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RES4LIVE
ENERGY SMART LIVESTOCK FARMING
TOWARDS ZERO FOSSIL FUEL CONSUMPTION

A Renewable Energy Based Solution for Heating Livestock Buildings: Design and Realization of a Case Study

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This research was funded by the European Commission, within the Horizon 2020 program for the Innovation Action project RES4LIVE “Energy Smart Livestock Farming towards Zero Fossil Fuel Consumption”, running in the period 2020-2024, Grant agreement ID: 101000785, DOI 10.3030/101000785

Introduction

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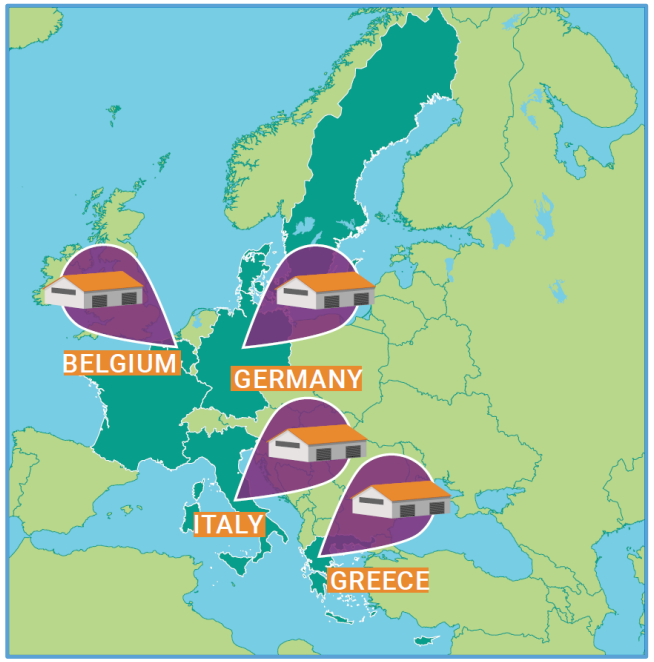
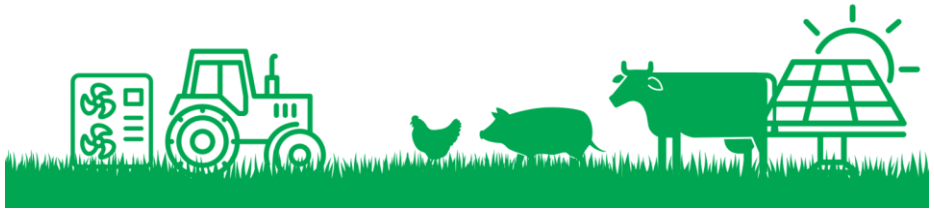
- The study was developed within the project RES4LIVE
  "Energy Smart Livestock Farming towards Zero Fossil Fuel Consumption" (H2020, IA, 2020-2024
- Sustainable livestock production and de-fossilising energy needs in husbandry facilities emerge as crucial aspects
- 4 pilot farms





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Pilot case

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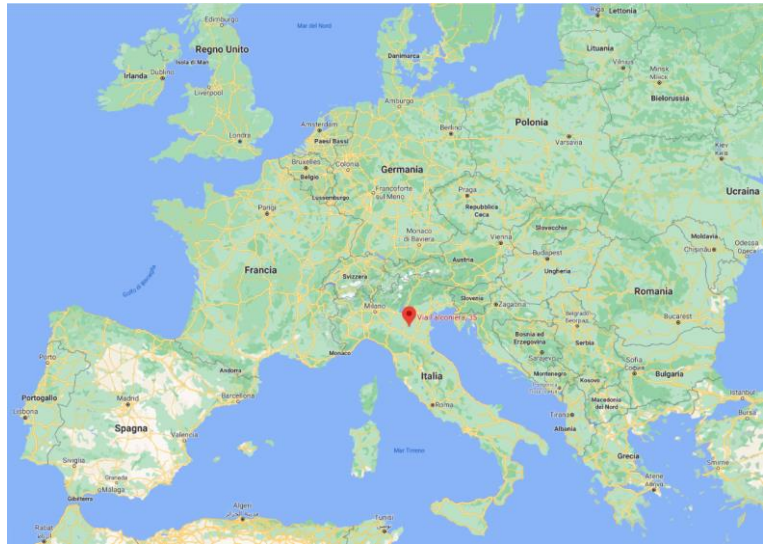
- Farrow-to-Nursery Swine Farm
- 500 sows, 2500 weaners
- De-fossilization of nursery barn

GOLINELLI
AZIENDA AGRICOLA



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Objectives

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- Development and installation of an integrated RES system combining
  - a photovoltaic-thermal plant,
  - a geothermal storage, and
  - a modular heat pump.
- Smart control system for environment monitoring and energy management
- Smart control system to monitor underground temperatures

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Integrated RES system

- 35 kW medium temperature heat pump,
- 8 kW PVT system with a solar station, to provide electricity for the heat pump operation and the electric needs of the nursery barn, and thermal energy
- Borehole Thermal Energy Storage (BTES) system that exploits both solar thermal energy and underground heat capacity to increase the heat pump efficiency by storing the excess heat from PVT, and
- Smart control system.

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Smart monitoring system

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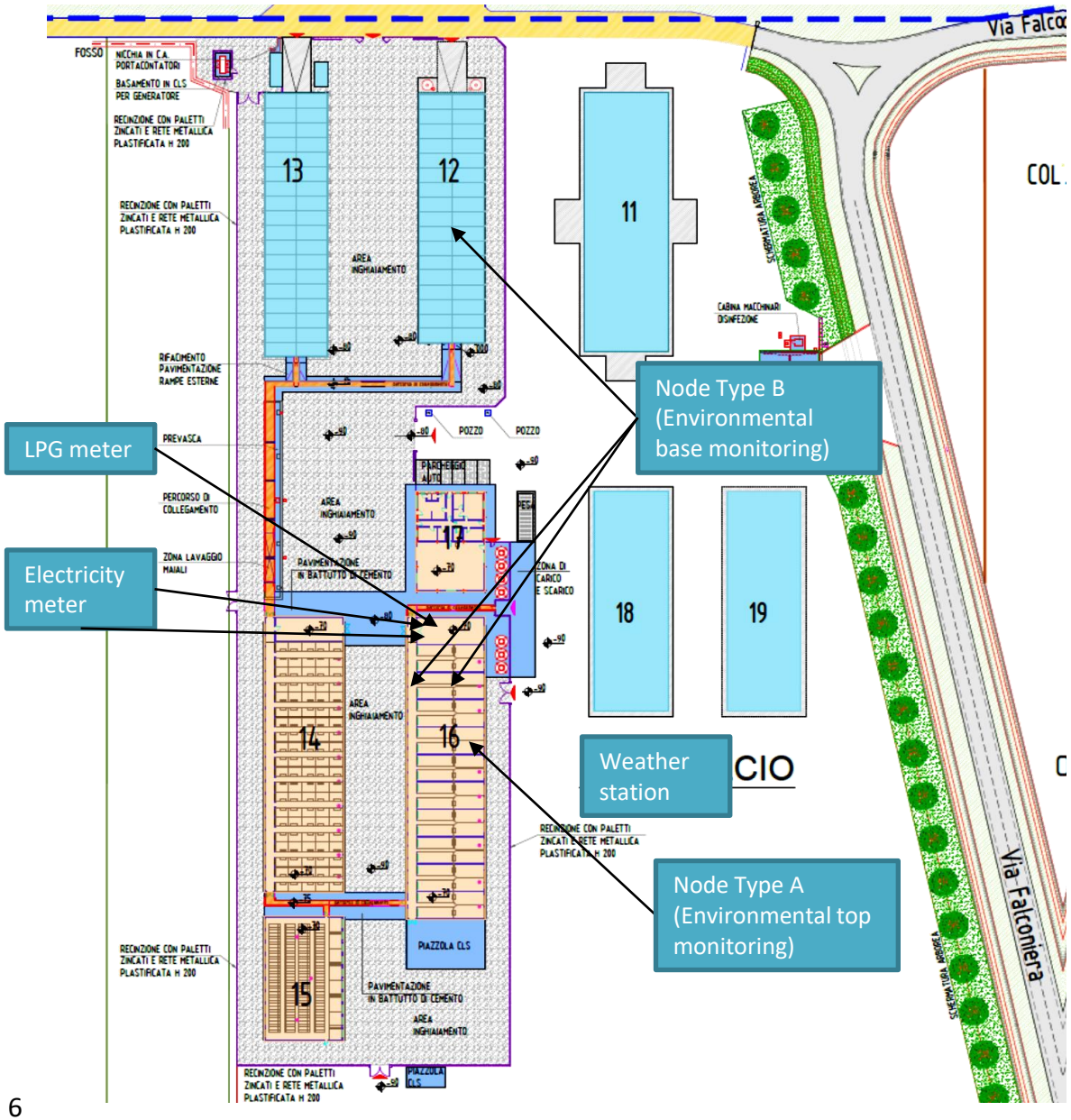
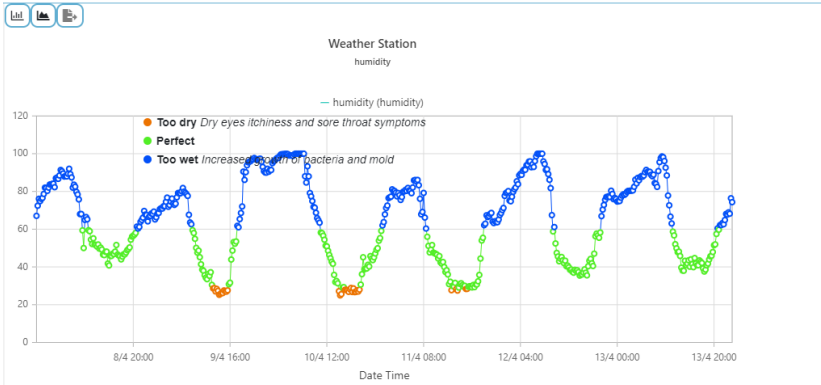
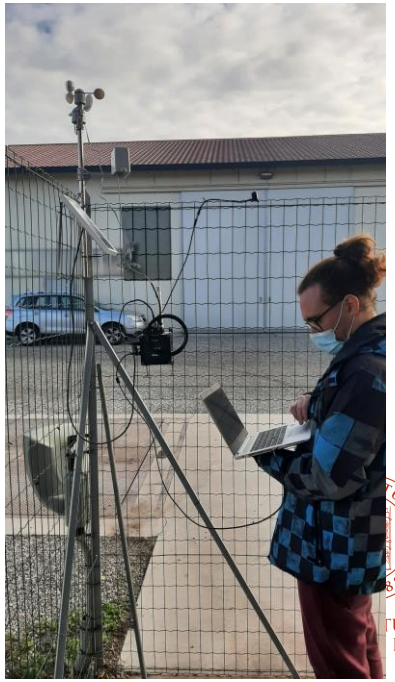




Compared with: 04/04/2022 - 07/04/2022

Device Name	Total	Average	Min	Max
Weather Station humidity	36690.7 +64.9 %	63.7 -9.5 %	24.9 -75.1 %	100 +0.5 %



Preliminary design - Energy loads

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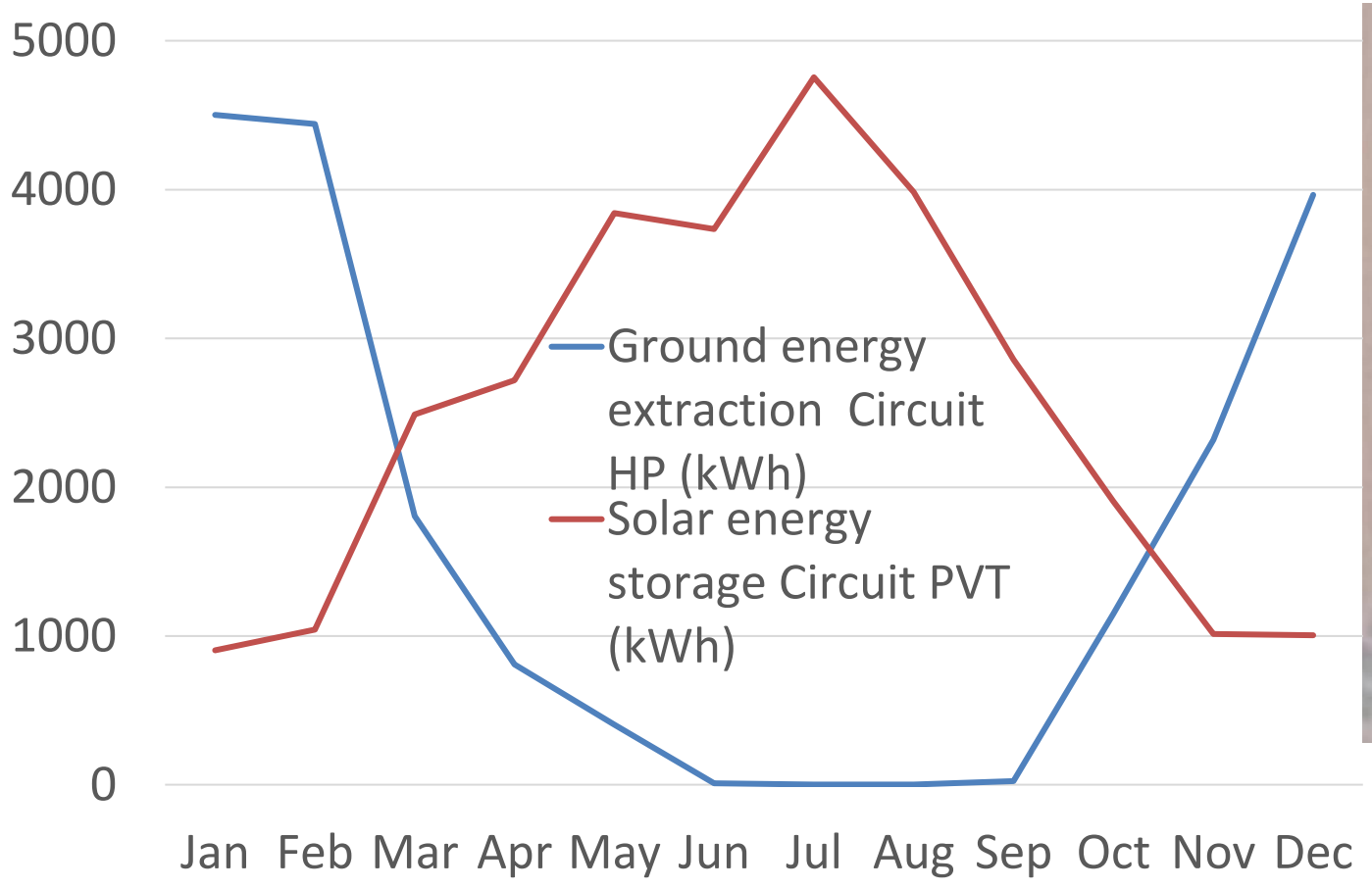

- 8 Boreholes 30 m
- 2 pezometers

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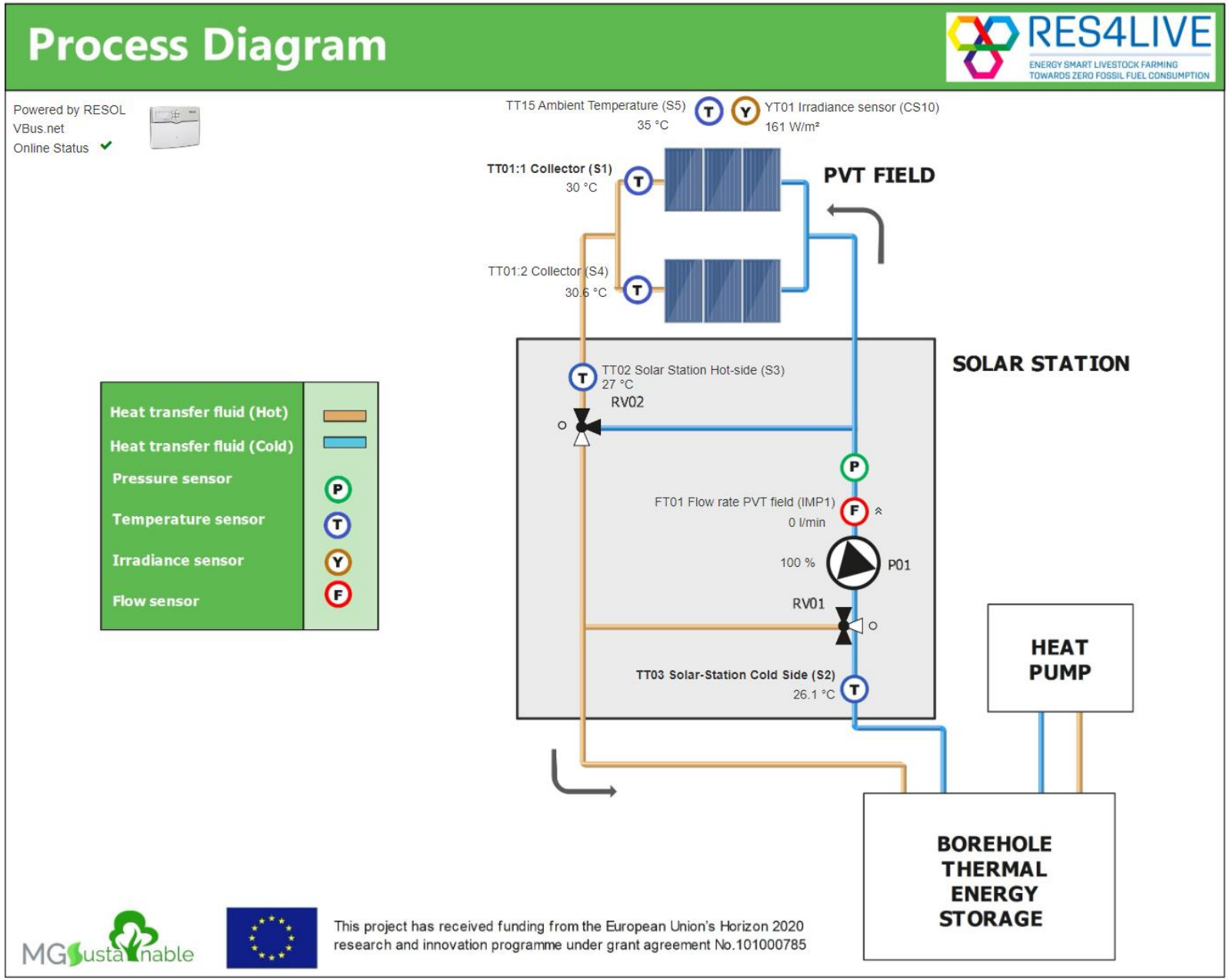
Installation of geothermal storage: 8 boreholes with double U pipes, 30 m deep

- The area is fully accessible again
- The connections can be inspected
- Works by Golinelli
- UNIBO keeps on measuring underground T, every m down to 25m

4 inlets and 4 oultets per each of the 2 collectors

System monitoring

Circulation of the vector fluid (water and propylene glycol) among PVT and BTES controlled by solar station through RESOL VBus



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Energy data analysis: numerical modelling

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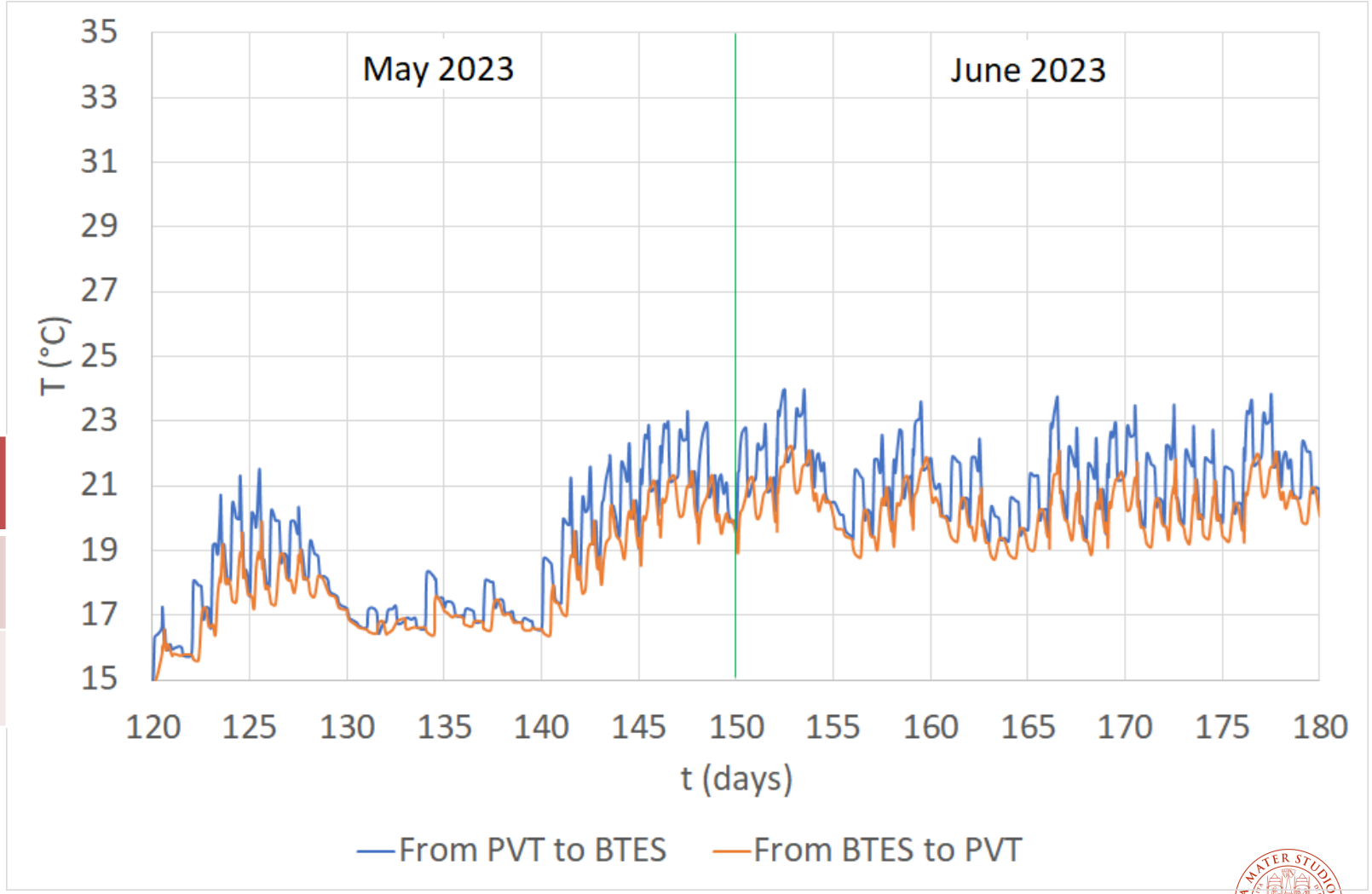
- Numerical temperature curves of the whole BHE array, in injection mode
- Based on energy data measured

Month	Energy (kWh)
May	1807.23
June	2220.27



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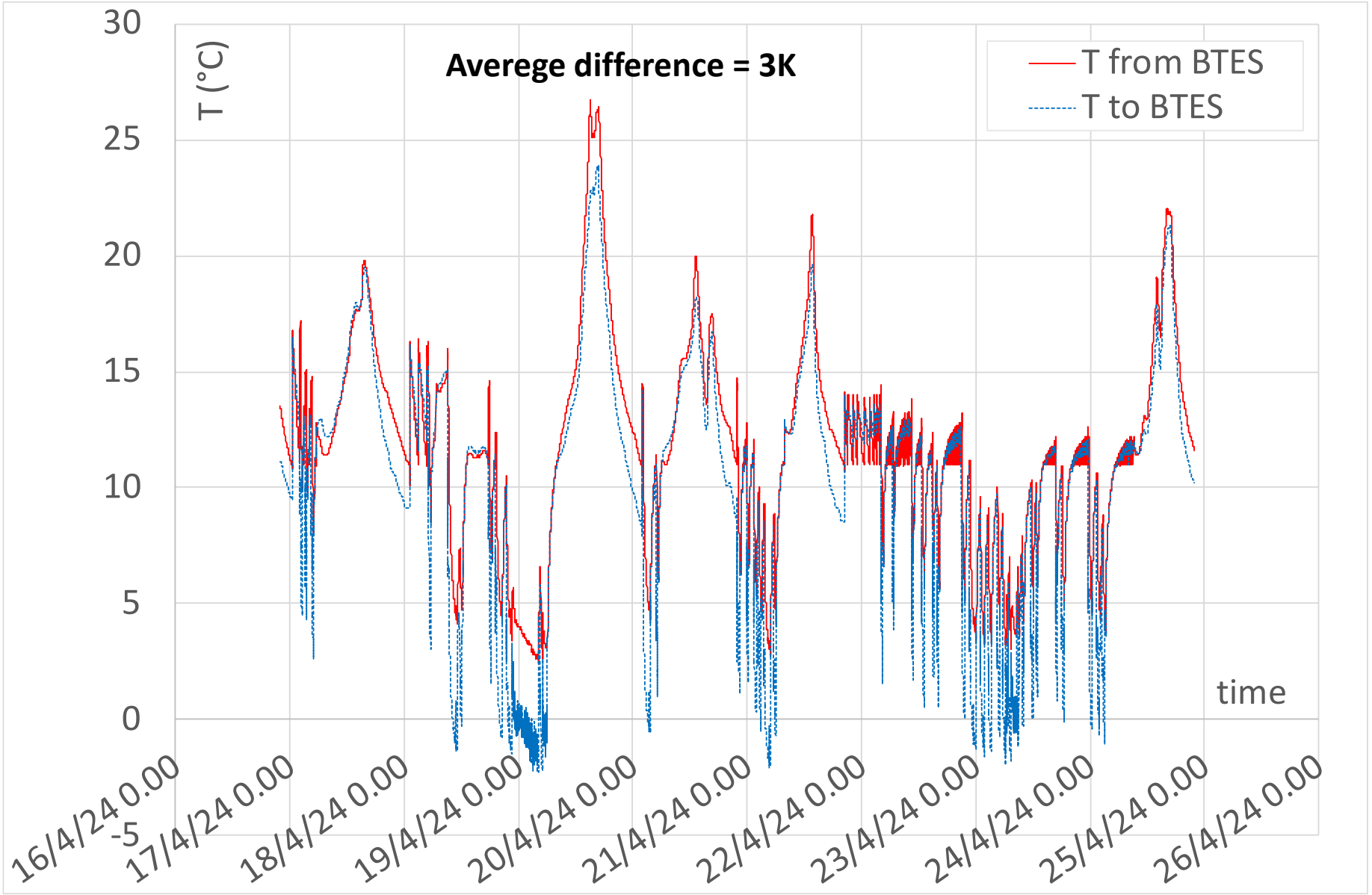
Energy analysis: measured data



Measurement of boreholes temperature

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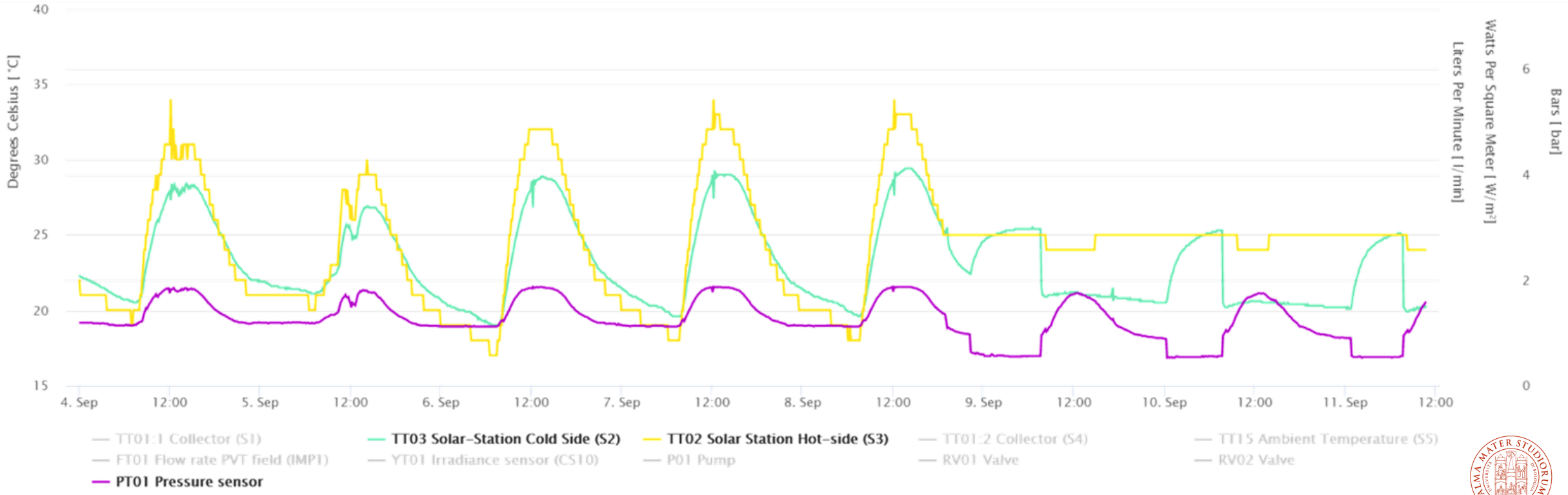
- Average Temperature in 30m borehole in March 2023: 15.9°C (before installation)
- Average Temperature in 30m boreholes on 10 Sep 2023: 20.5 °C
- Increase in TC temperature due to solar heat injection from May to August 2023: 4.6°C



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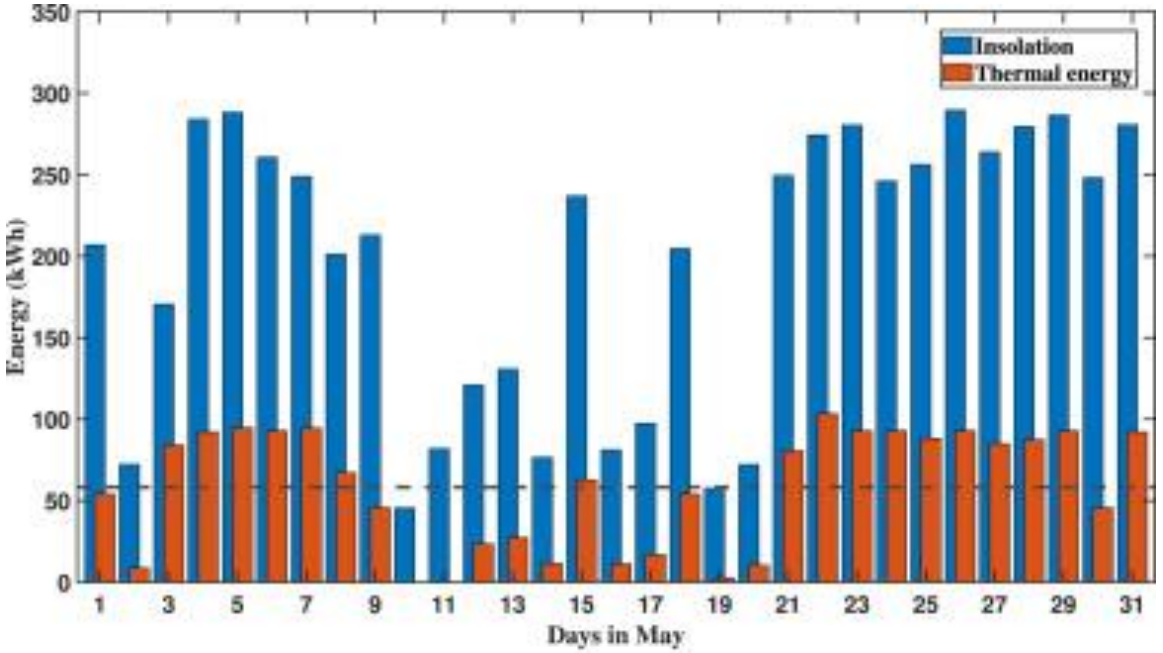
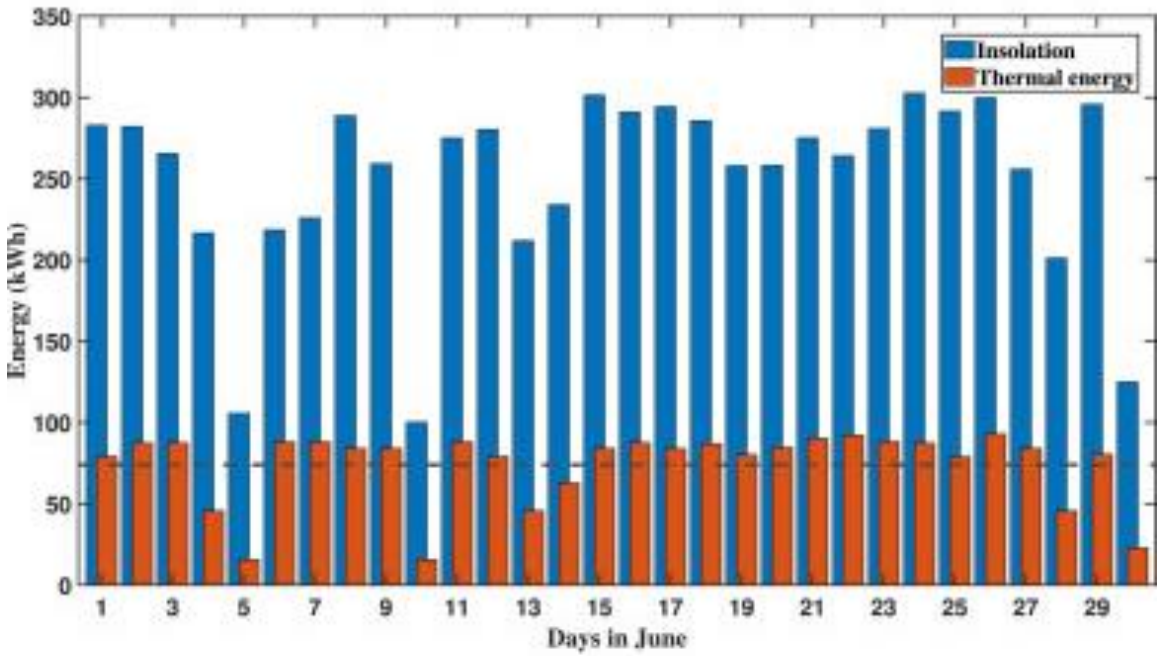
Energy production

Thermal energy produced 1807 kWh



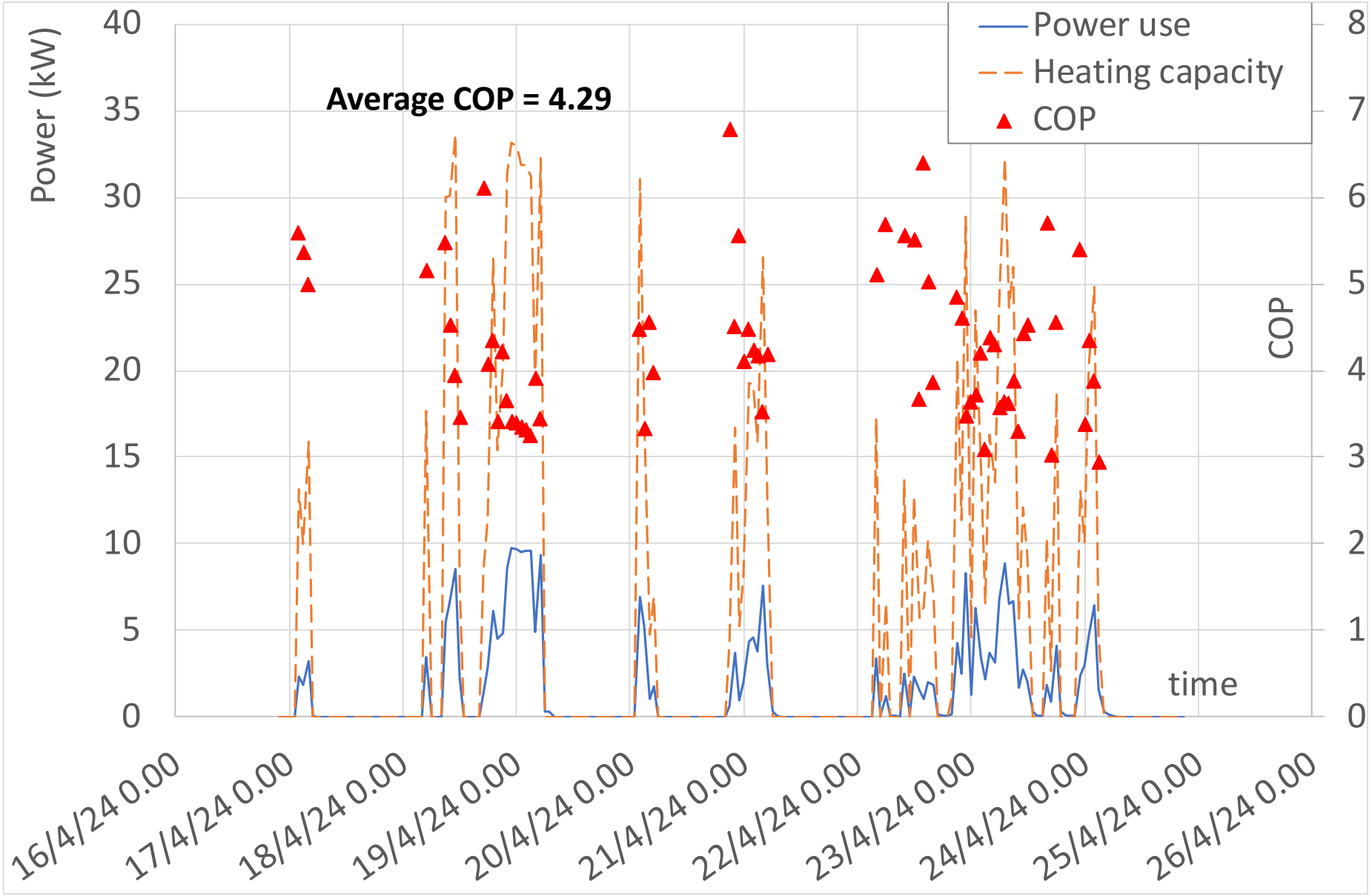
Thermal energy produced 2220 kWh



Thermal energy production and insolation during (a) May and (b) June.

(Thick dashed lines correspond to the average thermal energy production in each month.)

System performance



Conclusions

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- An integrated system with PVT, Borehole Thermal Energy Storage (BTES) and Dual Source Heat Pump (DSHP) was designed and installed; under monitoring.
- Underground areas of farmyards can be effectively exploited to install BTES, to store excessive heat produced by RES system, such PVT or biogas.
- A mix of RES can be specifically designed for a livestock farm, to exploit the renewable resources available.
- An effective solution requires monitoring the temperatures of the components, and environmental parameters outdoor and indoor.
- Data about energy usages were analyzed to assess efficiency. Smart monitoring systems have been developed.
- Databases created and fed by the systems; data processing ongoing.

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