Hydrogen and Energy Utilities

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Hydrogen and Energy Utilities

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Abstract

Renewable electricity generation plays one major role with the biggest share being wind energy. At the end of the year 2009 a wind power plant capacity of around 26 GW was installed in Germany. Several outlooks come to the conclusion that this capacity can be doubled in ten years (compare Figure 2). Additionally, the German government has set a target of 26 GW installed off-shore capacity in North and Baltic Sea until 2030.

At Vattenfall only a minor percentage of the electricity production comes from wind power today. This share will be increased up to 12% until 2030 following Vattenfall's strategy 'Making Electricity Clean'. This rapid development of wind power offers several opportunities but also means some challenges to Utilities.

1 Development of Wind Power

One challenge of electricity produced by wind turbines is the fluctuating generation of electricity. So the need for grid balancing and regulating power will increase, especially in the North where a large share of electricity from wind is produced.

Secondly situations where wind electricity production will exceed the actual demand or the transport capacities will occur more frequently since the regional demand will be almost stable in the near future.

Finally the installation of new conventional power plants in the north of Germany lead to an significant increase of capacity installed whereas demand and generation are separated locally from wind power production (demand centres in South of Germany, most of wind production capacity in the North).

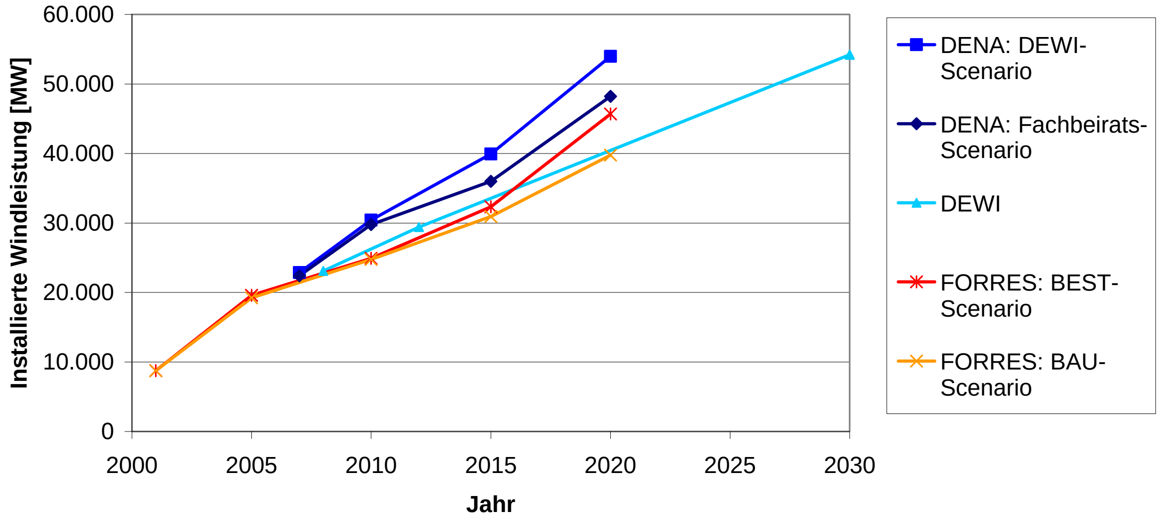

Figure 1: Prognosis of wind power development in Germany.

These high capacities in northern Germany need energy transport capacities to the south demand centres, balancing capacities and storage systems.

2 Consequences for Grid Operation

The classic requirement towards the transmission system operator (TSO) is to provide the grid and to balance it. This included stability of frequency, stability of voltage and the grid security (n-1 criteria). New challenges are the steadily increasing trading of energy, the feed in tariff (EEG) and the combined heat and power directive (KWK).

Challenge one is the system balance within the control area. The production from wind power has to be integrated which can be a tough task looking at the figures below. Table 1 shows the gradients of change of feed-in wind energy into the control area of Vattenfall transmission in 2007. The table shows how big deviations can be in one control area in Germany.

Table 1: Gradient of feed in change within control are Vattenfall Transmission 2007.

maximum feed-in	7.511 MW
minimal feed-in	2 MW
biggest increase over ¼ h	638 MW
biggest decrease over ¼ h	977 MW
biggest increase over 60 min	1.601 MW
biggest decrease over 60 min	1.618 MW
biggest difference between minimum and maximum a day	6.398 MW

Challenge two is the prognosis quality. Deviations between forecasted and actual feed-in of electricity can vary enormously as shown in Figure 1. For the control area of Vattenfall transmission alone deviations of 4000 MW between forecast and actual feed-in occurred during the storm “Emma” between February 29th and 3rd March 2008. So the requirements to meet the system stability criteria will be higher in future although forecast systems are good and are continuously improved. The need for balancing power will increase in future. Investments into the grid and the extension of it are necessary and economically the most reasonable choice. However the acceptance of newly constructed overland-lines is limited (“not in my backyard”) and so large grid extensions will be hard to realize in Germany.

Additional storage and balancing power capacities are desirable and hydrogen might play a role to offer these. When looking at the possibility of a re-conversion of stored hydrogen to electricity this might enable utilities to sell electricity on an exchange basis. The possibility to store energy in hydrogen helps to ensure the delivery of power in low wind phases and so to increase the reliability of the whole system – direct marketing of wind power might be easier with such systems and so an additional business opportunity for utilities might be enabled.

Compared to storing electricity in batteries (i.e. battery electric vehicles) storing energy in hydrogen offers a long term storage option. While battery electric cars will be connected and disconnected to and from the grid quite unpredictably and the energy content which might be usable by utilities is limited hydrogen can be stored in large caverns for weeks and months. This long term storage option of hydrogen also represents a new business field for utilities.

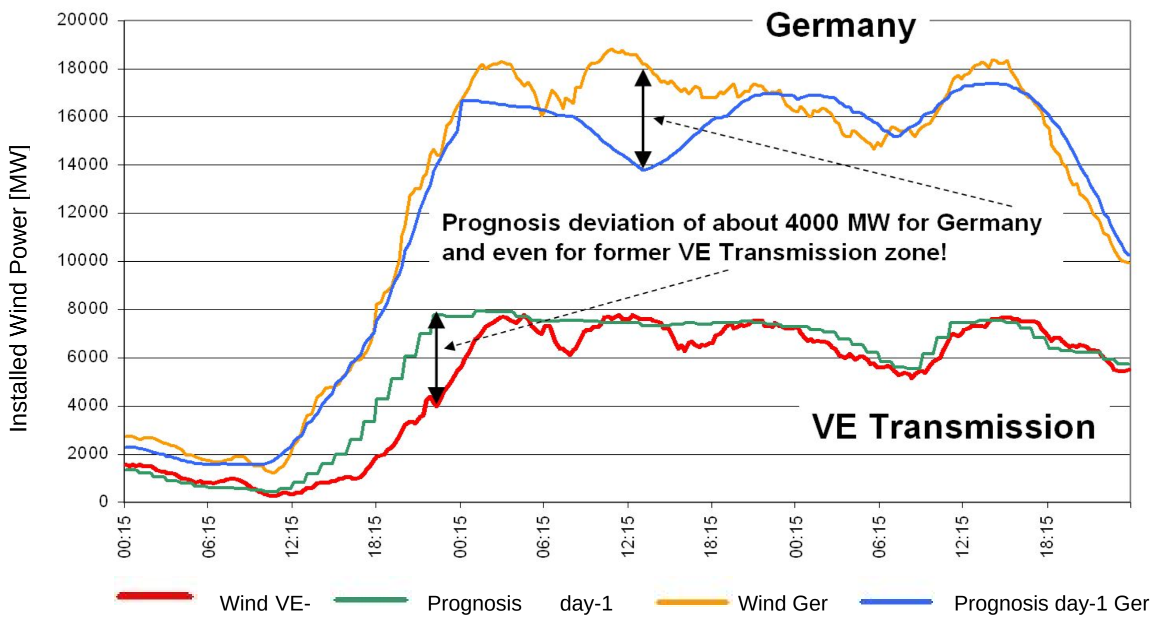

Figure 2: Prognosis deviations, example storm "Emma" Feb 29th - Mar 3rd 2008.

3 Options to Store Electricity from Wind

In Principle water pump storage, air pressure storage as well as hydrogen and battery storage systems are thinkable. Looking at different studies analyzing the “surplus” electricity amount which will be produced depending on the installed wind power capacity in the future one gets an impression of the order of magnitude. Looking at a 38 GW installed wind power-scenario the FHG-ISI scenario came up with 0.7 TWh of surplus electricity and even with 3.3 TWh in the 48 GW installed wind power scenario. For comparison: the installed water pump storage systems in Germany have an energy storage capacity of 0.21 TWh.

Additionally it is almost impossible to realize new big pump storage systems like Goldisthal in Germany particularly in northern Germany.

Compressed air storage systems have a low energy density and battery systems are large, costly and the life cycles are not proven yet.

Hydrogen produced from long proven electrolysis would convert wind electricity to another energy form comparable to water pump storage systems and make it storable. The production would be decoupled from the consumption.

Although proven for long time electrolysis and hydrogen as energy carrier also face challenges with the new requirements as using electrolysers for balancing, cost of the systems, transport and logistic for hydrogen as well as the build up of an relevant infrastructure.

In all hydrogen seems to be a storage option for electricity from wind. Once stored the hydrogen could be used for several purposes as for example in transport, chemical industry or electric re-conversion. In transport clean hydrogen enable CO_2-free transport and diversifies the resources demanded by transport means.

4 Hydrogen from Coal and Lignite

In the future also hydrogen production from coal and lignite might become a business field for utilities. The CCS technology will offer a CO_2-lean production method for hydrogen using the carbon gasification processes or the IGCC process. As these processes are only feasible in large scale commercial plants are not expected to be realized within the next 10 years. Until then the CCS technology has to be improved and significantly reduced in cost.

5 Business Opportunity Mobility

Stored hydrogen from renewable energies can offer a business opportunity with regard to mobility. In projects like CUTE and HyFleet:CUTE it has been already proven that hydrogen in public transport is an viable option to reduce green house gas, dust and noise emissions within cities. At the moment the h2mobility project, a consortium of major oil and gas companies, OEMs as well as utilities is working together on the realization of a nationwide network of hydrogen refuelling stations for cars in Germany. In a first step the business case for each company will be calculated and in a second the necessary infrastructure might be installed. All kinds of sources of hydrogen are analyzed - also hydrogen from renewables like wind or biomass. For utilities hydrogen from electricity is a new business field and could lead to a new segmenting on the field of fuels.

In Hamburg HafenCity the new hydrogen station HafenCity will follow the path of CUTE and HyFleet:CUTE. A new station with on-site electrolysis combined with trucked-in hydrogen will deliver enough hydrogen refuel 20 new fuel cell hybrid buses of Hochbahn when reaching the fleets' interim peak in 2013.