Master thesis project 2012 - Electric Power Systems

Evaluation of market models for the Stockholm Royal Seaport Project

Background:
Smart grids are the future electrical grids. Smart grid often refers to the driver to make the electrical system more environmental friendly and improve the markets functionality. In order to accelerate innovation in smart grid and technology applications, pilot projects have been employed throughout the world. One pilot project in Sweden is the Stockholm Royal Seaport project.

Stockholm Royal Seaport is an urban development project for a planned expansion of housing and services that will take place in the district of Hjorthagen in Stockholm [1]. The Stockholm Royal Seaport project has been designated as one of 18 projects in the world supported by the Climate Positive Development [2]. The projects are selected to show that cities can reduce carbon emissions and facilitate climate-friendly growth.

The Royal Seaport aims to develop a smart grid for integration of consumers and producers into the electrical grid. The Royal Seaport Smart Grid concept includes load balancing and demand-response control in a smart grid that contains irregular consumption and renewable generation. The main actors in the Royal Seaport Smart Grid are ABB, KTH and Fortum. This master thesis project will be a collaboration between KTH and Fortum.

A pre-study for the Stockholm Royal Seaport project was performed 2010-2011 [3,4]. In [3,4] market models that support a development towards an energy system with active consumers resulting in a more efficient use of the system and less environmental impact are presented. An active consumer might be a household that choose to postpone starting the dishwasher if the hourly electricity price is high. These new market models will be tested on voluntary households in the Royal Seaport area. The electricity price that the consumers face consists of different components such as tax, retail price and a network tariff. The retail price originates from the demand and supply of electric energy available in the system. The network tariff is related to the cost due to the transmission of the electricity to the consumer. The developed market models are both for the retail price as well as for the network tariff.

The aim with testing the new market models is to investigate their impact on energy consumption and load shifting which have been formulated in the “Active consumer” scenario and corresponding hypotheses listed in [3]. The next step in the Stockholm Royal Seaport project is to develop evaluation methods to test if the hypotheses formulated in the pre-study are true. A general framework for how to evaluate market models for smart grid projects was developed in [5]. Reference [5] also presented a compilation of the results of market models applied in smart grid projects around the world to verify if the hypotheses formulated in the

"Active consumer" scenario are reasonable. This Master thesis project is a continuation of the project presented in [5].

Aim with the Master thesis project:
The objective with this Master thesis project is to specify evaluation methods for the market models that are to be tested in the Stockholm Royal Seaport project.

Tasks in the Master thesis project:
The Master thesis project can be divided into four tasks:

1) Identify different ways to evaluate the hypotheses: analyzing load curves, interviews, comparison with neighbors, international compilation of similar smart grid projects and their achieved results, etc. Maybe many methods can be combined? Are other data needed such as daylight statistics, outdoor temperature, and electricity prices to verify the cause and effect relationship? In the Stockholm Royal Seaport project there will be district heating so the impact of outdoor temperature will not be large.
2) Is it possible to identify an active consumer from logged load data? How much load data are necessary to identify a difference in the load pattern due to an active consumer? To investigate this further load curves need to be simulated. Formulate a load model to simulate the household's load as a function of the use of the appliances provided in the Stockholm Royal Seaport flats. The load model needs to capture the stochastic activities that give rise to an electricity consumption. Seasonal variation in daylight will also have an impact on the consumption due to lighting during the year. Example of a load model for households based on a Markov model is presented in [6].
3) Assume that the market models will make the hypotheses formulated in "Active consumer" scenario true. Implement the behavior of an active consumer that is in line with the behavior specified in the hypotheses and simulate the load curve of this type of consumer. Compare the simulated load curves for non-active and active consumers. Since activity patterns are stochastic even for a non-active consumer it demands a deep analysis to see if it is possible to distinguish a non-active consumer to an active consumer from only looking at the load curves. How much load data needs to be logged in order to verify the hypotheses about an active consumer?
4) Summarize the Master thesis report in a scientific paper that will be submitted to an international conference.

The Master thesis project is expected to start in the beginning of September 2012. The project has short deadlines and therefore demands a student to be able to work full time.

Qualifications:
Electrical Engineering and Physics Engineering students as well as other engineering students are welcome to apply. Since the project demands mathematical skills, good grades in math courses are required. Furthermore, good oral and written communication skills in English are required. Since some of the references are in Swedish, it is good if the applicant can read Swedish. However, the Master thesis report will be written in English with a Swedish summary.

Application:
The application shall include a CV, a short personal letter and transcripts of finished courses.

The application is sent to:
karin.alvehag@ee.kth.se
in pdf format (only), with all documents merged into one single pdf-file. Please write "Master thesis project L2a" in the subject line.

Deadline for application is August 13th, 2012.

General information:
The master thesis project will be performed at the department of Electric Power Systems at KTH. The student will receive a payment of 35850 SEK when having finalized the Master thesis project and an international conference paper.

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References:
[1] Stockholm Royal Seaport, Retrieved January 9, 2012, from http://www.stockholmroyalseaport.com/

[2] Stockholms stad, Norra Djurgårdsstaden Stockholm Royal Seaport – Vision 2030. Sundbyberg: Alfaprint, 2009. Only available in Swedish.

[3] Christer Bergerland, Knut Faber, and Olle Hansson, Norra Djurgårdsstaden - Nya marknadsmodeller för engagerade kunder, Elforsk report 11:66, 2011. Only available in Swedish

[4] Yalin Huang and Henrik Olsson, Market concepts and the regulatory bottlenecks for smart grids in the EU regulations, Master thesis, KTH, 2011

[5] Ongoing Master thesis work on evaluation methods for market models applied on smart grids, project within the Stockholm Royal Seaport project.

[6] J. Widén and E. Wäckelgård, A high-resolution stochastic model of domestic activity patterns and electricity demand, Applied Energy, vol. 87, pp. 1880–1892, 2010.

Published: 2012-05-31