

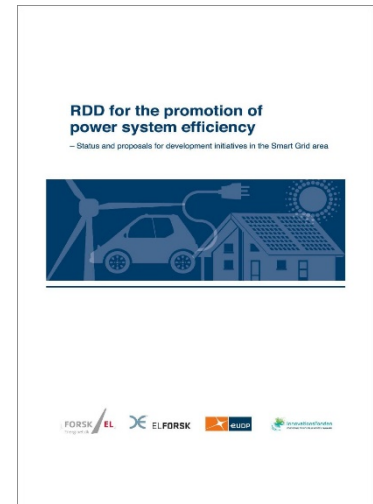
# Technological Sciences Dominate Danish Smart Grid Research

The Danish energy research programmes have supported Smart Grid research for several years. The total amount of money for Smart Grid research has not been published, but for the ForskEL programme alone, the magnitude could be 100 million DKK.

A Smart Grid, which is supposed to communicate with all electricity users, will be a highly complex system. Therefore, it is important to organize the research efforts carefully in accordance with the national targets for the energy systems and to involve a broad range of research environments.

In April 2013, the Danish Ministry of Climate published a Smart Grid strategy<sup>1</sup>. One of the 20 initiatives requested a report on Smart Grid research. The report was published in November 2014<sup>2 3</sup>.

The report includes a large number of recommendations for specific research areas, but the main findings can be summarized in a few headlines.



## Insufficient research in market design and communication

Already in 2011, a report<sup>4</sup> pointed out that more research in market design and communication would be a necessary contribution to the Smart Grid development. Nevertheless, very little happened within these areas since then.

Technological research environments conducted most Smart Grid development in Denmark so far. The result seems to be an underestimation of the challenges in market design and ICT<sup>5</sup>. Research environments covering economics, political science, and sociology should have central roles in the future Smart Grid research.

In that respect, it is good news that the ForskEL programme has announced that one of three focus areas in this year's call for research applications will be "Market and society".

## Promising research in transmission and distribution

The working group has found that a number of ongoing research projects are expected to deliver operating results well before 2020, particularly as concerns the operation of the transmission system and the planning of the distribution systems.

<sup>1</sup> Smart Grid strategy – the intelligent energy system of the future (Smart Grid-strategi – fremtidens intelligente energisystem). The Danish Ministry of Climate, Energy and Building. April 2013

<sup>2</sup> Full text in Danish: [http://pfbach.dk/firma\\_pfb/smart\\_grid\\_fud\\_dk\\_2014.pdf](http://pfbach.dk/firma_pfb/smart_grid_fud_dk_2014.pdf)

<sup>3</sup> Summary in English: [http://pfbach.dk/firma\\_pfb/smart\\_grid\\_rdd\\_summary\\_eng\\_2014.pdf](http://pfbach.dk/firma_pfb/smart_grid_rdd_summary_eng_2014.pdf)

<sup>4</sup> Analysis of the Danish electricity industry's Smart Grid RDD initiatives (Kortlægning af den danske elbranches Smart Grid FUD-indsats), Energinet.dk and the Danish Energy Association, 25 January 2011.

<sup>5</sup> ICT: Information and communication technology

## Decisive assumptions have changed dramatically since 2010

'Smart Grid in Denmark' published in 2010<sup>6</sup> includes a cost-benefit analysis. Major changes have already been made to some of the key prerequisites for this analysis, particularly regarding consumption for electric vehicles and electricity production from solar panels:

GWh in 2020	Smart Grid in Denmark 2010	Energinet.dk: Assumptions for analyses 2015-2035
Consumption EV	720	140
Production PV	110	840

The working group therefore recommends that the calculations be updated, preferably divided into individual Smart Grid elements, including heat pumps, energy storage facilities, electric car charging stations and solar cells and preferably divided into businesses and private households.

## Several measures depend on fluctuating electricity prices

A flexible electricity consumption assumes varying (volatile) electricity prices. Other concurrent means of addressing the new challenges may, however, dampen the price fluctuations, and, by extension, the flexibility of electricity consumption. For example, there are special incentives for the installation of reserve capacity (capacity schemes) as well as electric boilers and large heat pumps to absorb surplus energy.

While individual analyses of Smart Grid measures may show good profitability, the combination of potential measures may be loss making. It is therefore important to analyse the competition between all potential means and measures and their overall effect.

## Limited effect of consumer flexibility in 2020

The possibility of compensating for the natural variations in wind and solar power by influencing electricity consumption is not expected to gain more than marginal significance until after 2020. The wholesale model with the option of settling flexible electricity consumption will be launched towards the end of 2015, after which it will gradually be rolled out in the individual grid companies. It will then take some time before the industry and customers discover the new potential source of revenue. In 2020, other measures will therefore have to absorb most of the wind power variations.

## Conflicts of interests between the overall grid and the local grids

The transformation of power generation from dispatchable power plants to weather-dependent wind power and solar cells presents various challenges to the overall grid and the local grids. It involves dilemmas, because there may be conflicting interests between securing overall system balance and eliminating local congestion.

There are still rather limited experiences with electricity markets for end-users. Finding fair solutions will take new complex market models. Therefore, research environments for social sciences should participate in the development.

<sup>6</sup> Danish Energy Association and Energinet.dk: Smart Grid i Danmark, 2010

### **Unsatisfactory dissemination of research results**

The working group tried to gain a reasonably complete picture of the results of Danish energy research, but found it quite labour-intensive. A good grasp of the results could also provide a better basis for targeting future research activities. The working group recommends the research programmes to present summaries of the project results.

### **Too few projects with demonstration and implementation**

Compared to other EU countries, Danish Smart Grid research has a high share of basic research and a low share of projects involving demonstration and implementation. The working group therefore recommends that more projects focusing on these areas be approved.

One solution could be a two-stage procedure: 1) basic research covering a wide range of solutions and 2) more targeted projects for demonstration and implementation.