



RES4LIVE

ENERGY SMART LIVESTOCK FARMING
TOWARDS ZERO FOSSIL FUEL CONSUMPTION

The effect of renewable energy transition on the thermal comfort in a pig farm Animal compartment level experimental investigation

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ILVO pig farm (Melle, Belgium)
Farrow to finish - 105 sows, 600 piglets, 750 fattening pigs



Renewable energy transition at the ILVO pig farm

- Gas boiler with 220 MWh per year consumption

Type something

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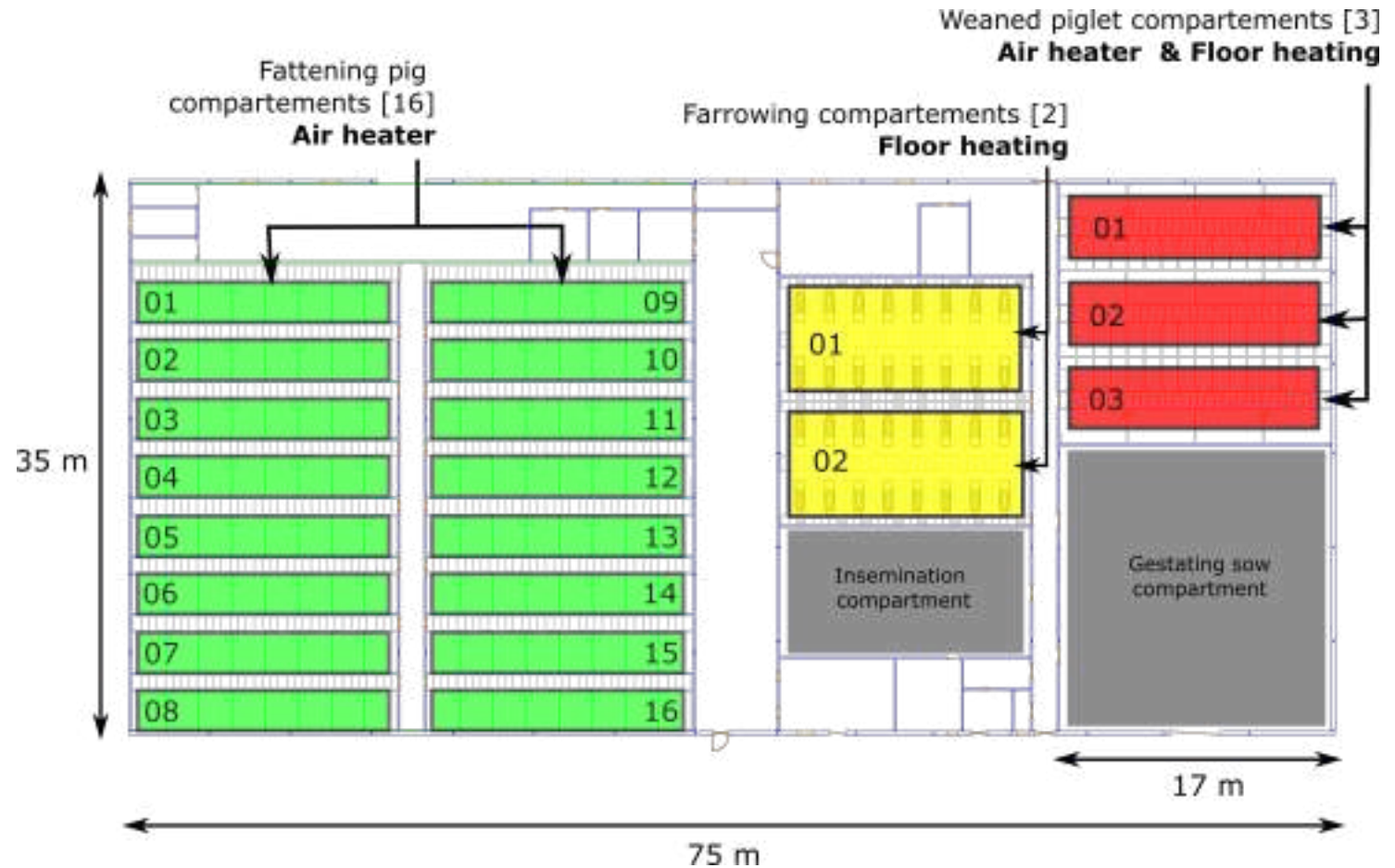
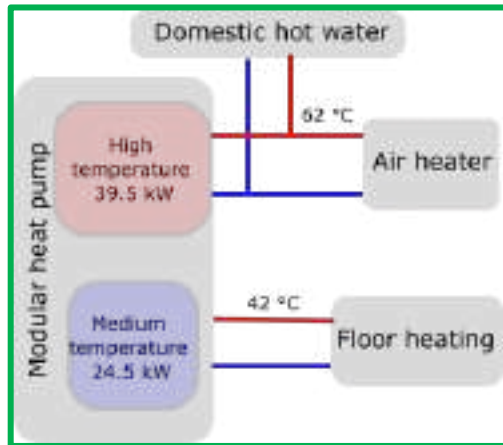
- Two modular heat pumps (24.5 kW and 39.5 kW)



Heating of the pig farm with renewable energy sources



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Environmental measurement sensors & systems



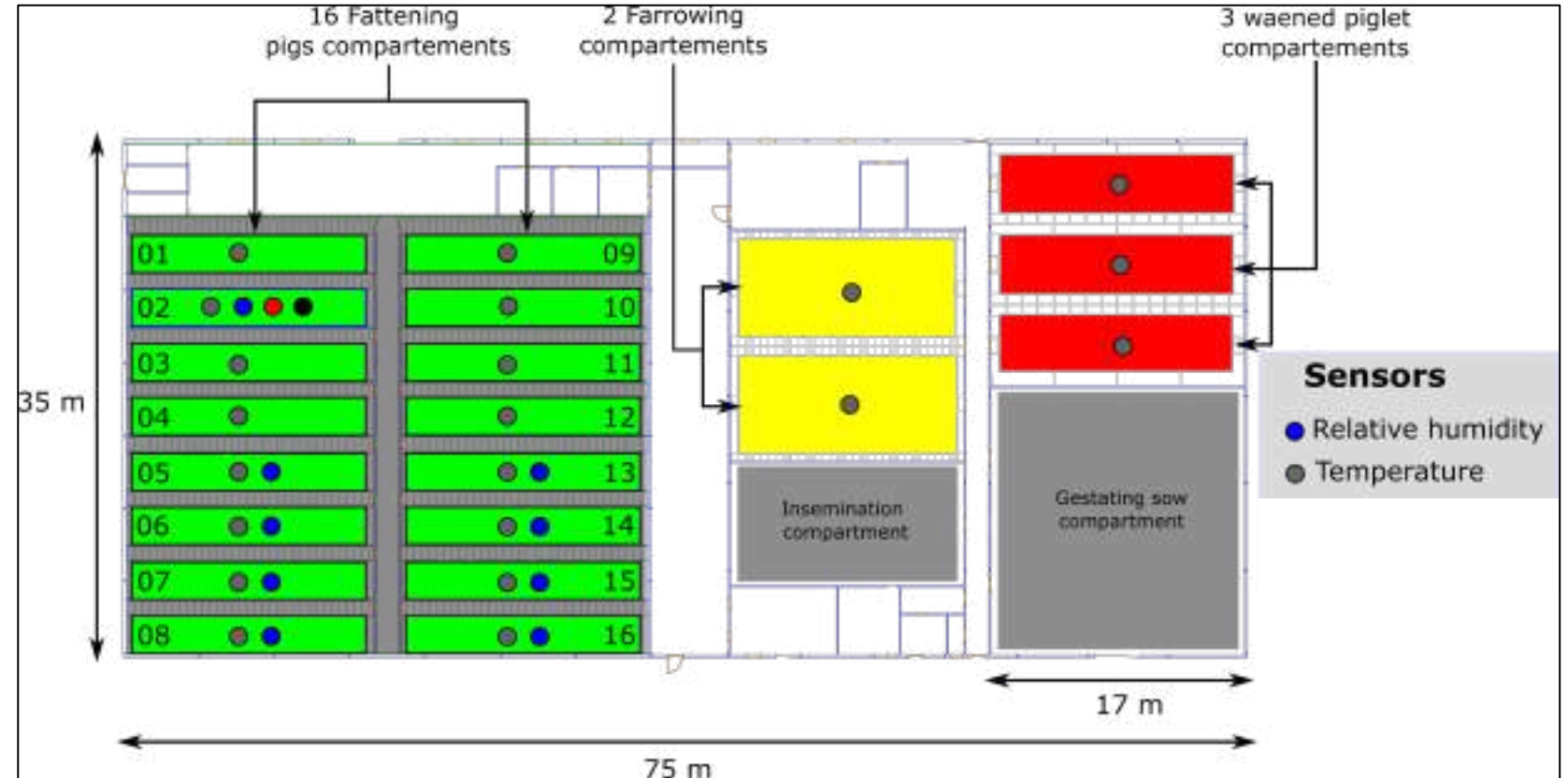
Temperature sensors [22]

- Pt1000



RH-Sensor [9]

- $\pm 2\%$



Data analysis

- **Trial periods**
 - Gas boiler (7th May – 7th August 2023)
 - Heat pump (7th May – 7th August 2024)
- **Temperature, relative humidity, ambient temperature, every 10 min**
- **The data from the RH and T sensors were used to calculate the Temperature-Humidity Index (*THI*)**

Type something

$$THI = 0.72 * (T_{db} + T_{wb}) + 40.6$$

$$T_{wb} = T_{db} * \tan^{-1}(0.152 * (RH + 8.314)^{0.5}) + \tan^{-1}(T_{db} + RH) - \tan^{-1}(RH - 1.68) + 0.0039 * RH^{1.5} * \tan^{-1}(0.0231 * RH) - 4.686$$

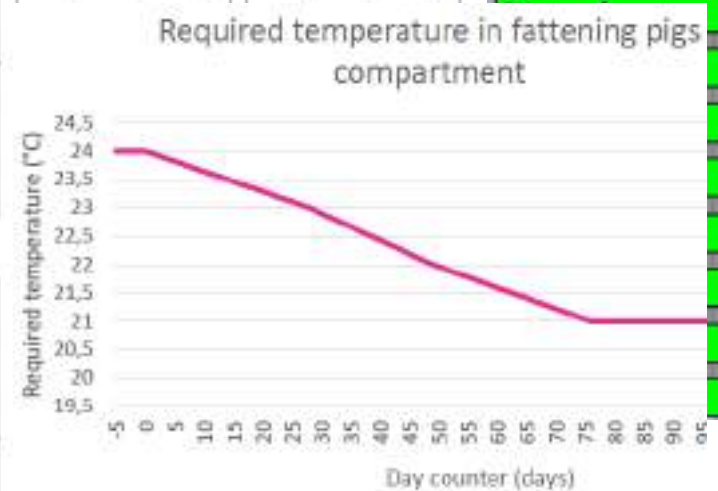
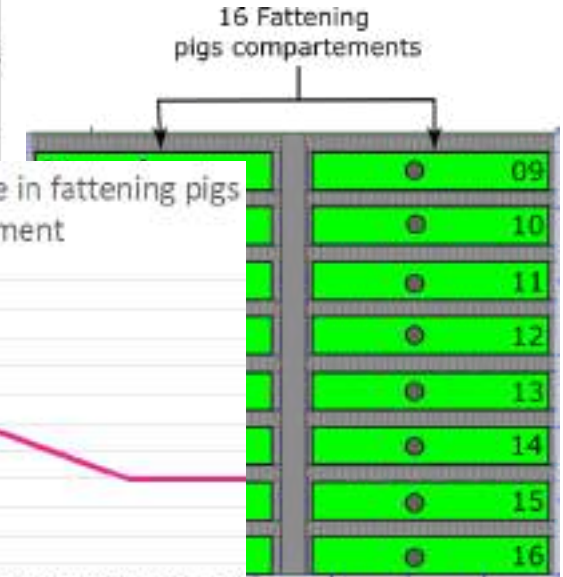
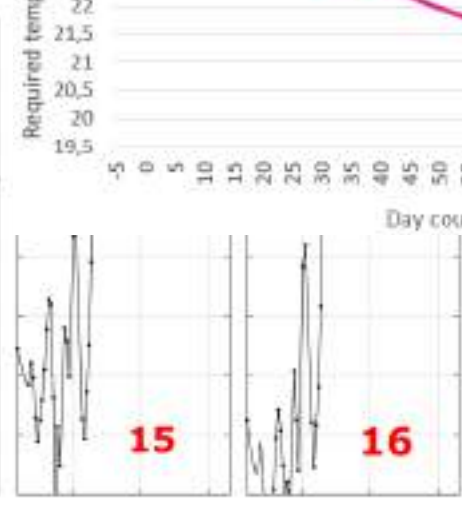
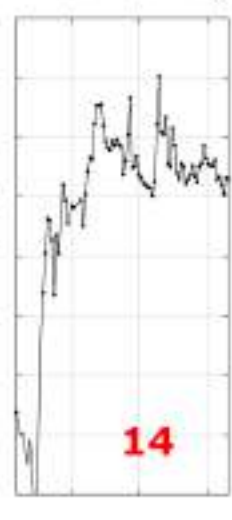
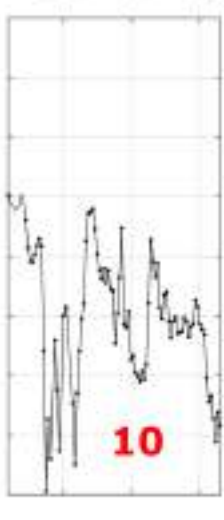
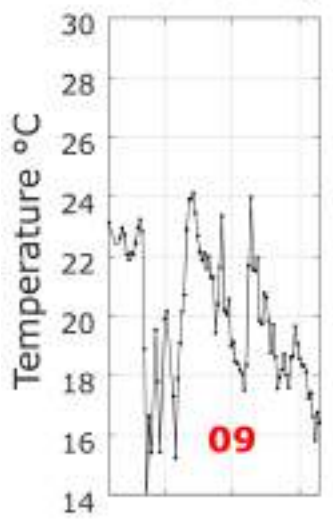
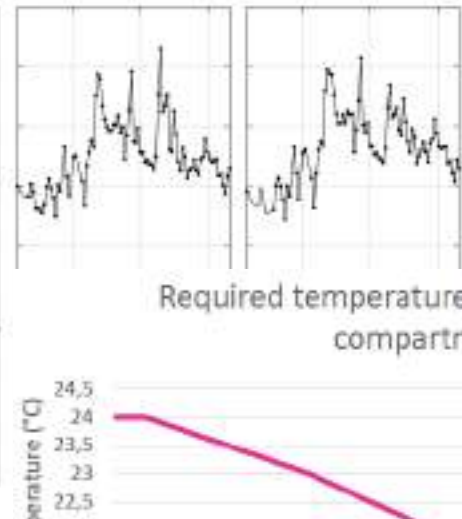
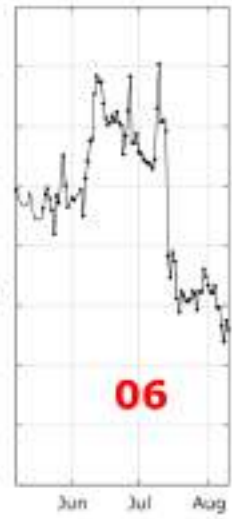
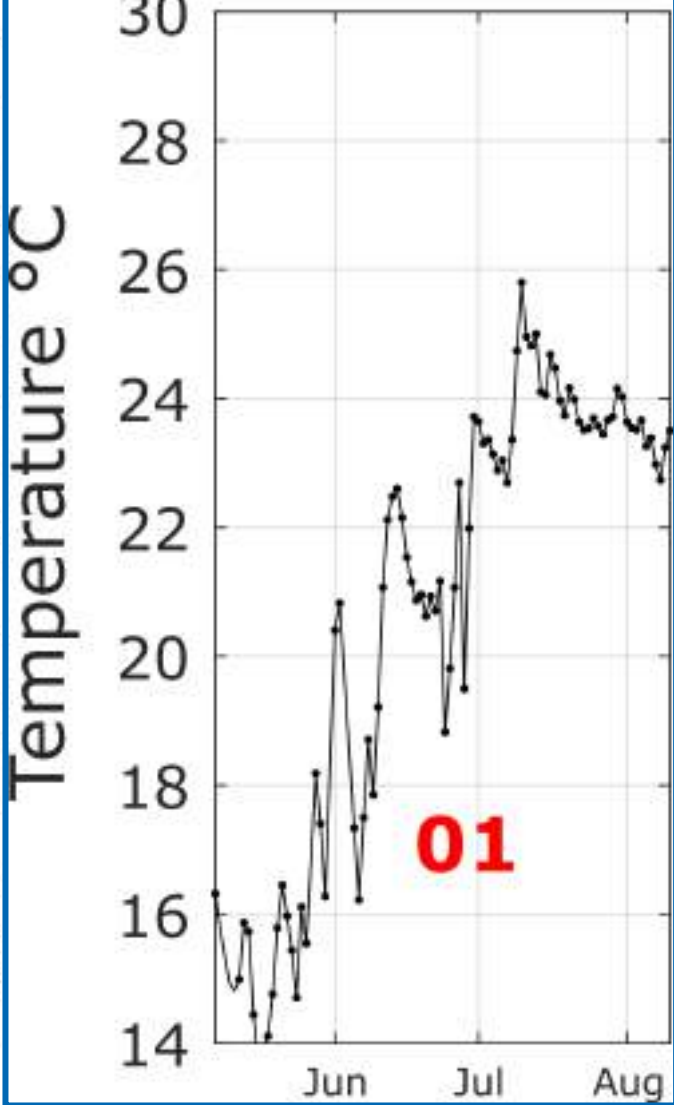
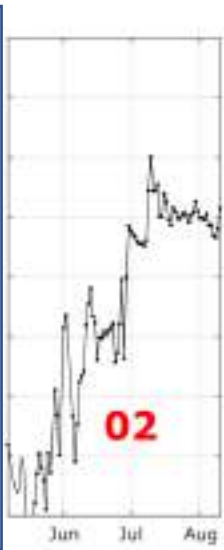
Where T_{db} and T_{wb} are dry-bulb and wet-bulb temperatures [°C], and RH: relative humidity [%].

- 75 < THI < 79: warning for heat stress,
- 79 < THI < 84: danger for heat stress,
- THI > 84: great danger for heat stress

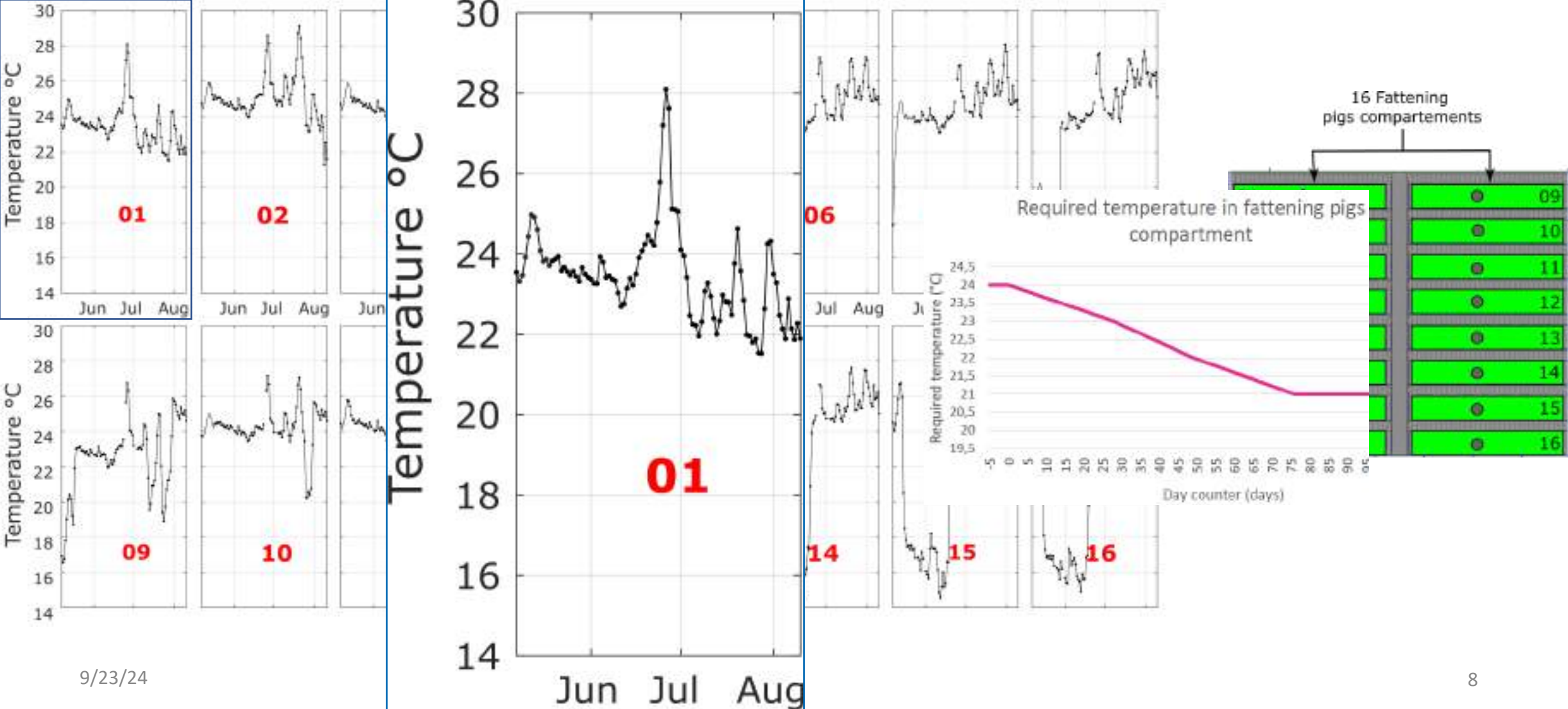
<https://doi.org/10.1016/j.animal.2024.101172>.



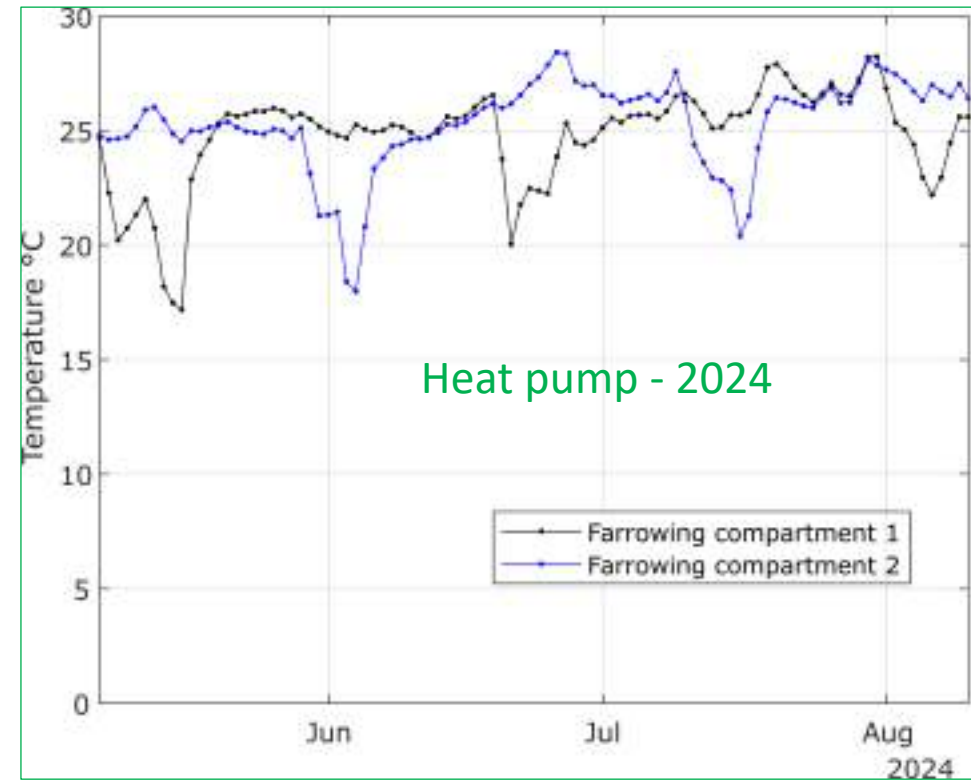
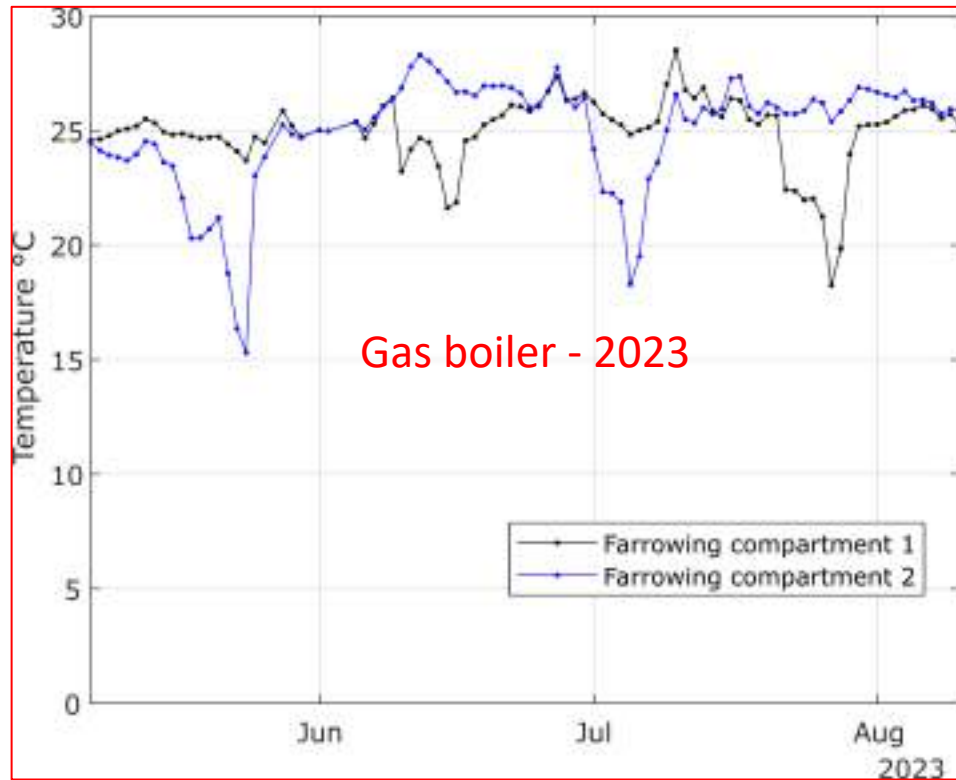
Fattening pig compartments: Time evolution of daily average temperature – Gas boiler 2023



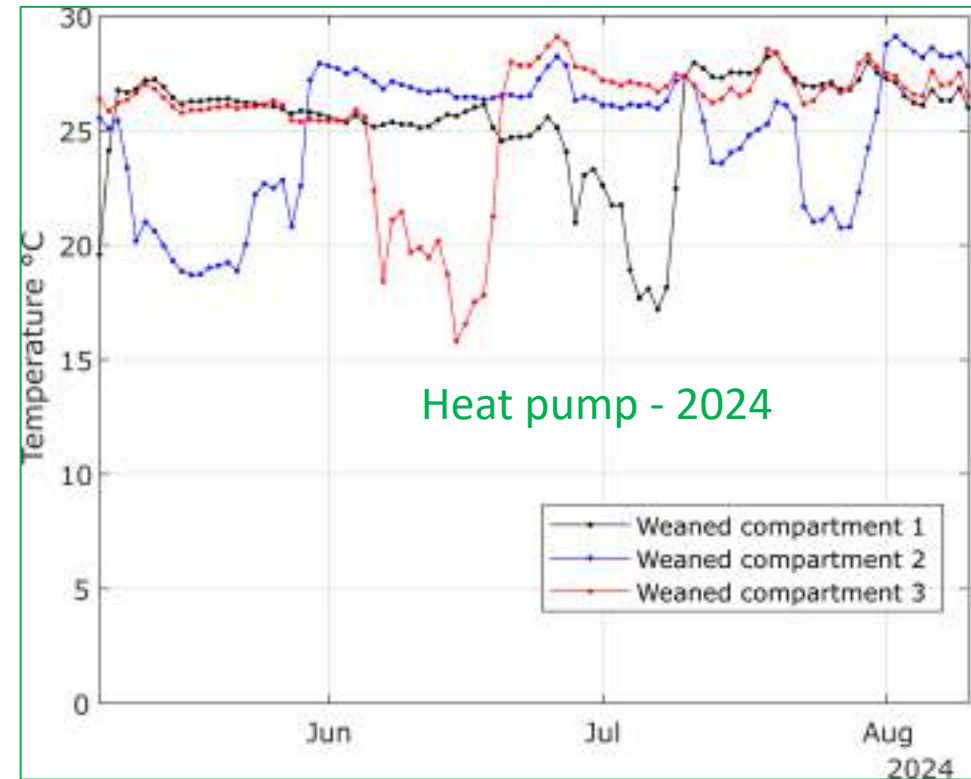
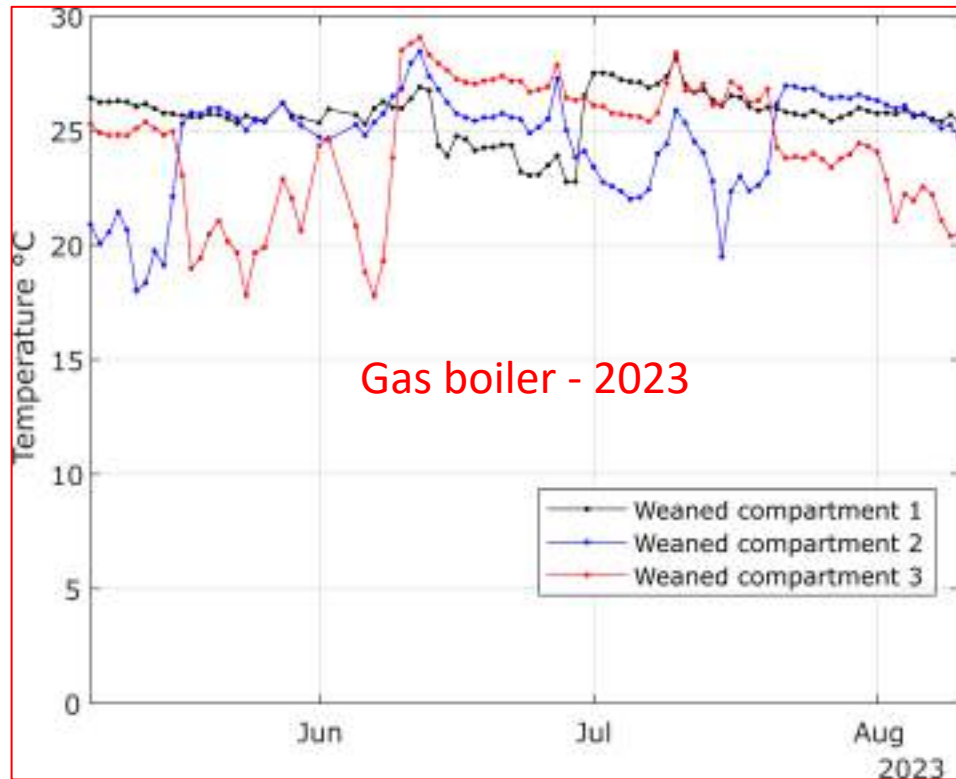
Fattening pig compartments: Time evolution of daily average temperature – Heat pump 2024



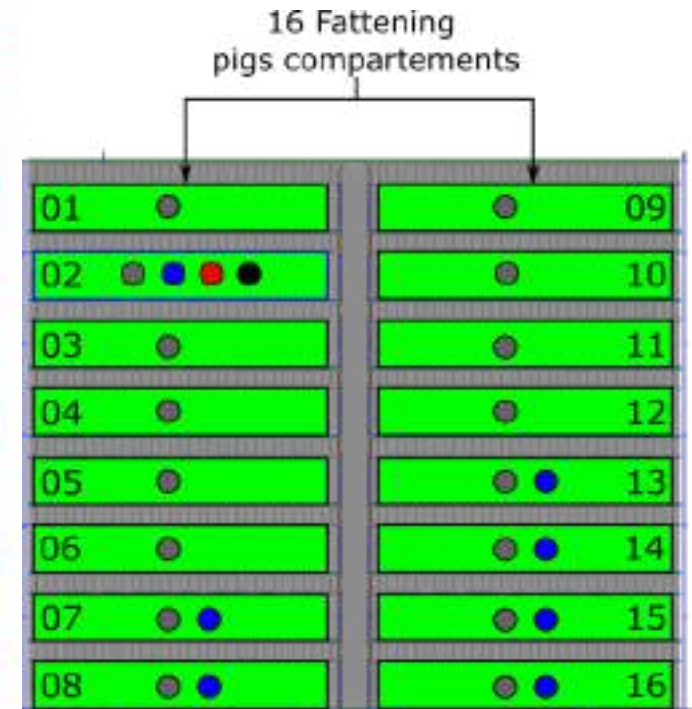
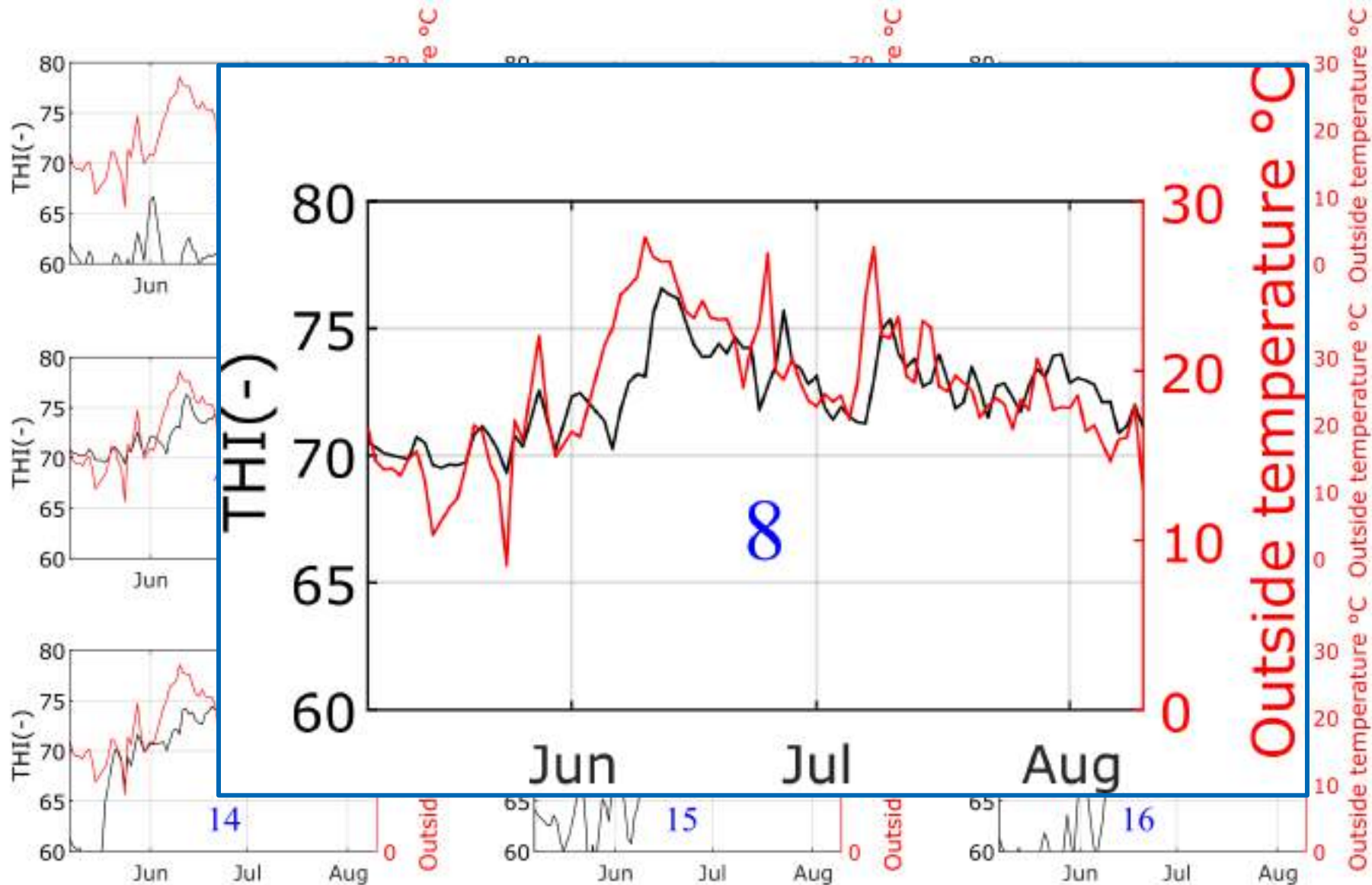
Farrowing compartment: Time evolution of daily average temperature



Weaned piglet compartments: Time evolution of daily average temperature



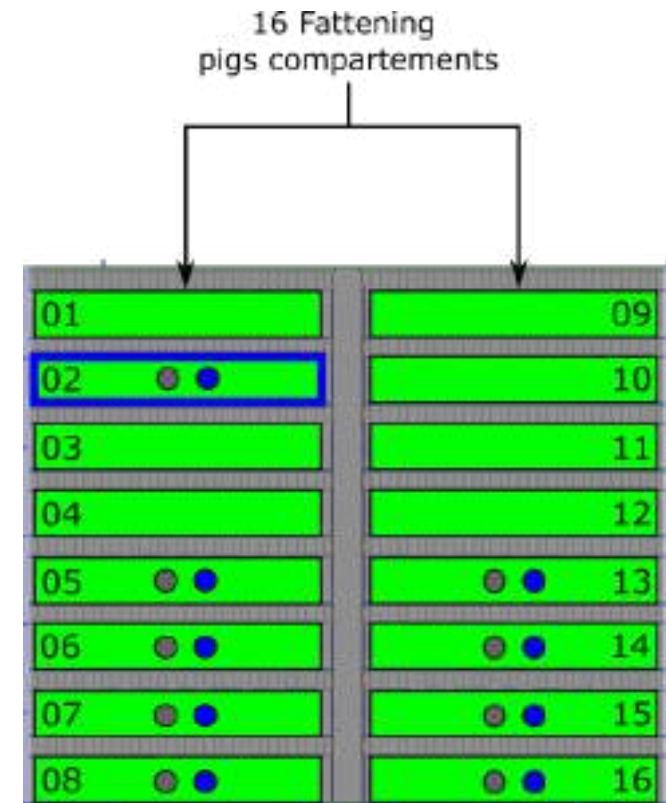
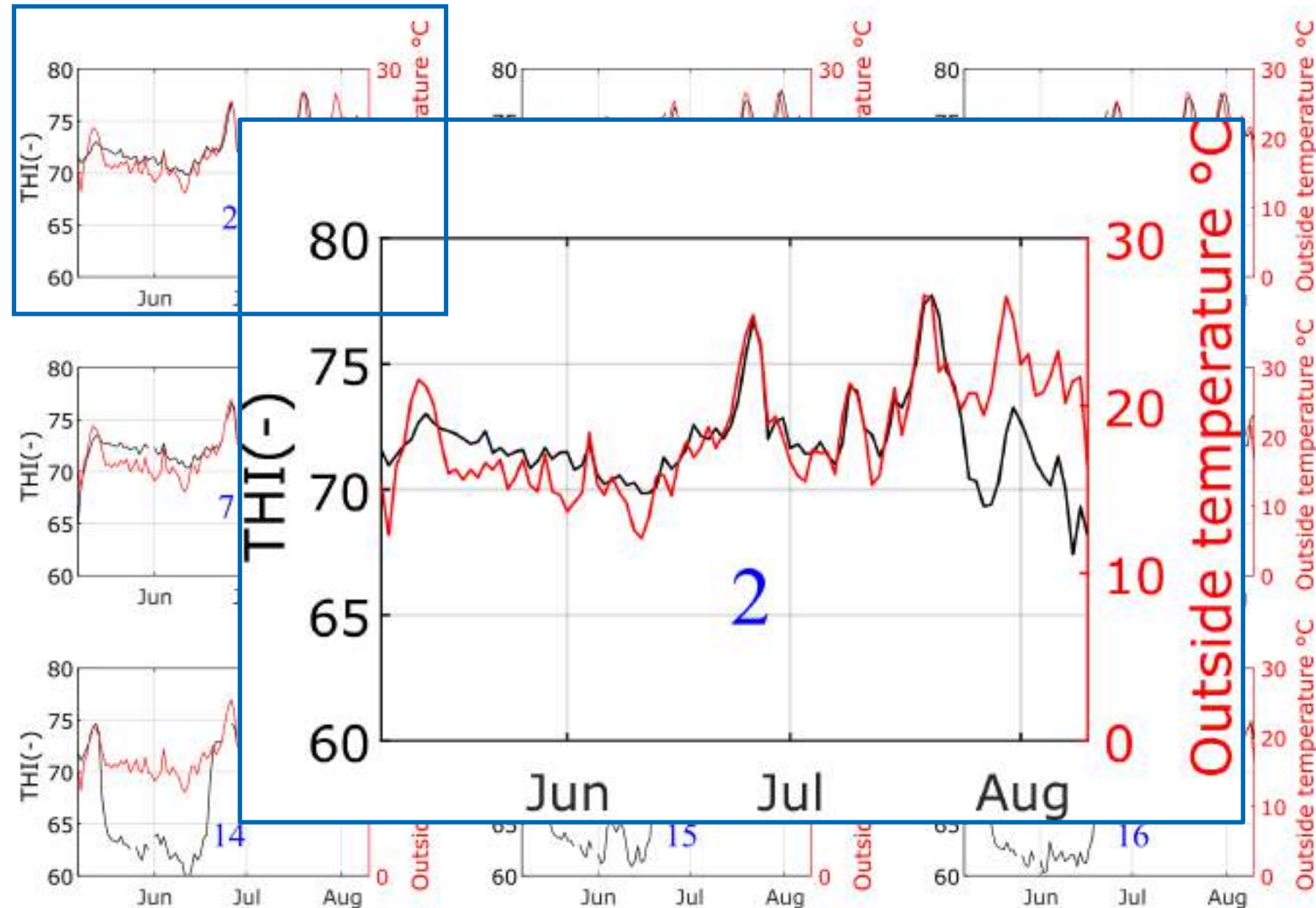
Compartment level animal comfort - Gas boiler 2023



Sensors

- Relative humidity
- Temperature

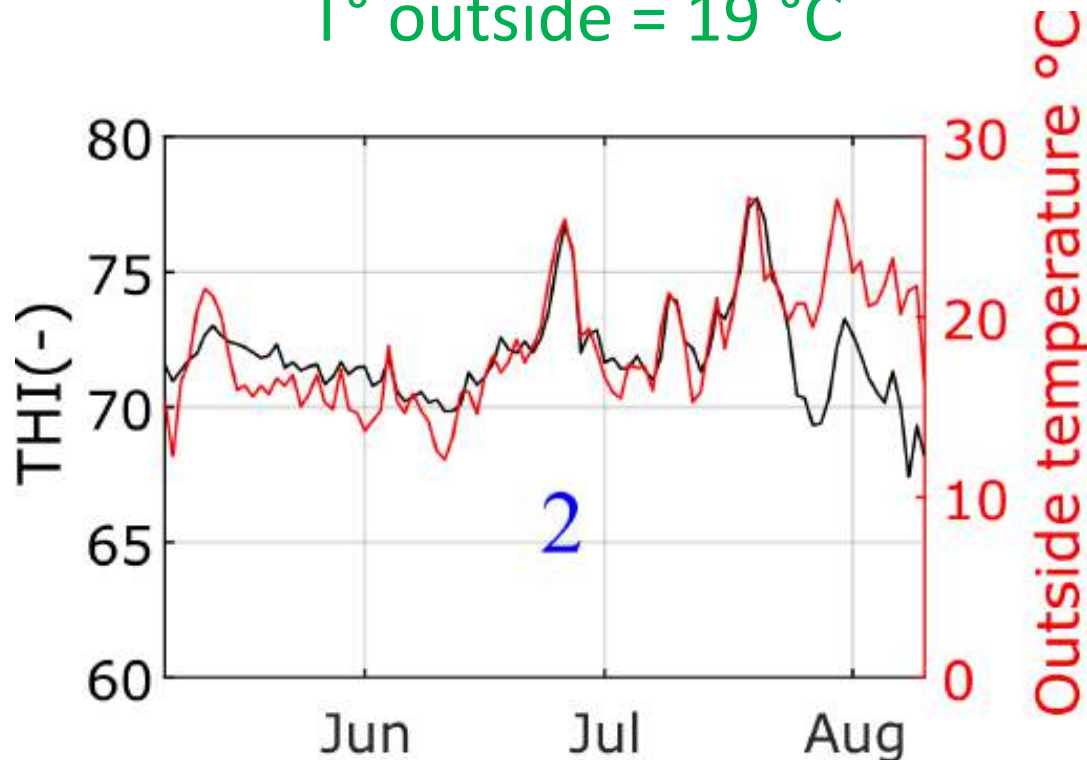
Compartment level Animal comfort - Heat pump 2024



Sensors

- Relative humidity
- Temperature

Heat pump 2024
Average THI = 72
T° outside = 19 °C



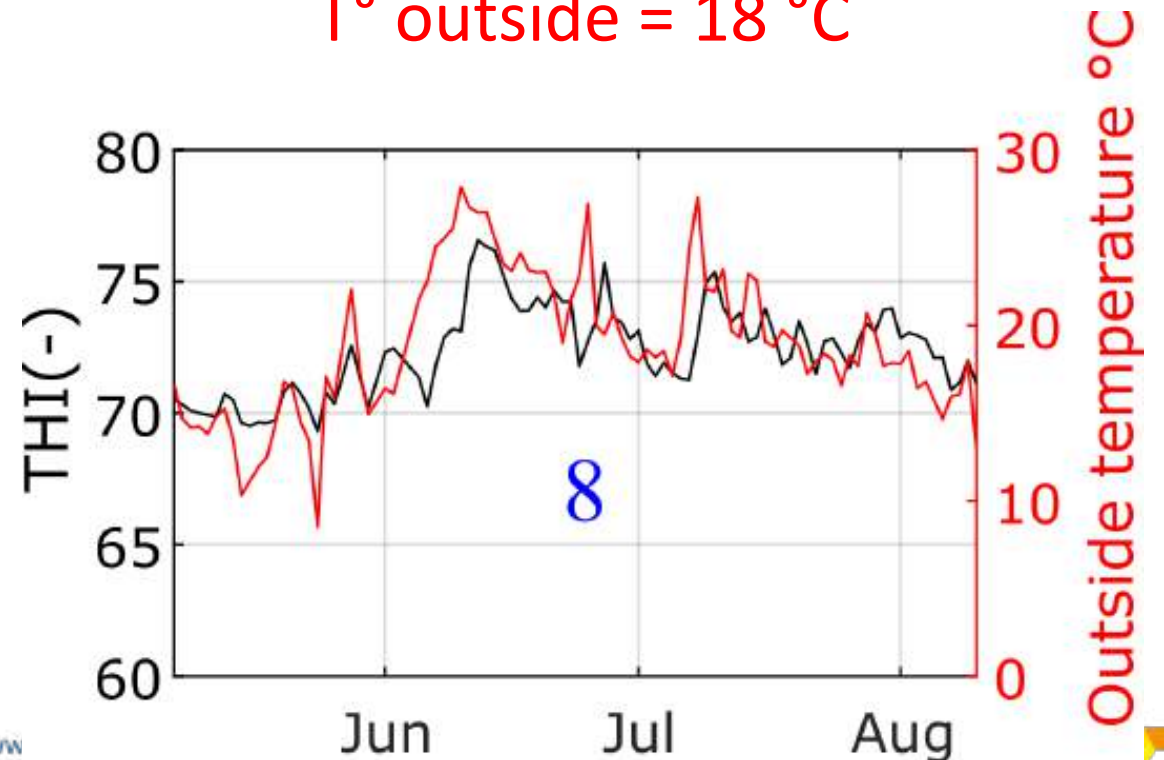
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Gas boiler 2023
Average THI = 72
T° outside = 18 °C



Conclusion

- The temporal evolution of environmental conditions at animal compartments level is analyzed on a real life pig farm facility.
- The RES systems has supplied the required heating demand of the pig farm
- The THI and the temperature levels in the animal compartments is affected by the outside ambient conditions
- The findings underscore the effectiveness of the integrated heat pump and PVT system in supplanting the fossil fuel-based gas boilers on the farm.
- The need for modern dynamic controller is emphasized for an optimal operation of the RES systems installed





Thank you!

