Part 6:

Energy storage and power-to-x

How to deal with volatility of renewable energy sources (RES)?

As wind and photovoltaic electricity production fluctuates with the weather, a surplus might cause grid congestion or negatively influence the security of the power supply system. In times of low supply by renewables, demand needs to be covered by reliable flexible power plants. Exporting power is often not economically viable. However, the observed evidence is that despite substantial shares of renewable capacity, power system stability has not been negatively affected over the past years. In contrast, fears voiced by critics that German customers will see more blackouts are not substantiated. The average power supply interruption for customers within one calendar year of around 15 minutes remained stable over the past years and far below the average of OECD countries.

Ancillary services – the German balancing power paradox

Grid operators contract out ancillary services[1], such as frequency and voltage control, which are required to keep the grid stable and ensure security of supply. Certain reserves for the time range of 5 to 15 minutes are available. Although wind and PV capacities increased very much the need for ancillary services could be reduced in Germany.

Smart grid services

A smart electrical grid includes a variety of operation and energy measures including smart meters, smart appliances, renewable energy resources, and energy efficient resources. Electronic power conditioning, control of the production and distribution of electricity are important aspects of the smart grid. This way, the grid ideally serves as indirect storage. The grid needs to change from passively moving electricity from the producer to the consumer, to becoming an active player. Data collection, digitization and smart meters allow optimal grid management. Roll-out of smart grid technology also implies a fundamental re-engineering of the electricity services industry. The new technologies have also opened up market opportunities for new technologies, such as battery storage plants. Germany is investing extensively in smart grid technology.

Storage technologies are essential for Germany's power supply

Storage needs to buffer times with excessive production and the times with seasonal lows, most of the time with expected mid-range manageability, often at short notice. In the future, storing renewable power is predicted to play a more important role in allowing

[1] Ancillary services between 30 sec and 1 hour, FCR = Fast Containment Reserve, aFRR = automatic Frequency Restauration Reserve, mFRR = manual Frequency Restauration Reserve, RR = Replacement Reserve and reactive power generation.

Germany to give up fossil fuels altogether, alongside flexibility options like demand-side management and sufficient grid infrastructure.

Pumped storage

Pumped storage has been a time-tested method. In pumped storage, water is pumped into a reservoir in times of low demand and low electricity price. In times of high demand, the water is released, running through turbines to generate electricity. Unfortunately, Germany's geography places significant restrictions on the possibility of developing new pumped storage capacity. An enforced interconnection to Norway shall make use of the vast hydro and storage potential in the Scandinavian country.

Batteries

Battery technology is one way to store energy. Some industry players already use battery storage plants to balance short-term fluctuations in power supply and to keep the grid stable. More and more battery storage systems are currently installed by home owners with a PV system on their roof. Around half of all newly installed PV systems nowadays are planned with a storage system. Costs for Solar storage systems have halved since 2013 according to information by the Solar Industry Association BSW-Solar. Meanwhile over 130,000 solar storage units are in operation in Germany. However, operators argue that the current design of the power market does not offer sufficient financial incentive for the development of battery plants.

Small batteries play an increasingly important role in ordinary households, as roof top solar panels now come with small energy storage systems. In the future, energy will also be stored in the batteries of electric vehicles.

At present, several demonstration and commercial projects have been put in operation for long term storage in large battery systems. Those batteries reach the size of huge containers or small houses. Longer term storage would require the availability of much larger volumes of power, which in turn would call for other solutions, for example power to gas conversion.

Power-to-gas or power-to-x Technology

So far, the shift to RES in Germany has been largely limited to the power sector. In order to reduce emissions from heating and transport and to enable renewable power to be stored, renewable electricity can be converted into heat or fuels, such as synthetic methane, hydrogen, and liquid fuels. These can be used as "climate-neutral" energy in the heating, electricity or transport sectors.

Therefore, power-to-gas technologies occupy a prominent place in Germany's plans for long-term energy storage, future mobility, and fuel strategy. A study done by the Fraunhofer Institute indicated that deep decarbonization (90%) in Germany requires up to 117 GW of power-to-X technologies.

In power-to-gas systems, energy (electricity) is used to convert water to hydrogen by means of electrolysis, and sometimes to convert it further to methane. The advantage of this system is that the hydrogen (H2, to some extent) and the methane (CH4, without limitation) can be fed into the existing natural gas grid and stored there or the methane is stored underground. The gas fed into the grid can then be reconverted to electricity, or it can be used for other purposes (for example heating, or gas-powered vehicles). At present, the technology is still expensive and not very efficient. Conversion loss remains the major issue.

The world's largest experimental green hydrogen production facility is currently running in Austria, with Siemens technology, providing clean hydrogen for steel production. They are testing whether the technology is suitable for industrial use on a large scale.

Further reading

Factsheet: Power-to-gas: Fix for all problems or simply too expensive? (Clean Energy Wire), 2018 https://www.cleanenergywire.org/factsheets/power-gas-fix-all-problems-or-simply-too-expensive, June 2018, last accessed 14 January 2020.