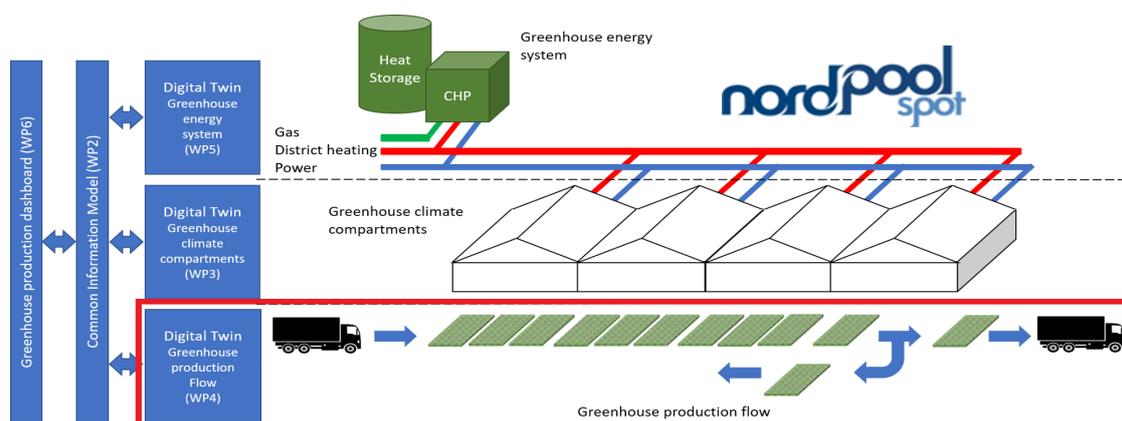


BACKGROUND

The Danish energy system has seen an increasing penetration of intermittent renewable energy production [1]. To accompany the renewable transition there has been an increasing focus on intelligent solutions that effectively exploit and adapt to the energy system. In Denmark, the greenhouse industry alone uses 4.2 PJ annually [2]. As labour and energy-intensive sector, for the greenhouse industry to stay competitive against low-cost regions a vertical integration and optimisation of the production processes is required, using the Industry 4.0 Digital Twin (DT) concept. The project will enable the greenhouses to become increasingly energy-efficient while maintaining sustainable production. Furthermore, a DT can incorporate essential parameters to optimise the overall production plan of the individual greenhouse hence providing a complete approach for commercial growers.

AIM

This project aims to develop a digital twin of greenhouse production flow, to create an artificial intelligence (AI) based simulation model of the greenhouse production flow for investigating the effects of co-optimizing production schedule, plant growth, energy consumption, and cost, by considering influential factors including production deadlines, quality assessment, (district) heating demand, gas and electricity prices, and weather forecasts. The research focus area (WP4) is represented by the red box in the figure.



OBJECTIVES

- Development of multi-agent simulation model for greenhouse production flow
- Identification of Common Information Model interface
- Investigating the effects of co-optimizing factors influencing the production flow
- Simulation of energy efficiency and demand response potentials



METHODOLOGY

The AI simulation platform AnyLogic will be used to create a generic multi-agent simulation model of the greenhouse production flow that includes all production steps from plant propagation, plant forming until the shipment of the final plants. A Common Information Model interface for the digital twin for greenhouse production flow will be established, including the digital twin for greenhouse production flow exchange information with the digital twins for greenhouse climate compartments. The effects of changing production deadlines, quality grading requirements, district heating demand, gas and electricity prices, and weather forecasts will be simulated and analysed using the multi-agent simulation model. Meanwhile, using the multi-agent simulation model, the potentials of energy efficiency and demand response participation will be investigated by simulating different scenarios of production flow optimization.

REFERENCES

[1] Energistyrelsen, "Energistatistik 2017," 2018. [Online]. Available: <https://ens.dk/sites/ens.dk/files/Statistik/pub2017dk.pdf>

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