Press Release.

Energy transition: Hydrogen CHP completes storage chain

Municipality masters 100% green electricity with Power to Gas and new H_2CHP

"The energy transition begins on a small scale" – with this sentence Norbert Zösch, M.D. of Stadtwerk Haßfurt GmbH, Germany brings the philosophy of the utility for about 14.000 inhabitants in the municipality Haßfurt in the Bavarian Lower Franconia to the point. For a long time great thought was given when it came to the transformation of the company and its services for an energy future based on renewable energies. Together with The Städtische Betriebe GmbH (near-heating and leisure facilities) and the Haßfurt GmbH data center, Stadtwerk Haßfurt GmbH forms the triad of municipal enterprises.

The four megatrends of demography, digitalisation, decarbonisation and, last but not least, decentralisation were the guiding principles for adapting to the challenges of the energy transition. As a result of decentralisation deemed necessary to ensure sustainability, the Stadtwerk Haßfurt sees major challenges ahead, as a growing decentralisation of production will have a strong impact on all levels of value creation. This is due to high investment costs for grid expansion, software and IT services and, last but not least, the fact that new players in the energy market and thus increasing competition are to be expected.

The Stadtwerk Haßfurt wants to address this with a whole range of services: an energy portal, innovative electricity tariffs based on EEX and smart home integration up to all-in-one contracting. But first of all, the focus is on proving that a secure and economically competitive renewable power supply is possible through the use of balancing generation technologies using storage. The heat supply has not been overlooked either, as a significant part of the heat demand for the local heating supply in the urban area is already covered regeneratively by the use of the waste heat from the biogas plant (2.35 MW), the solar collectors and other EE plants.

Power to gas

The electricity balance of the Stadtwerk Haßfurt from 2010 to 2017 shows a rapidly increasing share of renewable generation. While the initial figure was 29%, the figure had already reached the 100% mark in 2015 and accounted for 208% of the total at around 85,000 MWh in 2017. About 70,000 MWh resulted from solar and wind energy. In particular, the big jump in the amount of electricity generated by wind power from just under 2,400 MWh in 2010 to around 61,000 MWh in 2017 presented the Haßfurt Stadtwerk with new challenges.

In October 2016, Windgas Haßfurt GmbH & Co. KG – a joint venture between Stadtwerk Haßfurt and the Hamburg-based eco-energy cooperative Greenpeace Energy – commissioned a power-to-gas plant (PtG). The companies Siemens AG, the Pfaffinger Group and Next Kraftwerke GmbH as well as the University of Applied Sciences Schweinfurt participated in the project as part of the preliminary study. The core of the plant is a container-sized PEM electrolyser of the type Silyzer200 from Siemens with a peak capacity of 1.25 MW. The state-of-the-art plant at the Mainhafen converts excess electricity from the nearby Citizens Wind Farm Sailershäuser forest as well as from other wind energy and solar plants into renewable hydrogen, also known as Wind-gas. Each year the container-sized electrolyser generates one million kilowatt hours of wind-gas, which is fed into the gas grid for Greenpeace Energy's nearly 20,000 wind-gas customers. In principle, it can also be stored for long periods of time and streamed again.

> As in Hassfurt, wind gas plants are thus an important building block for a successful energy transition: they make renewable energies in enormous quantities long-term storable and thus ensure security of supply even with high proportions of renewable energies. Electrolysers based on the PEM (PEM = polymer electrolyte membrane) technology convert excess wind and solar power with a level of energy of about 70 per-

cent into hydrogen, ensuring that every kilowatt hour of green electricity can actually be used and that the renewable plants do not have to be regulated if the electricity supply exceeds the demand or the grid cannot absorb the electricity.

The container-sized PEM systems are extremely responsive, as the electrolyser automatically changes its power within milliseconds in order to stabilize the frequency in the network and thus prevent, for example, blackouts due to grid overload. In Haßfurt, the electrolyser offers this service through its partner Next Kraftwerke as part of a "virtual power plant" in which several plants are connected. This "standard service offer" enables electrolysers to generate revenue beyond hydrogen production. The plant, for which there was no funding, cost about two million euros. "The business model of Windgas Haßfurt GmbH is based on the fact that the investment costs are generated within ten years," explains Norbert Zösch, Managing Director of Stadtwerk Haßfurt GmbH, the economic basis for the investment.

Politics influences the economics of PtG

When it is important to be economic, the classification of PtG technology into policy frameworks and support mechanisms plays a major role. The Hassfurters work with two scenarios, which were created as a cost extrapolation in a study preceding the project: The production costs for electrolysed gas amount to about 18 ct/kWh for a current plant, network-oriented operation (approx. 3,000 full-use hours per annal). However, if the same plant is classified as a "final consumer", the production costs increase to 38 ct/kWh.

Electrolysis breaks down water into oxygen – which is discharged into the ambient air – and hydrogen with a high degree of purity. In the PEM electrolyser in Hassfurt, the process takes place at a temperature between approx. 30 and 70 °C and at a pressure of 35 bar. The gas is then dried to remove as much moisture as possible. The water treatment plant demineralizes the injected water before it is fed into the electrolysis stacks in which the actual process takes place.

New technical era with commissioning of the first hydrogen CHP

With the successful commissioning of a highly innovative hydrogen combined heat and power plant (H_2-CHP) for the re-electricity generation of renewable hydrogen in June 2019, the Städtische Betriebe Haßfurt GmbH has expanded the existing power-to-gas plant (PtG). The project was funded by the Bavarian State Ministry of Economics, Regional Development and Energy (StMWi). The installed CHP is an agenitor 406 SG from 2G Energy with an electrical output of 140 kW when operating with hydrogen. Project partners are Stadtwerk Haßfurt GmbH, 2G Energy AG from Heek and the Institute for Energy Technology (IfE) at the East Bavarian Technical University Amberg-Weiden.

In contrast to the previous practiced addition of hydrogen to the natural gas grid with re-electricity generation via conventional CHP plants, the new combined heat and power plant enables operation with pure hydrogen without fossil fuel components. This is the first time that a hydrogen-based and$_{CO2\text{-}free}$storage chain for renewable electricity has been implemented in municipal practice. The storage chain leads from wind power generation to conversion into hydrogen by electrolysis and storage in pressure tanks to re-electricity generation via combined heat and power. The hydrogen storage system allows continuous operation of the CHP for approx. 15 hours, thus significantly increasing the flexibility of the overall system.

Flexible response to excess current surge or underfunding

Norbert Zösch sees the completion of the storage chain as an important contribution to the compensation of generation and demand: "Since both the PtG plant and the H_2CHP have a high dynamic, the electrolyser - storage - H_2- CHP system can compensate for excess electricity and underfunding from renewable power generation in the local balance sheet or above all with control energy in the distribution network."

The CHP agenitor 406 SG got supplied by 2G Energy AG as a ready-to-connect container solution. Frank Grewe, Head of Development at 2G Energy AG, expects an increasing demand for H_2CHP: "After the first installation of an H_2CHP at BER Airport in Berlin in 2012, we are taking the next step in Haßfurt with a standard agenitor-series CHP, which has been cost-effectively adapted for the optional use of pure hydrogen, a hydrogen/natural gas mixture or natural gas. The safe and flexible operation within the framework of a future broad use of PtG concepts with CHP is an important cornerstone for the development work at 2G."

The H_2CHP in Haßfurt has a second gas connection for a change to natural gas operation, whereby the nominal electrical power is 200 kW. Grewe still sees development potential for the performance of H_2CHP compared to natural gas operations: "A significant increase in nominal power in hydrogen operation to the level of natural gas-powered machines is a short-term development goal. In addition to safe plant availability, the development work at 2G will focus on further reducing the specific production and operating costs of H_2CHP."

The project is supported scientifically and technically by the Institute of Energy Technology. On the one hand, the researchers hope that the project will provide practical insights and long-term experience for the hydrogen operation of combined heat and power plants, on the other hand, the module also serves as a research platform for further developments of H_2CHP technology and has therefore been equipped with special measuring technology access.

Many years of experience with natural gas CHP in local heating

With the commissioning in 1994 of the first natural gas combined heat and power plant at the "Großer Anger", the Haßfurt entered new territory in the field of heat supply. The heat produced supplies the leisure pool, the new primary school and, since 1999, the new building area "Fasanenanger". After this first step, another combined heat and power plant in the Haßfurt school centre has been supplying heat for the entire school complex, including the indoor swimming pool and pedagogical support centre, since January 2003. In addition, an additional CHP was built in 2006 in the school centre in Obertheres, which supplies the kindergarten, the school and the sports hall with heat. In relation to the use of conventional natural gas CHP plants, therefore, many years of experience are already available. The most recent project of a total of eight with a CHP heating centre is the moving local heating network in the Osterfeld II construction area. In addition to the use of a CHP, renewable energies are used for heat generation. The primary energy factor (fP, FW), which describes the quality of the energy source used for the local heatinggrid, is 0.40 fP, FW. An excellent value that falls below the required factor for local heating from CHP with fossil fuels.

Awards for pioneering role

While the implementation of the energy transition in the national framework has lost momentum at many corners or "clamps" such as the expansion of wind turbines and the expansion of transmission networks, a relatively small urban utility such as Haßfurt proves that the energy transition is possible with a decentralised approach. In addition to the producer side, there are, among other things, through the local heating network, consumers are also included in the concept with our approach. With a battery storage (8 MWh), which is in the construction phase and two more for which the execution planning is currently being realized, can be effectively countered with the so-called dark slack. The comprehensive roll-out of 10,000 smart meters in the Zeitraum2008-2011 and last but not least the inclusion of households in the context of Prosumer projects with "electricity-generating heating" have promoted the acceptance of citizens. Without this broad acceptance on the customer side, the implementation of a pioneering role in the energy transition would certainly not have been possible. The various awards such as the Bavarian Energy Prize 2018 or the Heinrich Böll Foundation's classification as the "Pearl of the Energy Transition" can therefore be justifiably proud in Haßfurt.

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Contacts

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About Combined Heat and Power (CHP)

The simultaneous generation of mechanical energy and useful heat is called combined heat and power (CHP) generation. While the mechanical energy is converted directly into electricity, the heat can be used to heat, cool or generate steam. This means that, instead of escaping into the atmosphere, the heat resulting from electricity generation is put to good use, making CHP technology efficient and environmentally friendly. Up to 40 percent of primary energy is saved. CO2 emissions fall by up to 60 percent compared to conventional electricity generation in large power plants.

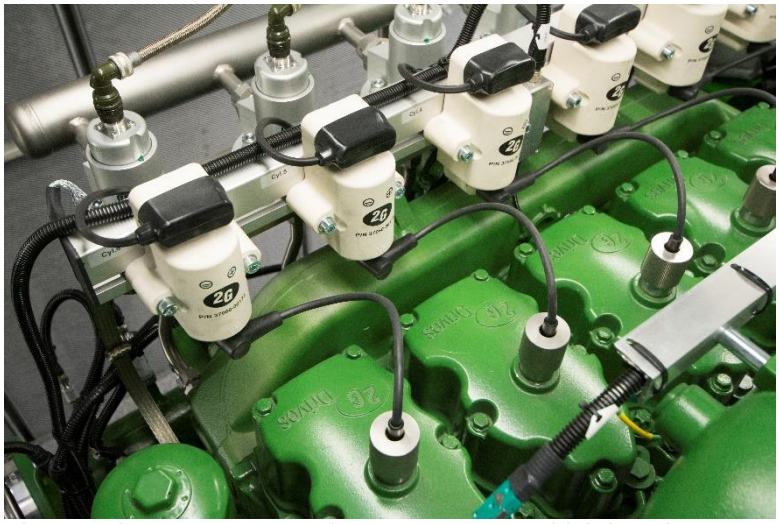
About 2G Energy Ltd (http://www.2-g.com)

2G Energy is one of the leading international manufacturers of combined heat and power plants (CHP) for the decentralised generation and supply of electricity and heat using CHP technology. The 2G product range includes plants with an electrical output between 20 kW and 2,000 kW for operation with natural gas, biogas and other lean gases and biomethane. To date, 2G has successfully installed several thousand CHP plants in 55 countries. In the output range between 50 kW and 550 kW
especially, 2G has its own combustion engine concepts with low fuel consumption, high availability and optimised maintenance requirements.2G Energy’s customer base ranges from farming to industry, municipalities, residential sector to utility companies and major energy suppliers. Customer satisfaction is closely connected with the dense service network and the high technical quality and performance of 2G power plants. Through combined heat and power generation, they reach overall efficiency levels of between 85% and far above 90%. 2G is consistently expanding its technological leadership through continuous research and development work in gas motor technology for natural gas, biogas and synthesis gas applications (e.g. hydrogen). In addition to designing and manufacturing CHP plants, the company offers full solutions, from planning and installation to servicing and maintenance services. CHP plants are increasingly gaining importance in intelligent networked energy systems, called virtual power plants, due to their decentralisation, controllability and predictable availability.

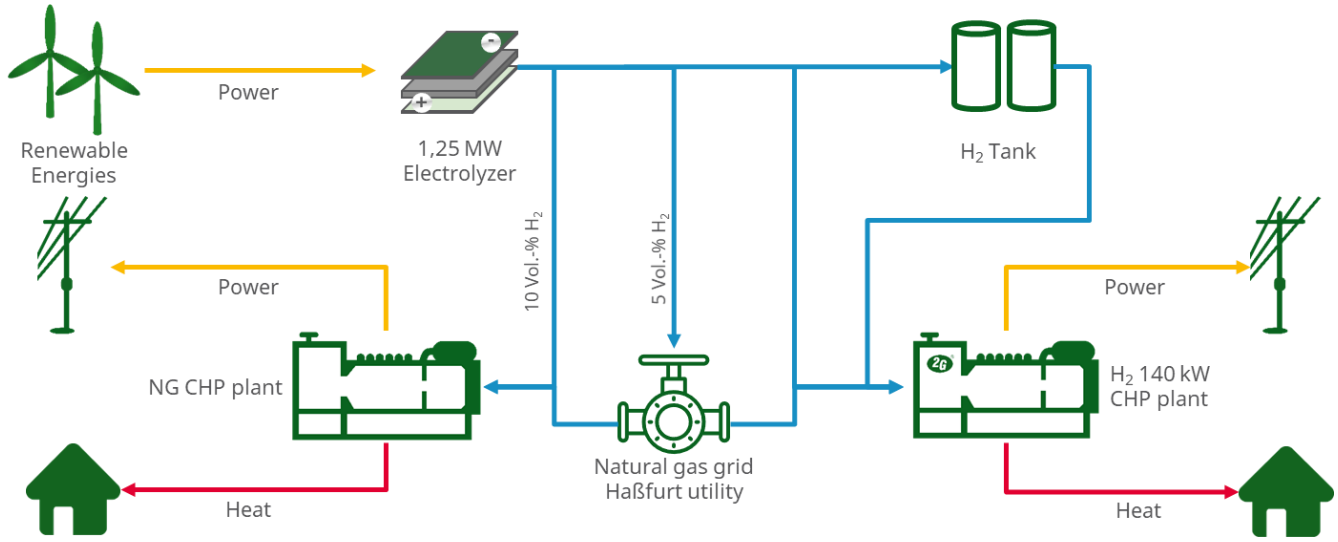
Picture

The H_2CHP agenitor 406 SG from 2G is used for the electrification of hydrogen, which is obtained from wind power with the help of an electrolyser as part of the PtG concept of the Stadtwerke Haßfurt.

The ready-to-connect container solution of the H_2CHP agenitor 406 SG from 2G has an electrical power of 140 kW.
Image source: 2G Energy AG

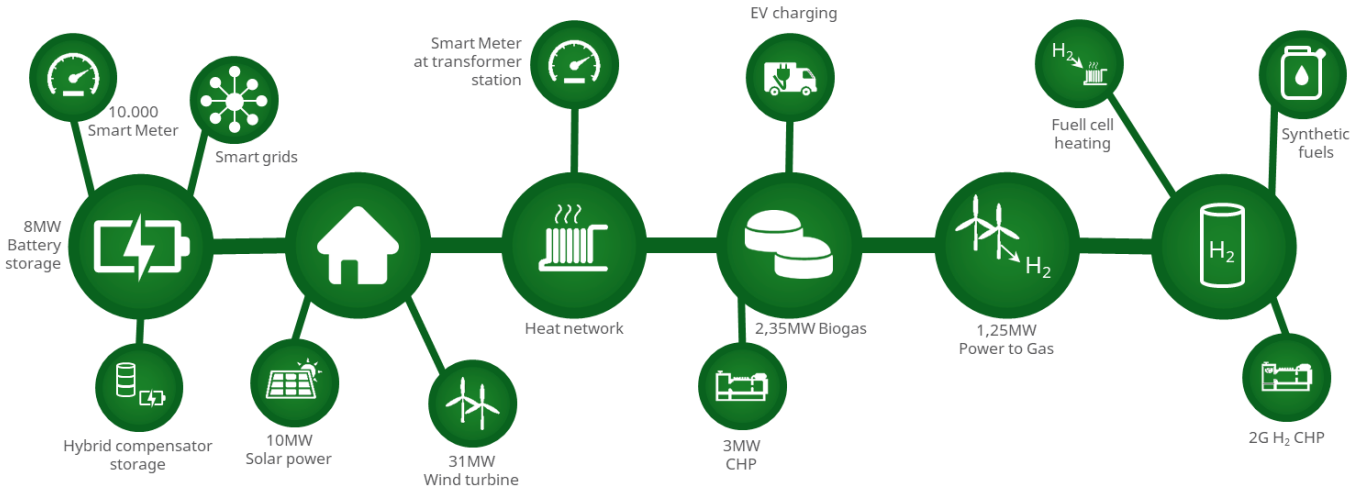


The agenitor 406 SG CHP from 2G Energy, which is to be operated with hydrogen, is based on a standard CHP of the agenitor series, which has been cost-effectively adapted for the optional use of pure hydrogen, a hydrogen/natural gas mixture or natural gas.
Image source: 2G Energy AG



Graphic of the construction of the PtG concept of the Stadtwerk Haßfurt

The Silyzer 200 (1.25 MW output) electrolyser from Siemens at the Stadtwerk Haßfurt is used to produce hydrogen with excess electricity from renewable energy generation plants.
Image source: Stadtwerk Haßfurt GmbH



Realized and current projects of the Stadtwerke Haßfurt