# Power and Renewables Insight

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## Hydrogen in the energy transition

### Recent policy measures bolster power-to-gas deployment in Germany

**The IHS Markit Hydrogen team**

### Key implications

Two recent developments in Germany have the potential to profoundly change the global landscape for the use of hydrogen (power to gas) in the energy transition.

- On 5 April 2019, the lower house of the German parliament approved amendments to the grid expansion acceleration law allowing transmission operators to build and operate large-scale storage facilities, including power-to-gas plants.
- In March, the energy minister for Mecklenburg-Western Pomerania proposed that Germany introduce federal legislation to create virtual generation and consumption sites that would link renewable generation and power-to-gas facilities bypassing power transmission charges.

The amendments to the grid expansion law open the door to the deployment of electrolysis within the regulated asset base of grid companies, and the creation of virtual generation and consumption sites would improve the economics of merchant electrolysis. With these developments, deployment of water electrolysis in Germany for producing hydrogen for the energy transition is expected to accelerate. The current project pipeline in Germany would increase the global capacity for such power-to-gas electrolysis by a factor of more than six.

Deployment of electrolyzers on the scale currently envisaged in Germany would have major implications for the role of hydrogen in the energy transition globally, since today the cost of electrolysis is one of the greatest barriers to the adoption of low-carbon hydrogen. Building scale in electrolyzers is expected to lead to rapid cost reductions, but to date, the economic model for larger-scale deployment has not been clear. For Germany at least, it now is.

## Early days for power to gas

Although the flexibility, storability, and versatility of hydrogen could make power to gas an attractive component of a low-carbon energy system, power-to-gas deployment is at an early stage. At the end of 2018, installed capacity in Europe stood at 32 MW, and projects have generally been small (1 MW or less). Outside Europe, electrolyzer capacity used for the energy transition is estimated to be less than 5 MW. Recently, there have been clear signs of a scaling up of ambition with announced projects moving to the 10–20 MW range and

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three 100 MW projects under consideration (see the box "Power to gas and the role of hydrogen in the energy transition").

## Policy changes cement Germany's position as a global leader in power to gas

Today, Germany is the global leader in power-to-gas development. At the end of 2018, out of 36 operating projects in Europe, 18 were in Germany. With a pipeline of almost 225 MW—including two 100 MW projects—this leadership role looks set to continue if market conditions are in place to allow developers to commit to larger-scale projects. With the increase in project size comes an increase in risk, so greater clarity on the business model is needed before investment can go ahead. In the past few weeks, two developments have

### Power to gas and the role of hydrogen in the energy transition

As the cost of renewable power has fallen and the challenge of fully electrifying the economy has become apparent, power to gas for producing hydrogen by the electrolysis of water using renewable-generated electricity is increasingly considered an important part of the transition to a low-carbon future. Power to gas can support the integration of intermittent renewables, ensure a reliable zero-carbon power supply, and provide a storable source of low-carbon fuel for multiple end uses.*

- **Support the integration of intermittent renewables.** Electrolysis increases the flexibility and price responsiveness of the demand side. Large-scale electrolysis—such as the two projects under discussion in Germany—could help stabilize the power grid by varying consumption in line with variations in generation from wind and solar, allowing for greater shares of intermittent generation and facilitating the storage and transport of renewable electricity.

- **Ensure a reliable zero-carbon power supply.** As well as generating electricity by fuel cells, hydrogen can be used in gas turbines to prove zero-carbon dispatchable power. In January 2019, Europe's turbine manufacturers committed to providing turbines that can run on 100% hydrogen from 2030 onward, and they are currently working on developing retrofit solutions for existing power plants to run on renewable gases.

- **Provide a storable, zero-carbon fuel.** Fossil fuels used in industry, heat, and transport could be displaced directly by hydrogen or synthetic fuels based on hydrogen. Multiple projects in Europe are evaluating the role hydrogen could play in end-use sectors. The largest end-use project based on power to gas is Project Centurion in the United Kingdom, which, if developed, would include a 100 MW electrolyzer providing hydrogen to industry, residential consumers, and the transport sector across northern England.

Throughout 2018, IHS Markit undertook a Multiclient Study on the potential role of hydrogen in Europe's transition to a low-carbon economy. The study ***Hydrogen: The missing piece of the zero-carbon puzzle?*** provided detailed quantification of the costs of hydrogen production from a range of sources, including natural gas and electrolysis. The study also identified a plausible outlook for hydrogen demand in each European member state through 2050. The demand outlook was underpinned by analysis of the economics of low-carbon hydrogen and electrification in a range of end-use sectors.

Through 2019, the European Hydrogen Forum will continue the work on hydrogen and low-carbon gases, analyzing a range of additional hydrogen production pathways and options for transporting hydrogen in Europe, as well as comparing the economics of synthetic methane and hydrogen. Further topics will be added based on feedback from the study participants. Additional details can be found here.

*See the IHS Markit Strategic Report *Hydrogen: The new supply spectrum.*

significantly altered market conditions for power to gas in Germany, which should accelerate deployment of electrolyzer capacity (see Figure 1).

## Grid operators are allowed to own and operate large-scale storage

On 5 April 2019, the grid expansion acceleration law was approved by the lower house of the German parliament. Among other measures, the law allows transmission operators to own and operate large-scale storage facilities (including power to gas) with capacity of 50 MW or above.

Two projects with capacity of up to 100 MW each have requested approval from the German Federal Network Agency (BNetzA). The ELEMENT ONE project—a JV between TenneT, Gasunie, and Thyssengas—is scheduled from 2022 onward, and Hybridge—a JV between Amprion and Open Grid Europe—starts in 2023. Both projects envisage direct use of hydrogen in transport as well as the injection of green gas into the existing gas grid. In addition, Hybridge proposes converting part of the existing gas grid to carry pure hydrogen. By directly linking the electricity and gas grid, upon completion, both projects would be concrete examples of sector coupling in action at an industrial scale.

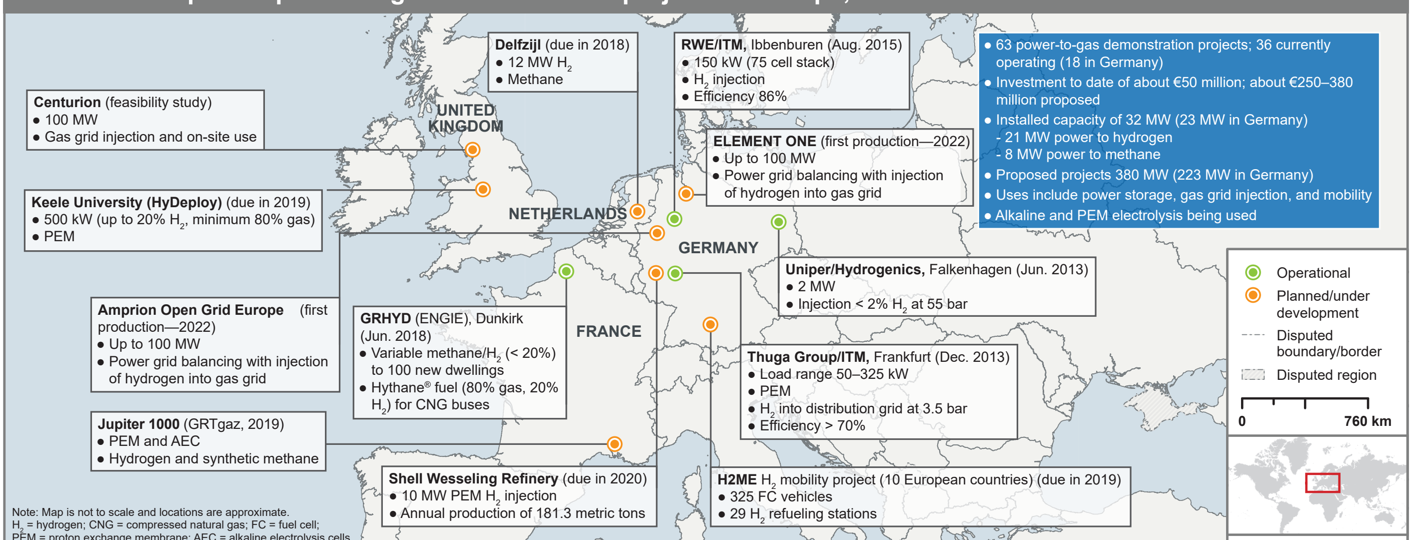
Germany's decision to allow grid operators to own large-scale storage changes the business model and future scale of power-to-gas development. Prior to the change in the law, unbundling rules prohibited grid owners from owning storage. Now, the way is clear for BNetzA to allow for the inclusion of power-to-gas projects of more than 50 MW in the asset base for grid operators derisking the investment and increasing the scale of future projects from the current 10–20 MW to at least 50 MW. Although approval is in place at the German level, there remains some uncertainty as alignment with European unbundling rules remains to be determined.

## Virtual power-to-gas plants

In March, the energy minister for Mecklenburg-Western Pomerania proposed that Germany introduce federal legislation to create virtual generation and consumption sites that would link renewable generation and power-to-gas facilities bypassing power transmission charges. For many, the creation of virtual generation and consumption sites (conceptually moving the electrolyzer behind the meter of the renewable generator) is essential to the development of a merchant business model for power to gas as grid fees can in some cases be

Figure 1

**Selected examples of power-to-gas demonstration projects in Europe, December 2018**



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the largest component of the cost of hydrogen produced from electrolysis. Virtual sites can further improve the economics of power to gas by linking the electrolyzer to more than one generation source, allowing for higher utilization and hence lower unit costs of hydrogen.

Although clearly advantageous for power to gas, the proposal is not without challenges—if power-to-gas facilities are exempt from grid fees, logically all storage facilities should be—including pumped hydro and lithium-ion batteries. Furthermore, exemptions from grid fees for specific groups are a highly political issue in Germany. To address these concerns, the current proposal is for the exemption to be provided for a small number of pilot projects (up to 100) rather than offered to all projects to create a virtual site. An informal meeting of state-level energy ministers in early May should provide further insight on the likelihood of adoption.

## Winners and losers from more rapid deployment of electrolyzers

Large-scale electrolysis will alter revenues in all areas of the German power market. The impact will vary by player. By increasing consumption in low-priced periods, power to gas is expected to reduce redispatch, curtailment, and the incidence of negative or very low-priced hours. As a result of the reduction in low-priced hours, revenues for merchant renewables would be increased versus a situation without power to gas. In contrast, revenues for flexible assets such as gas plants, hydropower, and short-term storage are likely to be lower as ancillary service, redispatch revenues, and price volatility would be reduced.

It is generally agreed that there is significant potential to reduce the cost of electrolysis by increasing deployment. This situation is not new for the power system—in recent years it has been evident with many renewable technologies that scaling up the supply chain can lead to very significant cost reductions. If a learning rate of 15% per doubling of volume for example were assumed, increasing from the 32 MW installed in Europe to more than 250 MW could reduce the capital cost of an electrolyzer about 40%. Cost reductions on this scale could be the start of a downward cycle, with each reduction stimulating more rapid deployment in other areas of the world that are considering a role for hydrogen, including China, Japan, and parts of North America. The impact of faster global deployment would in turn reduce the costs of electrolysis in Europe.

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