Automatic Data Validation, Fault and Anomaly Detection and Diagnosis for Operation- and Energy Performance Improvements

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Project period

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Partners

The PhD project will contribute to the EUDP funded research projects CELCIUS and PROMA. CELCIUS is conducted in collaboration with Develco Products, Elbek & Vejrup and UNITEN. While PROMA is conducted in collaboration with KMD and Fjernvarme Fyn.

Background

Improving and optimizing the operation and the energy use in building energy systems and district heating play an essential part in transitioning to a greener and more efficient energy consumption in Denmark.

Two thirds of Danish households currently utilise district heating, and energy efficiency improvements in this sector could drastically decrease the overall energy use in Denmark. Improvements can potentially be found both in the transportation of heat to buildings and the consumption within buildings. This is supported by the fact that buildings worldwide currently consume around 40 percent of all energy resources and contribute to an average of 30% of global CO_2 emissions. Meaning that advancements in these two sectors could drastically decrease energy usage and improve energy efficiency. To decrease this excessive use of energy, new solutions must be implemented, both to decrease costs, but also decrease CO_2 emissions and energy use.

Monitoring strategies such as fault detection and diagnosis could be implemented in the systems, to enable proactive maintenance and not rely on the philosophy of "waiting till it breaks", which can decrease costs. It would also open the possibility of identifying faults that have a negative impact of the systems e.g., water leakage in district heating pipes. Furthermore, energy performance monitoring can improve e.g., energy efficiency. These solutions are not used widely in the district heating and building energy systems. Implementing these methods could lower energy use, bring down cost and increase reliability. Large amounts of data is currently collected in district heating sector and building using sensors, but this data is not leveraged to its full potential. These methods could utilise this data to create something of value that can potentially drastically improve the energy sector.

It is expected that an implementation these methods in medium to large-sized buildings could result in a decrease of 20% in energy use, which in turn would also decrease costs.

Objectives

This project aims to develop methods such as data validation, fault detection & diagnosis and data reconstruction for building energy systems and district heating systems based on collected sensor data.

To achieve this aim, the following objectives are laid out:

- Developing general frameworks for handling and manipulation sensor data.
- Develop scalable and adjustable frameworks for implementation in different building and district heating set-ups (generalised methods, not only applicable to few scenarios).
- Development of ways to validate and verify the developed methods.
- Usage of several cases for applying methods to determine viability.

Methodology

This project will utilise a wide variety of tools:

- Development of various methods in programs such as MATLAB or Python.
- Other programming languages such as R and SQL, for database handling and data manipulation.
- Other relevant simulation software for district heating and buildings, such as Termis.