PhD Lecture

In partial fulfillment of the terms for obtaining the PhD degree, Emmanouil Valsomatzis will give a lecture on the following subject:

**Aggregation Techniques for Energy Flexibility**

on Monday 4th of December 2017, 13:00, in room 0.2.13 at Selma Lagerlöfs Vej 300

Abstract:

Over the last few years, the cost of energy from renewable resources, such as sunlight and wind, has declined resulting in an increasing use of Renewable Energy Sources (RES). As a result, the energy produced by RES is fed into the power grid while their share is expected to significantly increase in the future.

However, RES are characterized by power fluctuations and their integration into the power grid might lead to power quality issues, e.g., imbalances. At the same time, new energy hungry devices such as heat-pumps and Electric Vehicles (EVs) become more and more popular. As a result, their demand in power, especially during peak-times, might lead to electrical grid overloads and congestions. In order to confront the new challenges, the power grid is transformed into the so-called Smart Grid. Major role in Smart Grid plays the Demand Response (DR) concept.

According to DR, Smart Grid better matches energy demand and supply by using energy flexibility. Energy flexibility exists in many individual prosumers (producers and/or consumers). For instance, an owner of an EV plugs-in his EV for more time than it is actually needed. Thus, the EV charging can be timely shifted. The load demanded for charging could be moved to time periods when production from wind turbines is high or away from peak-hours. Thus, RES share is increased and/or the electrical grid operation is improved.

The Ph.D. project is sponsored by the Danish TotalFlex project (http://totalflex.dk). Main goal of the TotalFlex project is to design and establish a flexibility market framework where flexibility from individual prosumers, e.g., household devices, can be traded among different market actors such as Balance Responsible Parties (BRPs) and distribution system operators. In order for that to be achieved, the TotalFlex project utilizes the flex-offer concept.

Based on the flex-offer concept, flexibility from individual prosumers is captured and represented by a generic model. However, the flexible loads from individual prosumers capture very small energy amounts and thus cannot be directly traded in the market. Therefore, aggregation becomes essential. The Ph.D. project focuses on developing aggregation techniques for energy flexibilities that will provide the opportunity to individual prosumers to participate in such a flexibility market.

First, the thesis introduces several flexibility measurements in order to quantify the flexibility captured by the flex-offer model and compare flex-offers among each other, both on an individual and on an aggregated level. Flexibility is both the input and the output of the aggregation techniques. Aggregation techniques aggregate energy flexibility to achieve their goals and, at the same time, they try to retain as much flexibility as possible to be traded in the market. Thus, second, the thesis describes base-line flex-offer aggregation techniques and presents balance aggregation techniques that focus on balancing out energy supply and demand. Third, since there are cases where electrical grid congestions occur, the thesis presents two constraint-based aggregation techniques. The techniques efficiently aggregate large amounts of flex-offers taking into account physical constraints of the electrical grid. The produced aggregated flex-offers are still flexible and when scheduled, a normal grid operation is achieved. Finally, the thesis examines the financial benefits of the aggregation techniques. It introduces flex-offer aggregation techniques that take into account real market technical requirements. As a result, individual small flexible loads can be indirectly traded in the energy market through aggregation.

The proposed aggregation techniques for energy flexibilities can contribute to the use of flexibility in the Smart Grid in both current and future market frameworks. The designed techniques can improve the services offered to the prosumers and avoid the very costly upgrades of the distribution network.
Members of the assessment committee are Senior Scientist Henrik W. Bindner, Center for Electrical Power and Energy, Technical University of Denmark, Associate Professor Lukasz Golab, Department of Management Sciences, University of Waterloo, Ontario, Canada, Associate Professor Simonas Saltenis, Department of Computer Science, Aalborg University, Denmark. Professor Torben Bach Pedersen, Aalborg University, Associate Professor Alberto Abello, Polytechnic University of Catalonia (UPC), and Associate Professor Katja Hose, Aalborg University are Emmanouil Valsomatzi’s supervisors. Moderator is Associate Professor Hua Lu.

All interested parties are welcome. After the defense the department will be hosting a small reception in cluster 3.