

PhD Position in Renewable Energies:  
**PhD Position within Profit Optimization in Control of Smart Grids**

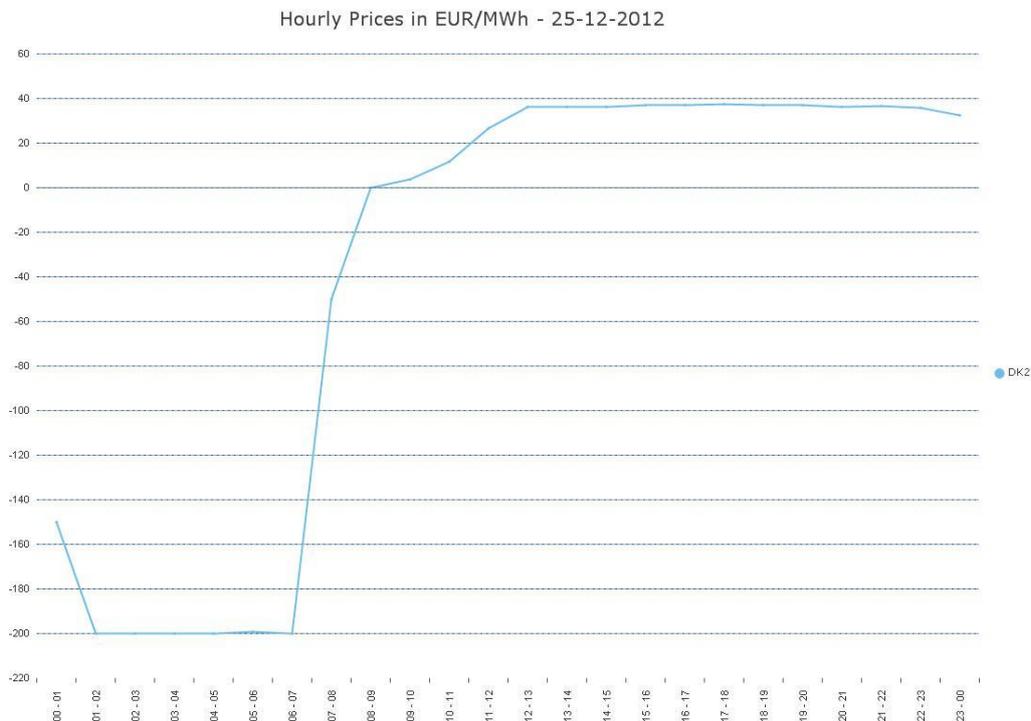
### Introduction to the Subject

Depletion of fossil fuels and environmental concerns motivate governments to increase investments in renewable energy resources such as wind, wave, and solar.

The Danish government aims at supplying 50% of the electricity consumption by wind turbines by year 2020. Unlike the conventional energy production, renewable energy resources are intermittent and difficult to control. This complicates the task of balancing production with consumption in a future power grid with high penetration of fluctuating renewables. This PhD project should develop methods for optimal usage of production and consumption to reach a balance on electricity market.

### Contents of the PhD Work

Electricity is traded in a number of markets: Power (electricity production that is delivered instantaneously), Energy (electricity production that is scheduled, e.g., a day ahead), and Ancillary Services (electricity production that maintains high power quality). In this project, a control concept will be established to optimize the combined profit on all three markets. Specifically, we consider the control of a wind farm that acts according to the market conditions. Production of active and reactive power is controlled in accordance with the current and expected future prices. Surprisingly, in times of overproduction of electricity a net operator pays for reducing the production. This is the case in the attached figure, where on December 25, 2012 between 1am and 6 am, the price was negative, -200 EUR/MWh; whereas, during midday the prices was at the level of 40 EUR/MWh.



The action of the controller is affected by uncertainties in the weather forecast and in the consumption. This makes it necessary to consider stochastic control. Additionally, the number of actors playing on the electricity market is huge; therefore, classical (centralized) optimization

algorithms fail due to the high system complexity. Hence, decentralized optimal control has to be developed in the project.

## **Outcome**

The goal of the PhD project is to develop novel methods for managing and aggregating the flexible demand/supply from consumers/producers, while at the same time optimizing profits based on market constraints. The theoretical study shall be empirically validated. To this end, the production, consumption, and price-history will be available. There will also be an opportunity to validate the developments in an experimental setup.

## **About the Research Group**

This project will be accomplished within the context of the Smart Grid Group in Automation and Control, Department of Electronic Systems led by Prof. Rafael Wisniewski. The group comprises of 9 researchers and is supported by three international research projects: EDGE, Smart & Cool, and SmartC2Net.

## **Supervisors**

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