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ENERGY STORY:

Developing the electricity grid for a sustainable society

The Smart Grid Gotland project wants to make the most of Gotland's wind power production, with the help from consumers and smart grid technology.

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In the past fifty years the way we produce and consume electricity has changed dramatically. European city population density has risen, increasing the energy consumption per subscriber and per square meter. The number of coal and nuclear power plants has been reduced while more and more renewable distributed energy sources – i.e. small production units, like household solar panels, have been developed allowing consumers to produce their own clean electricity. The grid which distributes the electricity towards consumers has to deal with these increased needs of the decentralised power production as well as with the increasing demand from the growing cities. The challenge across Europe therefore is to modernise the power grid, preferably without incurring massive extra costs on the consumers and users of the grid to make up for it.

Gotland – the perfect test ground for greener energy technology

Some 90 kilometres of Sweden’s east coast we find Gotland, the largest Swedish island. Located in the middle of the Baltic sea, Gotland is characterised by beneficial conditions for wind power generation. Most of the wind power production is in the south, while the majority of Gotlanders live in Visby in the north. The variable character of wind power combined with grid capacity limits, means that Gotland is forced to limit further development of wind power in order to handle power quality issues and avoid that consumers experience power cuts. These challenges are not merely a Gotlandic issue but are becoming more common across the rest of Sweden as well, as the integration of renewable energy increases, and the electricity demand in Swedish cities rises. Gotland is therefore the perfect test site serving as a miniature of Sweden.

“Smart Grid Gotland” was a large-scale demonstration, research, and development project, managed by the local distribution grid operator, GEAB, Vattenfall, ABB, SvK (the Swedish transmission system operating authority), Schneider Electric and financed by the Swedish Energy Agency. The aim was to test grid management solutions, using smart grid technology, which could later be replicated in mainland Sweden.

How to smarten the electricity grid and make it fit for a sustainable society?

The project’s smart grid technology makes it possible for the electricity grid operators to monitor the consumption and production of electricity on the island, in order to detect infrastructural hot spots and bottle necks in the system.



The aim of the Smart Grid Gotland project was to make the most of the island’s renewable sources while maintaining or even improving the power quality by use of smart grid technology. To this end, the project consisted of three main objectives:

- **Increasing the capacity for renewable energy by use of the existing network.**
The intention was to reach this without costly infrastructure investments, such as a



new sub-sea cable from mainland Sweden. Hence, the project planned to adjust the consumption to the intermittent production as well as propose accurate and automatic algorithms for control of renewable power production plants. In addition, it aimed to increase the capacity to integrate micro production of renewable electricity, such as that from roof solar panels.

- **Improve the power quality on the Island.** By implementing the smart grid management system and smart meters while applying also a zone concept to the grid, the grid operators were able to rapidly detect and isolate faults affecting the electricity on the island. This combination of solutions thus made it possible to limit both the disturbance time and the number of affected costumers.
- **Test customer demand response program.** A central idea was to increase the grid flexibility and make better use of the renewable energy by involving the customer. Smart plugs installed in homes across the island would inform the grid operator about the consumption – and production in the case of a household with e.g. solar panels on the roof. This information together with data from other consumers and producers connected to the grid, is used by the operator to forecast potential flow bottlenecks and take reactive measures. The consumers participated in the project by testing the technical solutions - a mobile app which gave, via dynamic price signals, incentives to adjust their consumption.

Impact

The results from the Smart Grid Gotland project contribute to the growing body of knowledge on the design and development of future smart grids.

The project showed that it is possible to make better use of renewable energy by incentivizing consumers to lower their energy consumption at times of limited renewable production. The consumers who participated in the project had a positive experience and did not suffer any deterioration of their comfort from the consumption adjustment.

With regards to the power quality, the results were also positive, with a 20 % improvement of outage statistics while minimizing the environmental impact and presenting several cost-efficient solutions. Moreover, the control algorithm for renewable power production plants proved to work in a satisfactory way and led to a decrease in power spillage (waste), during distribution grid down times.

Project Benefits

- Improvement of the management of the grid
- Decreased carbon emission
- Decreased Network costs
- Reduced energy bills

Keywords: Smart Grids, Wind Power, Customer participation

More info at: <http://www.smartgridgotland.se>

Note: Project benefits based on specific criteria outlined in [ETIP SNET monitoring exercise](#)



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