Research stay at the New South Wales University, Sydney, Australia Integration of Gas, District Heating and the Electric Power Systems – Integrated Simulation Framework

Background

In order to reduce the greenhouse gas emissions, Denmark aims to cover all the energy supply with renewable energy by 2050. Many studies have been carried out on the integration of renewable energy in the electric power systems. However, compared with the independent operation of separate energy systems (heat, electricity, gas), integrating the energy system on generation, conversion and demand side will reduce the energy losses, costs and greenhouse gas emissions. An integrated energy system is a solution which coordinates the conversion of gas, heat and the electric power systems. Coupling of the three systems provides an opportunity for optimizing energy efficiency and renewable energy utilization.

Purpose

The main objectives of this PhD project are: 1. Explore and identify differences and commonalities between the energy sectors gas, heat and power. 2. Modelling of the integrated system of gas, district heating and the electrical power system. 3. Investigation of the energy conversion between each energy system in different user cases including different production and load conditions. Evaluate the efficiency and speed of the energy conversion between each energy system, energy flow and energy losses in each energy system as well as the increased utilization of renewables in the integrated system. 4. Develop an integrated simulation tool or framework for the operation of the integrated system. Independent energy sectors will be coupled, and the simulation cases can be configured and run within the integrated simulation framework.

Methodology

The following methodology is proposed for this PhD project: 1. Initial identification of the differences (e.g. time constants, climate sensitivity, etc.) between the energy sectors as well as identification of necessary and important couplings and information flow needed in order to co-simulate more energy sectors. 2. Identification of standard methods and tools that are traditionally used for modelling and simulation in each energy sector. 3. Dynamic behavior of the integrated energy system. 4. Identification of technical advantages of the integrated framework for energy systems. 5. Validate the simulation framework in real life cases, e.g. the energy system in EnergyLab Nordhavn.

Outcome of the research stay

Dissemination of DTU and the research project can help improve the collaboration between DTU and the University of New South Wales (UNSW). Research collaboration with the research group at the UNSW is expected.