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1 Use cases for integrated electrical and thermal energy systems operation and control with a view on simulation tools

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There is a general lack of knowledge regarding energy systems coupling and few well-defined use cases (UCs) that properly describe the operation of such set-up. Domains integration increases complexity due to additional operational, physical, temporal and spatial constraints making it challenging for analysis and simulation but also for designing operational strategies (i.e. control). Here we present what we think to be the most representative UC for integrated electrical/thermal systems and elaborate on simulation tools requirements for their analysis.

2 The impact of prosumers and their clusters on the energy system

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3 Low-carbon municipalities – modelling of Sønderborg, Denmark

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The municipality of Sønderborg has set itself the target of becoming CO2-neutral by 2029. While a municipal plan to achieve this target exists, this study aims at comparing alternative pathways for achieving low-carbon energy system in Sønderborg, where novel energy conversion technologies such as large-scale heat pumps, biogas production, thermal gasification, electrolysis, biogas methanation and transport fuel synthesis are investigated. Using Energinet's Sifre tool, five different model scenarios for 2029 were evaluated and then results compared using the following four indicators: total system socio-economic costs, energy system's net CO2 emissions, total biomass consumption (relative to the locally available resources) and total energy conversion efficiency of the system. The poster is based on the article recently published in Applied Energy: https://doi.org/10.1016/j.apenergy.2017.03.086.

4 Towards the utilization of heat flexibility: a study of Danish dwellings

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In demand side management, building thermal inertia is a common strategy for short-term thermal energy storage. This study aims to use building thermal inertia to provide heat flexibility for district heating systems to reduce/avoid the operation of peak load boilers. For the operation of district heating systems, the heat flexibility of buildings have to be presented in a simple form to be applicable. We therefore formulated heat flexibility in a straightforward manner and developed a methodology to estimate heat flexibility based weather forecast.

5 Local Ownership Models as an Implementation Tool in Strategic Energy Planning

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6 District Cooling for Smart Cities

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Tropical regions are dominated by hot and humid climate. Lots of waste heat is usually available from power generation, as well as industrial processes, for which there is no matching heat demand due to the high temperatures. In order to estimate the potential of waste heat utilization for cold production in absorption chillers, a Matlab algorithm was developed for dimensioning district cooling grid. Singapore was chosen for a case study and the most beneficial scenario showed significant reductions in CO2 emissions, primary energy demand and total socio-economic costs compared to the business-as- usual scenario. Estimated cooling potential from waste heat was 22.85 TWh on a yearly basis.

7 A Hidden Markov-switching Occupancy Model with Autocorrelated Observations

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This study suggests a new occupancy model based on the use of CO_2 trajectories, trained on measurements in class rooms of two schools in Denmark. A Hidden Markov-switching Model with autoregressive observations using normal state dependent distribution was employed to identify the occupancy states. This modelling approach is a generalization both of Hidden Markov Models and Autoregressive models. In contrast to ordinary Hidden Markov Models, the suggested method takes into account that the current CO_2 level is not only dependent on the occupancy status but also heavily dependent on its own past values.

8 Exploiting Flexibility in Coupled Electricity and Natural Gas Markets: A Price-Based Approach

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9 Demand Response Opportunities in Wastewater Treatment

Author: Rasmus Halvgaard rhal@dtu.dk

In the transition to a green energy system a Smart Grid with flexible consumers is required in order to balance the fluctuating power production. The energy-heavy processes for wastewater transport and treatment can potentially provide a flexible operation with storage capabilities and be a valuable asset to a Smart Grid. In this poster oppotunities for demand flexible wastewater treatment are presented.

10 Forecasting of heat load for buildings and refrigeration load for supermarkets

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This poster presents models and cases studies for heat load forecasting: in buildings and in supermarkets. The models are data-driven time adaptive and are used for short-term forecasting up to 42 hours ahead. Case studies for 16 single-family houses in Sønderborg and a supermarket on Funen are presented.

11 Price responsive predictive control of a heat pump in a family house

Author: Jacopo Parvizi jacop@dtu.dk

The methods applied in this study show how to reduce the energy costs for the local house demand modeling and controlling a heat pump. Flexible demand side response is set to achieve a balance between energy production and consumption using a market price responsive controller.

12 Smart-Energy Operating-System

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This poster describes a framework for implementing smart and flexible energy solutions for future electrical energy systems. The method is formulated as a hierarchy of nested stochastic optimization problems connected via a family of aggregators operating at various spatial and temporal levels. At lower levels the optimization problem is formulated as stochastic model predictive control.

13 Decision Making Models and Support Systems

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The large scale integration of renewable sources into the Danish energy system involves both the power and the heat sector through expansion of wind and bio-fuels. Heat and power systems are nowadays in- dependently operated. However, the presence of CHP units, heat pumps, electric boilers can provide the flex- ibility needed to integrate larger shares of fluctuat- ing sources of power. In consequence, joint decision- making tools to operate heat and power systems to- gether must be developed to exploit these synergies, and in this poster a tool for optimizing combined heat and power systems are presented.

14 Long-term forecasting of daily electricity consumption for individual meters

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Models for long-term load forecasting, which can handle the huge diversity in electricity consumption observed in residences are needed for several applications. For this we have applied a Recursive Least squares (RLS) scheme with forgetting, and model selection tools to chose exogenous variables. This scheme is now used in the mobile app Watts, which now has over 24.000 user.

15 Data-driven models for energy advising leading to behavioral changes in SMEs and residences

Author: Jon Liisby jarl@dtu.dk

In cooperation with SEAS-NVE the focus in this project is to develop models describing the underlying occupant behaviour based on time series of electricity consumption with hourly time resolution. This is used for direct energy advice to residences and small and medium sized enterprises (SME's) through the mobile app Watts.

16 Bridging the building performance gap – Tools for Reliable Energy Performance Characterisation of Buildings

Author: Christoffer Rasmussen chrras@dtu.dk

The objective of this project is to develop reliable yet simple energy performance characterisation tools, that easily can be put into practice. The main research approaches to reach the goal consists of data splitting, building performance estimation and occupant behaviour trend recognition.

17 Structured Literature Review of Electricity Consumption Classification Using Smart Meter Data

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Structured review of the current state of smart meter analytics, with special focus on electricity consumption classification. The review highlights the prevalent methods applied for classification and validation. It describes the typical workflow and finally discusses the need for more thorough data and data wrangling description.

18 TotalFlex: A marketplace for flexibility

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19 TotalFlex: Device Level Demand Forecaster

Author: Bijay Neupane and Torben Bach Pedersen tbp@cs.aau.dk

20 Demonstration of Virtual Energy Market: A SOA-based Approach

Author: Thibaut Le Guilly and Torben Bach Pedersen tbp@cs.aau.dk

21 Dynamic pricing in district heating systems and the impact of heat storage

Author: Nina Dupont, Bjarne Bach and Mikael Togeby nd@eaea.dk

Marginal pricing is well-established in the power sector but is so far not applied in district heating systems, where heat producers receive prices based on the average costs of production. While average pricing has the benefit of simplicity, marginal pricing results in optimal, least-cost production and gives correct incentives for emerging heat technologies, such as solar thermal heat, heat pumps, industrial surplus heat and heat storages. We present a case where marginal heat prices are compared to average pricing in the Aarhus district heating system. A focus point is the impact heat storages have on the marginal heat prices.