CITIES
Centre for IT Intelligent Energy Systems

Smart water utilities for flexible energy systems

Motivation

Denmark is one of the most ambitious countries regarding the energy system transition. It aims to become carbon neutral by 2050. Furthermore, by 2030, it aims to reduce its CO2 emissions by 70% compared to the 1990 levels. Many years of expansion of primarily wind energy in its electricity system raised the need for making the whole energy system more flexible. Installing ever larger capacities of battery electric storage, or making ever-larger super grids is an expensive way of increasing flexibility in the energy system. On the other hand, cheaper solutions for increasing the flexibility of the energy system can be found by integrating different energy sectors in a smart (controllable) way. Some examples include the integration of power and heating sectors, power and electrified transportation modes, as well as power and water systems.

This demo project will focus on the latter point. By controlling the water systems in a smart way, it will aim for increasing the flexibility of the energy system as a whole. It will do so by consuming more electricity when there is an abundance of renewable energy, and curtailing its consumption when there is an excess of fossil fuel-generated electricity.

In order to show the benefits of integrating power and water sectors, two case studies were chosen. The chosen case studies fulfil the basic prerequisite of operating the water system in a smart way; it collects a large amount of data by using smart measurement devices at many points in the water grid.

Objective

Utilities have to focus on cost reduction, safe and secure operation, as well as to contribute to the CO2 emissions reduction.
The aim of the project is in the first phase to develop a tool for evaluating the provided flexibility, to value the provided flexibility in the economic and CO2 terms, and in the second phase to actively control the electricity consumption of the water utilities and make a proof of concept.
By running the equipment, in a flexible way, such as water pumps, the water utilities could provide the flexibility to the energy system overall. The water utilities included in this demo project are operating drinking water systems, waste and stormwater systems, as well as the sewage. The flexibility provided by the water utilities should increase the consumption in periods when electricity is cheap and/or its CO2 content is low. On the other hand, it should lower its consumption in periods when the electricity is expensive and/or CO2 emissions are high.

Methodology

Currently, most of the water utilities acquire the electricity from the suppliers via fixed price per energy unit. The latter hedging can be expensive for utilities. Moreover, it does not incentivize a provision of the flexibility to the energy system. As water utilities consume a large share of electricity on running the pumps within the system, there are no physical constraints on running the system in a more flexible way.
Electricity prices are known on an hourly basis for a 24-hour period in the case of the day-ahead market, which can be used as an input to optimize the operation of the water systems. Furthermore, large capacities of pumping power in the system makes it possible for water utilities to participate in balancing markets, too.
In this demo project, it will be tested the possibilities to run the water systems of the chosen case studies in a flexible way using different control strategies. The initial test will be based on the historic data. Two different inputs will be tested as a signal for operating the pumps in the water systems: CO2 intensity and prices of energy in a dynamic way.
The demo project will consist of the parts:

a) Initially, a simple model will be tested focusing on price signals of the day-ahead market. It will be tested the possibility to shift the consumption by one to two hours. Potential benefits will be calculated in terms of economic savings and CO2 emissions reduction.
b) Following the results of the part a), a more complex model will be created. Based on the potential showed in a), it will be tested the possibility to participate in the intra-day and regulating markets, too.

The method used in this demo-project will include the use of the large amount of historic data which will be used to create and validate the models of the electricity consumption of the chosen water utilities. In a combination with the energy price data from the Northpool electricity market, an overall potential for the business opportunities for the water utilities will be assessed.
Finally, all the relevant physical and security of supply constraints will be taken into consideration when calculating the potential flexibility, such as minimal up-time, quality standards, operational limits and others.

Partners

- CITIES WP5 (DTU Compute)
- Krüger-Veolia
- Two utilities one in DK1 (Jutland/Fyn) and one in DK2 (Sjælland)

Deliverables

- A presentation of the potential of water utilities for participating in more complex operating schemes
- A method for evaluation of the potential in flexibility for one utility based on historical data
- A scientific paper that will estimate the impact of the flexible operation of the water utilities on the energy systems
- A short technical report on the results of the demo project

Time frame

November 2019 – March 2020 Part 1
April 2020 - October 2020 Part 2

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