

In Haßfurt, Germany, Hydrogen is the present

The utility company Stadtwerk Haßfurt exemplifies the role that hydrogen can play on the local level of the energy transition. Their way of producing green gas and its retransformation in combined heat and power systems sets a precedent for other public utilities. Even policymakers should learn from the project.

When Stadtwerk Haßfurt first broached the subject of hydrogen production and its integration into their energy portfolio in 2015, the energy source was merely a niche topic in politics and media. Although there was already a broad consensus on the necessity to promote the expansion of renewable energies and the fact that flexible energy production capacities would be required as part of this process, but increased political attention or even accelerated legislation were not in the cards yet. Inexpensive and rarely scrutinized, natural oil and gas were broadly accepted as the primary energy sources and the construction of the Nord Stream 2 pipeline decided upon in 2015 seemed to ensure the security of supply for decades. As we now know, not everything turned out as projected and some political decisions can now safely be considered mistakes.

Innovative city leads the way

Haßfurt benefited from a happy coincidence: even before the regulation on the spacing of wind farms in Bavaria (10-H regulation) entered into effect in 2014, many parties were already invested in the subject of local energy transition. Municipality, suppliers, industries and citizens agreed that the city and region should lead with innovation when it comes to the future of energy supply in Haßfurt. This intention materialized in the inception of a citizens' energy cooperative which is held in high regard by the general public as well as economic actors. Haßfurt's public utility holds a stake in the cooperative and contributes with its energy market expertise. In conjunction with its foundation back in the day, the cooperative built ten wind power systems with a collective output of 24 megawatts (MW) as well as several large photovoltaic systems in open space with an overall output of 18 MW. With the completion of these major projects, Haßfurt's electricity production became more than 100% climate neutral.

However, it did not take long for the realization to sink in that the systems produced an enormous excess on many days that was difficult to place on the market. Stadtwerk

Haßfurt's commitment to innovation paired with dedicated local politicians then gave rise to thought experiments as to how the excess energy could be used to the best physical effect. Converting the excess electricity into green hydrogen crystallized as the obvious strategy. A connection to a green energy supplier on the national level that was about to be established proved to be the missing link. In 2016, an electrolyzer with a capacity of 1.25 MW and a hydrogen storage took up operation. Now, green hydrogen could be produced on site in Haßfurt. Besides a five-percent injection into the local natural gas network, part of the green hydrogen goes to the malting plant next door where it contributes to the decarbonization of the malting process.

CHP fuel

However, the contribution to malting processes would only be the beginning. Then as now, it was obvious that hydrogen would remain a scarce and therefore expensive resource for the time being. It was also obvious that the hydrogen which was produced in a climate-friendly manner should not end up as an inefficient natural gas replacement on the heating market. In fact, Stadtwerk was investigating the most efficient way for hydrogen to complement the electricity production profile of wind farm and photovoltaic system. A decision was made relatively quickly: the hydrogen was to be used in combined heat and power systems (CHP) that have always been a fixture of the public utility's energy production portfolio.

Around the same time this decision was made, the first CHP manufacturers succeeded in converting their product to operate on 100% hydrogen. Besides making the necessary mechanical adjustments to the product for the use of hydrogen instead of traditional gases, the change in operating mode was the primary consideration in Haßfurt. In the past, municipal suppliers primarily used CHP to heat properties or heating networks with electricity as a byproduct. The CHP systems in Haßfurt, however, were mainly intended to cover the

electricity demand during times without wind or sunshine. Stadtwerk mostly drew on the expertise of CHP manufacturers that originated in the biogas sector. Since the amendment to the Renewable Energies Act (German acronym: EEG) in 2012, suppliers are being rewarded for operating their CHP with a focus on the electricity markets, which is a where a parallel can be drawn to the efficient use of hydrogen in decentralized combined heat and power systems.

Its efficiency is based on the appropriate configuration and combination of heating demand, heat storage and hydrogen storage to make the most of

the strengths of cogeneration as part of a cross-sector concept. After exhaustive planning involving, besides the CHP manufacturer 2G Energy, the technical university Ostbayerische Technische Hochschule (OTH) Amberg-Weiden, the CHP was commissioned in June 2019 with an initial output of 140 kilowatts (kWel). After further optimization, the electrical output of the CHP was increased to 200 kWel.



Figure 1 In Haßfurt, green hydrogen is produced locally and converted back into electricity

After successfully commissioning and operating a first hydrogen-fueled CHP, Haßfurt also succeeded in linking it to the existing infrastructure. By cooperating so closely with the manufacturer and the OTH Amberg-Weiden, the Stadtwerk ensured that even the older CHP operated on natural gas could be retrofitted to run on hydrogen as soon as the availability of locally produced green hydrogen is sufficient. In this aspect, the project is setting the trend for many other public utilities across Germany that also already have considerable CHP capacities.

First and foremost, however, the project in Haßfurt is a pretty direct hint to federal decision-makers who - in the context of the overall power system strategy - are currently deliberating on how to cover the growing demand for secure energy production as fast and as efficiently as possible. The Federal Ministry for Economic Affairs (BMWK) only recently

communicated the target of creating 17 to 21 gigawatts (GW) gas-based power generation capacities that must be connected to the grid by 2031 on order to stabilize the electricity infrastructure in view of the plan to expand the use of renewable energies.

Decentral capacities

Nowadays, frequent mention of the phrase "ready for hydrogen" has become a matter of course. Instead, the question of how and at what scale the required gas-based power generation capacities should be conceived and put out for tender has come to the fore. One question must be at the center of both the expansion of wind and solar energy as well as the creation of the required gas-based power generation capacities: What is the most efficient way to reach the specified objectives? The answer is simple: decentralization.

For no other technology, the relation between decentralization and efficiency is as close as for gas-based power generation. Contrary to wind and solar energy where availability of the required input depends on the weather but is free of charge, gas-based systems run on the same high-quality medium. Therefore, true to the motto of "efficiency first", it is paramount to use the scarce energy sources - mainly hydrogen in future - to maximum effect. And no other type of power generation system uses resources as efficiently as decentral cogeneration systems since they produce heat and electricity at the site of their consumption.

But there are other obvious benefits besides the superior efficiency: If well supported, an increased reliance on decentral systems, be that as part of communal projects as in Haßfurt or integrated into industries, commerce and district heating solutions, would help in surmounting the challenges of the energy transition. Today, private operations such as industrial companies already lament the lacking grid development and face problem with the connection to the grid. The use of decentral hydrogen power systems would facilitate the urgently needed rollout of heat pumps and electric mobility in one fell swoop.

Although the advantages of decentralized supply structures in a back-up system are obvious, the question arises whether political decision makers are sufficiently aware of them and recognize them fully. Lately, the impression that shone through between the lines is that the intended power generation strategy solidifies the existing, centralized supply structures and not back decentralization even though it is often more expedient.

Political sphere can show courage

This is where actors of the political sphere can prove their courage by backing innovative, regional structures to secure the future energy supply and using projects like the one in Haßfurt as a blueprint for other regions in Germany. Ultimately, local actors know the state of plans and what must be done: How big is the local industrial sector? What public buildings are planned? Are there plans for new residential areas?

Although it is right and important to discuss a necessary back-up system and the conversion of power generation infrastructures, public utilities must also realize that they must start by expanding their energy supply based on renewable energies first. While commercial activities and the creation of business models are important, it is critical to link up with local actors who support the direly needed expansion of renewable energies as a social project and create local identification. In Haßfurt, people can already experience how the price for hydrogen decreases as a function of the expansion of renewable energies. In other words: Each kilowatt of wind or solar energy lowers the price of green hydrogen required for power systems covering the residual load.

Plans for communal heating

As far as Stadtwerk Haßfurt is concerned, the current project with its electrolyzer and hydrogen CHP is only the starting point for an intensified expansion of linkups between sectors. As part of the requirements for local heating structure planning, an efficient organization of local heating networks will become ever more important over the coming years. That applies to the existing and expanding heating networks in Haßfurt as well. The hydrogen CHP, for example, will be connected to the local heating network of a close-by school. A residential area with 1400 homes is also being supplied via a heating network with a CHP that partially runs on hydrogen and can prospectively be retrofitted to 100% hydrogen.

Haßfurt continues to back decentral cogeneration systems to convert the resource into energy. Besides the retrofitting of natural gas CHP to run on hydrogen and the installation of new hydrogen CHP, the portfolio of Stadtwerk Haßfurt will at some point potentially include fuel cells. Especially for applications and processes with continuous energy demands, hydrogen fuel cells could soon be the method of choice.

International attention

Although the early commitment to hydrogen by the city of Haßfurt was a niche topic if at all, the project now receives nationwide and even international attention. The project and all the stations in the process from the hydrogen production to its re-conversion into electricity by the CHP system receive many national and international visitors every year since it is a complete showcase of the frequently demanded sector coupling and the opportunities offered by it. The Stadtwerk Haßfurt is a trailblazer, but also an encouraging example for other energy suppliers and industrial companies who all will have to manage the balancing act between climate neutrality, security of supply and profitability.

Unbureaucratic legal framework

Many suppliers may have concepts and ideas in their drafts that fail due to reservations of citizens or investors. That problem could be solved by integrating the local population into the development and implementation. Haßfurt shows that the holistic approach works for these projects. Another positive experience made by the Stadtwerk over the past few years: The abstract subject of hydrogen has become graspable for many. Nowadays, there are many companies that reach out to Stadtwerk Haßfurt to learn more about hydrogen independently of energy supply topics.

All things considered, one thing remains certain: For the energy transition to succeed and the hydrogen sector to gain momentum, the policymakers must create an overarching and unbureaucratic legal framework that lays the responsibility on local actors and encourages them to get creative instead of limiting them. Local if possible - centralized if required.

Caption: In Haßfurt they produce green hydrogen and re-convert it into energy.



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