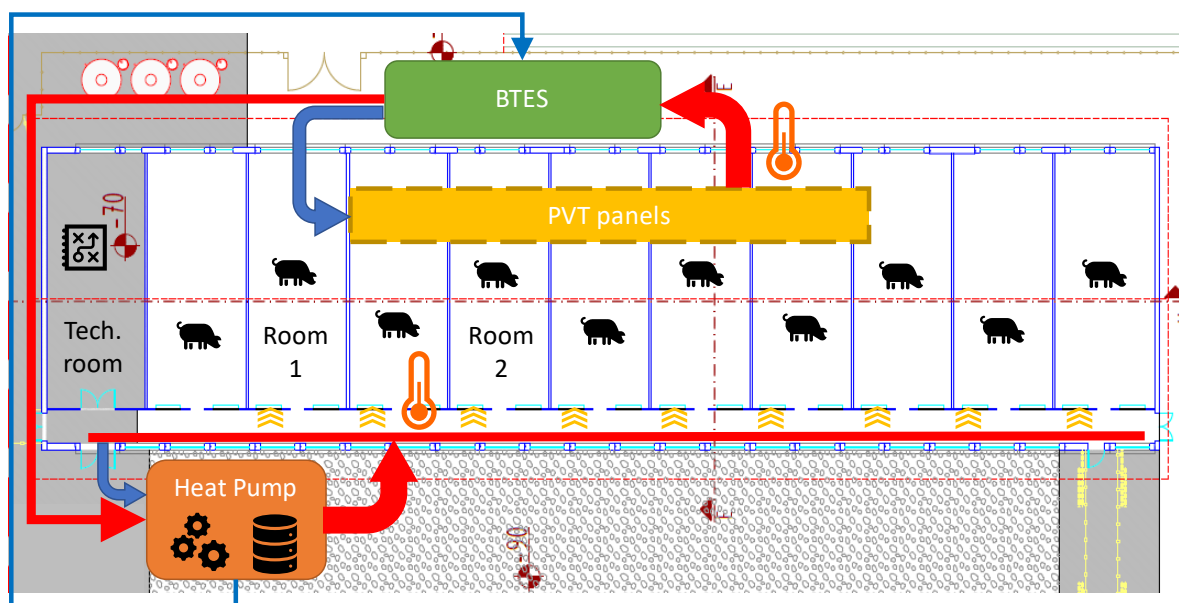


## An integrated renewable energy system for the decarbonization of swine farms

A sustainable heating system was developed for pig barns as an alternative to fossil-fuel-based ones. It consists specifically in an integrated Renewable Energy Source (RES) system incorporating a borehole thermal energy storage (BTES) and photovoltaic thermal (PVT) collectors, integrated with a Dual-Source Heat Pump (DSHP).



A sophisticated control system was developed and implemented to monitor energy usage and environmental conditions. The results of pilot installation and experimental trials showed that a tailored mix of RES can be effectively established for a given livestock farm, leveraging the renewable resources prevalent in farming environments.



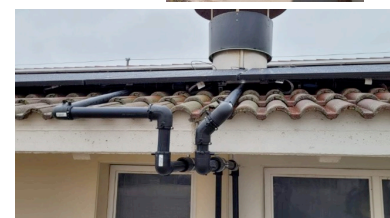
The heating load provided by the geothermal heat pump can rise the temperature of the radiant pipes up to 55°C, i.e. the operating temperature targeted with the previous fossil-based plant. The fundamental system architecture incorporates a dual-source heat pump featuring not only an air-cooled evaporator but also a heat exchanger for transferring heat with a water/glycol blend sourced from a sequence of PVT collectors connected to boreholes. The primary novelty of the system resides in its capability for hybrid operation, enabling simultaneous utilization of both ground-sourced and air-sourced heat, resulting in increased heating capacity and COP efficiency.





### Integrated RES system

- 35 kW medium temperature heat pump;
- A PVT system with a solar station, to provide electricity for the heat pump operation and the electric needs of the nursery barn with its 8 kW<sub>el</sub> electrical output, as well as thermal energy with its thermal output of 25 kW<sub>th</sub>;
- 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;
- Smart control system.



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