Short version profile plan for Electricity for Societal Development 2015–2019

Vision

Tomorrow's electric power systems must drastically change in order to become sustainable and efficient, meeting at the same time the changing societal challenges. Chalmers will be in the lead of this process by proposing, investigating and evaluating new solutions for reinforcing and transforming the power system and its associated infrastructures.

Background and context

With increased urgency of reducing greenhouse gas emissions from the energy system, it is reasonable to expect that electricity will be an increasingly important energy carrier across society. It is a common wish, both from the research society and from decision makers, that in future power systems the majority of the energy supply will be achieved through renewable energy sources, while the power systems should be increasingly controllable in order to optimise the power flow and reduce losses.

In the attempt to accommodate increased amounts of variable electricity production, the interplay with the demand side must be understood both with respect to possibilities and challenges. To do this, the *smart grid concept* has recently been introduced. Smart grid represents an evolution of the classical power systems, where distributed generation, energy storage, and information infrastructure are utilized to enhance the traditional system control. In addition, energy management systems are utilized to improve the system performance and reliability.

The expectation on the smart grid concept is that it will enable the grid to predict and quickly respond to changing power generation (from variable sources) as well as changing demand for power, abrupt source rescheduling and faults, with clear goals to enable an efficient use of variable power sources as well as increased use of distributed generation while maintaining efficiency. Empowering consumers and enabling energy trade market, where end-users can decide to use energy when affordable and save it when it is not, is included in the smart grid concept. In recent years, Chalmers has been very active in the area of smart grid from a number of different aspects.

Active fields

The profile includes three major, tightly cooperating, active research fields:

- Electric Power Generation, Transmission and Distribution System
- Materials and Diagnostics for High-voltage Networks
- Techno-economic Aspects of Energy Systems

Electric Power Generation, Transmission and Distribution System

The aim of the research in this active field is to investigate and evaluate solutions for an efficient, effective and secure design and operation of the future power systems. In particular, key focus will be on solutions to allow the integration of large-scale renewable energy sources in the power grid and on how power-electronics and electro-mechanical based devices can change the way in which electric energy is produced, transported and used.

Materials and Diagnostics for High-voltage Networks

The main goal within this active field is to develop and introduce new material solutions in the design of future power systems components, with a special focus on HVDC transmission. Polymers filled with nanoparticles, environmentally friendly gas mixtures and biodegradable fluids are the possible lines of development. The work will concentrate on elaboration of design criteria, testing and diagnostic methods, manufacturing technology and installation methods, to name a few directions.

Techno-economic Aspects of Energy Systems

Research within this active field aims at understanding the future role of the electricity system under various scenarios, considering different targets on emission reduction, renewable energy and efficiency. The scope is mainly the European electricity system and to cover the entire value chain from supply to end-use of electricity. A key is to assess how large amount of intermittent (variable) electricity generation can be integrated in the most cost-efficient way. A core of the work is to improve the modelling capabilities to allow for time resolved simulations of both supply and demand of electricity, including studies of the effects from demand response measures.

Planned activities 2015–2019

Our profile involves a number of key researchers that are at the research front in their respective fields. We strongly believe that the key-of-success for the profile lies in the combination of excellent research of each specific active field in conjunction with a tight cooperation, enabling broad and unique knowledge in the area of electric power systems.

Besides **classical community building**, two main activities will be initiated for developing the profile:

- Establishment of a **Profile Young Seniors Board** aiming to involve young and prominent Chalmers researchers in the Area of Advance and stimulate new ideas and information exchange.
- Establishment of a **Profile Advisory Board** aiming to advise and inspire activities within the profile. Chalmers researchers involved in the different active fields and industrial representatives will constitute the board.

Further, the profile will actively work for **internationalisation** by promoting mobility and funding Chalmers researchers spending time abroad as well as foreign researchers coming to Chalmers. The profile will also take an active role in the **strategic recruitment** of a new professor in high voltage engineering.

The profile will also initiate a number of research work packages. The topics of these research work packages are:

- **Societal and environmental aspects of decentralized electricity systems (2016–2019)**
  The research of this work package aims to contribute highly relevant and up-to-date theoretical and empirical understanding of system dynamics in emerging decentralized electricity systems, both in developed and developing countries.
- **INDEED: Information and data-processing in focus for energy efficiency (2016–2019)**
  The project is about using data and information technology for enhancing energy efficiency, as well as about studying the efficiency and energy-efficiency aspects of data processing.
- **Planning, operation, and control of future renewable power systems (2016–2019)**
  This work package aims at optimal planning and operation of distribution systems using power-electronic converters and distributed energy and balancing resources, as well as at developing methods to determine the best strategy to utilize the power-electronic converters and other advanced power system monitoring technologies to increase transmission efficiency and system stability.
- **Activities within Electric power generation, transmission and distribution system (2016–2019)**
  The aim of this work package is to investigate and evaluate solutions for an efficient, effective and secure design and operation of the future power systems. In particular, key focus will be on solutions to allow the integration of large scale renewable energy sources in the power grid and on how power-electronics and electro-mechanical based devices can change the way in which electric energy is produced, transported and used.
- **The techno-economics of the electricity system (2016–2019)**
  The aim of this work package is to understand the future role of the electricity system under various scenarios, considering different targets on emission reduction, renewable energy and efficiency. The scope is mainly the European electricity system and to cover the entire value chain from supply to end-use of electricity. A key is to assess how large amount of intermittent (variable) electricity generation can be integrated in the most cost-efficient way.
- **Activities within Materials and diagnostics for high-voltage networks (2016-2019)**
  The main goal of this work package is to develop and introduce new material solutions in the design of future power systems components, with a special focus on HVDC transmission. Polymers filled with nanoparticles, environmentally friendly gas mixtures and biodegradable fluids are the possible lines of development. The work will concentrate on elaboration of design criteria, testing and diagnostic methods, manufacturing technology and installation methods, to name a few directions.