Unige OpenLab: Invito a conoscere le infrastrutture di ricerca del territorio

UNIVERSITÀ
DEGLI STUDI DI
GENOVA

Progetto Multi-Dominio per Smart Communities: Production, Energy Harvesting, Mobility & Security

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UNIVERSITÀ DEGLI STUDI DI GENOVA

Sistemi di monitoraggio applicati agli impianti di climatizzazione a pompa di calore geotermica:

l'edificio SEB presso il Campus di Savona

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The Smart Energy Building (SEB) was designed by the University of Genoa to be an innovative and high performance building to meet goals of zero carbon emissions, energy and water efficiency and building automation.

The building, in operation since February 2017 at Savona Campus, has two floors covering a total area of 1000 m^2.

http://www.energia2020.unige.it/home/

The peculiarity of this Zero *Emissions* Building is the real-time interaction with the Smart Polygeneration Microgrid (SPM), the intelligent Microgrid that provides electrical and thermal energy to the Campus loads.

This connection allows the SEB to be an "Energy Prosumer", which is able to produce energy (thermal and electrical) for its own and, in case of need, to recall energy from the SPM.

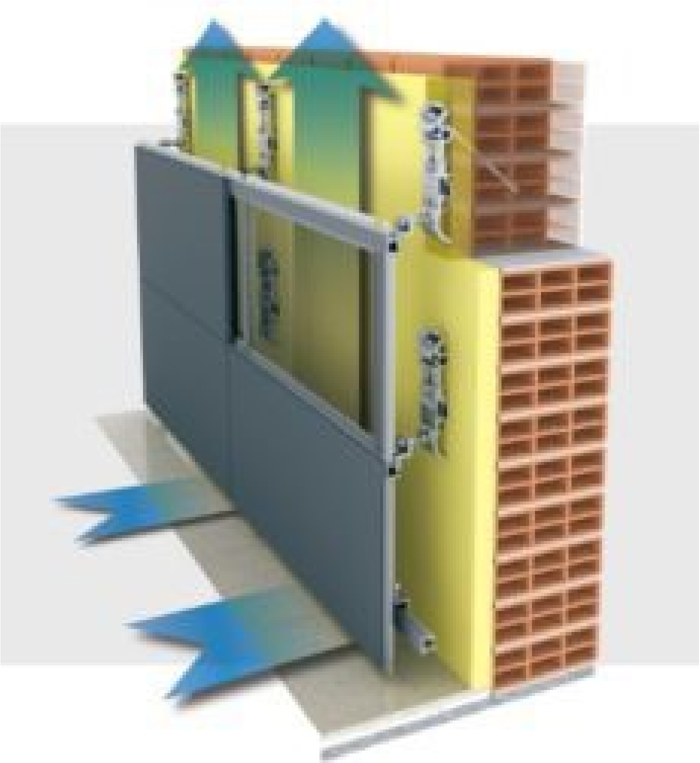
The SEB acts as a Living Lab with monitoring in real-time, allowing research and investigation of current and future sustainable energy technologies.

In particular, SEB is characterized by the presence of:

- **High performance envelope**:

  ✓ *High thermal insulation materials* (environmental friendly materials, with high percentage of recycled components).

  ✓ *Ventilated facades*, realized using panels mounted on a suitable structure and separated from the external wall of the building by an air gap. The air gap increases the level of insulation, reducing both the heating and cooling loads, and the upward movement of air in the gap (chimney effect due to natural ventilation) helps removing moisture thus guaranteeing a high level of comfort in the building.

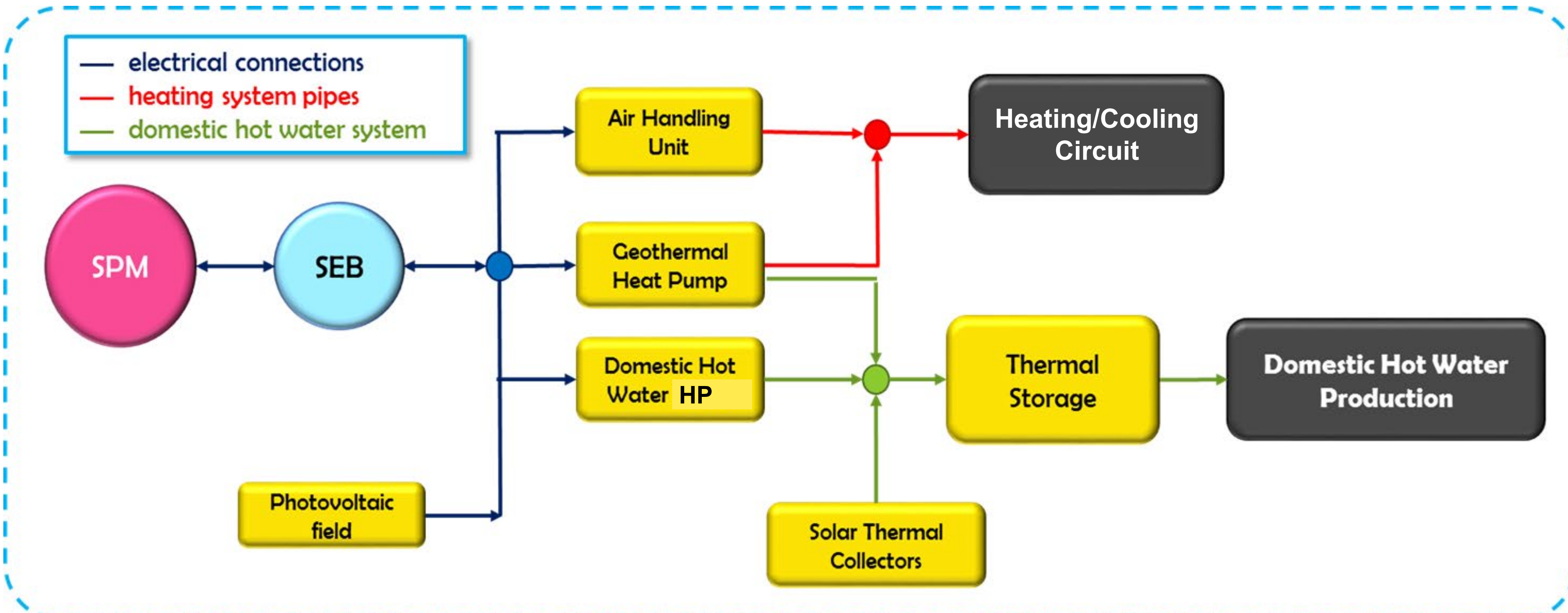
  ✓ *Low-ε double-pane windows*.

- A **thermal system** composed by:

  ✓ *A controlled mechanical ventilation system* (air handling unit)
  ✓ *A geothermal heat pump feeding radiators and fancoils*

- **Domestic Hot Water (DHW)** production:

  ✓ *Air source heat pump*, (rated thermal power of 11.5 kW and COP= 3.4).
  ✓ *Solar thermal collectors on the roof*, with total surface of 3.84 m^2.

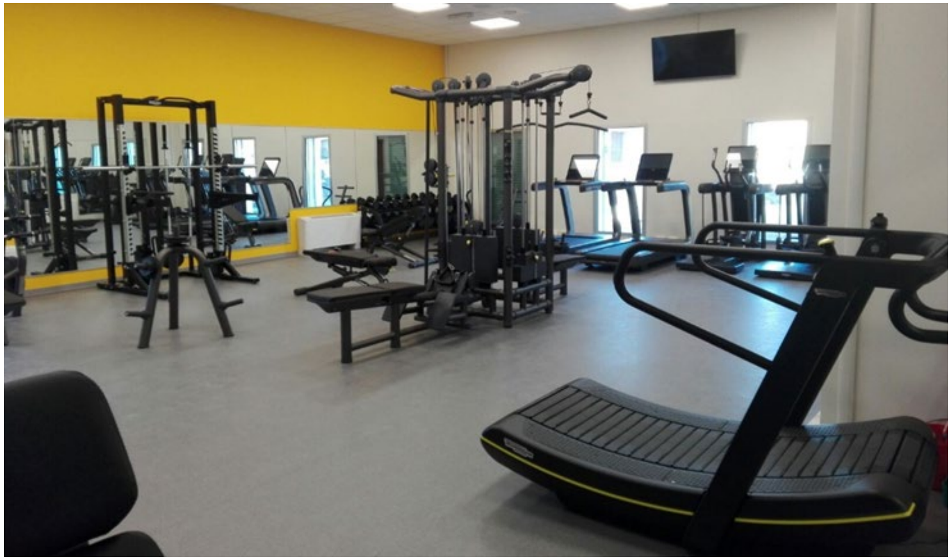


- A **photovoltaic field** on the roof (85 modules are used, covering an area of about 140 m^2), with a peak power of about 22 kW.

- Extremely low consumption **led lamps** (high luminous efficiency, 106 lm/W).

- A **rainwater collection system**, used for toilet flushing and for garden irrigation.

- A **technological gym**, with sport equipment are able to produce electricity thanks to the “human movement”.



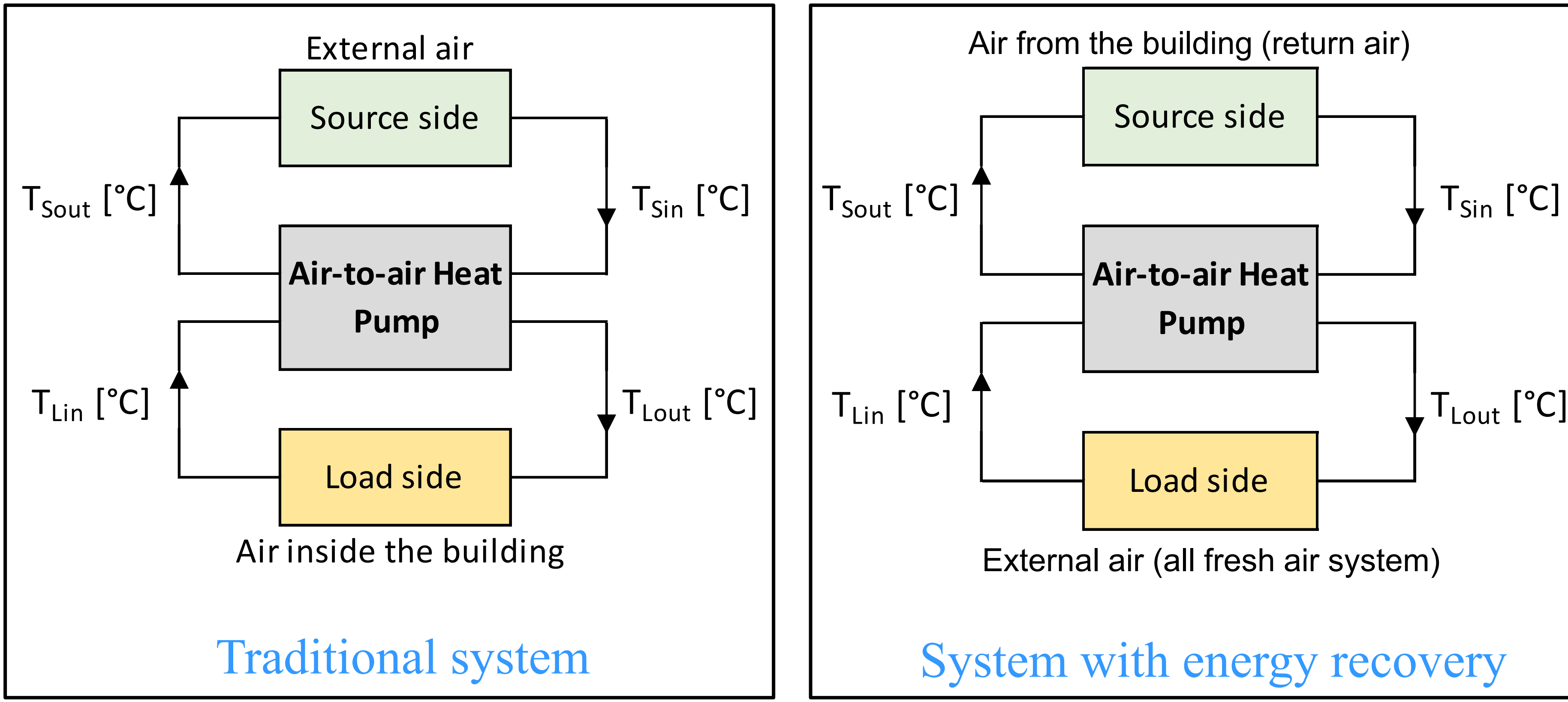
The air handling unit (AHU) with an air-to-air heat pump

The Smart Energy Building is equipped with an air handling unit (AHU), installed on the roof, which performs functions such as circulating, cleaning and potentially humidifying the air of the building.

The AHU, a Clivet Zephir3 CPAN-XHE3, is a complete packaged primary air supply system with thermodynamic energy recovery.

The AHU is characterized by a standard air flow of 4600 m^3/h, a nominal heating power of ≈25 kW and a nominal cooling power of ≈ 40 kW.

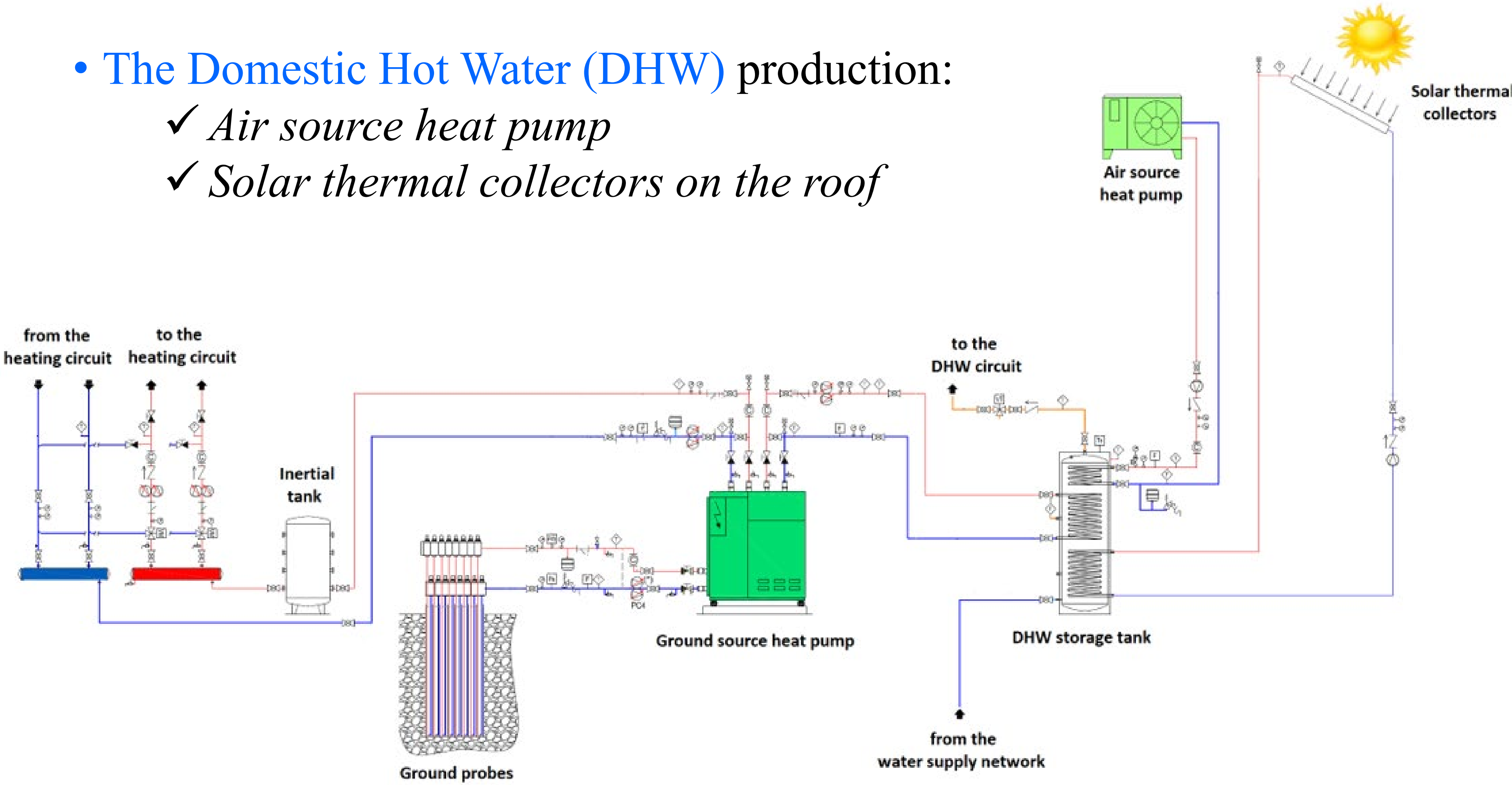
Thermodynamic energy recovery



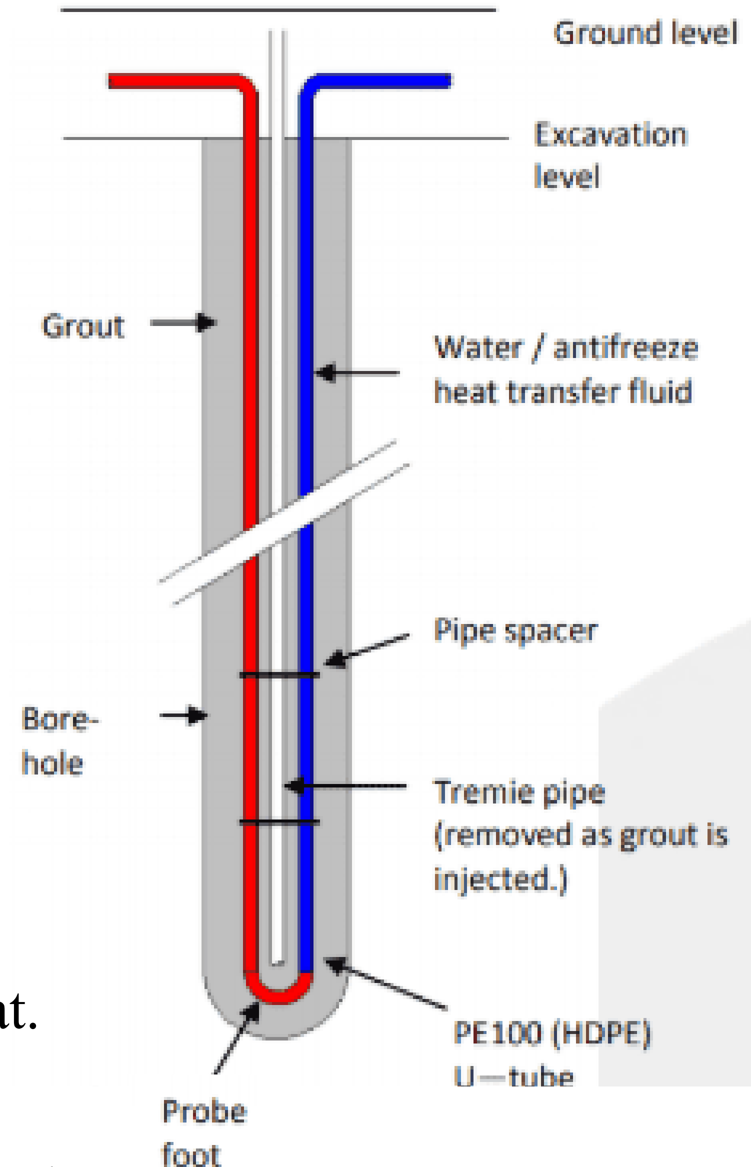
The water systems of the Smart Energy Building

The main devices that constitute this thermal system are:

- The water-to-water ground coupled heat pump (GCHP) that feeds fancoils and radiators
- The Domestic Hot Water (DHW) production:
  - ✓ *Air source heat pump*
  - ✓ *Solar thermal collectors on the roof*



The ground coupled heat pumps (GCHPs)



For the plant, the ground represents the source side of the HP from/to which extract/reject heat.

The HP is coupled with a system of Borehole Heat Exchangers (BHEs), buried into the ground, with proper length and arranged in a suitable configuration.

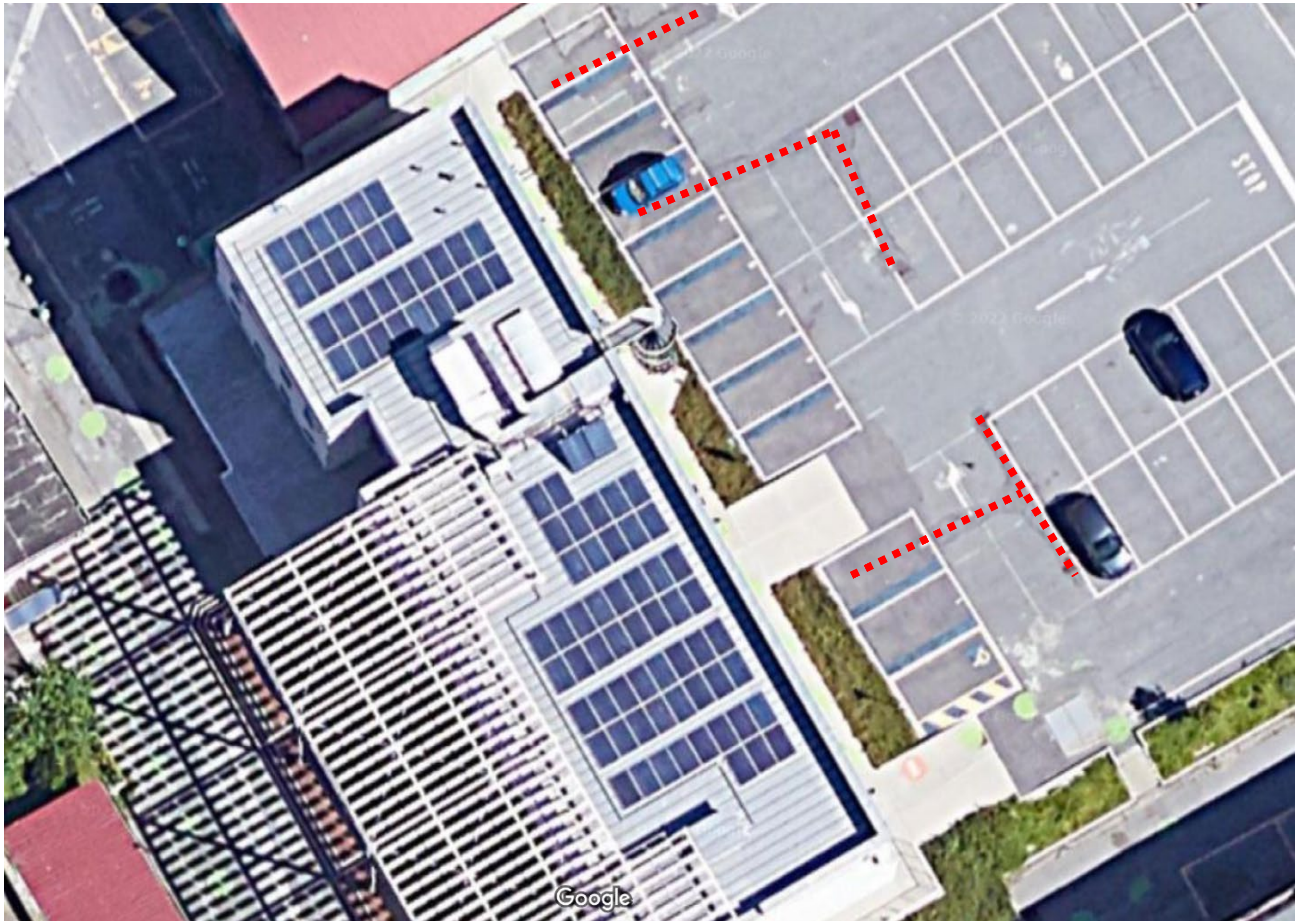
The geothermal system of the SEB

The ground is characterized by a nearly constant temperature during the year. Thus, the efficiency of the GCHP is higher if compared to traditional systems.

The GCHP plant installed in the Smart Energy Building is characterized by a close-loop vertical configuration.

8 borehole heat exchangers (BHEs) are buried about 120 m deep in the soil.

The BHE field of the SEB geothermal plant



The ground thermal response depends on the geometry of the BHE field and it is taken into account by means of a proper *g*-function.

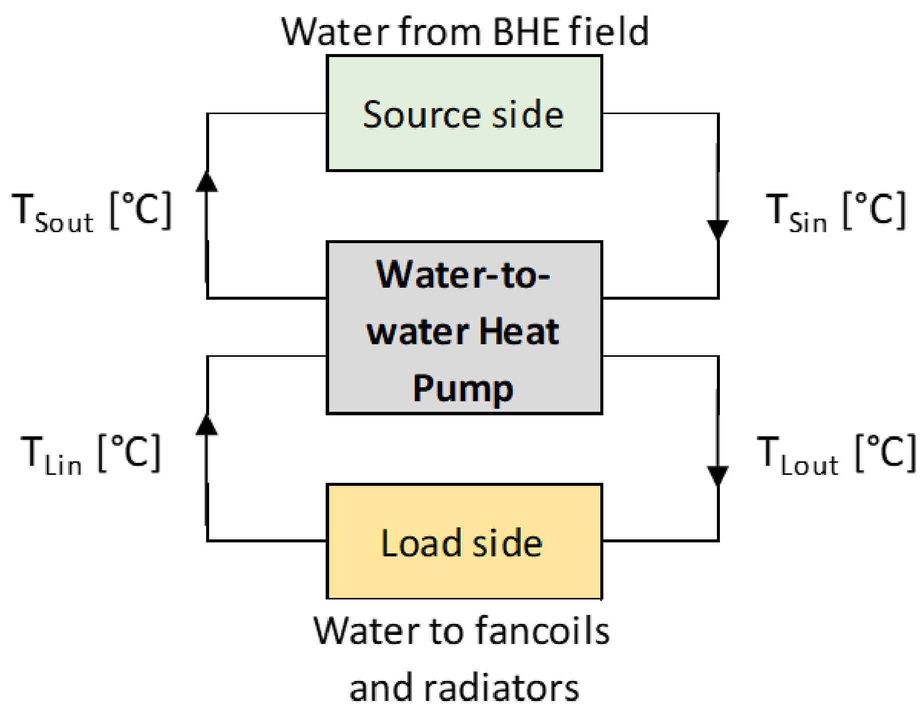
The ground thermal response greatly influences the performance of the HP.

The ground coupled heat pump (GCHP) of the SEB

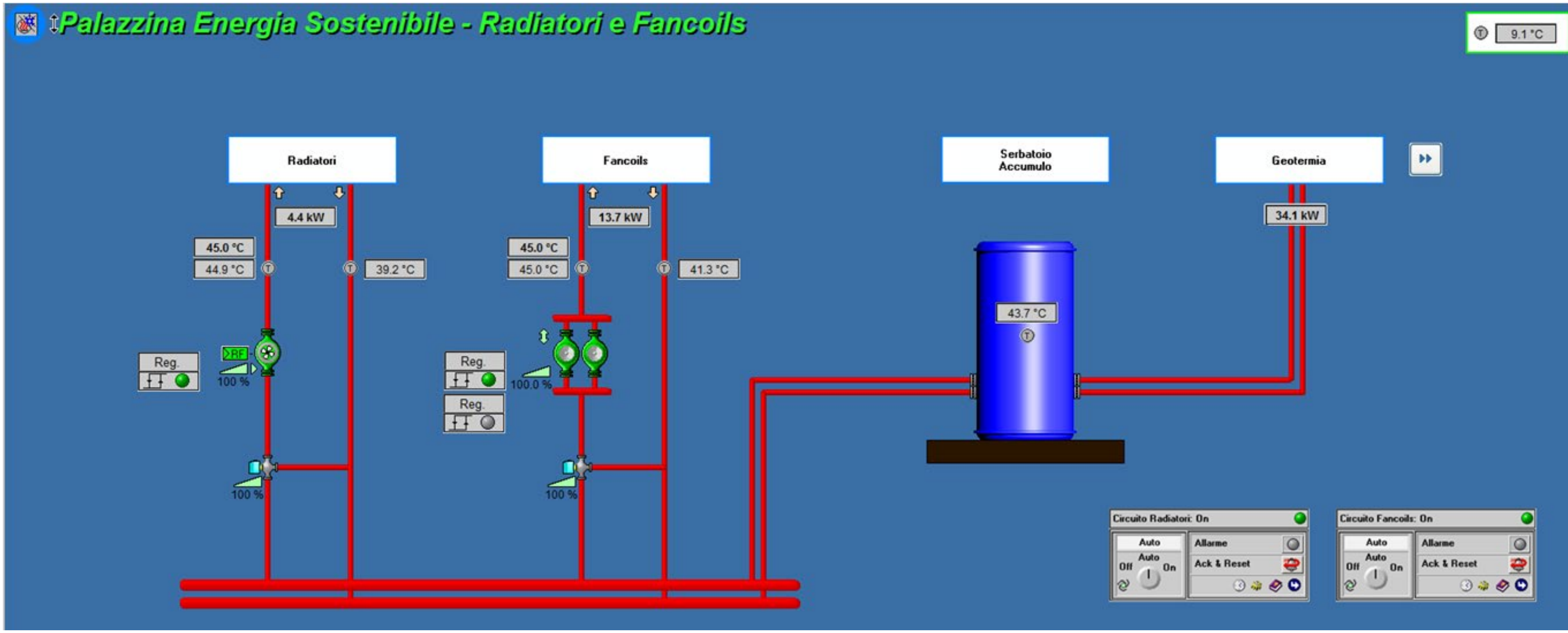
The geothermal heat pump is a Clivet WSHN-XEE2 MF 14.2.

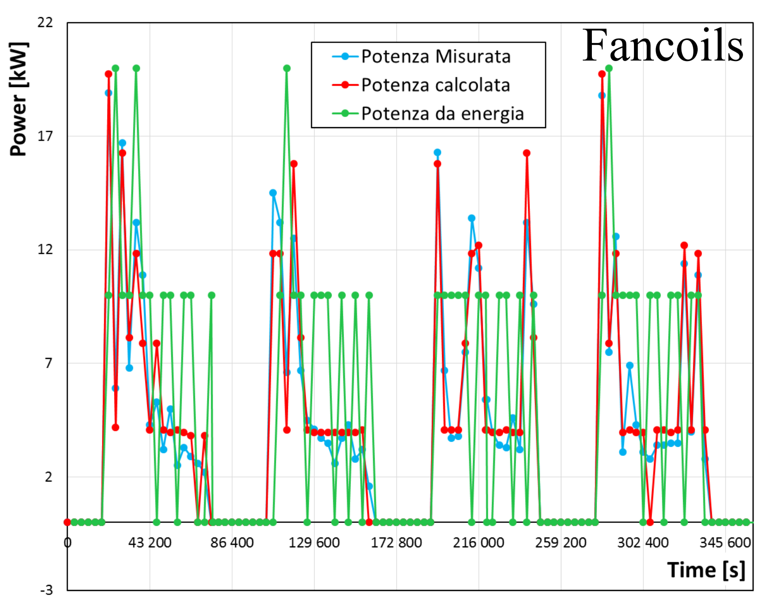
It has a rated heating power equal to 48 kW and a COP in heating at full load equal to 4.49 (reference conditions user side water 40/45°C, source side water 10/7°C).
The rated cooling power is equal to 40.7 kW and the EER in cooling at full load equal to 4.17 (reference conditions user side water 12/7°C, source side water 30/35°C).

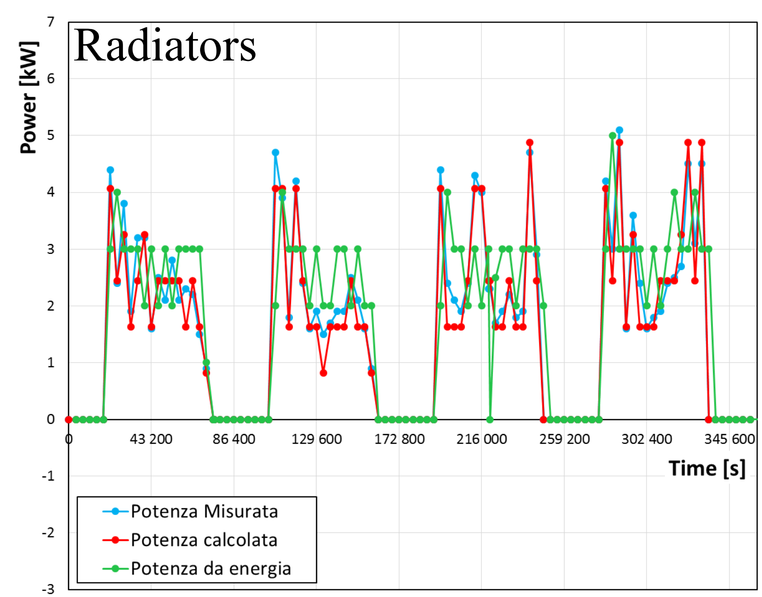
The hot water from the geothermal heat pump is transferred to an inertial tank (having a volume of 500 liters) and to the collector that feeds the heating circuit (composed of a pipeline network and several two-pipe fan-coils and radiators).



SEB monitoring in real-time



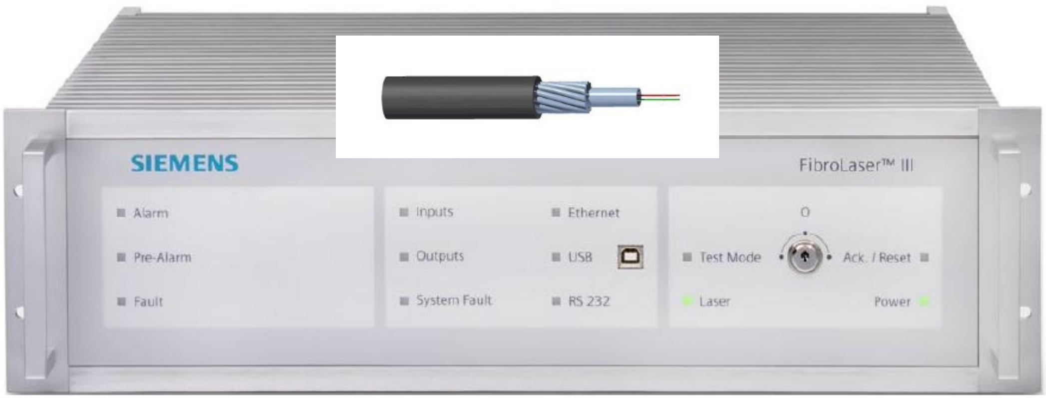




The BHE field monitoring

Two BHEs of the SEB field are equipped, since the installation, with some sensor cables of an optical fiber system. Sensor cables are a cheap measurement tool but they request a devoted expensive reading system, the FibroLaser.

The FibroLaser is based on a laser beam being sent through a fiber-optic cable that scatters a small part of the laser radiation at any point, back to the source. The backscatter is measured by the controller and allows the estimation of the real-time temperature in defined points of the fiber-optic cable.

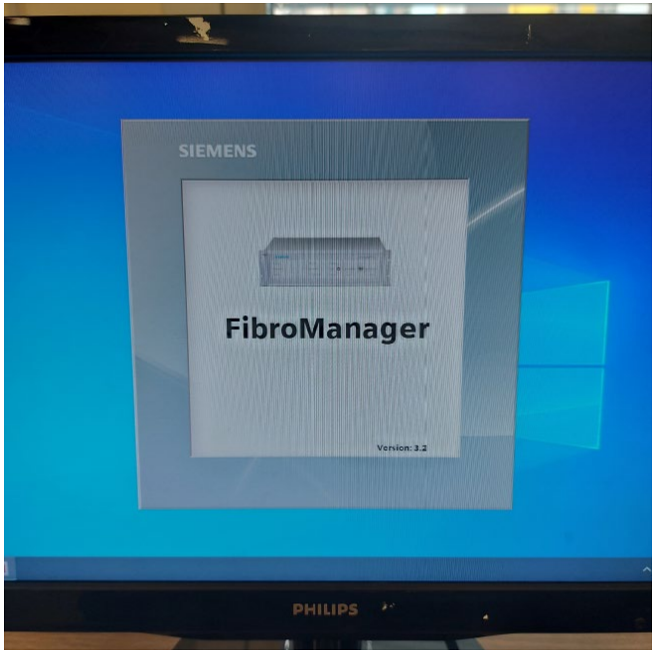


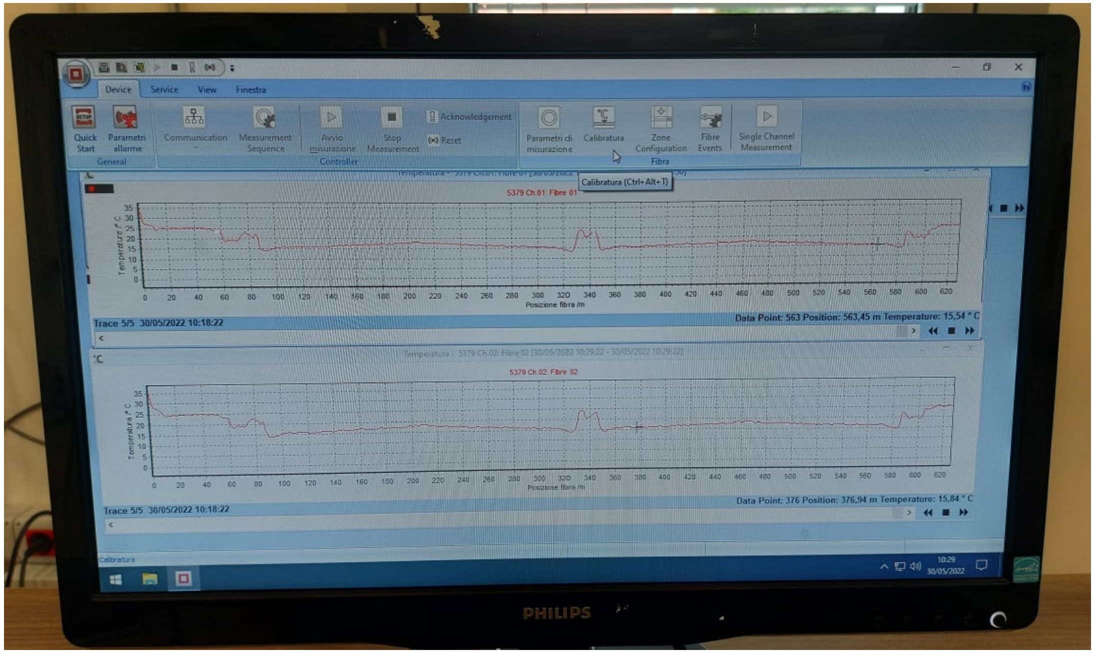
Siemens- SwitchController
OTS3001S-SC 115/230VAC

The distributed temperature measurement along the BHEs

The distributed temperature measurement along the BHEs allows the continuous monitoring of the BHE field performance and the variations of efficiency in the long period.

In addition, the analysis of time-dependant profiles of temperature allows to detect potential failures of the plant and to identify geothermal and hydrological changes over time.





Thanks for the attention!

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