



CITIES

Centre for IT Intelligent Energy Systems

Thermal mass for energy storage: Impacts and perspectives on a system scale

Motivation

Denmark is a well-known country for its eagerness to achieve zero carbon energy supply by the year 2050. Fully renewable power and heating sectors should be achieved even before that. Currently, Denmark already produces more than 40% of its electricity power from wind turbines while the share of renewables in the energy sector as a whole is 27%. On the other hand, transition of the energy sector towards a sustainable one is sometimes hard to impose from the national level as this may cause resistance from people at the local level. Hence, actively involving local population in the transition is one logical step towards achieving an even larger share of renewables in the energy sector.

One municipality that suits well to the latter reasoning is Sønderborg municipality, located in Southern Denmark. The Municipality of Sønderborg sets an ambitious goal of becoming carbon neutral by the year 2029. In order to facilitate this transition, ProjectZero has been established to coordinate active participation of different stakeholders. Due to their involvement from the beginning of the Sønderborg project, as well as their active involvement in the CITIES project, they are a well-suited partner for a demo project. Sønderborg Fjernvarme is the operator of the district heating system in the city of Sønderborg. Hence, their involvement in this demo-project will bring additional knowledge about the present operation of the district heating grid, as well as important insights into the heat demand of the local area, which would otherwise be missing.

Objective

The aim of this demo project is to assess or activate/utilize the thermal energy storage potential of different building archetypes, calculate the potential of thermal mass as a storage component on the system scale and assess the impact of utilizing this storage capacity in the energy system as a whole. Furthermore, special attention will be paid to assessing the possible increase in the integration of renewable energy sources into the power and heating sectors, reduction in CO₂ emissions, as well as increased energy supply security. Possibly, successful results obtained from the model could be applicable to other Danish district heating systems too.

Methodology

Using different building models, a periodic complete cut-off of the heating system will be applied to different building archetypes. The characterization of the building archetypes will be based on two building databases, TABULA¹ and BBR². TABULA will be used for the classification of archetypes according to the building type and construction age, while BBR data will be used to make the urban model of the city of Sønderborg being represented by the suitable archetypes. The potential for thermal cut-off will be estimated based on two preheating strategies and subsequent complete cut-off of heat supply until the indoor temperature drops to the lowest acceptable thermal comfort level. The whole study will be implemented for an average cold day during the heating season of the Danish Design Reference year to represent an unfavorable and demanding scenario. Increased heat demand after the demand response event will also be assessed.

In the second step, obtained data for thermal mass as storage potential on a system scale will be used for estimation of the potential impact of utilizing automated demand response events on heat and power supply sectors. Special attention will be paid to the possibility of integrating a larger share of renewable energy and/or utilizing renewable energy sources in a more efficient and intelligent manner. For the second part of the demo project, a linear optimization model will be developed in order to allow fine refinements of the energy system during the modelling stage.

Partners

- CITIES WP2 (DTU Energy)
- CITIES WP3 (DTU Civil Engineering)
- ProjectZero
- Sønderborg Fjernvarme

Deliverables

- A presentation on potential of thermal mass of different building archetypes for storing heat
- A presentation on impacts on a system scale of utilizing thermal mass as storage in an automated demand response manner
- A scientific paper on the complete model description(s) and results obtained using the city of Sønderborg for a case study

Time frame

December 2016 – June 2017

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¹ TABULA Webtool, <http://webtool.building-typology.eu/#bm>

² Bygnings- og Boligregistret, <https://ois.dk/>