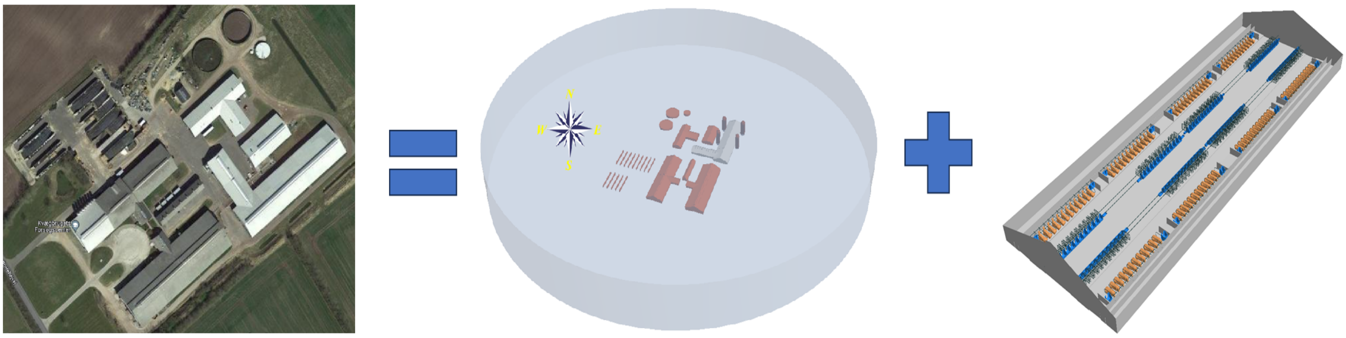
Domain decomposed technique to model naturally ventilated barns by CFD

Computational Fluid Dynamics (CFD) is a promising technique to simultaneously obtain the fields of velocity, concentration, temperature, pressure and humidity ratio in livestock production barns over the entire computational domain, compared to field on-site measurements with limited measuring points. Although the distinct advantage of CFD modelling, one of challenges lies in the high requirement of computational compacity for large-scale livestock production buildings when the computational domain is wholly simulated with all geometrical detailed in the barns. This has limited the application of CFD modelling in study on sustainability and mitigation of heat stress and gaseous emissions from livestock buildings. Without proper prediction of those parameters, especially under the pressure of climate change, large uncertainties exist in assessment of the microclimate surrounding animals, which is highly related to the animal welfare and productivity, after new techniques are implemented for adaptive climatic barns.



In this context, we strive to predict the air speed, temperature and relative humidity around animals by adopting a domain decomposed technique to model the naturally ventilated barns by CFD in RES4LIVE project. As shown in the figure, the computational domain is decomposed into two domains, (1) the atmosphere domain plus the animal housing domain without detailed information inside the animal housing, and (2) the domain of animal housing with detailed information of housing configuration and animals. The parameters such as velocity, temperature, pressure etc. at openings of the animal housing achieved from modelling of domain (1) are used as boundary conditions for modelling of domain (2). This approach allows us to conduct CFD simulations with durable computational capacity and reasonable accuracy in predicting the velocity, temperature, humidity ratio surrounding animals. Thus, the technologies in preventing and alleviating heat stress, e.g., tube ventilation augmented with mechanical cooling developed within the context of RES4LIVE, can be evaluated with reasonable accuracy.

The RES4LIVE project has received funding from the European Union's Horizon 2020 Research and Innovation Program under grant agreement No 101000785.