Final pilot action report

Porto Nogaro

Deliverable no. D.4.2.2

DISCLAIMER

Table of contents

This deliverable summarises the outcome of the pilot action implemented by PP1-COSEF in the framework of the SUSPORT – *SUStainable PORTs* project, co-funded by the Interreg Italy-Croatia Programme, consisting in:

1) study on potential use of geothermal energy in Porto Nogaro
2) replacement of port lighting systems with LEDs
3) refurbishment of the main port building to improve its energy efficiency.

1. Ex Ante Situation

As outlined in the Territorial Needs Assessment for Porto Nogaro (deliverable no. D.3.2.3), the final energy consumption for each type of activity in the land and sea port areas is summarised in the table here below:

Type of activity	Electricity [MWh]	Methane [MWh]	GPL [MWh]	Diesel [MWh]	Petrol [MWh]	LSFO [MWh]	Total [MWh]	Total [%]
Electricity	323	-	-	-	-	-	**323**	**0,6%**
Electricity produced by RES	21	-	-	-	-	-	**21**	**0,0%**
Heating	-	-	188	-	-	-	**188**	**0,4%**
Operational vehicles	-	-	-	232	-	-	**232**	**0,4%**
Port operational equipment	-	-	-	1.869	-	-	**1.869**	**3,6%**
Heavy trucks Articulated	-	-	-	1.398	-	-	**1.398**	**2,7%**
Locomotives	-	-	-	123	-	-	**123**	**0,2%**
Other	-	-	-	-	-	-	**-**	**0,0%**
Vessel during manoeuvring phase	-	-	-	-	-	1.929	**1.929**	**3,7%**
Vessel at anchor or during mooring	-	-	-	-	-	46.294	**46.294**	**88,4%**
TOTAL	**343**	**0**	**188**	**3.622**	**0**	**48.223**	**52.376**	**100%**

Table 1 – Summary of final energy consumption by type of port activity and energy carrier

The analysis shows, that in the port area of Porto Margreth the most energy-consuming activities are those related to the hotelling of vessels at the quay (88%). However, the consumption of ships during the manoeuvring phase (4%) and that of operational vehicles involved in the handling of

goods (4%) are also significant. There is also a very significant incidence of LSFO consumption associated with ship traffic compared to other energy carriers.
The most CO2eq-consuming activity, i.e. the mooring of the ship, requires significant financial investment to be reduced. To this end, the Regional administration provided the necessary funds through the RRF funds received by the Italian government.
Within SUSPORT, PP1-COSEF focused on other activities, which are described in the paragraphs here below.

2. Pilot Action Description

2.1 Geothermal study

COSEF entrusted the "Study on the potential use of geothermal energy in Porto Nogaro", to the geologist dr. Mocchiutti Andrea located in Via Nievo 31, Udine, after the end of the tender procedures.
Dr Mocchiutti submitted the final works on 19.05.2021.
This study refers to the ex-ante situation to the implementation of pilot action no. 2 (illustrated below), and concerns a two-floor building, built in 1988, called Palazzina Servizi Portuali, divided into 5 independent main units.
There are also n. 2 building units that constitute common compartments to the main units (hallways and stairwell with common toilets).
Finally, it is also to consider the toilet block of the detached technical building as it is heated by the same heating system serving the entire building.

Conditioning system:

At the service of the Port Building there is a detached technical building in which the thermal power plant has been obtained. Inside this technical building there is a drinking water pressurization system.

WINTER HEATING
The heating of the buildings is substantially entrusted to the original heating system, dating back to 1988, consisting of:

- thermal power plant comprising:

1. heat generator with LPG burner;
2. primary distribution with manifold for n. 7 circuits;
3. system for the production, storage and distribution of domestic hot water;
4. systems for metering the heat transferred from each circuit;

5. Electrical System;
    - system for the distribution of hot heating water. There are steel pipes in mainly underground and screed lay;
    - emission system including heating elements. There are fan coils and radiators.

SUMMER COOLING

For the summer cooling of some rooms, autonomous air conditioning systems of the split type, electrically powered, have been installed.

DOMESTIC HOT WATER PRODUCTION

Currently there is a production and accumulation system of domestic hot water. The system consists of a kettle with heat exchanger powered directly from the primary heating circuit.

The distribution, to the various toilet blocks, takes place through galvanized steel pipes and also includes the recirculation network.

The study foresees that the local Thermal Power Plant, powered by LPG, will be converted into a geothermal power plant. Therefore, it will be necessary to provide for the complete disposal of all the equipment responsible for the production of heat (thermal unit, chimney, gas system).
Furthermore, in consideration of the different operating parameters (temperatures and flow rates) that characterize a low enthalpy geothermal system, we will also remade this items:

1. the main distribution system, in a (geo)thermal power plant;
2. the secondary distribution system (external and internal lines to the building served);
3. implant terminals.

All this in order to make adequate and functional every component of the system that must be able to guarantee both winter heating and summer cooling of the various rooms of the Port Services Building.

Description of geothermal system:

Below are described the components constituting a hot water generation system (low temperature) or chilled for heating or cooling the building.

1. Geothermal Probe Field

The geothermal field will consist of, indicatively, n. 16 vertical geothermal probes, developed up to a depth of 100 m. For the installation of the probes we will proceed to the drilling of the ground with drilling machines.
Upon completion of the works, the probes field will be connected to the primary circuit of the heat pump and filled with a mixture of water and antifreeze. This is needed in order to ensure continuity of operation in all climatic situations.

2. Geothermal power plant

The new geothermal power plant will include the following components, hydraulically connected.
The heat pump, of the water-cooled type, will be able to produce hot / chilled water with characteristics suitable to meet the air conditioning needs of the premises of the Port Services Building.
The unit will be installed in the room converted into a Geothermal Power Plant. This unit will be able to produce the thermal energy required to meet the needs related to the air conditioning of the rooms.
The heat pump will consist of the following main components:

1. High efficiency scroll compressors powered by electric motors;
2. Single refrigerant circuit with electronic expansion valve;
3. Brazed plate evaporator in stainless steel externally insulated. This plant has a differential pressure switch and antifreeze electrical resistance;
4. Externally insulated stainless steel brazed plate capacitor. This plant has a differential pressure switch.

The Geotermal Power Plant will be completed with the following devices:

1. Safety devices;
2. Devices of correct functioning;
3. The inertial tank (or thermal flywheel);

The hot/chilled water for heating/cooling from the geothermal power plant to the end users will be conveyed through main backbones divided into circuits;

3. Plant Systems

New fan coils will be installed. Those ones will have a battery to be sized with hot water at low temperature and suitable to be traveled also by chilled water.
In the toilet rooms, especially for reasons of space, it is planned to install radiators to be used only during the winter period.

Basic thermoregulation will always be able to control, room by room, the temperature. To this end, wall panels will be installed equipped with room temperature and user selector, and able to communicate with electronic fan coil control modules.

4. Production of domestic hot water

The production system, with heat pump, doesn't allow the chance of producing domestic hot water during the summer. On the other hand, given the evolution of the intended use of the premises (currently all offices), it is reasonable to hypothesize that the satisfaction of sanitary water consumption can be achieved with kettles equipped with local electrical resistance, installed in the individual blocks of toilets.
In any case, it is possible to evaluate the installation of one or more systems with solar collector that are able to meet the need for domestic hot water on most summer days. This would allow to achieve, at least, one preheating of the water during the less favorable days.

More work suggested:

It's believed, in consideration of the age of the structure we talk about, that any maintenance interventions (such as, for example, the replacement of windows and doors) that can also have a positive impact on the energy performance of the building, must be properly evaluated.
In addition, it is also worth considering the opportunity to follow the recommendations suggested by the EPAs (exterior insulation, cover insulation).
For a complete evaluation of the suggested more works (in terms of investment) and for a more targeted sizing of the geothermal plant, it is advisable to carry out a preliminary energy analysis or diagnosis.
Following the energy analysis, the opportunity to install a photovoltaic system at the service of the geothermal plant will also be evaluated.
In consideration of theoretical energy consumption, it is estimated, in the first instance, that the installation of a 40÷45 kWp system, capable of producing about 50,000 kWh / year of electricity, can be consistent.
The system could be installed on the roof of the building after verification of suitability or any adjustments related to fire prevention aspects.

2.2 Replacement of port lighting system with LEDs and refurbishment of the main port building to improve its energy efficiency

COSEF awarded the Studio Tecnico Runcio e Associati di Udine the design service of the "Pilot Actions Implementation of the main port building in Porto Nogaro (OP82)" project. Than the COSEF has approved, after a public bill, the executive project oh those works. The works has been entrusted to Electrix S.r.l. company based in vicolo Modon 1 di Cervignano (UD) to a contractual amount equal to €_358.325,51=. On may 2, 2022, COSEF has approved a variant report of the project, due to unpredictable facts, in which the new final even amount is €_376.246,78. All documents project are available at Consorzio COSEF.

Service Building and external technical compartment:

The Service Building is a building, built in the 1988-1989 years by ZIAC Agency, whic houses several companies for rent, including Port Companies, Shipping companies, la Dogana, la Capitaneria di Porto, piloting station, the mooring group and a small COSEF office.
The building, who the projected works are for, is a two floor structure. In this building there are space dedicated to peer office about 1100 square meters. During the works, COSEF has already improved the external technical compartment of the same building, which comprises, a thermal power plant and a service group with dressing room.
The Service Building and the external technical compartment have the same load bearing structure in reinforced concrete, external infills prefabricated panels and intenral partitions in plasterboard and brick. Internal finishes are made in marble (atrium and staircase), in PVC squares (office rooms), in cermic tiles (toilet rooms) and wood parquet (office rooms). The false ceiling is made in minerla fiber.
Office doors are made in wood, windows are made in aluminium with no insulating materials.
Lighting and ventilation rooms are made by big stained glass. Toilet rooms have their ventilation system.
The Service Building has the following assets:

- water-sanitary including the complete services of the usual ceramic equipment with chromed steel taps powered by autoclave pertaining from artesian well. Hot water is produced by a kettle located in the thermal power plant;
- thermal including plate type heating elements or wall and ceiling fan coils fed by hot water from a boiler with a capacity of less than 100,000 Kcal / h. This boiler operating with methane;
- electrical including arrival panel of the lines located in the external technical compartment, secondary control and protection panels, underground and external ducting arranged in

skirting boards, light points, sockets, lighting fixtures flush with the ceiling. There is a video door entry system and an anti-intrusion system, no emergency equipment is installed;
- Telephone system limited to a few points of use.

With regard to the conditions of the plants described above, it was found that:
- the electrical system is adequate to safety standards;
- The winter conditioning of the rooms takes place by means of fan coils powered by the boiler placed within the technical compartment with connection lines within the channel consisting of steel pipes in different parts attacked by rust and with numerous leaks;
- The summer conditioning takes place by means of autonomous splits hanging on the wall with outdoor units;

The building is in good maintenance conditions but as regards the insulation of the walls it isn't in the right standards required by law.

The following photographic documentation was before of the works .

01 Service Building

02 External technical Compartment

03 Service Building Interiors

Port Warehouses:

The port warehouses, located in the southern part of the port in front of the canopies, have a height of 10 mt and are made of prefabricated concrete blocks with foundations in the stalls. They consist of 3 modules with a length of 45 mt each and equipped with 4 doors per module on the east and west sides. They have skylights on the roof. The lighting is provided by 36 lamps . Each lamp has 400W of power.
The following photographic documentation was before of the works.

04 Port Warehouses Exteriors

05 Port Warehouses Interiors

As mentioned above, the interventions carried out, listed below, take place on the office building, the adjacent technical building and the port warehouses:

A) Completed works of insulation of the building envelope:

1. Elimination of the external air conditioning units fixed to the perimeter walls. Preparation of the prefabricated panel for subsequent processing;
2. Realization of external thermal coat with application of glass wool panel (thickness 20 and thickness 12 cm) on all facades. In gray color in several shades;
3. Replacement of external windows for windows including windows with PVC products with thermal break and glazing with triple glazing and double air chamber: n. 107 linear elements partly openable and n. 14 round elements partly openable;

B) Technological systems efficiency completed works:

1. Dismantling of the existing gas-fired boiler and all the equipment supplied inside the thermal power plant;
2. Dismantling of fan coils, radiators and air conditioning units located inside the service building;
3. Installation of the VRV system, consisting for winter and summer air conditioning. The system provides for the load distribution with two external condensing units for air conditioning with the respective power of 20 HP (56 kW in cooling and 63 kW in heating) and 14 HP (33.5 kW in cooling and 37.5 kW in heating) in order to guarantee greater flexibility of operation; the utilities consist of 38 VRV air units that produce heat in winter and cold in summer: the distribution network consists of copper pipes insulated anti-condensation with liquid consisting of inert gas. In addition, for heating the toilets were installed n. 7 electric radiators;
4. Installation of domestic hot water producer inside the technological plant consisting of a solar thermal system with 2,2 KW power, capacity 300 lt, with thermal panels installed on the roof of the external technical building;
5. Installation of the14.85 kW photovoltaic system consisting of 54 photovoltaic modules of 275 Wp each. The system has a inverter with a nominal power of 15.0 kW;
6. Replacement of discharge lamps, inside the modules, of no. 36 IP 65 lamps with LED lamps of 80 W and 11174 lumens.

06 Service Building exteriors

07 Inverter and external air conditioning units

08 Internal air conditioning units

09 Photovoltaic System

10 Thermical Central Boiler

11 Port warehouses Led illumination

3. Conclusions

From the results of the APE we can estimate the following annual energy needs for the conditioning of the building and for the production of domestic hot water thanks to the implementation of the geothermal study execution.

Type of use	Energy [kWh/year]	Type of primary energy	CO_2 emissions [5] [kg/year]
Summer cooling of the premises	30.500	Electricity from the grid	14.000
Winter heating of the premises	240.000	LPG	57.500
Production of domestic hot water	23.500	LPG	5.500
			77.000

[5] Conversion parameters from ENEA-GSE (2017) were used for the estimation of CO2 emissions. The following conversion ratios have been considered.

LPG => 0,24 kg of CO_2 emitted for every kWh of energy “deliverd”

Electricity from the grid => 0,46 kg of CO_2 emitted for every kWh of energy “delivered”

The following emission savings can reasonably be estimated, on the basis of the estimated energy requirements:

1 Heat pump powered by electricity + domestic hot water production with electrical systems CO2 Emissions : -45.000 kg/year

2 Heat pump powered by mains electricity + domestic hot water production with adequately sized solar thermal system CO2 Emissions: -56.000 kg/year

3 Heat pump combined with adequately sized photovoltaic system + production of domestic hot water with adequately sized solar thermal system CO2 Emissions: -77.000 kg/year

As regards the replacement of the port lighting system with LEDs and the refurbishment of the main port building to improve its energy efficiency, the energy savings and the reduction of CO_2, on an annual basis, as a result of the interventions carried out, can be highlighted in the following table:

Plant	Power Supply	total start cosumption MWh/year	Initial CO2 Emissions (CO2eq [t/year)	New plant design cosumption MWh/year	New CO2 emission from design (CO2eq expected [t/year)	Consumption decrease after works MWh/year	CO2 savings after works (CO2eq expected [t/year)
Sostitution of Port Warehouse lamps	electrical energy	189	117	139	86	50	31
Coat + windows (LPG) + Boiler (VDR) + solar thermal panels	LPG - electric	170	41	76	19	94	22
Building user/ Photovoltaic System	electrical energy	65	40	49	31	16	9
TOTAL		**424**	**199**	**264**	**136**	**160**	**62**

It should be emphasized that during the works phase, compared to what was initially planned and from TNA, it was necessary to provide for a downsizing of the photovoltaic system from 20 to 14.80 kW / peak and the limitation of the intervention of the replacement of the LED lamps of the warehouses to the first 3 modules compared to the 9 budgeted. This has led to a lower reduction in fuel consumption and emissions.