

Denmark's Smart Grid Intentions

Doubtful if the risk of power failures has been properly addressed

The Danish Ministry for Climate, Energy and Building has realized that a further increase of wind power in Denmark will put an additional strain on the electricity grids, eventually far beyond their load limits. The answer to this new challenge is called **Smart Grid**.

The ministry has presented its Smart Grid intentions in a report: "Main Report – The Smart Grid Network's recommendations".

Denmark will develop domestic balancing resources

New wind power will cause an increasing mismatch between traditional electricity demand and electricity generation.

In the Smart Grid concept new types of electricity consumption such as electric vehicles and flexible heating systems are expected to contribute to the utilization of surplus electricity during windy periods. It will be a special challenge to serve this additional electricity consumption without a corresponding reinforcement of the grids. Advanced automation of the grids and new market arrangements are supposed to replace or reduce grid reinforcements.

So far the growing need for balancing services due to Danish wind power has been covered mainly by foreign resources. Excellent opportunities have been provided by strong interconnections. Reinforcements of primary grids and interconnections will improve Denmark's access to international balancing services.

However, the neighbouring countries also have ambitious plans for wind power development and an increased competition for limited Norwegian balancing resources must be anticipated. Therefore I welcome the intentions of developing local flexibility in Denmark.

The 9 recommendations

The main report includes 9 recommendations and 35 part-recommendations. The 9 recommendations have the following headlines:

1. Pricing signals to customers that reflect the value of flexible usage
2. New economic regulation of distribution companies' Smart Grid activities
3. Electricity taxes that support an effective electrification
4. Effective activation of storage and decentralised production
5. Strengthening of standardisation and interoperability
6. Research and development as a dynamo for green growth
7. Strengthen consumer engagement
8. Minimise the risks for electricity customers and other stakeholders
9. Make it easier to create new services

Most of the part-recommendations have deadlines in 2013 or 2015. The recommendations include actions to be taken by the energy sector, by the authorities and joint actions.

There is no argument against the directions of the recommendations. They express intentions, but they do not indicate methods or quantities. Nobody knows the possible magnitude of consumer contributions to the balancing of wind power.

A joint international research effort

The new procedures and methods will not be off-the-shelf items. Therefore a comprehensive development activity will be required. It is questionable if the research environments in Denmark have the required capacities and qualities for these activities. Ongoing research activities indicate that there is still a very long way to go.

Therefore joint international projects such as the EcoGrid.eu project with field tests at the island of Bornholm can be useful contributions in the development process.

Growing risk of power failures

The report envisages operation of the grids closer to their capacity limits. Due to the stressed grids and the increasing wind power variability the risk of power failures will increase.

Smart Grids are supposed to be self-healing, but new self-healing arrangements seem to be missing in the recommendations.

The main report and its underlying "issue papers" do recognise the changing need for short term operational reserves (STOR) and the growing risk of power failures. The report recommends a careful monitoring of the need for reserves. The purpose is to prevent serious power failures.

However, power failures can never be excluded, and Smart Grid facilities for black start seem to be forgotten. The blackout in East Denmark in 2003 demonstrated insufficient black start capabilities except at Bornholm.

Serious power failures cannot be avoided, but it will be possible to obtain more acceptable restoration times than in 2003 with appropriate Smart Grid measures. A cell-structure of the grid and the ability to perform a separate black start within each cell has been outlined in the past.

Super Grid or Smart Grid?

There is a strong movement in favour of solving the variability problems of the wind power by adding a European-African super grid to the existing primary grids. The hope is that widespread European wind power together with African solar power can provide a smooth and balanced electricity supply for all the nations concerned.

This may be a possible solution in the very long term. In the short term new interconnections to Norway and the Netherlands together with the outlined offshore grids in the North Sea and the Baltic Sea will probably give Denmark the best possible access to purchase balancing services in the international electricity markets.

Balancing services from district heating

The Smart Grid report is focussed on the electrical networks. Therefore it cannot be blamed for ignoring other potential balancing resources.

Denmark has a unique balancing capacity in the combined heat and power (CHP) systems. The flexibility of the CHP systems is due to the fact that most CHP systems include a large hot water tank. Surplus electricity can be converted into hot water by heat pumps or electri-

cal heaters. During periods of suitable demand for electricity and hence profitable market prices, CHP plants can supply heat while recharging the hot water store.

Several CHP systems are already participating actively in the electricity spot market and in the market for regulating power. The potential can easily be quantified and mobilised when needed.

A robust Danish strategy

It will be a robust Danish strategy to develop the access to both international and domestic balancing resources including among others the following:

International trade:

Until now wind power variations have mainly been absorbed by neighbouring countries. Norway is a major supplier due to its large hydro storages. Increasing wind power capacity in several countries is expected to cause an increasing international demand for balancing services.

Flexible demand at end-user level:

This is a domestic balancing resource to be developed as a Smart Grid element. It includes electrical vehicles and individual heating systems. It is difficult to estimate the potential.

District heating systems:

When the market prices are low the district heating systems can absorb electricity for heating. When high market prices indicate a demand for electricity the CHP plants can produce electricity and store excess heat in the hot water tanks. The interest among CHP systems for supplying balancing services will depend on the demand for this service.

Thermal power plants in condensing mode:

Nearly all large thermal power plants in Denmark are CHP extraction units. They can operate in condensing mode and deliver balancing services. Operation in condensing mode is less efficient than CHP mode and should be minimised.

Curtailement of wind power:

This way out must be available for emergencies, but curtailing wind power should be minimised due to the waste of energy.

The future mixture of measures cannot be optimised in advance due to uncertainties. The planning must be currently adjusted in a moving planning process. Balancing services from the district heating systems can be mobilised at any time in accordance with demand. Flexible end-user demand will require a research and development period and considerable investments. Research activities should be maintained in order to keep this option open for implementation when needed.

References

1. Links to the main report and the summary report in English:
http://www.kemin.dk/en-US/Climate_and_energy_policy/Denmark/energy_supply_and_efficiency/smartgrid_intelligent_electricity_system/recommendations/Sider/Forside.aspx
2. Links to the main report, the summary report and the issue reports in Danish:
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- DK/KlimaogEnergipolitik/danmark/energiforsyning_og_effektivitet/smartgrid/smartgrid_anbefal/Sider/Forside.aspx
3. Energinet.dk: Strategy Plan 2010