GHENT
UNIVERSITY

FACULTY OF ENGINEERING AND ARCHITECTURE

DEPARTMENT OF ELECTROMECHANICAL, SYSTEMS AND METAL ENGINEERING
RESEARCH GROUP SUSTAINABLE THERMOFLUID ENERGY SYSTEMS

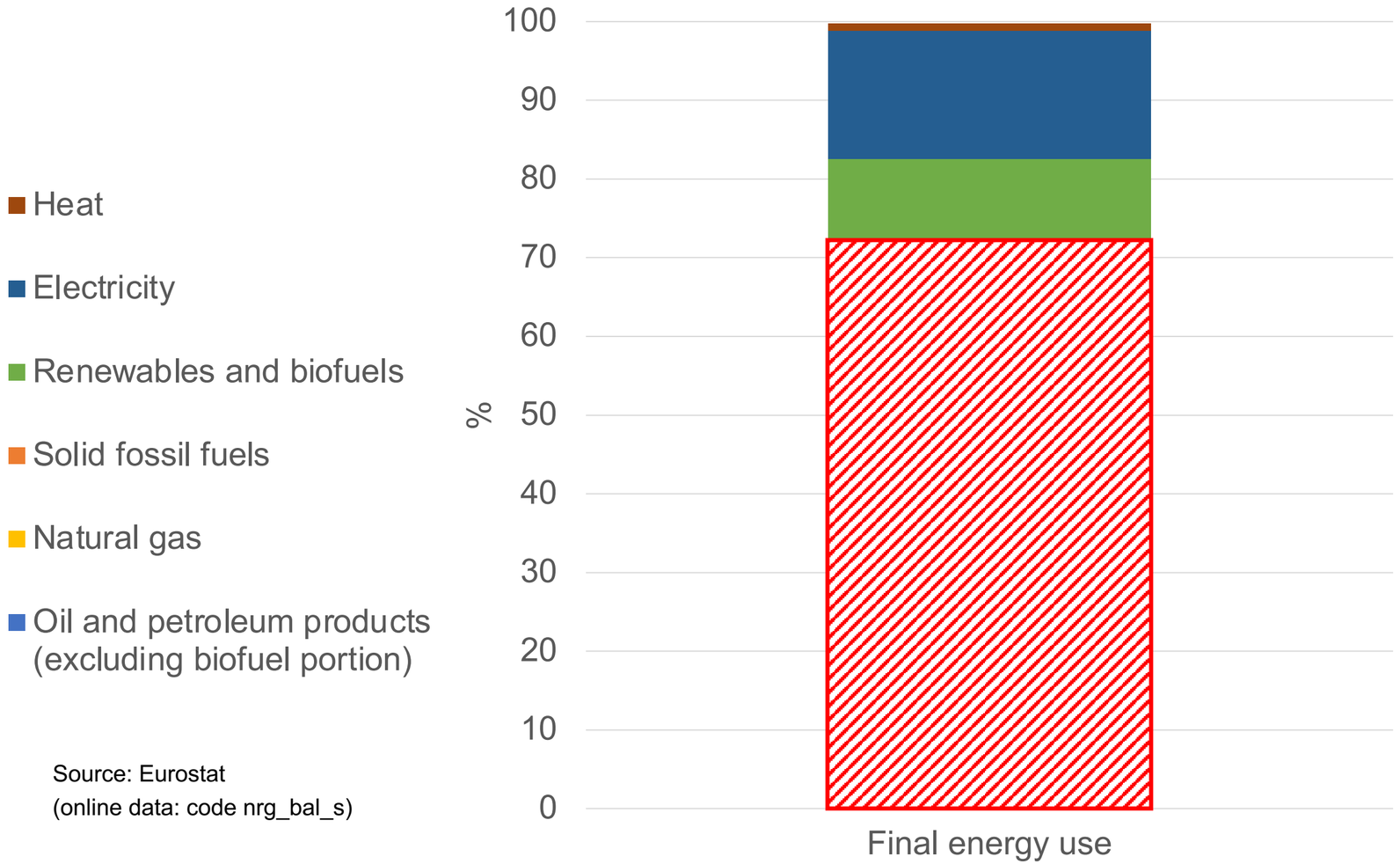
MODELLING THE ENERGETIC PERFORMANCE OF A PIG STABLE

W. Faes, W. De Win, J. Maselyne, M. De Paepe & S. Lecompte
ECOS2021

GHENT UNIVERSITY

ILVO
Flanders Research Institute for Agriculture, Fisheries and Food

EUROPEAN AGRICULTURE



Source: Eurostat
(online data: code nrg_bal_s)

Heavy reliance on fossil energy

GHENT UNIVERSITY

ILVO
Flanders Research Institute for Agriculture, Fisheries and Food

RES4LIVE
ENERGY SMART LIVESTOCK FARMING
TOWARDS ZERO FOSSIL FUEL CONSUMPTION

RES4LIVE

RES4LIVE

ENERGY SMART LIVESTOCK FARMING
TOWARDS ZERO FOSSIL FUEL CONSUMPTION

- Renewable Energy Sources (RES) for fossil free livestock farming
- 17 partners from 8 countries
- 4 year project (start October 2020)

GHENT UNIVERSITY

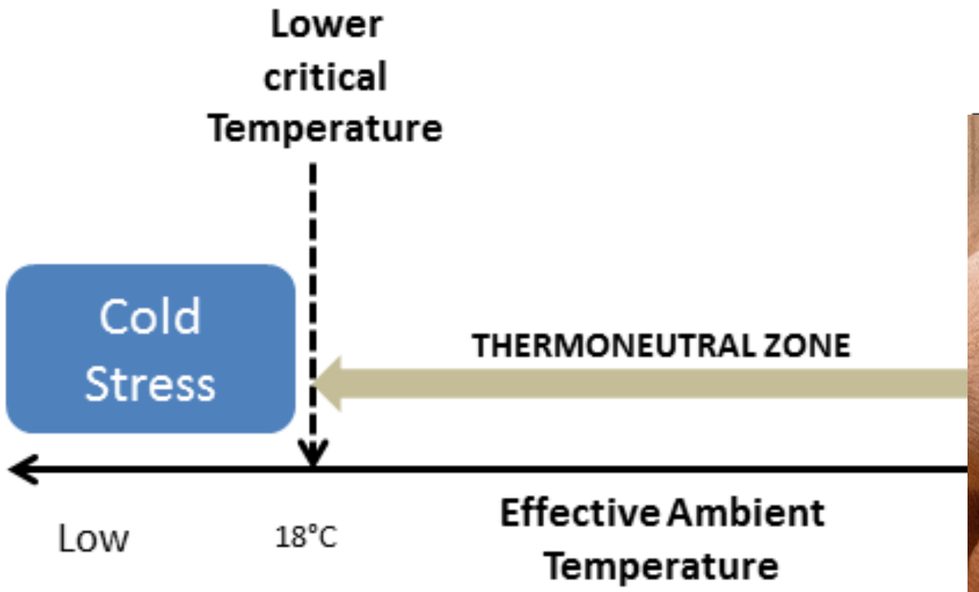
ILVO
Flanders Research Institute for Agriculture, Fisheries and Food

RES4LIVE
ENERGY SMART LIVESTOCK FARMING
TOWARDS ZERO FOSSIL FUEL CONSUMPTION

PIG FARMING

- Productivity linked to environmental conditions
- High energy demand for climate control

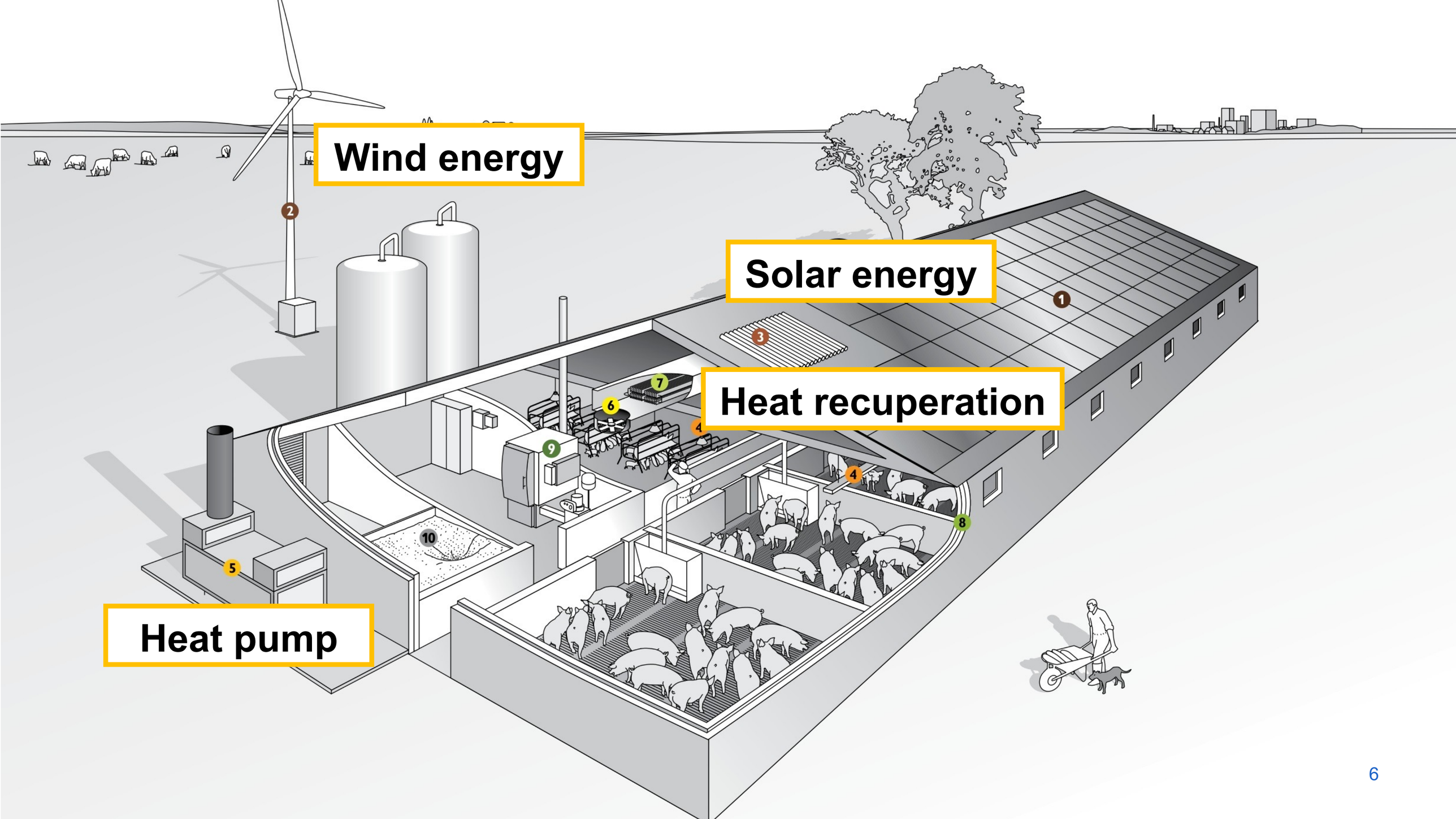
Possible with RES solutions?



GHENT UNIVERSITY

ILVO
Flanders Research Institute for Agriculture, Fisheries and Food

RES4LIV
ENERGY SMART LIVESTOCK FARMING TOWARDS ZERO FOSSIL FUEL CONSU


Wind energy
Solar energy
Heat recuperation
Heat pump
1
2
3
4
4
5
6
7
8
9
10

REFERENCE FARM

- Different needs per type
- Air preheating + underfloor heating
- 60 kW condensing boiler
- Yearly consumption:
  - Gas: 220 MWh
    (198 MWh for heating)
  - Elec.: 115 MWh
- Load profile?

GHENT UNIVERSITY

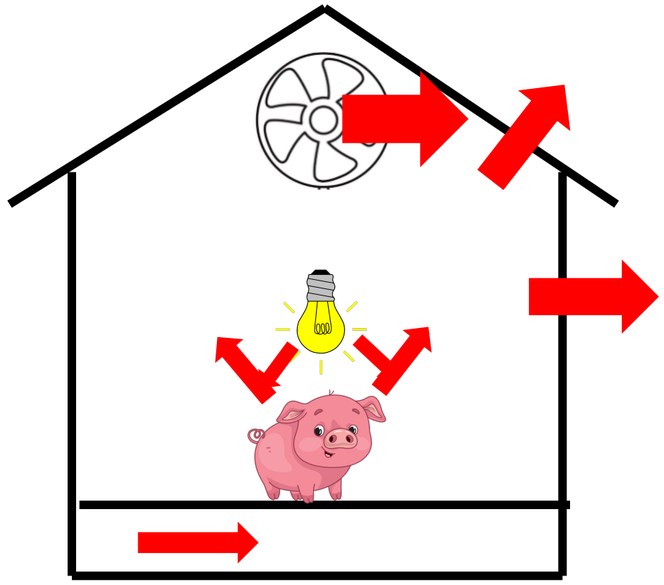
ILVO
Flanders Research Institute for Agriculture, Fisheries and Food

RES4LIVE
ENERGY SMART LIVESTOCK FARMING
TOWARDS ZERO FOSSIL FUEL CONSUMPTION

THERMAL LOAD MODEL

- Steady-state model ($T_{zone} = T_{set}$)
- Stable divided in 23 compartments
- Implemented in Python

$$\dot{Q}_{load} = \dot{Q}_{loss} + \dot{Q}_{vent} - \dot{Q}_{pig} - \dot{Q}_{add}$$

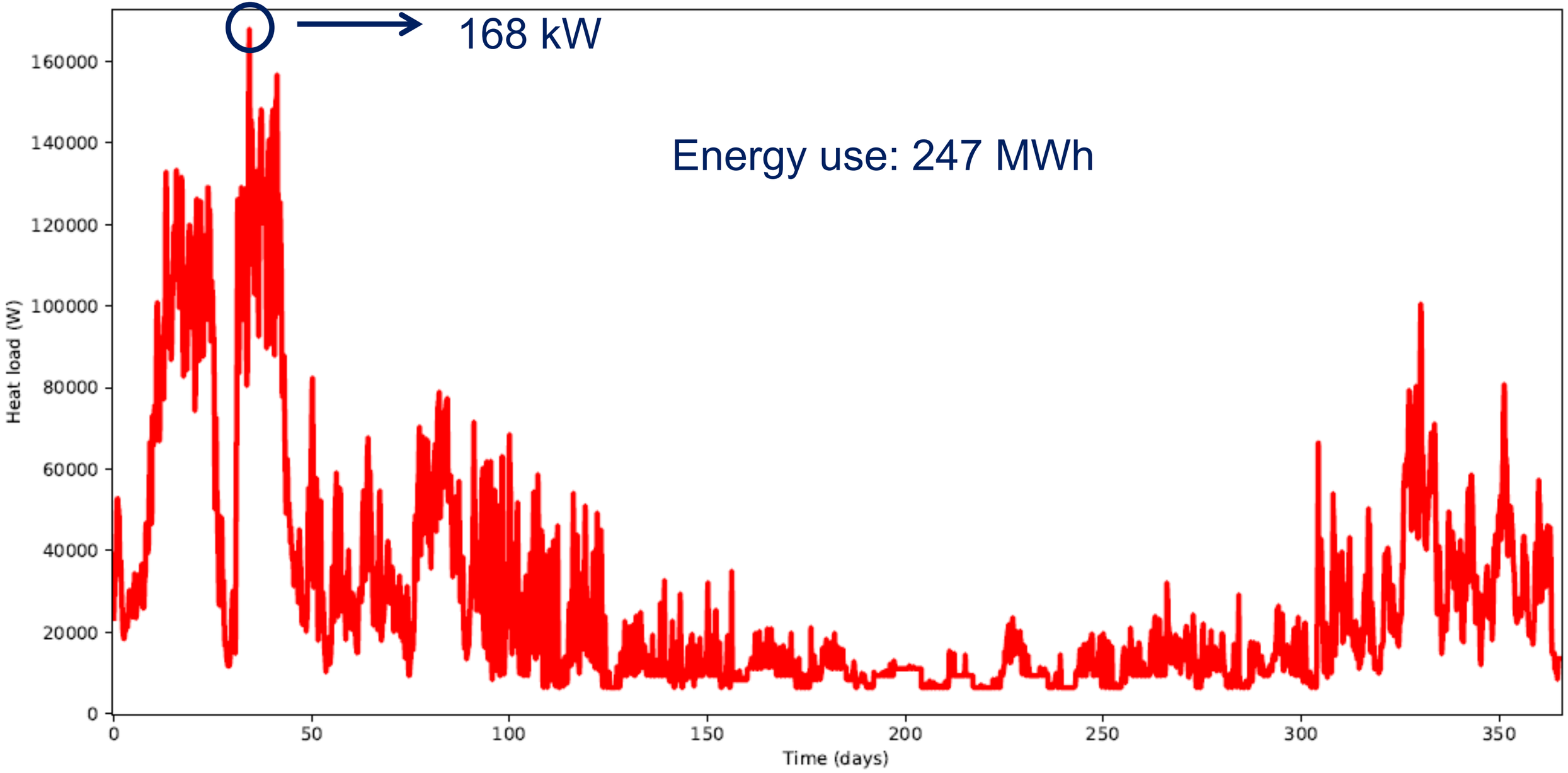


GHENT UNIVERSITY

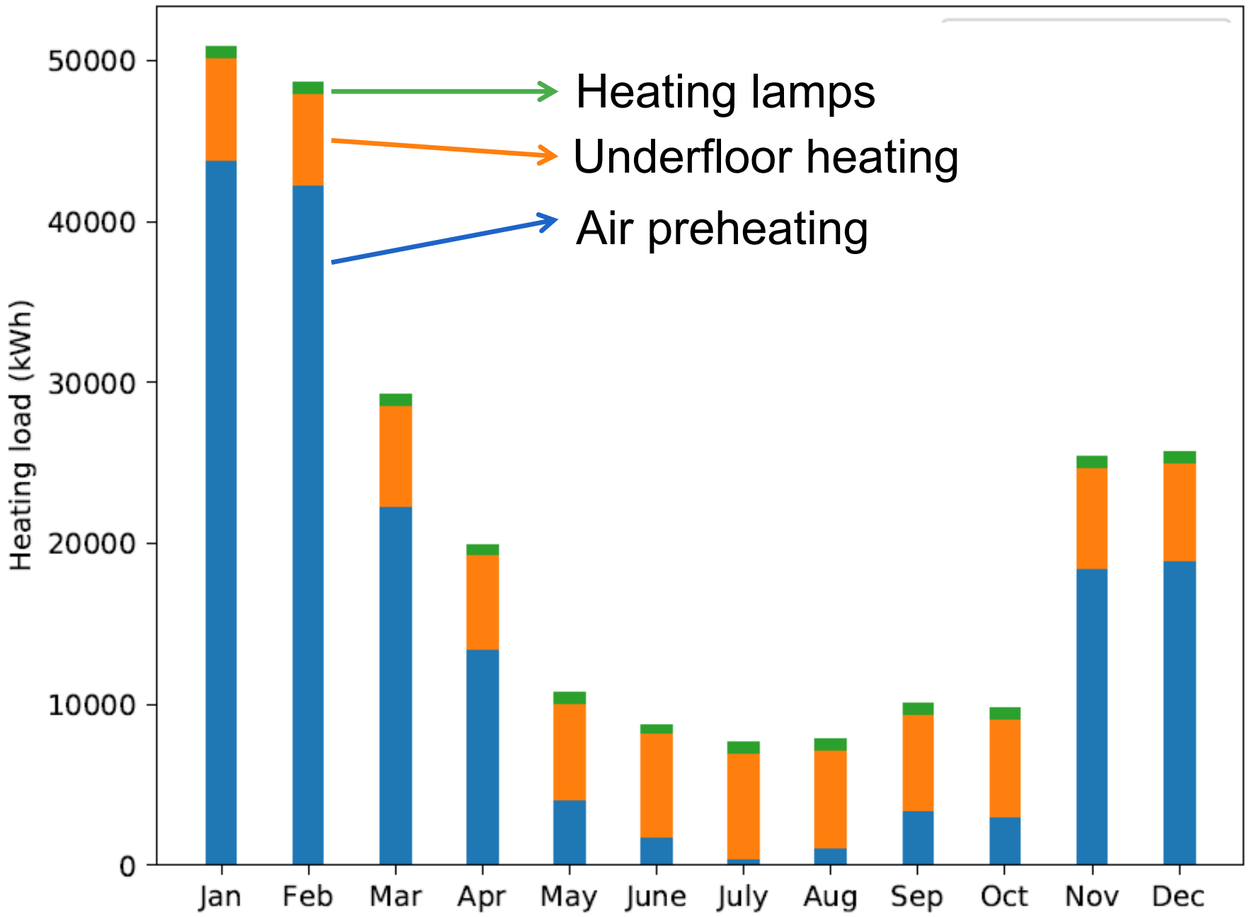
ILVO
Flanders Research Institute for Agriculture, Fisheries and Food

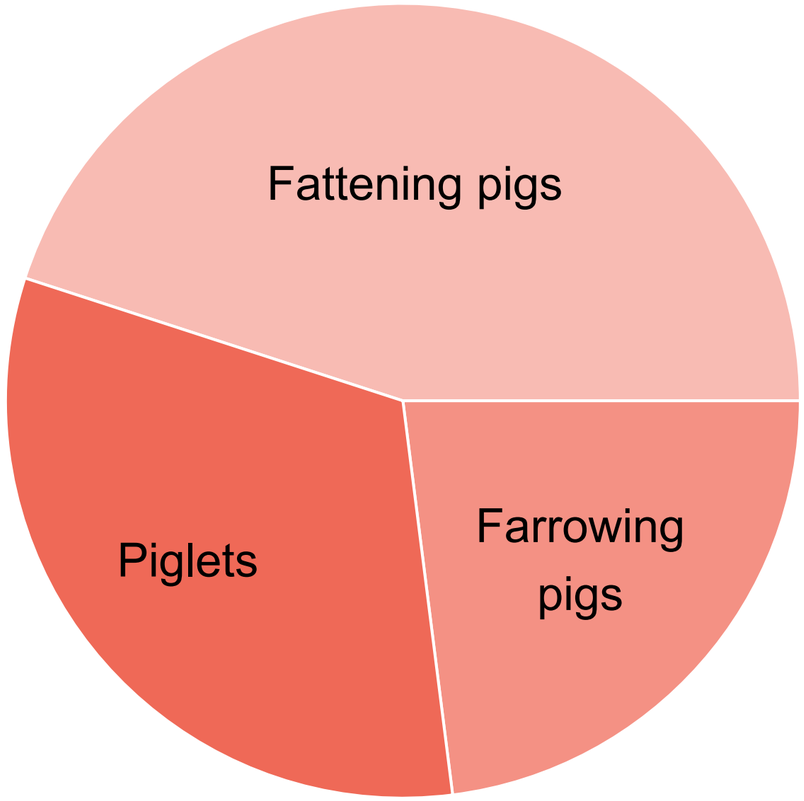
RES4LIVE
ENERGY SMART LIVESTOCK FARMING
TOWARDS ZERO FOSSIL FUEL CONSUMPTION

OBTAINED HEAT LOAD



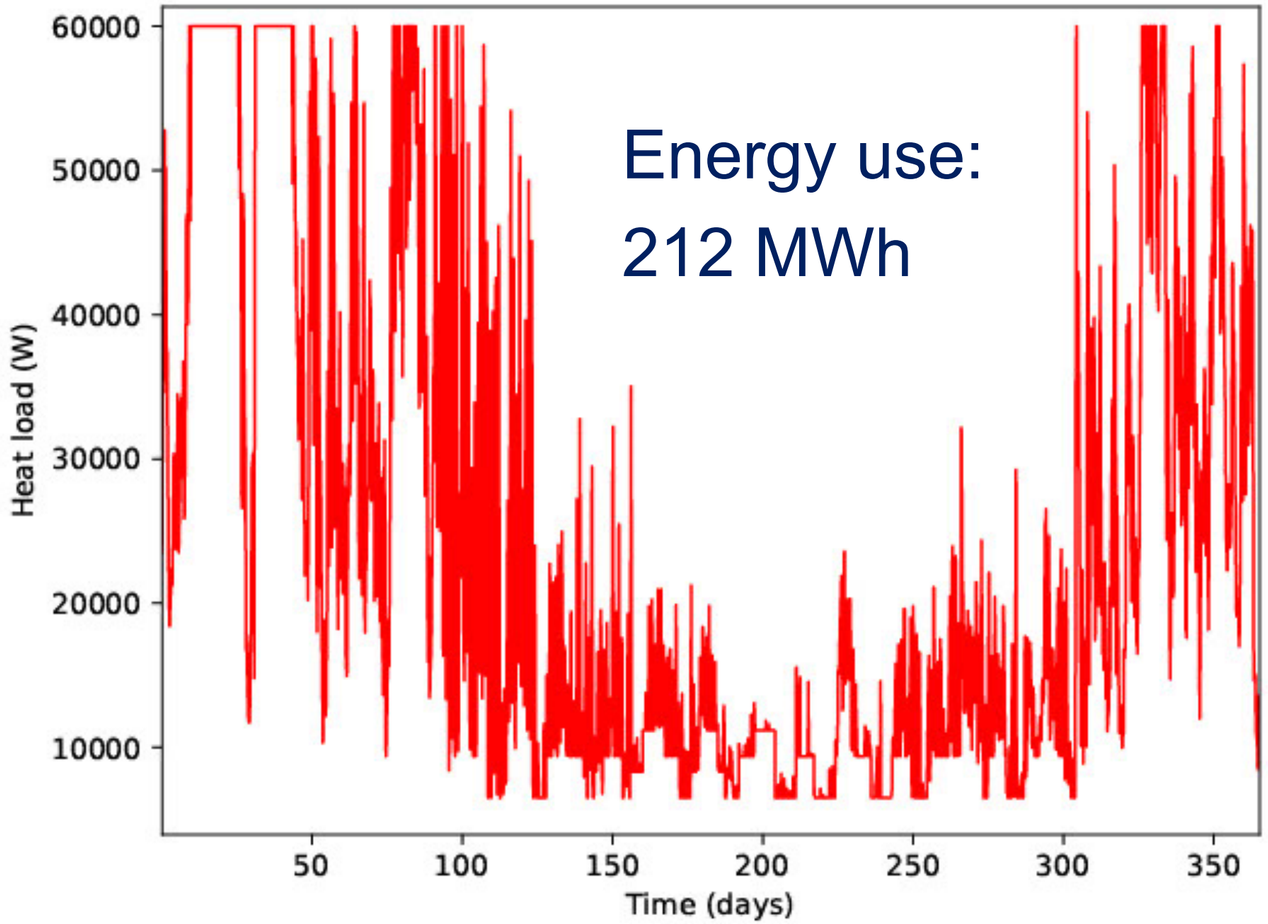
ENERGY USE ANALYSIS





LIMITED HEAT CAPACITY

- Peak power (168 kW) too high
- Reduce zone temperatures until heat load is 60 kW

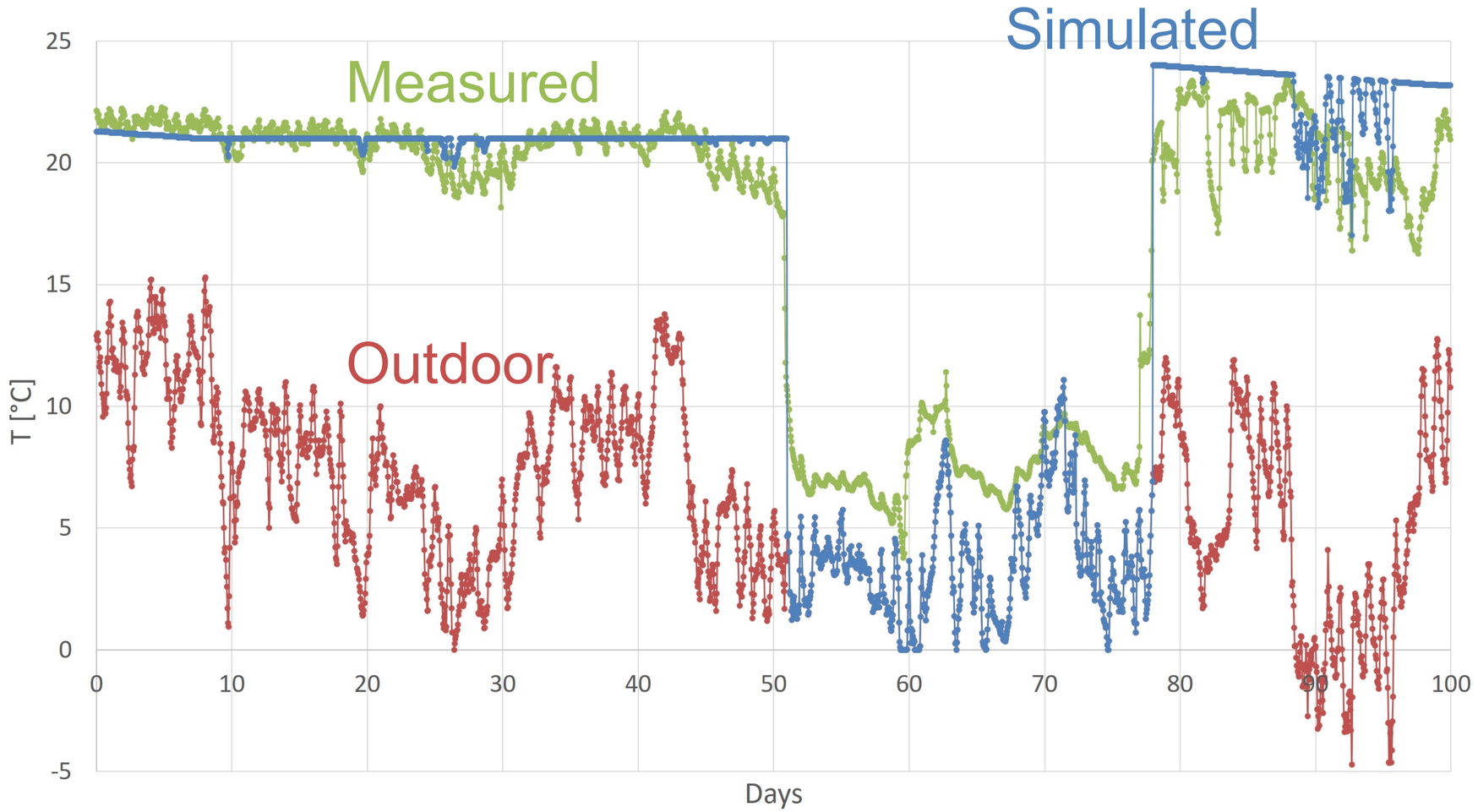


GHENT UNIVERSITY

ILVC
Flanders Research Institute f
Agriculture, Fisheries and Fo

COMPARISON WITH MEASUREMENTS

Temperatures



GHENT UNIVERSITY

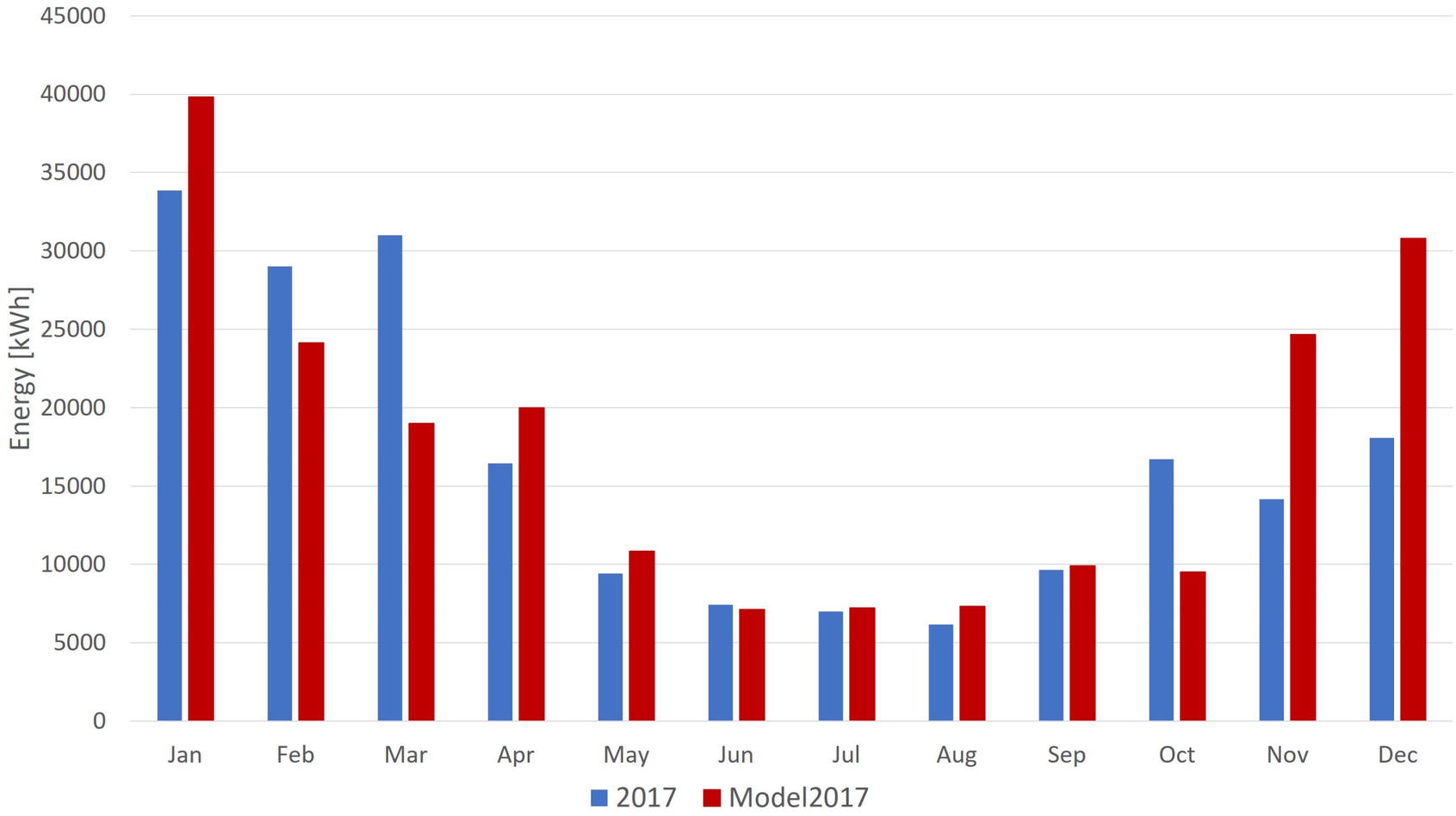
ILVO
Flanders Research Institute for Agriculture, Fisheries and Food

RES4LIVE
ENERGY SMART LIVESTOCK FARMING
TOWARDS ZERO FOSSIL FUEL CONSUMPTION

COMPARISON WITH MEASUREMENTS

Temperatures

Energy use



GHENT UNIVERSITY

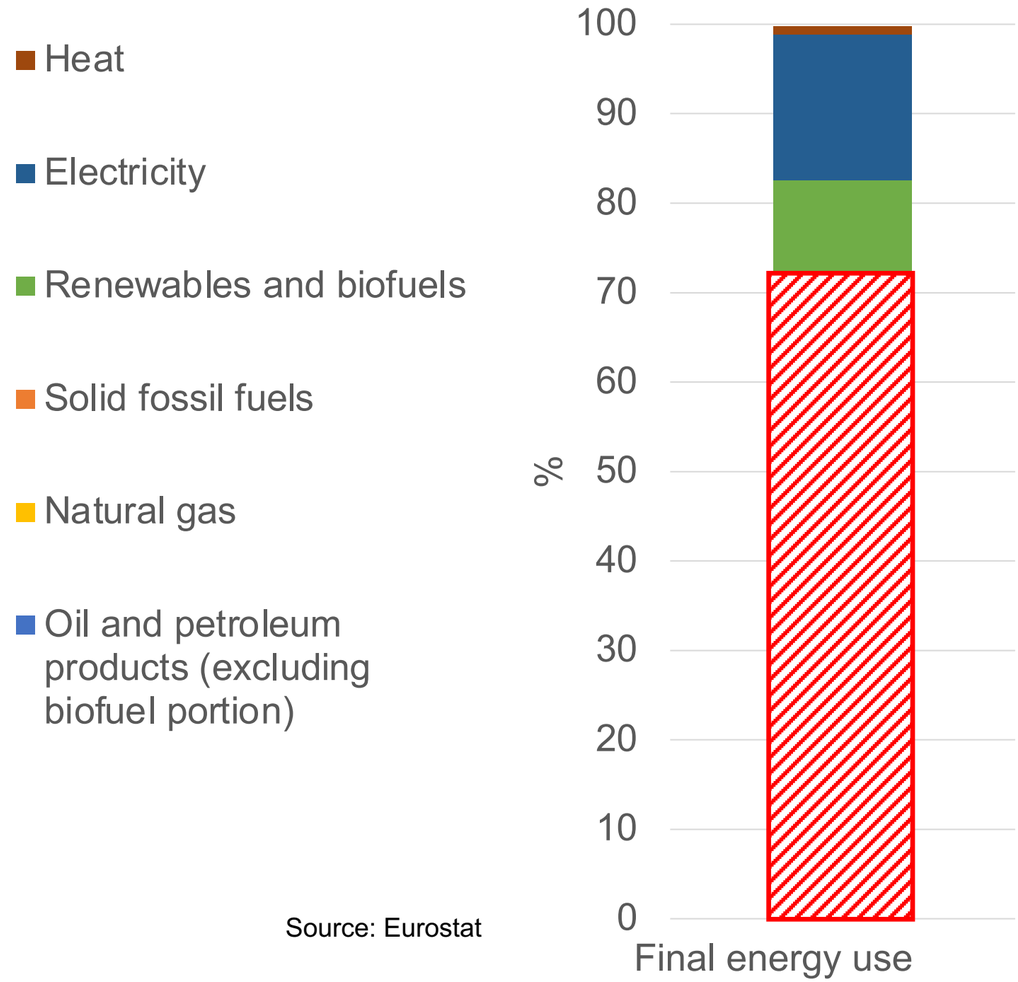
ILVO
Flanders Research Institute for Agriculture, Fisheries and Food

RES4LIVE
ENERGY SMART LIVESTOCK FARMING
TOWARDS ZERO FOSSIL FUEL CONSUMPTION

CONCLUSION

- Steady-state thermal model
- Compared with measurements
- Realistic load profile

- Improvements to model
- Reduction of load
- Implementation of RES solutions



Source: Eurostat

GHENT UNIVERSITY

ILVO
Flanders Research Institute for Agriculture, Fisheries and Food

RES4LIVE
ENERGY SMART LIVESTOCK FARMING TOWARDS ZERO FOSSIL FUEL CONSUMPTION

FACULTY OF ENGINEERING AND ARCHITECTURE

DEPARTMENT OF ELECTROMECHANICAL, SYSTEMS AND METAL ENGINEERING
RESEARCH GROUP SUSTAINABLE THERMOFLUID ENERGY SYSTEMS

MODELLING THE ENERGETIC PERFORMANCE OF A PIG STABLE

W. Faes, W. De Win, J. Maselyne, M. De Paepe & S. Lecompte
ECOS2021

GHENT UNIVERSITY

ILVO
Flanders Research Institute for Agriculture, Fisheries and Food