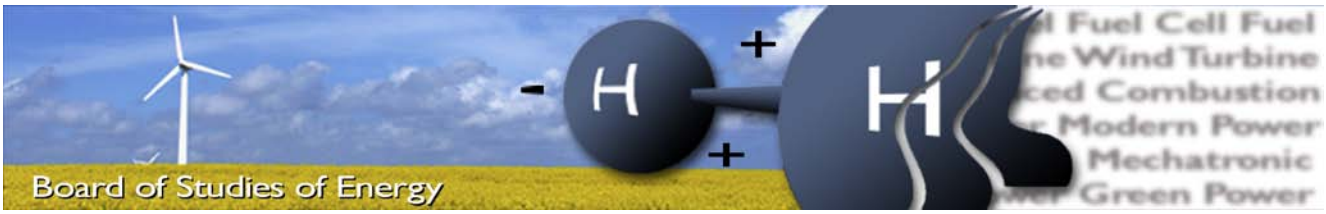

Electrical Power Systems and High Voltage Engineering (EPSH)

Introduction

In the future it is expected that the electrical energy production area and the belonging network grid structure will change. It is expected that an increased amount of dispersed renewable generation units such as for instance PV-systems, biomass systems and small wind turbines will be connected to the network grid at the distribution level. At the same time connection of large offshore wind farms at the transmission level can also be expected. This will offer potential economic, environmental and technical benefits, but it also presents a great number of challenges and uncertainties. The introduction of dispersed generation and wind farms will affect the network technically in a number of ways concerning load flow pattern, power quality problems, voltage control, frequency control and reactive power control. Further, the dispersed generation units and the wind farms could alter the fault level and the fault current in the distribution and transmission system and may require adjustments or replacements of the protection system. Also attention should be paid to the availability and security.

Programme description:

The MSc programme in Electrical Power Systems and High Voltage Engineering aims to teach the student at high standard to be able to compete with the challenges of the future network grid and at the same time ensure a solid grounding with great career opportunities and perspectives. Topics included in the programme are for instance:

- High voltage technology
- Network planning
- Computer simulation of transient and steady-state phenomena
- Compensation systems
- Application of advanced control and surveillance strategies
- Stability, reliability and power quality

- Relay protection
- Fault calculation and localisation
- Power flow.

The MSc programme in Electrical Power Systems and High Voltage Engineering is taught in an innovative, dynamic and challenging environment through a combination of research-based courses, team-based project work and a high degree of interaction with the industrial partners and the energy supply companies. The industrial partners and the energy supply companies take an active part by providing project proposals for the problem-oriented project work, guest lectures and visits to the companies.

Students following the Electrical Power Systems and High Voltage Engineering specialisation will study high voltage technology, network planning, and computer simulation of transient and steady-state electromagnetic phenomena, compensation systems, and application of advanced control and surveillance strategies.

The objectives are as follows:

- To provide students with knowledge of production, transmission, distribution and utilisation of electrical energy
- To enable students to apply different methods of analysis and synthesis for design and simulation of various electrical energy systems
- To enable students to apply different control and surveillance systems for control of a network. This will include power system protection and the application of power electronic compensation units
- To provide students with knowledge of how to apply test methods and systems for testing high voltage components (non-destructive, SIWL and LIWL) according to applicable standards. This includes testing for electromagnetic compatibility (EMC)

1st Semester (see profile description for 1st semester of the specialsations in Energy Engineering)

2nd Semester

Project theme: Control and Surveillance of Electrical Power Systems

2nd semester projects will study a component, an application or a process involving control or surveillance of electrical power systems. A variety of

advanced courses covering power converters, high voltage technology, electrical machines and different control methods are offered. These will provide the background knowledge and support for the projects.

The courses offered on the 2nd semester are:

- Finite Element Method
- State Space Control
- Innovation and Entrepreneurship
- Optimisation Theory
- Non-Destructive Test Methods in High Voltage Engineering
- EMC regulations and apparatus design
- Advanced Control of AC-drives
- Harmonics in Power Systems
- Load Flow Methods for Power System Analysis
- Power System Protection

Project examples:

- o A new proposal for the grid connection of large off-shore wind turbine parks
- o Frequency control of wind farms
- o Earth fault test equipment installed on a trailer when measuring at the Kyndby Power plant test area
- o Stability analysis of synchronous generator with rotating diodes controlled by various different voltage regulators
- o DSP-based differential protection algorithm, applying a Kalman-filter, for the protection of an auxiliary transformer at a combined cycle plant

3rd Semester

Project theme: Electrical Power Systems and High Voltage Engineering

3rd semester projects will study stability issues, network planning, compensating systems, electromagnetic compatibility (EMC), load flow, and high voltage technology.

Projects may study a component, an application, or a complete Power system. To continue practising scientific communication, the project result or parts of it should be published in an article written in English which is to be presented at an internal seminar.

The courses offered on the 3rd semester:

At this semester all the courses are PE courses, and the students must follow a course load corresponding to at least 8 ECTS, of which 2 ECTS are mandatory for all students under the Board of Studies of Energy, the rest is elective and can for instance be courses offered at other specialisations or research intensive packages either within the specialisation or multidisciplinary packages. The elective courses will/or can be changed from year to year.

Mandatory courses:

- Stiff systems and differential algebraic equations
- Linear optimal control theory

Courses of which at least 6 ECTS must be chosen could for instance be in the area of:

- Control engineering
- Power electronics in power systems
- Electrical machines
- Mechatronic control engineering
- Thermal energy engineering
- Energy planning
- Nonlinear control
- Grid-connected power converters
- Finite element analysis in electromagnetism
- Power system stability
- Dielectric breakdown and insulation coordination

Project examples:

- Flexible AC Power Systems
- Load Flow analysis of the ENV 60kV grid studying changes in reactive power flow when overhead lines are replaced with cables
- The effects of connection of wind power systems to the network grid
- Measurement of the distortion in the No-Load Current of a 20/60 kV Power Transformer at the HEF Utility

4th Semester

Project theme: Master's thesis

The final project may study new subjects or be an extension of the project work of previous semesters. The project will be carried out in collaboration with an industrial partner, energy supply company or transmission system operator assuming the character of industrial research or development work. Alternatively it may be support one or more research projects at the Institute of Energy Technology, or another research facility assuming the character of research. Often, students write scientific papers reporting the work of their final project.

Examples of masters thesis projects:

- Probabilistic network planning at the transmission level
- Power grid studies for the Karahnjúkar hydro-electric power plant and Fjardaál Aluminium Smelter
- Analysis and modelling of the dynamic behaviour of the 400 kV line from Thrige to Ferslev
- Performance analysis of 60 kV distance relays for the HEF net.

- Optimisation of power flow
- Overvoltage protection of large power transformers
- Distance protection on a 150 kV combined OH and cable connection
- Lightning protection of transmission lines
- Wireless Current Transducer
- Dynamic simulations of switching transients in a compensated 60 kV cable grid

Specific admission requirements
Successful completion of the 1st semester of the M.Sc specialisation in Electrical Energy Engineering or Introductory Semester under the Board of Studies of Energy, or equivalent.

For further information:

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