Goal Document

Master's Thesis - Development of an integrated hybrid energy system model for cloud-deployment

People involved and contacts

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Background

MODELON is a provider of a cloud platform for virtually designing, simulating and analysing industrial systems. Within the cloud platform, the company provides several models that can simulate different energy systems e.g. heat pumps, district heating systems, and thermal energy storage. However, there is no model that contains all of the above components. Such a model could potentially be used to develop and analyse systems where an industrial heat pump is used to satisfy heat consumption. That's why MODELON is providing an opportunity for this Master's Thesis to be conducted.

Project Description

The purpose of this Master's Thesis project is to create a coupled system model based on available Modelica components within Modelon Impact cloud-based simulation platform, which will include:

- High-fidelity industrial heat pump model,
- District heating network model,
- Thermal energy storage,
- Other needed equipment such as backup boiler, electric heater, and solar thermal.

Next simulation study using the developed model will be conducted to address the following problems:

- Economic control strategy,
- Safety of supply temperature with varying weather conditions,
- Live-coupling of the cloud-based system model with online available weather data and electrical grid frequency.

Optional delivered packages:

- Optimization of the developed model operation,
- Creating a Web-Application to demo the model.

Research Questions

- Can a district heating system with a heat pump be modelled in the Modelon Impact platform?
- What are the other necessary components that are needed in such a system?
- Can such a system provide a safe heat supply regardless of varying weather conditions?
- How to optimise the operation of that system?

Method

The project will be divided into several phases. During the first one the literature review, familiarisation with the platform, market study and definition of a representative reference system aligned to a real-world hybrid energy system are going to be conducted. The second phase will be concentrated on the development of the model, the next one will be focused on the simulation study of the developed model and the development process of optional deliverables. Finally, in the last phase, the results are going to be summarized in the report and presented.

Timeline

The project is planned to run for approximately 20 study weeks, with the initial date 16th of January 2023 and the ending date 29th of May 2023.

Planned Results

The finalized report will present the outcomes of the project. The results could potentially help in the development and analysis processes of modern district heating systems with heat pumps and thermal energy storage.

Preliminary description of the resources required for the completion of the work

To perform this Master's Thesis a license to the Modelon impact platform is required which will be provided by MODELON. The company will also provide tutorials that are necessary to work within the platform.

Related work

Salman Siddiqui, John Macadam, Mark Barrett,"The operation of district heating with heat pumps and thermal energy storage in a zero-emission scenario", Elsevier, 2021 ,https://reader.elsevier.com/reader/sd/pii/S2352484721007617?token=3A863B51F8B932D593C781698805EAC9667DCF450B1BB2A03104BD6D91D171C1CF6892868EFB5B406FBE0A3A342F8325&originRegion=eu-west-1&originCreation=20221104105545

Helge Averfalk, Paul Ingvarsson, Urban Persson, Mein Gong, Sven Werner, "Large heat pumps in Swedish district heating systems", Elsevier, 2017 https://reader.elsevier.com/reader/sd/pii/S1364032117307839?token=ACA9EB41F66849BECFE2A856FE0CBE7A43FAB20745ABC83464DFA7023B731D79D2A8BC2BD8D44634D15E6469D40A5226&originRegion=eu-west-1&originCreation=20221104105606

Adapting to the Future of Energy Technology with System Simulation, MODELON Blog, https://modelon.com/support/heat-pump-technology-adapting-to-the-future-with-system-simulation/

Cogeneration Power Plant Optimization for Managing Renewable Energy Efficiently and Economically,MODELON Blog, https://modelon.com/cogeneration-power-plant-optimized-for-renewable-energy/