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APPLIED THERMODYNAMICS AND HEAT TRANSFER - DEPARTMENT OF ELECTROMECHANICAL, SYSTEMS AND METAL ENGINEERING (UGENT)
TECHNOLOGY AND FOOD SCIENCE – PRECISION LIVESTOCK FARMING GROUP (ILVO)

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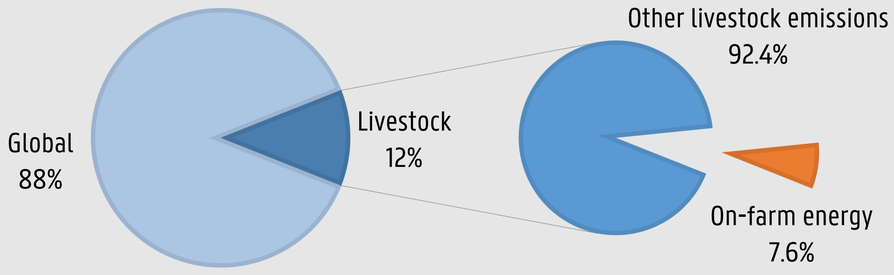
EXPERIMENTAL SET-UP AND COMPARISON TO A THERMAL LOAD MODEL FOR LIVESTOCK BARNS

INTRODUCTION [1, 2]

SHARE OF ON-FARM ENERGY USE OF LIVESTOCK BARNS IN GLOBAL GREENHOUSE GAS EMISSIONS

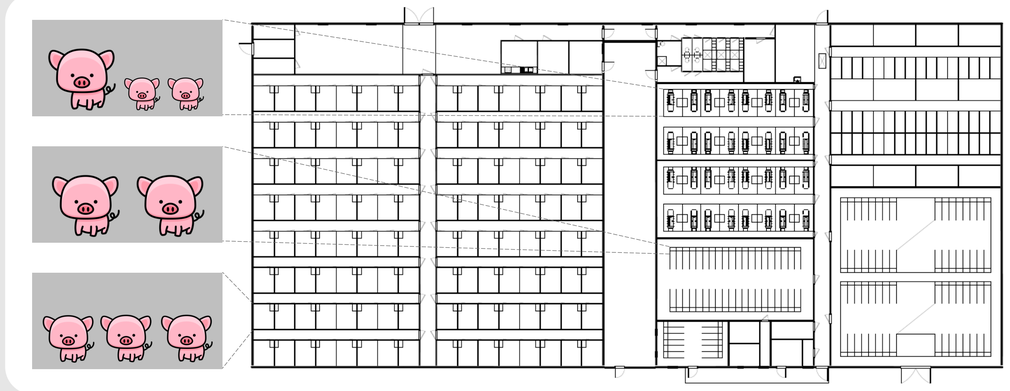


Global renewable energy integration	≈ 30%
Renewable energy integration in livestock	≈ 4%

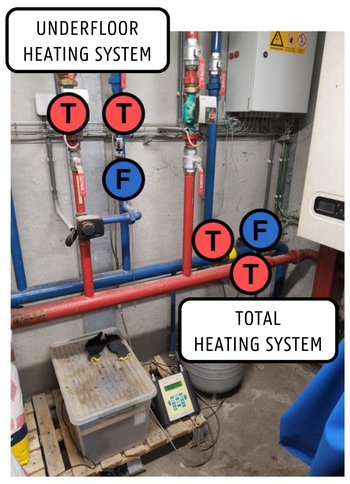
THERMAL LOAD MODEL [3]

MODEL PARAMETERS

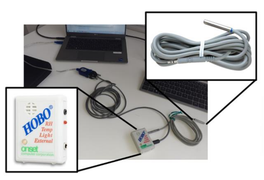
- Building envelope
- Heat balance per compartment
- Animal occupation
- Ventilation rate
- Heating mechanisms
- Outside temperature



EXPERIMENTAL SET-UP



TEMPERATURE MEASUREMENTS



LOGGER
HOBO h08-004-002

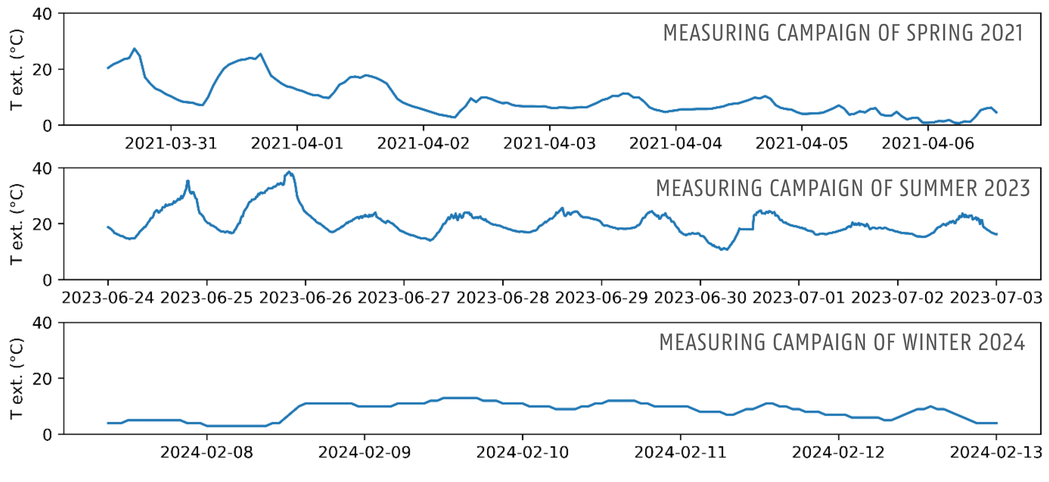
SENSOR
TMC6-HD sensor

FLOW RATE MEASUREMENTS

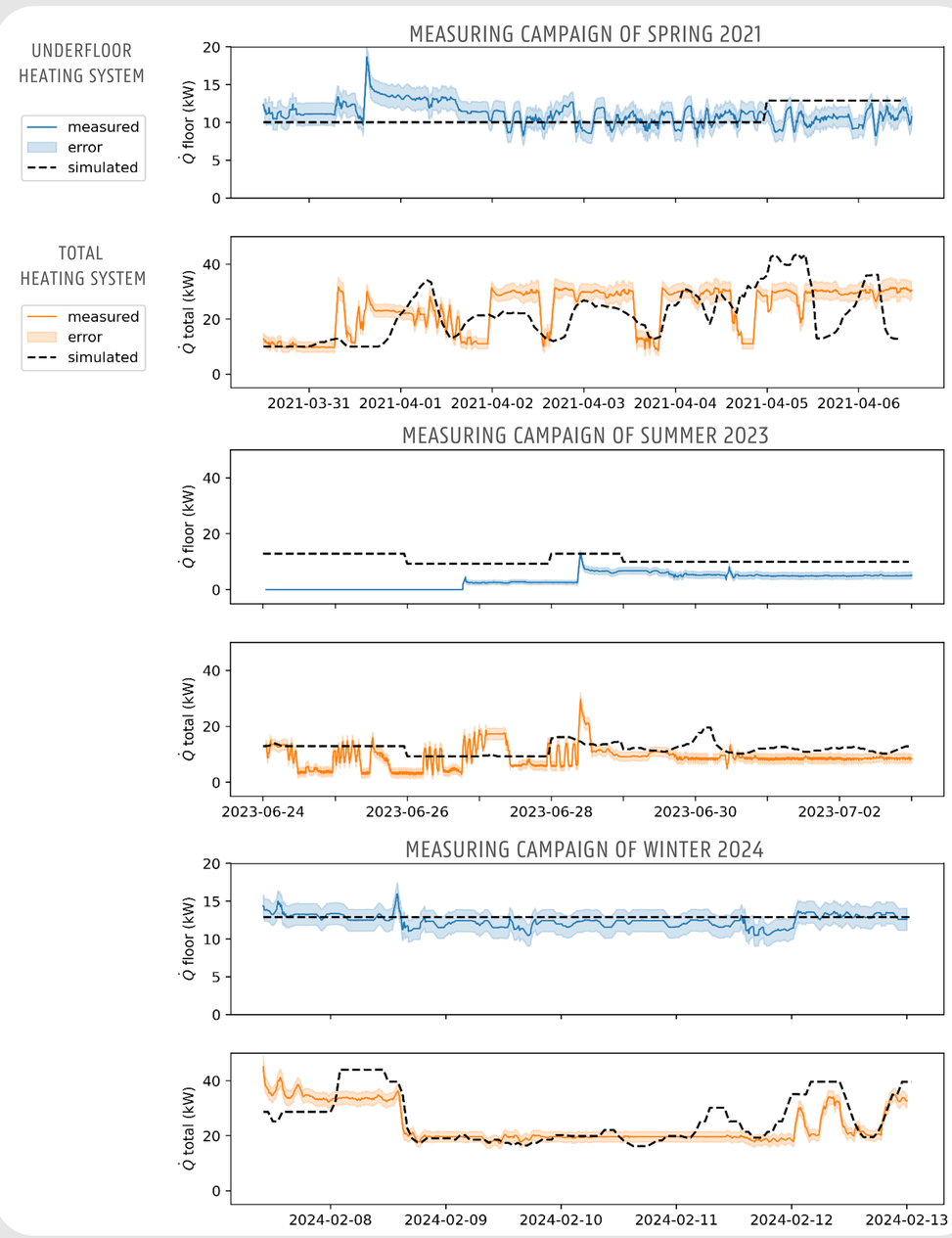
LOGGER
Fluxus-F601

SENSOR
Ultrasonic flow rate sensors

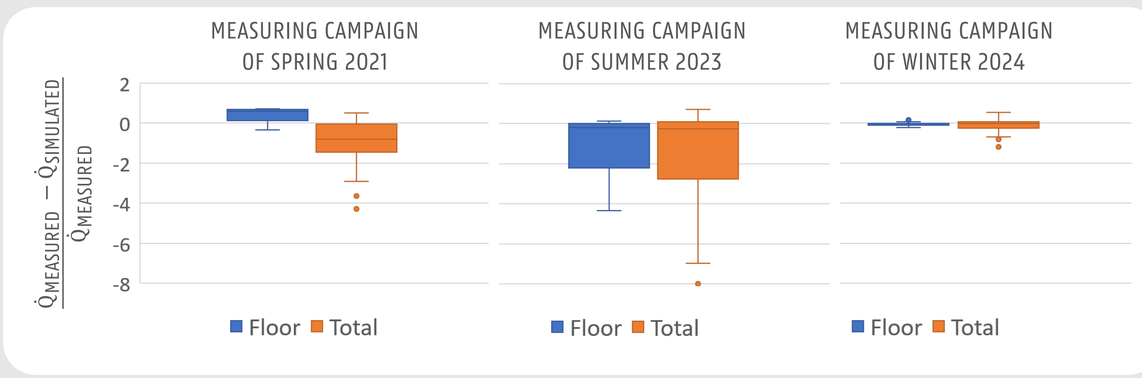
$$\dot{Q}_{total} = \dot{Q}_{conduction} + \dot{Q}_{infiltration} + \dot{Q}_{ventilation} - \dot{Q}_{lamps} - \dot{Q}_{animal}$$



RESULTS



CONCLUSIONS



UNDERFLOOR HEATING

Transient fluctuations are neglected in the thermal load model.

Overestimation of 227% during summer.

TOTAL HEATING SYSTEM

The thermal load model is correlated to the outside temperature.

Underestimation of 80% during summer.

GENERAL CONCLUSION

The thermal load model predicts the trends of the hourly heat demand. Absolute values deviate because of missing model details, including sanitary hot water use and manual interactions such as set-point deviations and closing valves.

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Resources

[1] Costantino, A., Calvet, S., & Fabrizio, E. (2023). *The Use of Renewable Energy Sources as a Driver to Reduce the Carbon Footprint of the Livestock Sector* (pp. 217–250).

[2] FAO. 2023. *Pathways towards Lower Emissions – A Global Assessment of the Greenhouse Gas Emissions and Mitigation Options from Livestock Agrifood Systems.* Rome: FAO.

[3] Faes, W., Maselyne, J., De Paepe, M. and Lecompte, S. (2022). *Modelling the Energetic Performance of a Pig Stable.* (Pp. 910–915) in 34th International Conference on Efficiency, Cost, Optimization, Simulation and Environmental Impact of Energy Systems (ECOS 2021). Tokyo, Japan: ECOS 2021 Program Organizers.

GHENT UNIVERSITY

ILVO Flanders Research Institute for Agriculture, Fisheries and Food

RES4LIVE ENERGY SMART LIVESTOCK FARMING TOWARDS ZERO FOSSIL FUEL CONSUMPTION

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