

CHP Journal



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Preface

Dear readers,

The second wave of corona is extremely challenging for us all. Additional necessary social distancing measures must be followed to protect ourselves and others. After all, the continued rise in infection rates, and perhaps even people you know personally who are suffering from COVID-19, highlight how important it is to act responsibly.

What else happened in 2020? We will tell you in this issue of the CHP journal. We are delighted to report on the initial successes in addressing a new market segment. New greenhouses are being built all over the world to supply the population with food reliably and with reduced dependency on imports. An additional power supply via combined heat and power generation increases the economic efficiency of greenhouses. We will present the concept from page 4 and as part of a reference from page 12.

And it goes without saying that we are replacing the lack of communication options due to the corona crisis with virtual measures as best as we can. If customers can no longer visit us, we are proactively trying to maintain the relationship with our partners and customers by digital means.



Christian Grotholt

And then there's our 25-year company anniversary, which we sadly were unable to celebrate to the extent we would have liked. We will take you on a journey through time through the last two and a half decades and would like to emphasize that the celebrations have only been postponed in light of the current circumstances and not permanently canceled. We recently received two "consolation prizes" from DLG in the form of a gold medal and the second place in the Umweltwirtschaftspreis. NRW environmental award for our innovative hydrogen CHP solutions. We will report on this on pages 6 and 7.

Have fun reading through our latest news and, above all, stay fit and healthy.

Yours,

A handwritten signature in blue ink that reads "Christian Grotholt". The signature is written in a cursive style.

Christian Grotholt
CEO of 2G Energy AG



The principle of CHP pays off in greenhouses of any size.

CHP in greenhouses – triple efficiency

The energy requirement in greenhouses is constantly high. This means that a CHP solution from 2G pays off even more in this environment – and not just in the form of electricity and heat.

Fresh fruit and vegetables are extremely popular, and not only among chefs. To ensure that tomatoes, strawberries, peppers etc are available all year round, greenhouses are required that simulate the natural environment of the plants as closely as possible at all times. This includes the suitable temperature, as well as sufficient light during the growth phase – ideal conditions for using a combined heat and power plant. These conditions are strengthened even more by the option of using the CO₂ for fertilizing the plants and thus supporting the growth process of the plants. Greenhouses also place high demands on the reliability of the CHP system, however: the output and quality of the relevant end product rely greatly on a continuous and well-regulated power supply.

Different usage concept of greenhouses

The technical setup in greenhouses can be optimized through targeted regulation of light, shade, water, nutrients and heat. Lucas Gesenhues from International Sales explains: “The design and size of the CHP system depend heavily on the region, the product being grown and the business model of the operator. Whether the operator has a further processing chain, a cold store or a lighting system for the greenhouse also plays a key role for the energy concept and its economic efficiency.” Supplying a lighting system in particular often uses a significant amount of power in the greenhouse, but there are also many other small consumers: “Apart from

the artificial lighting, power is often required for the general building technology such as pumps or control technology.”

Running times dependent on the heat consumption

In addition to covering the power requirements, selecting a suitable plant design to suit the heating requirements is also essential when installing CHP systems in greenhouses. “CHP systems in greenhouses are usually operated with an annual usage period of 3,000–4,500 hours – this varies depending on the project. In traditional applications in particular, such as garden centers in the Benelux countries, we have running times of approx. 4,000 hours, which take place exclusively in the growing season”, Lucas Gesenhues explains, outlining the operation. According to Gesenhues, it isn’t just the outside climatic conditions or the season that are key, but the entire interplay between temperature, sunshine, watering etc: “In greenhouses, the important thing is to support the growth of each individual plant optimally at all times. We take this into account as early as the engineering stage. For the plant control, it is therefore essential to match the technical properties and characteristics of the CHP system to parameters such as humidity, temperatures or the CO₂ content of the air.”

CO₂ fertilization further increases the efficiency

In addition to the usual coverage of the electricity and heat requirements with CHP, the efficiency of greenhouses is increased even further, as the CO₂ released in the combustion process can be used to fertilize the plants. This works as follows: harmful substances in the exhaust, such as carbon monoxide and nitrogen oxides, are made harmless in a catalytic reaction so that it can be made available for the plants. Lucas Gesenhues

also refers to the interplay with the generated electricity and heat here: “CO₂ is always added when photosynthesis, i.e. daylight, is present. For unlit greenhouses, only during daylight hours. With fully lit greenhouses, also overnight in some cases. With our CHP technology, we can supply CO₂ on command.”



CO₂ is always added when photosynthesis, i.e. daylight, is present. With our CHP technology, we can supply CO₂ on command.

Lucas Gesenhues
International Sales | 2G Energy AG

Further enormous potential for CHP technology in greenhouses

Many greenhouses all over the world already rely on the benefits of reliable and efficient power supply using CHP technology with CO₂ fertilization. Lucas Gesenhues summarizes: “The triple efficiency of power supply, heat supply and CO₂ fertilization means that a CHP system can be used in practically any greenhouse. With our extensive, global project experience, we can supply individual solutions for any application completely from a single source.” |

H₂ CHP awarded 2nd place in the Umweltwirtschaftspreis.NRW 2020 environmental prize

2G comes second in the 1st "Umweltwirtschaftspreis.NRW" awarded on the 15 December 2020 by the Ministry for Environment, Agriculture, Conservation and Consumer Protection of the State of North Rhine-Westphalia (MULNV) and the NRW.BANK.



CEO Christian Grotholt with the prize for second place in the environmental award

The Ministry for Environment North Rhine-Westphalia and NRW.BANK award the Umweltwirtschaftspreis.NRW environmental prize to companies who combine ecological innovations with economic success in an outstanding way. In 2020, in the first year the prize was awarded, 80 innovative entrepreneurs from the North Rhine-Westphalia Green Economy submitted an entry for the award. The prize was awarded as part of the SUMMIT Umweltwirtschaft NRW, the annual networking conference of the environmental economy in NRW, which was held in digital format this year due to corona. Of the total prize money of EUR 60,000 for the three top places, 2G Energy AG received EUR 20,000 for second place.

Hydrogen CHP as the backbone of the energy revolution

As part of the energy revolution, it is essential to reconcile renewable generation with its usage. "Electricity and heat aren't always needed exactly when wind or sun are available. And the reverse is also true – the sun or wind aren't always available when the need is actually there. The goal is to bridge the time gap – and this is where hydrogen comes into play," explains CEO Christian Grotholt. The surplus electricity from wind and sun can be converted into hydrogen and used later for decentralized CHP units. "CHPs are the backbone of the energy revolution," summarizes Grotholt.

Convertability of existing plants enables the energy system to be changed affordably

All hydrogen-operated CHPs are based on the established gas engine technology from 2G, which has been successfully operated by thousands of customers around the world. It is also possible to change the fuel on existing plants. CTO Frank Grewe refers to the costs of the current change of the energy system: "We have, above all, created an economical solution that makes the energy revolution affordable. All CHPs delivered with natural or biogas operation today can be converted to hydrogen operation at a later time with a modest amount of work." |



The agenitor H₂ series hydrogen CHP includes an electric power range of 115 kW to 360 kW with a maximum total efficiency of 82.2%.

Hydrogen CHP awarded “EnergyDecentral 2021” gold medal

With the agenitor H₂, 2G Energy has succeeded in making 100% hydrogen suitable for permanent use in CHP systems and bringing the concept to maturity. 2G has now received the “Innovation Award” from DLG for the successful development.

Since 2014, the DLG (engl. German Agricultural Association) has been awarding the Innovation Award as part of the annual EnergyDecentral, which is regarded as one of the leading trade fairs in the energy sector in Germany. Despite the in-person event being canceled due to the pandemic, the neutral expert commission of the DLG chose the hydrogen CHP from 2G as the only innovation to receive the gold medal from 81 eligible entries. The official presentation will take

place during the digital EnergyDecentral from 09–12 February 2021.

Decade of experience with using hydrogen in CHP

The development of CHPs operated exclusively with hydrogen started over ten years ago at 2G for a funding project in Berlin – long before the decision was made to phase out nuclear and coal power in Germany. “The innovative

spirit has always been strong at 2G, combined with longstanding experience in the field of gas engine development, providing the optimal foundation to enable the use of hydrogen in CHP," explains CTO Frank Grewe. "So it's even better that the time it is reaching market maturity is now coinciding with the increasing identification of hydrogen as an important element in the energy world of the future," continues Grewe. In addition to a joint project with Stadtwerk Haßfurt, which was named "CHP of the year" by the specialist magazine Energie & Management, amongst other things, 2G has already successfully implemented four other hydrogen projects.

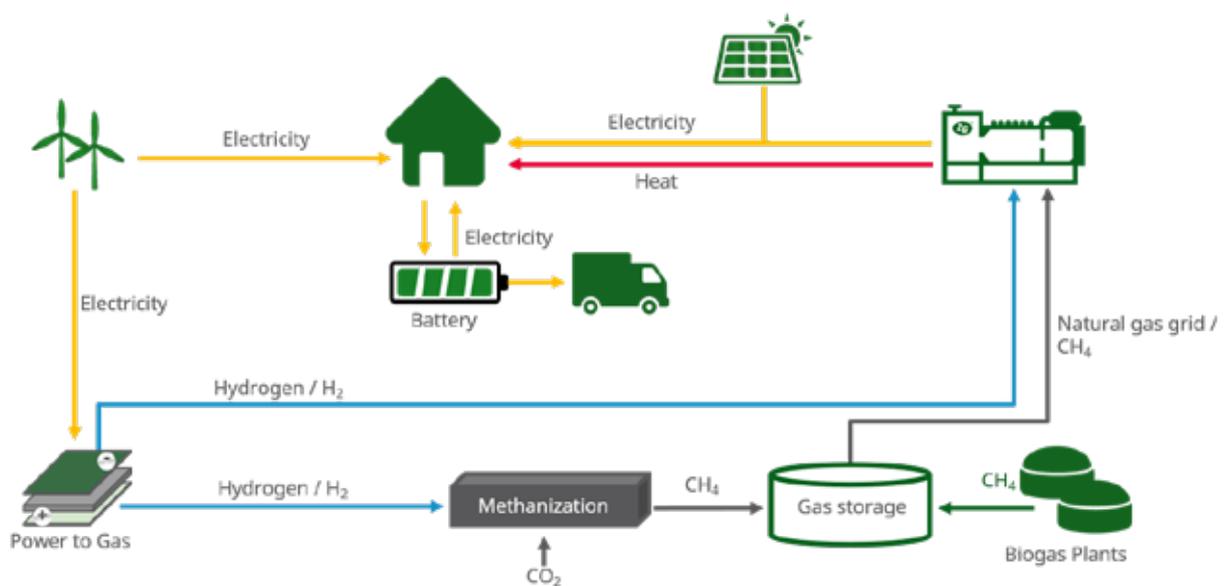
Use of established components – conversion possible during running operation

All hydrogen-operated CHPs are based on the established gas engine technology from 2G, which has been successfully operated by thousands of customers around the world. Grewe refers to the established processes and supply chains here: "The first rule with any new development is to offer the customer an

attractive product. It goes without saying that this also includes an attractive market price. By using many components from the natural gas and biogas sector as well as almost identical production processes, we can keep the costs for the hardware comparatively low." Another important goal of the development was the option to convert existing natural gas or biogas plants for operation with hydrogen at a later date. "We already have some pioneers among our customers who prefer to start running hydrogen plants now rather than in the future. Virtually every CHP installed now can be converted for operation with hydrogen at a later date as part of regular maintenance with a modest amount of work. Our advice to every operator is: natural gas today – hydrogen tomorrow."

Hydrogen in CHP balances out the volatility of wind and sun

CEO Christian Grotholt is delighted with the award, particularly in view of the ongoing discussions surrounding the changing energy market: "We are extremely pleased to have been awarded the gold medal at the



A functioning energy system of the future requires efficient sector coupling of different systems.



Hydrogen agenerator 406

Innovation Award and would like to express our sincere thanks to the judges. Receiving this renowned prize at one of the most frequented events in the energy sector in Germany is also certainly a good confirmation of the system relevance of decentralized CHP systems." In particular of the efficient interplay with wind and solar energy: "In light of the increasing volatility in the power grid due to the further expansion of wind power and photovoltaic plants and the simultaneous discontinuation of conventional electricity production via nuclear and coal power, we are increasingly in need of a reliable means of balancing out the supply, a kind of backbone power plant, which compensates for the fluctuations of supply-dependent energy conversion. CHPs as the backbone and partner of wind and solar enable precisely that. The use of hydrogen enables this flexible service to be provided in a completely climate-neutral manner and with grid-supporting, rotating masses," states Grotholt.

CHP systems form the backbone of the energy revolution

But Grotholt doesn't want to rest on this success: "We see the prize primarily as motivation and an incentive to continue along this successful path. With our innovative products and services, we have a major opportunity to help create a secure, environmentally friendly and affordable energy supply." |

2G expands the aura series with high-performance modules

2G has expanded the aura model series to include a power range of 100–420 kW_{el} with low NO_x emissions based on Lambda-1 technology.

Three years after the launch of the particularly low-emission aura series with CHP modules with 100 or 170 kW electrical output, 2G is expanding the series to include two high-performance natural gas modules that are also based on the company's own Lambda-1 technology ($\lambda = 1$). 2G is therefore expanding its product portfolio for those customer applications where a high thermal power, low operating costs – also by means of eliminating exhaust treatment – and compact design, are essential.

The new aura 408 EG and aura 412 EG modules, with an output of 280 kW_{el}/408 kW_{th} and 420 kW_{el}/611 kW_{th} respectively, are unique in the market in terms of efficiency, performance and lifecycle costs for particularly low-emission CHP systems. Without a lean combustion concept or SCR catalyst (selective catalytic reduction), they achieve nitrogen oxide values below 50 mg/Nm³ during operation. This means that they fall far below the current limit value specifications of the 44th Federal Immission Control Ordinance (BImSchV). These low values are made possible by the Lambda-1 technology, which is at the heart of the engine development at 2G. $\lambda = 1$ is the fuel ratio at which exactly the amount of air is present that is theoretically required to completely burn the fuel.

The module 408 is based on a 4-stroke V engine with 8 cylinders, the module 412 on a V12 engine. Both modules have a total efficiency of over 94% with a thermal

efficiency of around 56%. With limited module complexity due to a single-stage charge air cooler, the combustion air is weakly charged using a turbocharger. Since no SCR catalyst is used, the lifecycle costs of all aura modules are reduced by eliminating the need to inject a urea solution.



With the aura 404 and 406 modules, we offer a higher specific output of 15% for the same displacement compared with the competition.

Frank Grewe | Chief Technology Officer (CTO)

For Frank Grewe, Chief Technology Officer (CTO), the fundamental motivation for the new development stemmed from the requirements of international markets: “Originally, conurbations such as Tokyo, London or California, with their high demands on low nitrogen oxide limit values, provided the impetus for our development work at 2G. In light of the extremely low NO_x emissions of the aura modules, any potential tightening of the limit values in Germany to 100 mg/Nm³ for all engine concepts are generally not a problem for our customers. We are thus creating security for the future for our domestic customers.”

Back when the aura series was introduced in 2017, in addition to the reduction in emissions, the increase in power was also an important aspect in the development goals, summarizes Grewe: "Regarding the power output, we can offer a 15% specific increase in performance with the aura 404 and 406 with the same engine displacement compared with the competition. And the aura 404 module, for example, achieves a total efficiency of 102% with regard to the heating value. This is the result of an electrical efficiency of 37% and a thermal efficiency of 65%, which is made possible by a fuel value exhaust gas heat exchanger."

Customer benefit is paramount for the objectives of development work at 2G. In addition to reducing nitrogen oxide emissions while improving power output, reducing the total cost of ownership was also at the top of the agenda when developing the new modules. Grewe also highlights that the aura 408 with 8 cylinders offers a much lower

consumption than common 12-cylinder power units through better efficiency values for thermal and electrical power. However, he believes that the proven service-friendly design of the 2G engines also plays a major role in the economic assessment of many customers. It is achieved with a minimized number of cylinders with single cylinder heads and reduces the lifecycle costs, e.g. through digitalized remote maintenance.

During the development work for the aura series, 2G was able to build on the benefit of experience compared with new developments from competitors. With over 500 units in the market and over 6 million operating hours since the launch in 2011, 2G has the longest operative experience in the use of the latest engine technology in Europe with the agenitor series. The agenitor series is thus the longstanding core segment of the in-house engine development at 2G and forms the technical basis for the aura series and the hydrogen CHP agenitor H₂. |



The low-emission new module aura 408 (280 kW_e) is based on the proven agenitor and, in addition to NO_x emissions below 50 mg/Nm³, also offers a particularly good specific efficiency.

Westhof Bio – CHP as part of the recycling economy

In the far north, Westhof Bio uses CHPs from 2G at both its sites, which fit seamlessly into the sustainable philosophy of the company.

Locations:	Wöhrden, Hennstedt
Operator:	Westhof Bio-Gemüse GmbH & Co. KG
CHP types:	3 x avus 2000a, 1 x avus 2000a, 1 x avus 3000a
Gas types:	biomethane, biogas
Electr. power:	3 x 2,004 kW, 1 x 2,004 kW, 1 x 3,360 kW
Therm. Power:	3 x 2,330 kW, 1 x 2,330 kW, 1 x 3,801 kW
Installation:	indoor installation



Westhof Bio operates two of the largest organic greenhouses in Germany at its sites in Wöhrden and Hennstedt in Schleswig-Holstein. Maintaining an intact environment is just as important here as the production of healthy, high-quality food. Westhof Bio places great importance on ensuring that production takes place cleanly according to organic farming regulations and that all areas of the company are managed with a focus on saving resources and an environmentally-friendly approach. At the site in Hennstedt, a total of 105,000 tomato plants are planted from 2021 (panicle, mini panicle and roma tomatoes), while, at the site in Wöhrden, 70,000 pepper plants are also planted in addition to 45,000 tomato plants (panicle, mini panicle and roma tomatoes).

Due to the high energy requirements and the generally extremely advantageous conditions in greenhouses, Westhof has been operating CHPs at both sites for a number of years. The existing modules are currently being supplemented with a total of five 2G systems (three in Hennstedt, two in Wöhrden) as part of a flexibilization measure.

The three avus 2000a modules in Hennstedt are supplied completely with biomethane and therefore cover a large portion of the occurring electricity and heat requirements with gas from renewable production from the grid. At the site in Wöhrden, Westhof Bio also operates its own biogas plant that supplies gas for operating the avus 2000a. The site in Wöhrden is also supplemented with another avus 3000a CHP run with biomethane.

CO₂ fertilization as a central component

The already high efficiency or sustainability in energy generation with CHP systems is increased even further during use in greenhouses, as the CO₂ produced during the combustion process can be collected, filtered and used to fertilize the plants. In addition to efficiency, this was one of the main reasons for the investment in CHP systems and for the expansion at Westhof, explains Project Manager Nils Wiczorek: "The focus of our actions is on ecological farming, hand in hand with nature and natural cycles. So it's obviously really great that we can even support the plant growth with the by-product from energy generation."



Westhof Bio runs a biogas plant at the site in Wöhrden. This plant supplies gas for operating an avus 2000a from 2G.



It's really great that we can even support the plant growth with the by-product from energy generation.

Nils Wieczorek | Westhof Bio

Everything from a single source: planning, installation, financing

The smooth implementation of the project with a total of 11 MW required careful planning and, above all, the experience from many other plant construction projects over the past few years, explains 2G Project Manager Christoph Rotthaus: "In addition to the construction of a new machine house, some of the modules were also integrated in existing infrastructures. A separate area with masonry and additional concrete ceiling was created in an existing hall, for example, to fulfill the noise protection requirements." He particularly emphasizes the extremely pleasant cooperation with Westhof here. "The important thing in this dimension of project is that all parties work hand in hand – this was definitely the case with Westhof." In addition to the technical integration, Rotthaus also points out the financing of

the project: "The project is a great indication of the complete range of services that we can offer our customers. With our company subsidiary, 2G Rental GmbH, we were also able to help with the financing of this mammoth project." Nils Wieczorek really values this combination: "We really appreciate the fact that we can combine our commitment to sustainability with good economic efficiency. The support from 2G, from the financing to the implementation, made the entire project much easier." |



Over 500 apartments, some shops, a high-rise office block with twelve stories and a campus for around 1,800 students will be located on the site on the Neckar after completion.



The advantage of 2G is that the manufacturer already has operating experience with pure hydrogen.

Manuel Thielmann | Polarstern GmbH

District supply of the future

Neue Weststadt district relies on Power-to-Gas-to-Energy with hydrogen combined heat and power plant.

- Location:** Esslingen am Neckar
- Operator:** Polarstern GmbH and Green Hydrogen Esslingen GmbH
- CHP type:** agenitor 406 H₂
- Gas type:** hydrogen
- Electr. power:** 150 kW
- Therm. power:** 172 kW
- Installation:** indoor installation

The district supply of the future is climate-neutral – and low-cost. Although this may sound visionary, it is currently becoming reality in the “Neue Weststadt” district (also known as LOK.West) in Esslingen am Neckar. There, city planners and energy experts are implementing a concept to act as a blueprint for an ecological and economical city district supply. Electricity and heat for the district comes from green energy and local storage which provides a high degree of independence and flexibility.



Over 500 apartments, some shops, a high-rise office block with twelve stories and a campus for around 1,800 students will be located on the site on the Neckar after completion. The

first office buildings in the south of the site have already been built and occupied, the rest will be completed by 2022.

Affordable climate protection

The things that make the energy concept of the Neue Weststadt district so special are:

- the focus on low-cost, sustainable supply,
- the simultaneous planning of generation and consumer plants
- the holistic consideration of the electricity and heat sectors, incorporating mobility.

The focus is on reducing the energy consumption significantly and covering the remaining requirements in a climate-neutral way. So it's not a matter of exploiting every energy-saving opportunity – that makes climate protection affordable. The use of renewable energy to cover the remaining requirements secures the climate-neutral approach and represents more value for money in the long-term than reducing consumption through expensive energy saving measures.

A mix of energy sources or plants and energy stores is required for implementation. The electricity comes from local, roof-mounted photovoltaic plants (PV) or is purchased as green electricity. Heat is produced with eco gas or – indirectly, as outlined in more detail below – also from green electricity.

Where there used to be a freight station, a flagship neighborhood is being built in Esslingen. Blocks B and C have already been completed.

Batteries store surplus electricity and the fields of electricity and heat are connected. But, while other concepts achieve this link through Power-to-Heat with electric heating bars or heat pumps, the sectors are merged in a different way with the energy plant for residential block D with 167 residential units, the office block and the university building.

Local sector coupling with green hydrogen

The new energy plant produces green hydrogen from renewable electricity with an electrolyzer installed underground. This forms a “gas store”, which decouples the power generation and power consumption, as the gas can be “fed back” into a combined heat and power plant (CHP) with a time delay. The heat generated during operation of the CHP flows into the district heating grid. The electrolyzer is another heat source. It produces so much waste heat at approx. 55 °C that it can cover the basic requirement for heating and hot water preparation.

Electricity, heat, mobility – everything becomes one

The “Power-to-Greengas-to-Power&Heat” energy conversion is more complex than the use of electrical power for heat pumps or heating elements, but the concept is probably also more versatile and promising. There's a reason why the Neue Weststadt district project is funded by the Federal Ministry for Economic Affairs and Energy (BMWi) and the Federal Ministry of Education and Research



(BMBF) as part of the “Solar building/energy-efficient city” funding priority.

Hydrogen offers advantages for the energy system

Prof. Dr.-Ing. Manfred Norbert Fisch from the Steinbeis-Innovationszentrum Energie-, Gebäude- und Solartechnik (EGS) highlighted the potentials of sector coupling with green hydrogen in a press release of the city of Esslingen. The goal is to “demonstrate the function and suitability for everyday use of hydrogen production with all its advantages for the energy system, including on district level”.

The hydrogen storage can decouple local electricity production from energy consumption, and it can serve the grid by, for example, compensating for electricity oversupply or undersupply, or by working with batteries to reduce the amount of PV electricity fed into the grid when there is a threat of grid overload.

Effective marketing of green hydrogen

“We can’t set up a large seasonal store for hydrogen for space reasons”, explains Manuel Thielmann, expert for decentral energy supply at Polarstern GmbH in Munich. His team created the innovative energy concept for the Neue Weststadt district. “Surplus hydrogen is therefore fed into the natural gas grid or sold to the industry.” In the future, a portion will also be used for transport. A hydrogen fuel station is already planned.

CHP is more economical than a fuel cell

The primary goal, however, is to use hydrogen on-site. To ensure that the reconversion takes place at affordable prices, the responsible parties preferred the motorized hydrogen CHP. Thielmann explains why: “Although a fuel cell converts a higher proportion of the energy contained in the gas into electricity, the costs per installed kilowatt are much higher than with a motorized CHP. And we couldn’t purchase a fuel cell of this performance class from Europe.”

The CHP heat can be used well on-site, meaning that a higher total efficiency can be achieved, says Thielmann. “We don’t just look at the efficiency of the power supply, but optimize

the energy system as a whole.”

Cold from heat increases the annual efficiency

Efficient heat usage is also achieved through the fact that the cold for the air conditioning in the university building and the office block is also produced using heat: an absorption chiller will effectively convert the waste heat from the CHP system, which is generated at a high temperature level, into cooling energy and will complete the reverse power generation plant to create an attractive combined heat, power and cooling system.

CHP from 2G works with 100% hydrogen

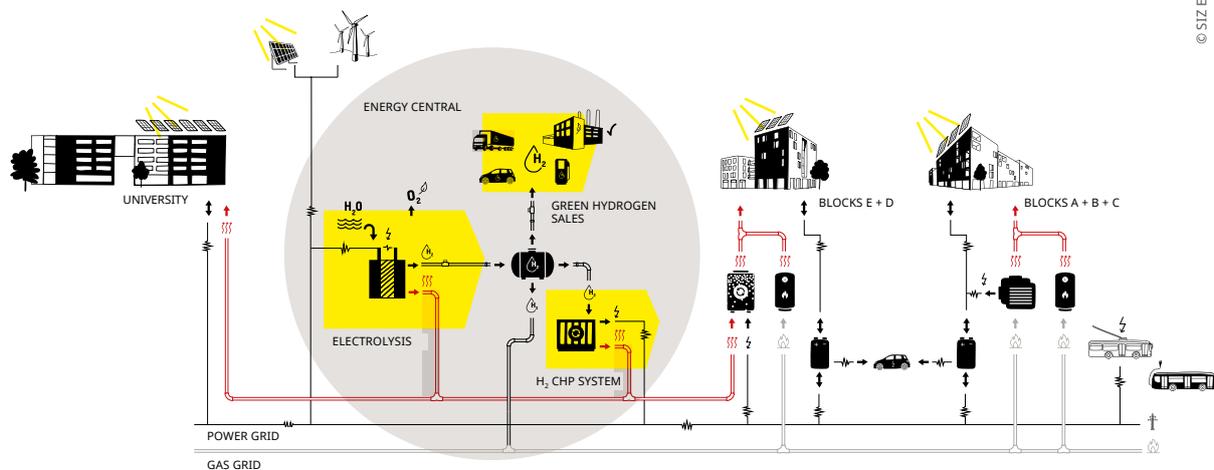
Once the decision was made in favor of the



There is only one manufacturer in Europe with a CHP that can offer the suitable powers and that can be operated with 100% hydrogen.

Manuel Thielmann | Polarstern GmbH

NEUE WESTSTADT // ILLUSTRATION P2G2P



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In the energy plant of the Neue Weststadt district, the energy sectors power, heat and mobility are combined effectively.

combined heat and power plant over the fuel cell, the choice of supplier was easy. “There’s only one manufacturer in Europe offering CHPs with the right powers and that can be operated with 100% hydrogen,” reports Thielmann, referring to 2G Energy. The CHPs could also work with a hydrogen-eco gas mixture or pure eco gas, so that operation is also possible if the electrolyzer fails. “Another argument in favor of 2G is that the manufacturer can already demonstrate operating experience with pure hydrogen, for example in a project in Haßfurt,” the energy expert continues.

Commissioning of the CHP in spring 2021

The CHP from 2G, an agenitor 406, is due to be commissioned in the Neue Weststadt district in spring 2021. A sound insulation capsule will mean that the operating noise of the engine won’t be heard in the neighboring residential properties. With hydrogen as a fuel, the CHP supplies around 150 kW_{el} and 172 kW_{th} power; in eco mode, it is 200 kW_{el} and 206 kW_{th}. Only during winter or during maintenance work on

the CHP, for example, will the peak load gas boiler installed in the energy plant (1,200 kW) have to work.

The 2G CHP is thus becoming a key component in the district supply, which will prove its worth in the coming years. The energy experts will therefore oversee the operation of the plants. “Polarstern, the Steinbeis-Innovationszentrum and the city of Esslingen founded the operating company Green Hydrogen GmbH, which is responsible for the energy plant,” explains Thielmann, who is also manager of the new company. “We will study the interplay between the components and the options of local compensation precisely.” |

Site supplier

Privatmolkerei Naarmann invested in two additional combined heat and power systems to cover the power and heat requirements.



Quiet, but effective: the two new combined heat and power systems at Naarmann (front container) and the direct steam generator (rear container).

Location:	Neuenkirchen
Operator:	Privatmolkerei Naarmann GmbH
CHP types:	patruus 400, agenitor 408, avus 500plus
Gas type:	natural gas
Electr. power:	400 kW, 360 kW, 550 kW
Therm. power:	504 kW, 381 kW, 578 kW
Installation:	sound-insulated container

NAARMANN



**The European Agricultural
Fund for Rural Development**
Europe investing in rural areas

Heat, cold and power – large amounts of energy are constantly required for processing milk. Because processes such as pasteurization, cooling raw milk and milk products, operating separators or homogenizing machines run around the clock in most milk-processing companies. The plant run by Privatmolkerei Naarmann GmbH in Neuenkirchen also runs seven days a week and processes around 200,000 tons of milk per year into long-life milk, cream, sauces, puddings, concentrates, powders and many other products, mainly for large-scale users, gastronomy, the food industry and export.

CHP covers the constant power and heat requirements

The simultaneous consumption of electrical and thermal energy at practically constant levels throughout the year is the ideal application for combined heat and power systems (CHP systems). Naarmann has been relying on a natural gas CHP from 2G for a long time: a “patruus 400” has been in use on the company site since 2014. Set up in a sound-insulated highline container, it supplies the plant with up to 400 kW_{el} and 504 kW_{th} power. The heat is supplied to the consumers with a flow/return temperature of around 95 °C/75 °C or – to decouple load peaks – buffered in a 100 m³ buffer storage; the power is used on-site practically to the limit.

“The operation of the CHP system is not only much more economical than purchasing from external sources and separate heat generation with fossil fuels, it also reduces the CO₂ emissions,” states Matthias Kemper, who is responsible for the energy plants at Naarmann. However, he also reports that the energy requirements have increased with the expansion of production capacities over the past few years. “This is why we wanted to make use of further efficiency potential.”

More efficient through combined heat and power generation plus steam generator

In 2018, Naarmann wanted to refine the proven principle of combined heat and power generation: the new technology had to supply power, heat at a high temperature level, and cold too. Kemper therefore planned to expand the combined heat and power generation with an absorption machine for cold generation and also to generate hot steam for ultra-high-temperature processing in the new energy plant. The responsible parties also wanted a high power yield, as the CHP power costs less

than purchasing electricity from the supplier.

The need for high efficiency prompted the customer to turn to 2G once again as a CHP supplier. “It’s not just the efficiency that’s right – the plants also impress with an extremely high power yield,” explains Kemper, the person responsible for managing the project, outlining the reason behind the choice. There were also other factors in favor of 2G, such as a good after-sales service, continues the energy manager: “The technology team at 2G is also on hand after commissioning; they helped us to optimize the heat decoupling on the older CHP after it had been commissioned.”



The technology team from 2G is also available after commissioning.

Matthias Kemper | Privatmolkerei Naarmann GmbH

New combined heat and power systems offer a megawatt of electrical power

This time, the CHP models “agenitor 408” and “avus 500plus” were chosen, which were also installed in sound-insulated containers and have been running smoothly for around a year. Thanks to the sound insulation, the working noise at a distance of ten meters is just 45 dB(A), which was important to Naarmann due to the proximity of the plant to residential properties in the surrounding area. The agenitor 408 provides around 360 kW_{el} and converts around 42.5% of the energy contained in the fuel into electricity. It also produces up to 381 kW_{th}. The second new CHP, avus 500plus, has a similar



The CO₂ emissions are around 3,600 tons lower each year.

Matthias Kemper | Privatmolkerei Naarmann GmbH

electrical efficiency, but offers even more power – in this case up to 550 kW_{el} and 578 kW_{th}.

The engine heat of the two new combined heat and power systems is decoupled at around 84 °C and is available to the absorption chiller; the exhaust heat at 420 °C is supplied to the steam generator installed in a third sound insulation container next to the combined heat and power systems.

Saving effect with refrigeration technology

The cooling power supplied by the absorption chiller machine pre-cools the coolant ice water coming from the plant in the return tank. This relieves strain on the conventional refrigeration technology. “This saves so much energy that it relieves the strain on our refrigeration system, which is also new,” explains the energy manager.

In contrast to the patruus CHP, the two new plants are electricity-based. The goal: to keep the amount of electricity purchased from external providers to a minimum. This was one of the reasons in favor of purchasing combined heat and power systems with around one megawatt of total electrical power. Now there’s so much electricity

generation capacity available that electricity only needs to be purchased to any meaningful degree in the event of the power peaks or CHP maintenance. Another advantage of self-production is that suppliers and grid operators have to provide less capacity, which has a positive effect on the charges. Together with a planned peak load management, which uses the newly set up ice storage as a buffer and thus avoids power usage peaks from the refrigeration technology, large amounts of money can be saved.

Zero supply regulation reduces supplier bill

To achieve maximum efficiency, the new CHPs run practically non-stop, but not always in full load operation. The zero-supply regulation specifies how much power they provide. It regulates the two machines so that the power demand curve is followed as closely as possible. The regulation also ensures load distribution. This means that the operating hours and the wear are distributed evenly over the power units. Energy managers and 2G technicians can see the condition of the power units remotely, as the control technology offers remote access for authorized users online.

Self-production covers 92% of the electricity requirements

Now, one year after commissioning the two new combined heat and power systems, the concept implemented by Kemper has been validated. The zero supply regulation works with maximum precision; 97.6% of the self-production capacity is used – despite occasional maintenance. And the degree of self-supply has increased massively, as the energy manager reports: With the new plants, which were funded with subsidies from the EU ELER fund, Naarmann can now cover 92% of the power consumption through self-supply.

“And it’s also good for the environment,” says Kemper. “With the new combined heat and power systems, the integration of the steam generator in the heat line and the more efficient chiller system, the CO₂ emissions are reduced by around 3,600 tons each year.” |

Milk processing requires power, heat and cold at the same time – ideal conditions for using combined heat and power systems with additional absorption chiller.



25 YEARS FOR THE CAUSE

The founding duo (from left): Ludger Gausling and Christian Grotholt



In the CHP Journal, we will keep you informed with news from the world of 2G at regular intervals. We will also present exciting CHP projects. What these projects have in common: they are implemented by people from all over the world, who have consciously chosen the top technology from Münsterland and who are thus making their contribution to the energy supply of the future. An energy supply, which is decentral, economical and ecological.

And not much has changed in this mission 25 years after 2G was founded. The original plan of the two founders Christian Grotholt and Ludger Gausling initially didn't include the production of the company's own CHP systems. But no one has regretted this decision. After all, the company has progressed from the small office container where everything started into a global network of the company's own subsidiaries and authorized sales and service partners. A development that seems logical in view of urgent global challenges such as climate change and population growth, and yet is anything but self-evident.

With the goal of becoming a global technology leader, 2G is helping to continuously increase the share of environmentally-friendly energy producers in the global energy mix. CHPs are much more than just a bridging technology in this respect: they form the foundation for a reliable, decarbonized supply based on renewable energies. Because, even if solar and wind energy are constantly expanded, the risk of natural capacity fluctuations and the scenario of possible supply bottlenecks remains. As a flexible, weather-independent and environmentally-friendly generator, combined heat and power generation can compensate for this volatility in a targeted way.



The Energy AG board of directors in the anniversary year (from the left): Ludger Holtkamp (COO), Frank Grewe (CTO), Christian Grotholt (CEO) and Friedrich Pehle (CFO)

The driving force behind the lasting success of 2G were and remain the innovative spirit and the constant focus on continuous improvement. This is reflected in our latest development: the hydrogen CHP, which was recently made ready for market. The operation of our CHP with natural or biogas is already much more environmentally-friendly compared with conventional energy sources. Through operation with pure hydrogen – one of the key technologies of the energy revolution – climate-neutral operation is no longer a vision of the future, but is already being implemented with concrete solutions in practice. The option of converting existing conventional 2G CHPs enables our existing customers to enter the world of hydrogen technology without having to invest in a new CHP.

In the future, we will continue to help shape the global energy revolution actively with our technological developments. Combined with the many other facets of sustainability, as firmly anchored in the philosophy and in the business model at 2G, we aim to make a positive contribution for a good quality of life in the future.

Thank you for supporting us in this endeavor! We look forward to the next 25 years with you at our side. |

NOT TOO LONG AGO

1995

THE FOUNDATION OF THE COMPANY

Christian Grotholt and Ludger Gausling found 2G Energietechnik GmbH at Markt 7 in Heek. 2G primarily supplies customers from the agricultural sector with CHP systems, as the switch to strawless husbandry at the time means that there is a need for continuous power and heat in the stalls.



2002

MOVE TO THE INDUSTRIAL ESTATE IN HEEK

2G needs space for further growth – and moves to the industrial estate in Heek, Benzstraße 10.

2007

ENERGY MOVES TO THE STOCK EXCHANGE

2G is the first company supplying integrated, highly-efficient technology for combined heat and power generation to be listed on the capital market: 2G Bio-Energietechnik AG. 2G has around 50 employees at this time.

2009

A GROUNDBREAKING INNOVATION

As the first provider on the German market, 2G presents a performance-optimized combined heat and power plant with electrical output of 220 kW for operation with biogas in the form of the agenitor. The electrical efficiency was increased by 2.2% to 40.6%.



2010

R&D

With the establishment of the R&D company 2G Drives GmbH in Heek, 2G is consistently expanding the continuous research and development work into gas motor technology and the optimization of peripherals.



2011 EXPANSION



The increasing focus on the natural gas sector and growing globalization also become evident in the company name: 2G Bio-Energietechnik AG becomes 2G Energy AG. 2G continues to grow and establishes subsidiaries for sales and servicing in Italy, Poland and UK. Meanwhile, international business grows, not only with European customers. The number of plant installations in the USA, Canada and Japan is also increasing. The production capacities opened in 2009 are increased further by 3,000 m².

2016 DIGITALIZATION

With the “my.2-g.com” developed in-house, 2G enables plant operators and distribution partners to continuously optimize their plant management using twelve useful applications or services.

2017 AURA SERIES

Based on the successful engine concept of the agenitor series, the aura from 2G offers outstanding efficiency properties. Equipped with 2G’s own Lambda -1 technology and weakly charged turbocharger, it also offers extremely low exhaust emissions.



2018 H₂ CHP

2G receives an order from Stadtwerk Haßfurt GmbH to supply a CHP plant that runs purely on hydrogen. Together with the client, 2G thus implements a project that is groundbreaking for renewable energy supply in conjunction with wind and solar power.



2020

25 YEARS OF 2G

The 2G team consisting of around 700 employees is proud of the 25-year history of the company. Due to the corona pandemic, the celebrations will be held in 2021.



2



GETHER

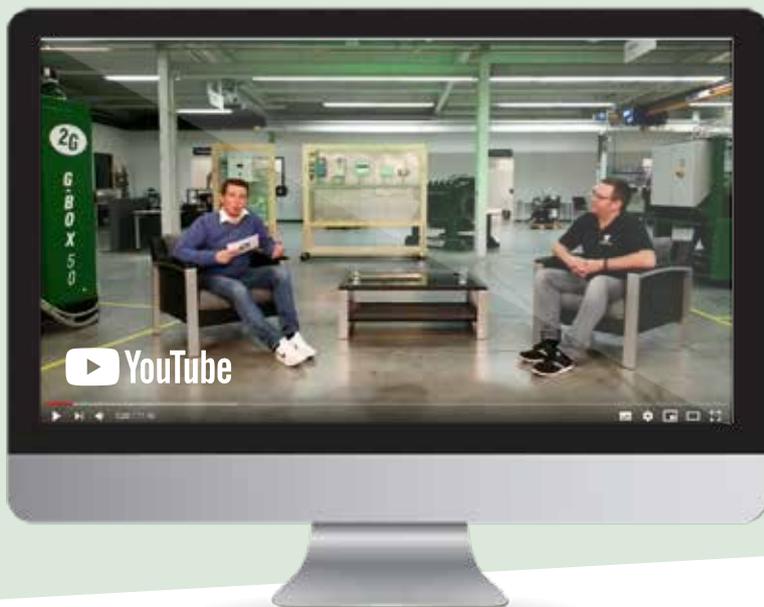
25 years of 2G





2VLOG

The new video blog – with exciting insights into the world of 2G.



Now available
on YouTube.



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CHP Journal

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