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Dynamic CO2 based control

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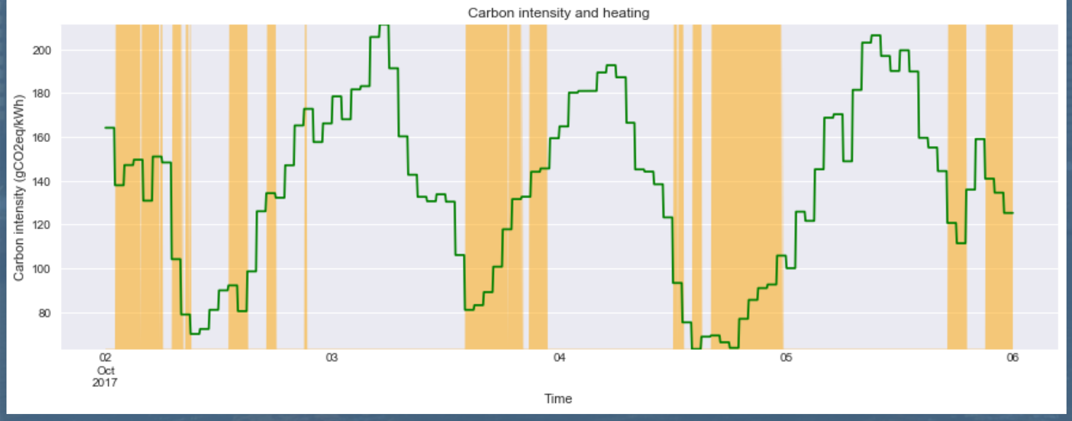
INTRODUCTION

In 2017 in Denmark, it was seen that 44% of the electricity load were covered by the fluctuating and partly unpredictable wind power generation. This large penetration of the stochastic wind power often leads to balancing problems. The Pilot, which also is linked to the H2020 SmartNet Project, aims at assessing the potential of provision of ancillary services from an aggregation of Danish summer houses with swimming pools.

Summer houses with swimming pools consume substantial amounts of electricity for heating the water and humidity control. The electricity demand from summer houses is particularly flexible. For example, swimming pools have a large thermal mass, thus, the load to heat pool water can be disconnected or shifted with little consequences on the comfort of the occupants. This makes them particularly well-suited to the provision of ancillary services and balancing. Field testing of the proposed setup involves a small but representative number of summer houses. For this Pilot, it has been decided that 30 houses, located in Blokhus and Blåvand in Denmark, would be enough proof-of-concept for the estimation of the potential of summer houses in the provision of ancillary services.

Predicted carbon intensity (green) and periods at which the heat pump is turned on (orange). The installation is located in Denmark.



SOLUTION APPROACH

Using the Smart-Energy OS (SE-OS) the CO_2 - or price-based indirect control provides a setup for storing excess wind and solar power, and at the same time the setup can provide services for the smart grids. Here the Distributed Energy Sources (DERs), i.e., swimming pools, after receiving the control signals, calculate: i) the optimal consumption profile within the forecast horizon, and ii) the set-point for the thermostat of each individual summer house. The control signal is based on the grid load forecasts, electricity price or CO_2 forecasts, weather forecasts, and booking information. Measurements from the summer houses are afterwards collected and used, among other information, to feed price-responsiveness information in the price response model. The heterogeneous and stochastic nature of the responses of the DERs calls for new procedures for: i) predicting how to invoke the needed flexibility, and ii) characterizing and describing the relationship between control signals and the resulting electricity load.

Example: CO2 based control

When the wind power production is high, CO_2 emission are low and electricity prices low, the SE-OS based controllers store the excess wind power in the water in the pools. The controllers then control that electricity consumption is avoided the following couple of days when the CO_2 content again is high

Example: Price based control

When the electricity prices are the SE-OS based controllers avoid using power to heat the water in the pools. The controllers will then control that electricity consumption is avoided until the price again is low. In this case the CO_2 content associated with the power production is not taken into account.

EXPECTED OUTCOME

- The SE-OS based control procedure can lead to 20-30 pct lower CO_2 emissions (or similar cost savings).
- Energy consumption may at the same time increase with 5 pct – but at low cost periods.
- The pools are heated only when the CO_2 emissions or price is at minimum.
- We have demonstrated that we can accelerate the transition to a low carbon society simply by using forecasting and predictive controllers.

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