasks for the drafting of deliverable

No.	Partner	Involvement in the activity
LP	Port Network Authority of The Adriatic 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

The Port of Termoli is located in a natural bay on the Adriatic coast, in the Molise Region. The Port of Termoli is classified by law 84/1994 as a port of regional and interregional economic importance.

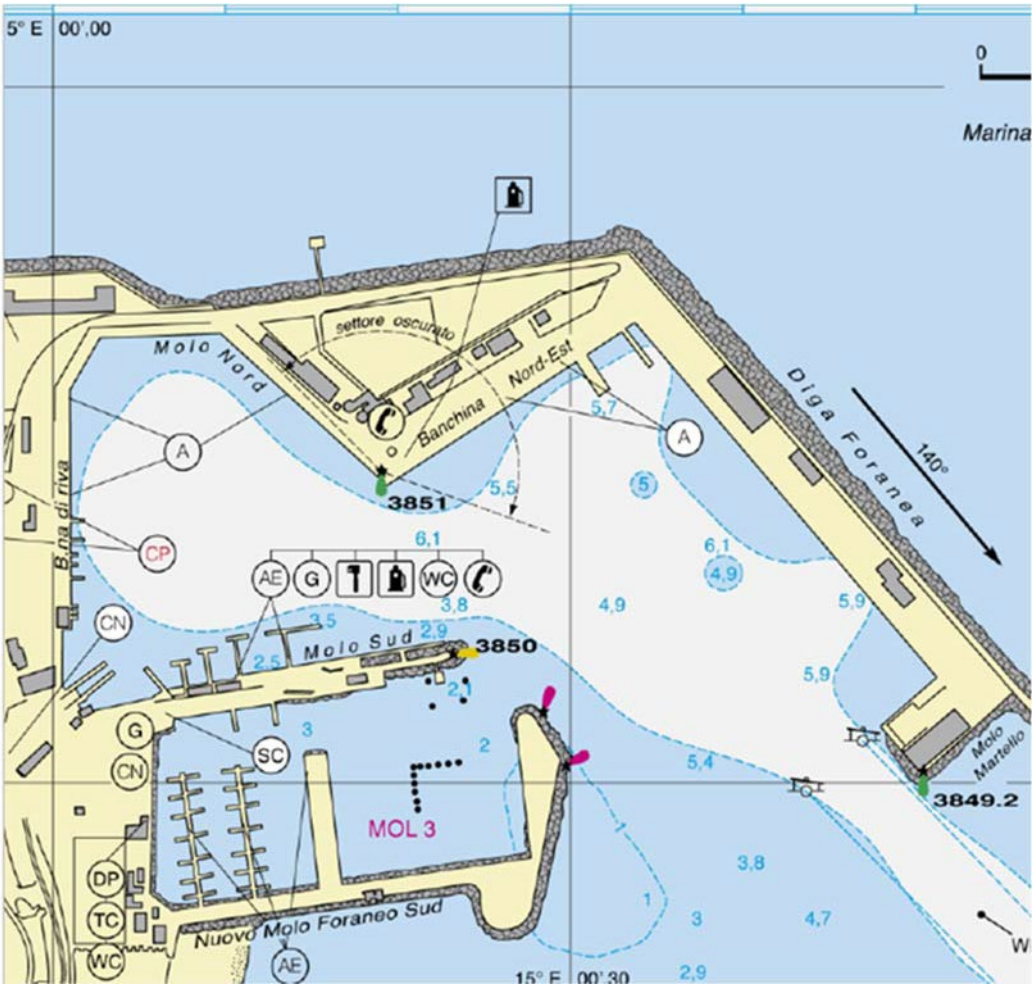


Figure 1: Planimetric view of the port of Termoli

The Port is administered by the Molise Region, which has the task of planning, designing, implementing and maintaining the infrastructural interventions concerning the port area. The total surface area of the port basin is 360,000 square meters while the maximum depth of the seabed is 6 metres.
The port is adjacent to the historic center of Termoli (Borgo Vecchio) and rises at the foot of the fortified historic centre; it is, therefore, perfectly integrated into the urban context.
Termoli is classified as a multifunctional port and its operations are mainly related to tourism (passengers and ferries, yachting), fishing, commercial activities and shipyards.
The infrastructure is characterized by the presence of three piers: the southern ones of the San Pietro marina used as a tourist port and the northern one (about 1,200 m long), which houses the shipyards of Termoli (CNT). The quay between the south pier and the arm hosts, like the first part of the port arm itself, the fishing port and the vehicles of the Coast Guard and the Guardia di Finanza while the second part of the arm welcomes the passenger ships headed to the Tremiti Islands, with which connections are guaranteed all year round.

The tourist port of Termoli, recently expanded with the construction of a new pier parallel to the existing one, has around 300 berths for boats, from 8 to 30 metres.
The Marina di San Pietro, opened to the public in 2009, has 4 piers and 2 docks.
Operations are mainly related to tourism (passenger and ferry, yachting), fishing, commercial activities and shipyards.
The Marina di San Pietro, opened to the public in 2009, has 4 piers and 2 docks. The structure has hosted private boats of considerable capacity (40 m) in relation to the size of the port itself and offers various types of services including refreshments. The landing place is owned by Marinucci Yachting Club s.r.l.
The following services are currently available:

- *Port trailer*
- *Piloting*
- *Moorers*
- *Divers*
- *Slipway*
- *Water supply*
- *Sif diesel and petrol depots (24 hours a day) or tank trucks*
- *Guarding*
- *Shipping agencies*
- *Waste collection*
- *Warehouse for supplies to fishing vessels*
- *2 mechanical workshops*
- *Supply of ice with daily production of 60 quintals*
- *20 refrigerators for storing fish*
- *Electrical supply cables*
- *Dock lighting*
- *Fixed crane up to 20 t*
- *Mobile crane up to 250 t*
- *Outdoor storage*
- *Engine repairs*
- *Electrical repairs*
- *Repair of wooden, VTR and steel hulls*
- *Toilets*
- *Food supply in the city*
- *Car parking*
- *Telephone booth*
- *Bar/restaurant*

A recent study published by the Italian Ministry of Transport1 estimates for the period 2016-2019, an average annual flow of 200,000 passengers, approximately 3,000 cars and more than 19,100 linear meters of goods, moved along the Termoli-Tremiti route (40 nautical miles long).
It is worth saying that the is strongly influenced by seasonality, with traffic peaks during the summer and lower flows during the winter. The port of Termoli represents the only port structure in the Molise region.

From the port of Termoli, it is possible to reach the Tremiti Islands faster than any other port (both in Puglia and Abruzzo). Furthermore, a fast connection to Croatia is possible.

The Port of Termoli benefits from the presence, along the north-south axis, of three main transport infrastructures transport infrastructures of national importance, the A14 motorway, the Bologna-Bari railway line, it is on a transversal connection axis with the Tyrrhenian side constituted from the road network (SS.647-SS.17-SS.85-A1 (Rome-Naples section, San Vittore toll booth) and from the Termoli-Campobasso-Isernia-Rome railway network.

Therefore, the port of Termoli potentially represents a significant logistics hub.

The Molise Region, together with the coastal regions of Marche, Abruzzo and Puglia, have signed a Memorandum of Understanding with the aim of sharing a common strategy and a united position, in view of the revision of the EU regulation for transnational transport.

The strategy identifies four main priorities that could really contribute to filling the infrastructure gap that affects the transport networks of the Adriatic regions involved, both along the east-west and north-south axis.

The priorities include the following strategic interventions:

1. *Corridor I, Baltic-Adriatic: extension of the corridor along the entire Adriatic-Ionian coast*
2. *Corridor 5, Scandinavian Mediterranean: extension of the corridor from north to south*
3. *Strengthening east-west connections between Spain, Italy and the Western Balkans*
4. *Strengthening port infrastructure to improve connections between the two shores of the Adriatic and towards Central Europe.*

Figure 2: European routes and corridors

The objective of the port administration is to make it more efficient by reducing energy consumption and optimizing services.

To achieve the objective it was decided to resort to the use of renewable energy sources such as photovoltaic, tidal force and wind.

Furthermore, it was decided to use LED lighting and to implement the electrification of the docks serving the ships that use the port.

In the light of the above, it is therefore necessary to define a plan of objectives and strategies related to the energy/environmental issue that develops in a coordinated manner, a plan that can be divided into two macro areas:

- *energy efficiency*
- *renewable energies*

The plan can be developed as follows:

STRATEGIES	***GOALS***	***SHARES***
Development sustainability	*Reorganization of the layout of the functions*	*Small changes to the works*
		Identification of new layout
	Mitigation of environmental criticalities	*Renewable energy*
		Energy efficiency
	Energy autonomy	*Renewable energy*
		Energy efficiency
	Strengthening of infrastructures and connections	*Improvement of inland waterways*
		Improvement of the road network
		Improvement of the railway network
	Reduction of port-city interference	*Urban area facing the port*

In order to define the strategies to follow, it is necessary to examine the energy issue from various points of view.
First of all, the current energy needs must be analyzed and future needs estimated, which cannot be done at the time of drafting this document due to the lack of documentation made available by the entities and commercial activities present at the port.
Subsequently, a series of actions relating to the production of energy from renewable sources and energy saving must be indicated, without quantifying the contribution that these actions could give.
In the following paragraphs, this document attempts to clarify the future scenarios relating to both the needs and the potential for savings and energy production from RES, or it describes the uncertainties and elements of indeterminacy that make it impossible to develop reasonable estimates and provides guidelines guide to address these issues in the near future, with the involvement of the entire port community.

The indications for the future development of the port concern:

- *the future energy choices related to the macro functional and infrastructural structure of the port;*
- *the energy efficiency of the current and new fixed structures of the port system;*
- *the assessment and estimation of the energy intensity and environmental impacts of various maritime transport development scenarios with the consequent impact on urban and port and regional traffic;*
- *the creation of a governance system for the development, implementation and operation of energy resources from renewable sources in the port;*
- *the periodic update of the energy audit of the port;*
- *the integration of this approach in the local economic and territorial planning, since the choices in the energy field of the port system will have an impact on the governance choices of the urban area and the territory.*

The appropriate interventions can be identified in:

- *extensive use of low-consumption lighting fixtures in the yards;*
- *WIND: evaluate the installation of wind farms,*
- *PHOTOVOLTAIC: in the car storage yards, and in general in port yards where the types of goods handled allow it, suitable roofing structures equipped with photovoltaic systems will be studied, which will also be extended to the roofs of the new sheds.*
- *BIOMASS: the possible installation in the port of two authorized plants for the production of electricity fueled by biomass, could in the future trigger opportunities for the exchange of energy on the spot.*
- *the development of the COLD IRONING project (also known as OPS, Onshore Power Supply), for the direct supply of electricity to ships (generated elsewhere or from plants powered by renewable sources), starting from cruise ships and ferries, plus close to the town*

2 RATIONALE FOR PILOT ACTION

The knowledge framework to be built, detailed and monitored over time must concern at least two macro areas:

- *Energy infrastructure*
- *Analysis of current and future needs*

Below are the elements available to date from which to start for the necessary insights in drafting the definitive document. The elements of the cognitive framework will have to be the basis of the information activities towards the port community, making an effort to translate the specialized information necessary to understand the dimensions of the topic into "non-technical" language.

2.1 ENERGY INFRASTRUCTURE

At the time of drafting this document, we did not have detailed information relating to the energy infrastructures present in the port areas, therefore it is not possible to carry out an analysis.
During the preparation of the cognitive energy framework, all the information necessary for the preparation of the cognitive technical paper relating to the energy infrastructures must therefore be found, in order to be able to study its optimization and any expansion/integration.

2.2 ANALYSIS OF ENERGY NEEDS

Preliminary to the drafting of this document, a survey of energy needs was carried out at the following entities:

- *Municipality of Termoli*
- *Molise Region*
- *ARPA of the Molise Region*
- *Port Authority of the Port of Termoli*

From the feedback received, it immediately seemed unlikely to be able to have available in a short time and above all have certain and complete data available relating to the Port and its functioning as most of the activities are managed by private individuals through state concessions or other types of concessions.
The outcome of the investigations carried out is reported in the document "Energy Requirements Report" attached to this document, in fact the documented and tangible needs with proof provided by the electricity supply bills appear to be that relating to public lighting and to the charging stations with supplies attributable to the Municipality of Temoli and the Molise Region, consumption which is summarized in the following table:

ELECTRICAL NEEDS - year 2022

MUNICIPALITY OF TERMOLI						
PO CODE	**USER**	**ANNUAL CONSUMPTION [kW/h]**	**NOx [g/kWh]**	**SO2[g/kWh]**	**pm[g/kWh]**	**CO2[g/kWh]**
IT001E69272559	Fish market	18'526	3'612.57	1'130.09	370.52	9'022'162
IT001E68640364	Charging columns	174	33.93	10.61	3.48	84'738
IT001E68640365	Charging columns	3'707	722.87	226.13	74.14	1'805'309
IT001E68623415	Charging columns	1'899	370.31	115.84	37.98	924'813
IT001E69234138	Charging stations + access bar + dock lighting	18'860	3'677.70	1'150.46	377.20	9'184'820

MOLISE REGION						
PO CODE	**USER**	**ANNUAL CONSUMPTION [kW/h]**	**Nox [g/kWh]**	**SO2[g/kWh]**	**pm[g/kWh]**	**CO2[g/kWh]**
IT001E67242062	shipyards (6 light towers)	35'375	6'898.13	2'157.88	707.50	17'227'625
IT001E69272607	purifier (7 lighthouse towers)	16'485	3'214.58	1'005.59	329.70	8'028'195
IT001E69338879	captaincy wall (floodlights)	20	3.90	1.22	0.40	9'740

Emission conversion factors		
electricity kWh	NOx [g/kWh]	0.195
electricity kWh	SO2 [g/kWh]	0.061
electricity kWh	PM [g/kWh]	0.020
electricity kWh	CO2 [g/kWh]	487

Therefore, there is an annual energy requirement for the reference year 2022 of 95,046 kWh/year.

3 PILOT ACTION IMPLEMENTATION

3.1 INTERVENTION AREA

The area subject to the intervention is represented by a stretch of cycle/pedestrian path existing in the port area of Termoli along the municipal road for vehicles called Viale Marinai d'Italia in the stretch between the roundabout of the "Marinucci" tourist port and the Via Rio Vivo roundabout.

The cycle/pedestrian path appears to have been built in a state-owned area in 2011 as part of the project called "Intercomunale litoranea Termoli-Campomarino", said project did not envisage equipping the path with a public lighting system but only the implementation of works relating to the predisposition for its installation.

Figure 3: Google maps photo of the operartion area at the port

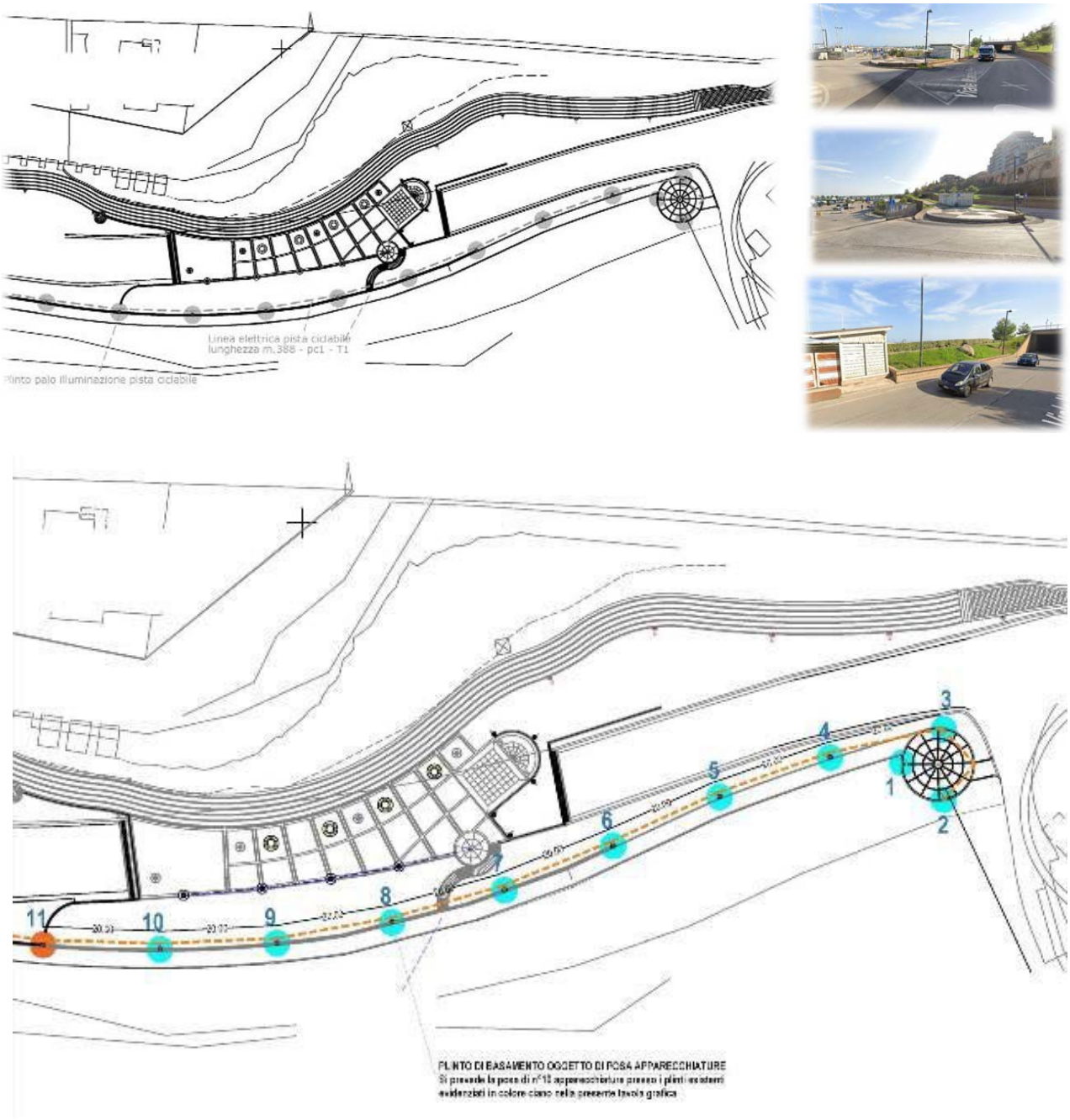


Figure 4: Plan of the operation area at the port

3.2 DESCRIPTION OF THE INTERVENTION

The proposed intervention consists in equipping the cycle/pedestrian path, in the stretch between the "Marinucci" tourist port roundabout and the Via Rio Vivo roundabout, with a grid-off public lighting system created through the installation of luminaires equipped with LED lamps and powered by a photovoltaic module interfaced with a storage system and charge regulator installed on the support pole of the lighting fixture itself.

Specifically, it is planned to install, in the section of the cycle/pedestrian path, at the cement base plinths previously prepared during the construction of the cycle/pedestrian path, 10 lighting fixtures with relative photovoltaic module and charge regulator.

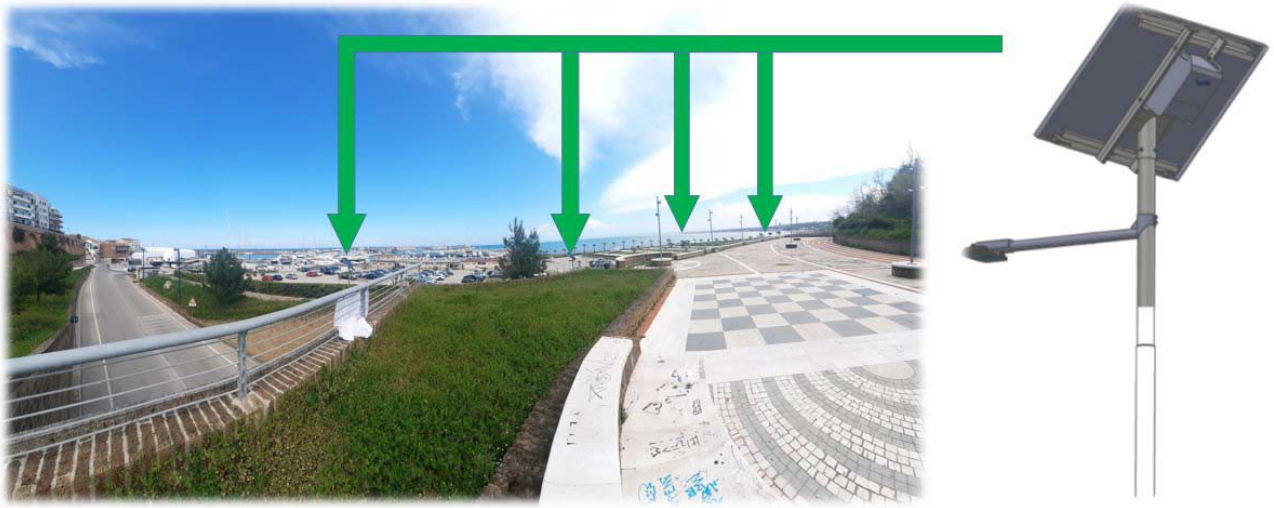
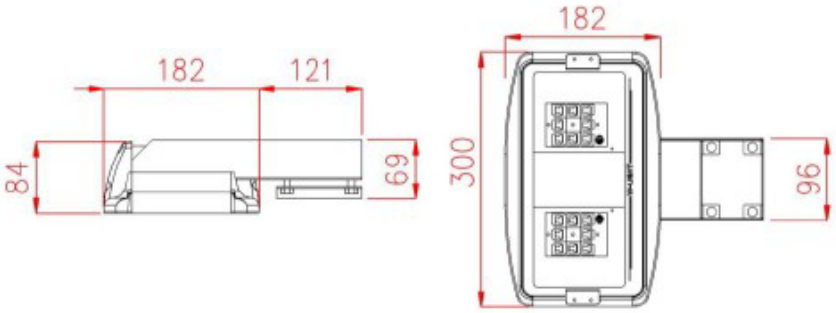


Figure 5: Lamp installation points

Figure 6: Photo at the end of the work

W-LIGHT LED Luminaire

LED Luminaire for Solar Energy applications



LIGHTING FEATURES	
LED source efficacy @ I_F=350mA, T_j=25°C [lm/W] *	178
Color temperature	4000K
Minimum CRI (color rendering index)	70
IESNA TM-21 LED useful lifetime @ I_F=1050mA *	> 60000 ore @ L80(10k) –Tsp=85°C
Optic	Asymmetric for street lighting
Photometric classification CIE 1965	Semi Cut-off
ELECTRICAL FEATURES	
Alimentazione	10 ÷16 VDC
Classe di isolamento elettrico	III (SELV)
Corrente LED [mA]	330 / 480
Connection	3 conductors (+VDC, -VDC, DIM) IP68 connector with cable: max section 4mmq max total diameter 13.5mm
Luminous flux reduction	Automatic or controlled from Western CO PV charge regulator
Luminous flux reduction value	-30%
LED thermal protecion	Control of heatsink temperature
GENERAL FEATURES	
Protection degree	IP 65
Impact resistance degree	IK08
Dimensions [mm]	300 x 182 x 84
Weight [Kg]	6.0
Side surface [m²]	0.03
Top surface [m²]	0.10
Fixing	Bracket Ø60mm
Tilt angle	No
Omologations	CE Mark
Warranty [years]	5
MATERIALS	
Pole or bracket coupling system	Cataphoresis treatment and varnished black steel
Heatsink body	Anodized black extruded aluminum
Caps	Varnished black die-cast aluminum
Screen	Tempered extra-clear 4mm thick
Optic	PMMA (polymethylmethacrylate)

Figure 7: Technical features of LED lamp

CODE	NUMBER OF LEDs	LUMINAIRE POWER @ Tq=25°C [W]**	LED CURRENT [mA]	NOMINAL LED FLUX @ Tj=85°C [lm]*	LUMINAIRE FLUX @ Tq=25°C [lm]**	LUMINAIRE EFFICIENCY @ Tq=25°C [lm/W]**
WL12 017114	12	11.8	330	1992	1630	138
WL18 017115	12	17.4	480	2851	2332	134

* Rated data extrapolated from LED manufacturer datasheet
** Rated data extrapolated from photometric measures executed in an accredited laboratory according to UNI EN 13032-4 rule

The indicated values on this technical sheet are to be considered rated values subjected to a tolerance of +/-5%.
The characteristics of the product listed above are subjected to change without notice.

Optic for street lighting

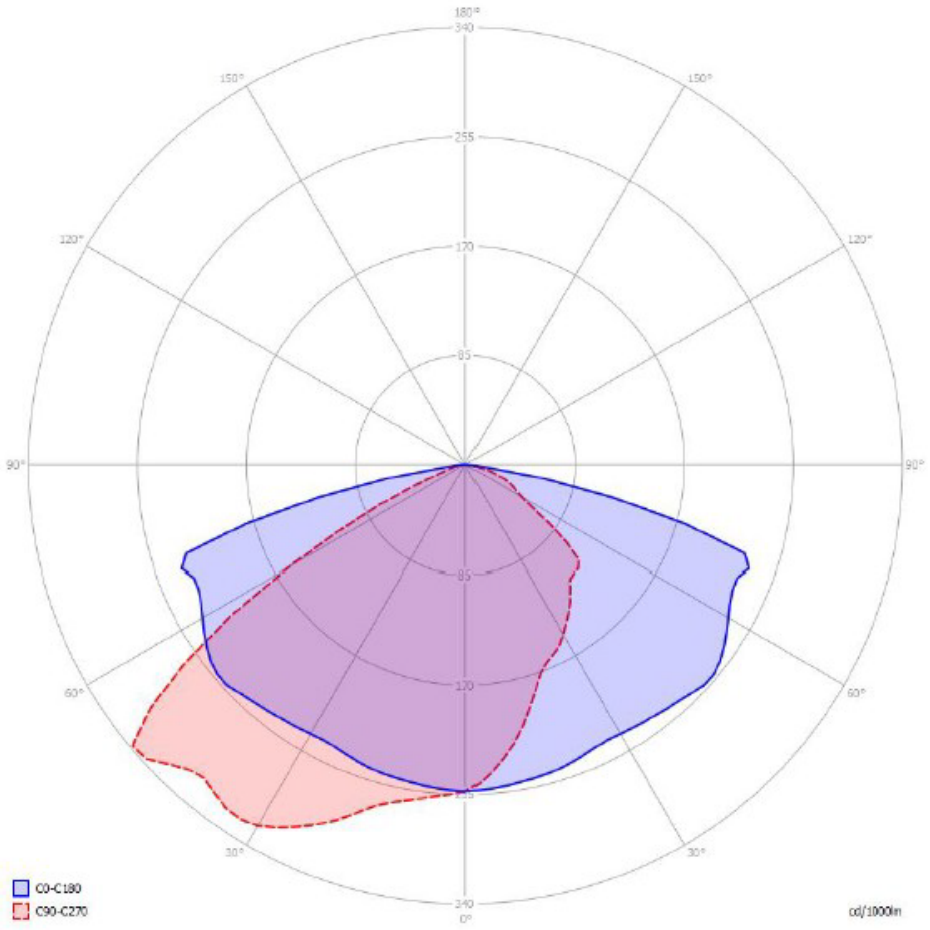


Figure 8: Technical features of LED lamp

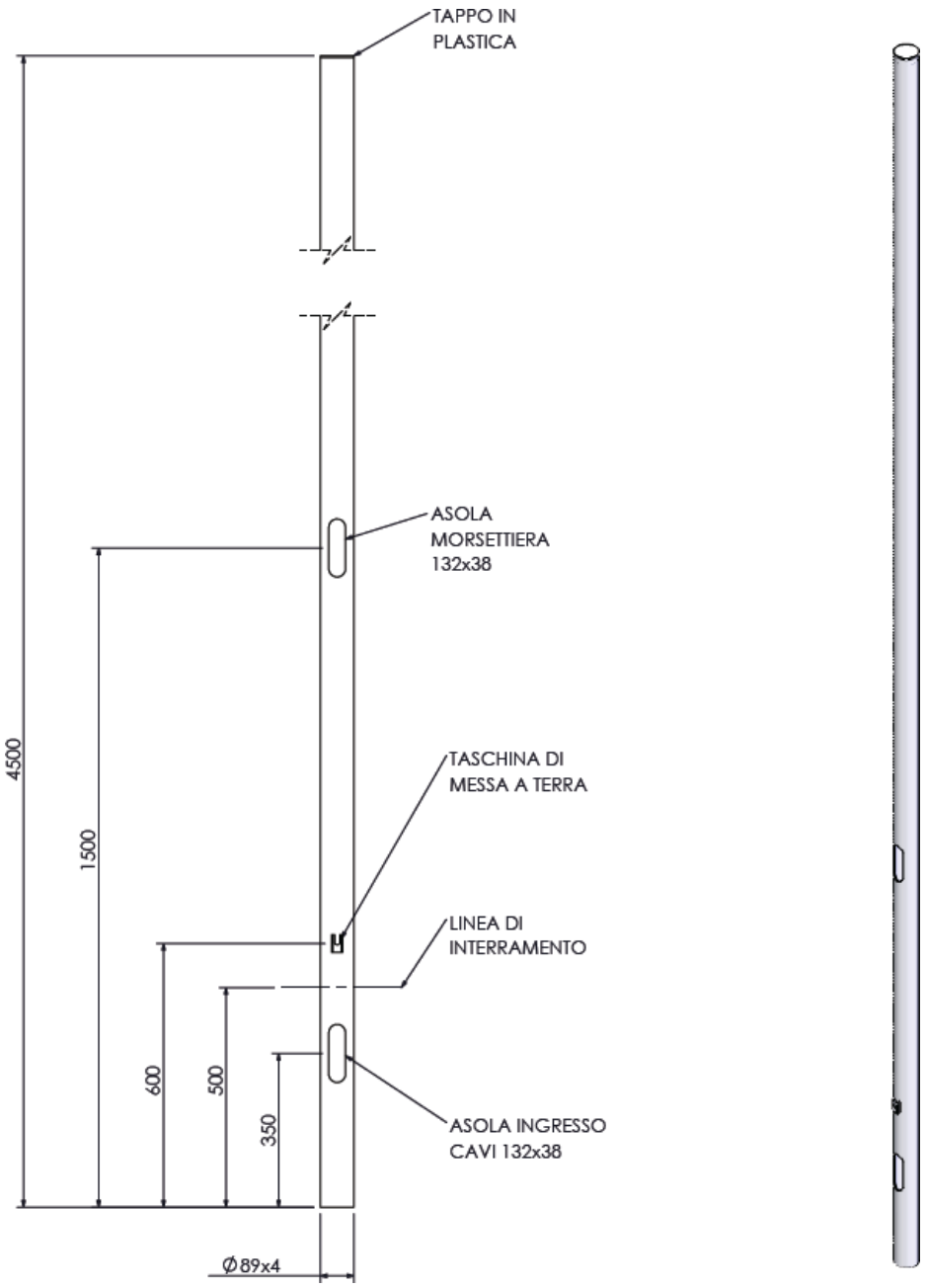


Figure 10: Technical features of Support system

UFX100PM
Polycrystalline Module(PERC)

UFLEX

Key Features

- Excellent module conversion efficiency of up to 14.89%.
- Up to +3% positive power output guaranteed.
- Module designed with high efficiency Solar cells.
- Loss minimization due to excellent temperature co-efficient.

Quality & Reliability

- Manufactured in an ISO 9001:2015, ISO 14001:2015, OHSAS 18001:2007 certified facility.
- Manufactured using high grade raw materials from reputed international suppliers adopting a stringent quality criteria.
- IP65 rated junction box for long-term weather endurance.
- EL inspection to ensure micro crack - free modules.
- Automatic Stringer & Semi-automated facility for cut Cell Modules.
- Certified for IEC & BIS.

Technical Data for UFX100PM - Polycrystalline Module(PERC)

Electrical Parameter at STC

Module Type	UFX100PM		
Capacity rating – Pmax(Wp)	090	095	100
Power Tolerance (%)	0 - 3	0 - 3	0 - 3
Module efficiency (%)	13.40	14.14	14.89
Rated voltage - Vmp(V)	18.92	18.94	19.05
Rated current - Imp(A)	4.78	5.03	5.28
Open circuit voltage - Voc(V)	22.45	22.50	22.52
Short circuit current - Isc(A)	5.38	5.65	5.89

Under Standard Test Conditions (STC) of irradiance of 1000 W/m², spectrum AM 1.5 and cell temperature of 25°C.

Temperature Coefficients (TC)

Temperature Coefficient (Voc)	-0.30% /°C
Temperature Coefficient (Isc)	0.05% /°C
Temperature Coefficient (Pmax)	-0.38% /°C

Permissible Operating Conditions

Temperature range	-40°C to + 85°C
Maximum system voltage	1000/600 VDC
NOCT	45± 2°C
Hail resistance	Maximum diameter of 25 mm with velocity 23 m/s

Guarantees and certifications

Product Certifited	IEC 61215, IEC 61730,IEC 61701, CE, BIS

Packing Information

Module Quantity/Outer Box: 5, Outer Box Size : 1030 x 230 x 685 mm

Mechanical Specification

Solar cells	36 pcs Polycrystalline Silicon, 5BB/4BB
Encapsulation	Ultra - clear PID free EVA (Ethylene-Vinyl-Acetate)
Backside	UV protected reflective backsheet
Frame	Silver Anodized Aluminium Alloy
Front glass	Low Iron tempered Solar glass
Dimensions	(L) 1010 mm x (W) 665 mm x (H) 34mm
Weight	8.1 kg
J-box	IP 65 certified, 2 diodes junction box
Cable & Connector	Optional
Application Class	Class A
Electrical Safety	Class II
Surface load	Wind load 2400 Pa.

Drawing measurement in mm

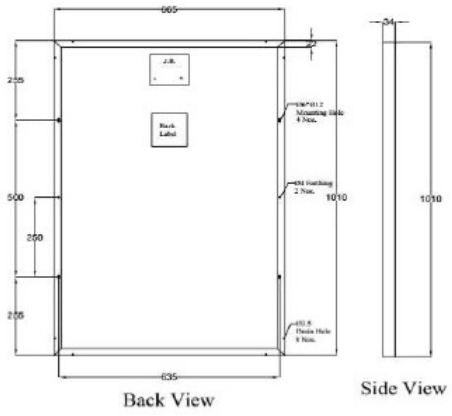


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Figure 11: Technical features of photovoltaic module

3.3 ECONOMIC FRAMEWORK

ECONOMIC FRAMEWORK	
Work cost	
Work cost	*€ 29'073,68*
Security cost	*€ 2'133,00*
TOTAL A.	***€ 31'206,68***
Amounts available to the administration	
I.V.A. 10 % of Total A.	*€ 3'120,67*
Technical functions	*€ 657,98*
Amounts for unexpected events and other work	*€ 1'014,67*
TOTAL B.	***€ 4'793,32***
TOTAL A. + B.	***€ 36'000,00***

4 MONITORING DATA

Since this is an intervention relating to the new installation of a system and the creation of a service that did not previously exist, it is not possible to carry out an analysis of consumption before and after the works.

Furthermore, the installation of energy meters was not foreseen, as the photovoltaic street lamps installed are autonomous and powered by the free energy provided by the sun captured by the photovoltaic panel present on the lamp post itself and stored in the battery present under the photovoltaic lamp post.

It is possible to state that the implementation of the intervention has made a previously unlit area of the port safer, guaranteeing a service with almost zero management cost given the non-need for electricity supply from the local distributor's network.

5 STAKEHOLDERS INVOLVED

The Molise region, the port authority and the port operators were involved in the process, led by the Municipality of Termoli.

6 PROBLEMS AND SOLUTIONS FOUND

The implementation of the pilot project neither did not run into any particular problems, from an administrative/legal point of view nor from a technical point of view as the area was already prepared to host the intervention thanks to previous works carried out in 2011.

From discussions with the port authorities and port operators, it emerged that the project could potentially also be extended to other areas of the port, thus creating a completely autonomous lighting system powered by renewable energy sources, thus minimizing or eliminating consumption of electricity from the mains for night lighting of the areas.

7 ANNEXES

Below are photos of the area before the intervention

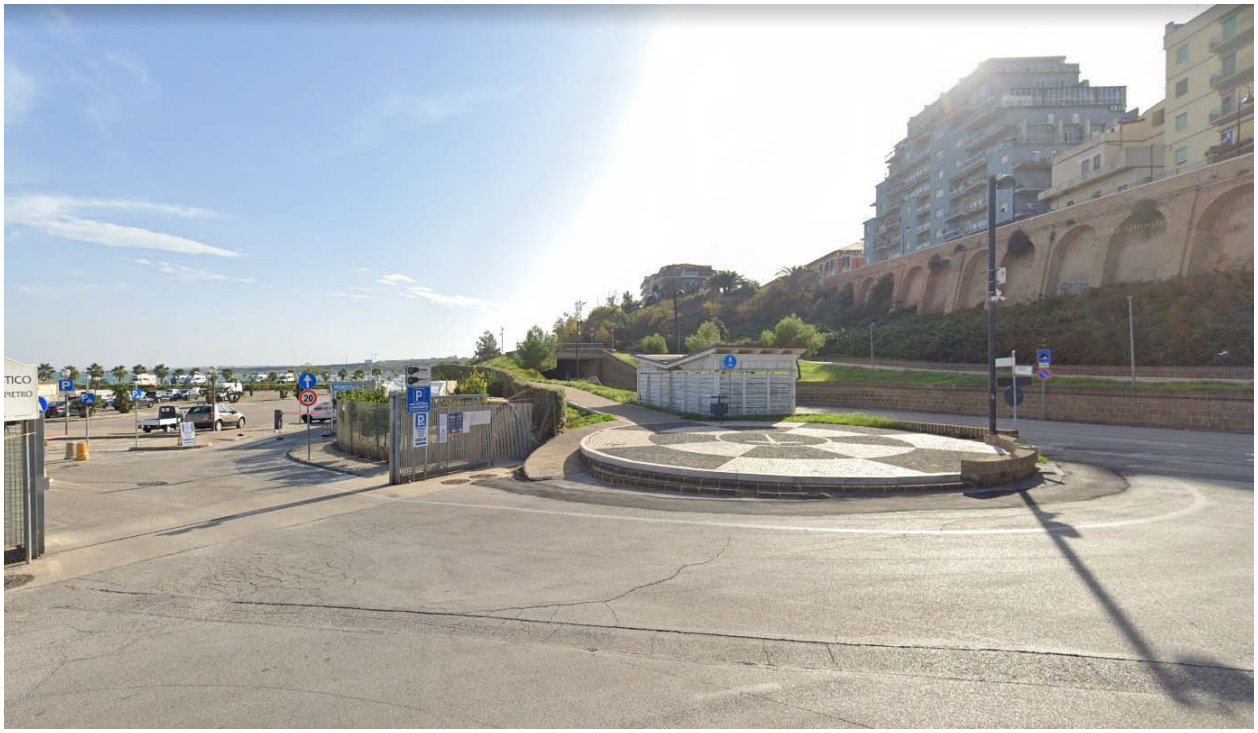

Figure 12: Area before the intervention

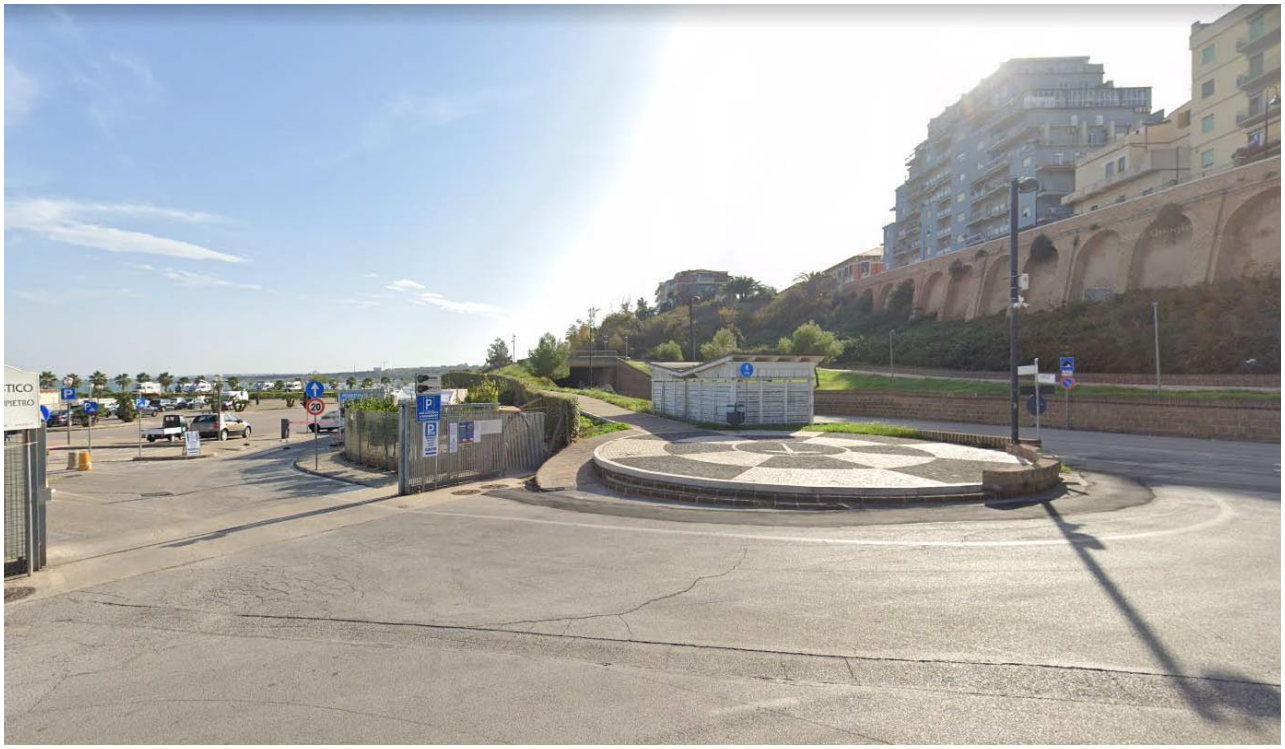

Figure 13: Area before the intervention

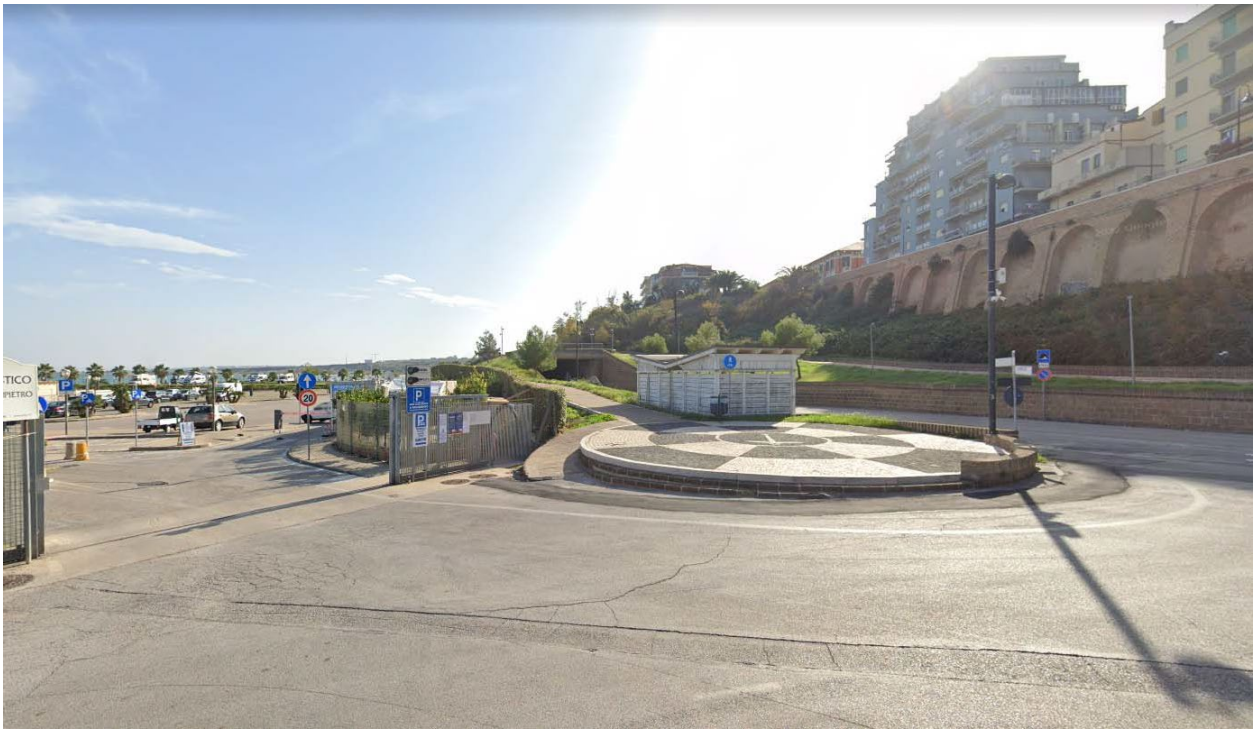

Figure 14: Area before the intervention

Below are photos of the area after the intervention

Figure 15: Area after the intervention

Figure 16: Area after the intervention

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