

# CHP Journal



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## Preface

Dear readers,

The coronavirus pandemic continues to keep us all on high alert. Although the number of new infections is known to be dropping in Central Europe, new figures of COVID 19 cases in USA, Brazil and Russia for example have shown us that this is a virulent disease which continues to spread around the world and demands our vigilance, respect as well as social responsibility.

We extend our sympathy and compassion to all those who have been directly or indirectly affected by the coronavirus pandemic. At 2G, we can be thankful that, until now, we have come through this coronavirus crisis relatively unscathed. Sincere thanks go to all our colleagues whose conduct and behavior have helped to keep the number of recorded cases low and prevent damage to our business despite the difficult circumstances. We will of course have to wait and see how the situation pans out and what effects this will have on our business activities. It is difficult to predict the social, political and ecological ramifications of the coronavirus. Recovery packages, such as those recently announced in Germany, do not exclude climate protection and this approach is to be endorsed. It lies with politics to implement rescue packages that support both integration and the environment in order to avoid reinforcing social imbalances between countries and regions.



Christian Grotholt

The National Hydrogen Strategy (NWS), announced on June 6, the decarbonization agreement and the ideas of the EU Commissions which are reflected in the “New Green Deal” paper make us confident that our products and services will play an important role in actively shaping the energy revolution.

In this edition, we have again tried to choose a potpourri of entertaining topics and comments to keep you informed about the new developments and events happening in your 2G Group. The extension of our company network with the partner concept will be presented in this issue as well as the progress of “Artificial Intelligence”. We will also showcase new products and, last but not least, we will be reporting on our hydrogen CHP solutions and demonstrate the clear benefits of a rental CHP plant.

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".

Christian Grotholt  
CEO of 2G Energy AG

## When, If Not Now?

### Corporate responsibility also includes energy efficiency – and not just in the here and now

Times are changing. Despite cross-border challenges such as the Euro and refugee crisis, trade conflicts and sanctions, the German economy was in a healthy condition in the years following the global financial crisis of 2007/2008. You sometimes had the impression that growth was guaranteed and as long as product, price and market activities were gaged correctly, success was virtually guaranteed. The low-interest-rate policy pursued by the central banks certainly played a part in this success. Large order volumes in the industry, trade and service sectors ensured high turnover and profits in many areas. Liquidity was available, the mood was positive and the investment climate was “warm”. A high utilization of capacities often led to a focus on the core business and opportunities for growth. Companies outside the energy sector and those not working directly with energy often relegated energy efficiency to a side issue. Understandably so, since resources are always limited and inevitably have an effect on prioritization.

### ... But then the coronavirus hit

And there was and is something which cannot be outsmarted: the business cycle. Following years at the top of the curve, experts were increasingly warning of the dangers in 2018/2019. In January 2019 for example, the Manager Magazine asked whether Germany was on its way into a recession after repeatedly reporting a deterioration in economic data. That said, the overall situation was still respectable. A clear recession had not been witnessed. But

then the coronavirus hit. The consequences had an immediate effect on consumer behavior and the incoming orders of many companies. Others have felt nothing but fear that they will be hit by the effects later. Only a handful of sectors will be left unscathed or will profit from this pandemic.

Whether we are dealing with predicted economic developments or sudden events such as a pandemic, one thing can be said for certain when it comes to energy efficiency: It has always been a good idea. When viewed from this perspective, it becomes evident that the current situation poses challenges for companies today but also for their decisions for the future. How can we react to a decline in demand and investment restraint? The tasks are diverse and vary from company to company but include production and capacity planning, targeted sales activities and savings to drive liquidity. And then there is also the future to consider. It's difficult to plan for a future which is full of uncertainties as to the development of the business. No matter what challenges the future holds, one thing is sure: **Those who do not consider their energy efficiency potential today will be faced with added cost and a competitive disadvantage in the future.** This applies now and when a “catch-up” is needed once the difficult times are over. One other point: **The climate is not interested in today's problems. The environmental awareness of many people as well as many consumer decisions have changed at the latest since the Fridays-for-Future movement.**



### Immediate gain in efficiency

The solutions from 2G can play a valuable and supportive contribution NOW to many of these challenges. Cutting-edge, climate-friendly and economical technology ensures an immediate boost in efficiency and more competitiveness. Making use of 2G Rental to implement a new plant will allow you to profit from the unique selling points of your rental model without tying up liquidity or investments and roll out projects quickly without the involvement of banks or difficult budgeting processes. Amortization periods do not pay bills. But an increase in liquidity will do. The flexibility of 2G Rental models not only offers advantages for the here and now, it also creates a solution for any changing demands in the future.

In effect, what does this mean? It is necessary to take this current situation as an opportunity to address topics which allow a more efficient, cost-effective and compatible

value added strategy for the future. Energy efficiency is a cornerstone in this equation. Not only does the climate benefit but the company's own competitive position, too. Corporate responsibility is not governed by economic cycles or pandemics. It is something that a company always needs. But lost time equals loss of efficiency which is why the following applies today more than ever before: When, if not now? |

By Thomas Gawlowski,  
Managing Director of  
2G Rental GmbH



## Rolls Royce Purchases CHP Modules from 2G – and Vice-Versa

Both the engine and CHP suppliers extend their product portfolio



From left to right: From Rolls Royce, the contracts are signed by Michael Wagner, Director Business Development for Decentralized Energy Systems, and Andreas Görtz, Vice President for Power Generation, and from 2G CEO Christian Grotholt and Heiko Barth, Head of Product Management at 2G.

On November 8, 2019, 2G Energy AG based in Heek and the Power Systems Business Unit of the Rolls-Royce Technology Group in Friedrichshafen signed a reciprocal purchase agreement for gas generators for combined heat and power plants (CHP).

Rolls-Royce will purchase from 2G gas generators and CHP modules with power outputs from 250 to 550 kW with and without heat extraction. Once fitted with their own control unit and other specific components, Rolls-Royce will then market them under its own product and solution brand, MTU. In return, 2G will purchase from Rolls-Royce gas

power generators from the 4,000 series in the electrical output range of 776 to 2,535 kW for its combined heat and power generation plants for the decentralized generation of power and heat.

Christian Grotholt, CEO of 2G Energy AG, regards this cooperation as a success in terms of the years of development work at 2G aimed at combining high levels of efficiency with low lifecycle costs for engine development: “The combination of environmentally-friendly energy conversion technology, high availability and low service costs is the foundation for a sustainable profitability of CHP plants for the

plant operator. That is the strategy behind our CHP solutions which are designed for the increasing demands for flexibility in operation. We regard these CHPs, designed with gas engine technology for biogas, natural gas or hydrogen, as an integral technology for a cost-effective way of forcing the energy revolution."

In terms of this cooperation with Rolls Royce, Grotholt expects 2G to strengthen its market position in the 50 to 550 kW electrical power output range which should lead to further developments with regard to customer benefits: "We will continue to expand our technological leadership by continuing to pursue research and development work beyond gas engine technology with the digitization of plants and processes and software development."

### **2G products replace CHP of Rolls Royce in the lower power output range**

"The strategic cooperation with 2G has helped to extend our product range to include energy-efficient and environmentally-friendly cogeneration power plants and take one strategic step further to becoming a solutions provider," says Dr. Petar Pelemis, Vice President Corporate Strategy & Product Management of the Rolls-Royce Power Systems Business Unit. In the foreseeable future, the 2G products will replace the CHPs from Rolls Royce in the lower power output range which are based on the tried-and-tested MTU gas engine 400 series.

"Combined heat and power plants from Rolls Royce are based on gas power generators in the power output range 220 to 11,800 kW and are ideal for use as components in microgrids, in other words autonomous power grids, which combine renewable energy sources and battery storage units with gas-powered generators, for example", says Andreas Görtz, Vice President for Decentralized Energy Systems at Rolls

Royce. "Thanks to intelligent control units, they make optimum use of the energy stored in the microgrid and avoid harmful CO<sub>2</sub>." If the gas engines are operated with biogas or synthetic fuel generated with power from renewable sources, these combined heat and power plants, whether used alone or as part of a microgrid, significantly contribute to ensuring an environmentally-friendly supply of energy. |

## More Efficient Training Concept

**New practical training center in Heek and wide range of online training programs**

With the launch of a new training concept, 2G is increasing learning efficiency within the company while reducing travel times and cost. The new concept is based on an extensive series of online courses which cover theoretical aspects as well as a new training center for practical learning.

This clear division between theory and practical-based training offers numerous advantages, says Andreas Ramschulte, Head of the 2G Training Department: "Our participants can complete the theory-based training courses online, from wherever and whenever they want. They can interrupt courses and continue with them later or navigate through them as they choose to refresh aspects which they have already learned or to access information which they need for work. In contrast to classroom learning, this means less stress and also saves on travel time and costs."



Practical training on CHP

Training participants can then utilize the time spent on location in Heek for honing their practical-based training skills for maintenance, commissioning, operation or troubleshooting on 2G CHPs. "Training on the machines makes absolute sense and cannot be replaced by virtual learning", believes Ramschulte. "Hand movements and manual procedures are easier to learn and remember when you perform them on the machines. Besides the transfer of knowledge between trainer and trainees, classroom-based learning also enables participants within the group to share their experiences."

To increase learning success with practical-based training, 2G has opened a new training center with CHPs, engines and peripheral components for trainees to practice working on. The center offers plenty of space for all participants in a group to watch demonstrations and work on the machines. It also accommodates a large number of practice CHPs and is divided into various areas which means several training sessions can be held at the same time without being disturbed by other groups. The first practical training courses are expected to be held in the new training center in summer 2020. |



# Virtual Power Plants for Safe Supply and Climate Protection

## CHP and flywheel generator used as components in the virtual power plant vwk++ “Industry” award

Wind power generation is one of the central pillars of the energy revolution and for climate protection, too. Consequently, years with extremely strong wind intensity such as 2019 are, in principle, extremely beneficial. Yet the network structure in Germany is increasingly struggling to cope with the volatile and intermittent feed-in of energy and increasingly requires drawing on the power grid to secure the supply of energy. In February 2020, the German distribution grid operator MITNETZ STROM reported that the power generation from renewable energies had to be shut down a total of 357 times in 2019. Approximately one third of energy was drawn from the power grid operated by the



Ministerium für Klimaschutz, Umwelt,  
Landwirtschaft, Natur- und Verbraucherschutz  
des Landes Nordrhein-Westfalen



upstream transmission grid operator, 50 Hertz. On 92 days of the year, power generation plants were not allowed to feed in energy or not at full rate so as not to jeopardize grid safety. In the company's own blog, Dr. Adolf Schweer, Chief Technical Officer at MITNETZ STROM, explained the situation as follows: “In comparison to 2018, we recorded an increase of eight percent in the amount of generated wind power. In contrast, the installed capacity of wind power plants increased by only one percent.”

## Safe supply and climate protection go hand in hand: the Quirinus project

In spring 2017, the NRW leading market agency launched a climate protection competition entitled “VirtuelleKraftwerke.NRW” (virtual power plants for North Rhine-Westphalia). Six of the submitted projects were chosen. Varying in their approach, all of the projects focused on solutions to control the load and generation units and the flexibility of power grids. All of the funded projects had until spring 2020 to implement their systems.



One 550 kW power plant supplies the power required for microgrid operation.

At the project tender stage, the approach taken by the QUIRINUS project managed to convince the selection committee and was awarded a total funding of EUR 6 million. The main idea behind the QUIRINUS project is to bundle the decentralized flexibility of power generation, storage and consumption plants into one virtual power plant to use it according to grid and system demand. To make systematic use of this flexibility, the effective and economical implementation of the two factors below is of essential importance:

- A high level of power grid transparency, i.e. monitoring and recording the current status of all relevant components which far exceeds today's standards in this sector
- An intelligent and dynamic aggregation and management of all available flexibility resources.



The aim of the QUIRINUS project was to develop and technically demonstrate a new generation of virtual power plants by designing a virtual power plant (VKW) which functions according to the demand of the system, distribution grid as well as regional needs. The team chose "vkw++" as the name for their project. The first "+" stands for efficient infrastructure use and the avoidance or reduction of grid extension measures and the resulting costs. The second "+" stands for the digital revolution in power distribution grid management and related IT security which takes top priority in this project.

The system was first piloted as part of the project in the Rhineland, a region dominated by

industry and commerce but can be expanded and transferred to regular operation.

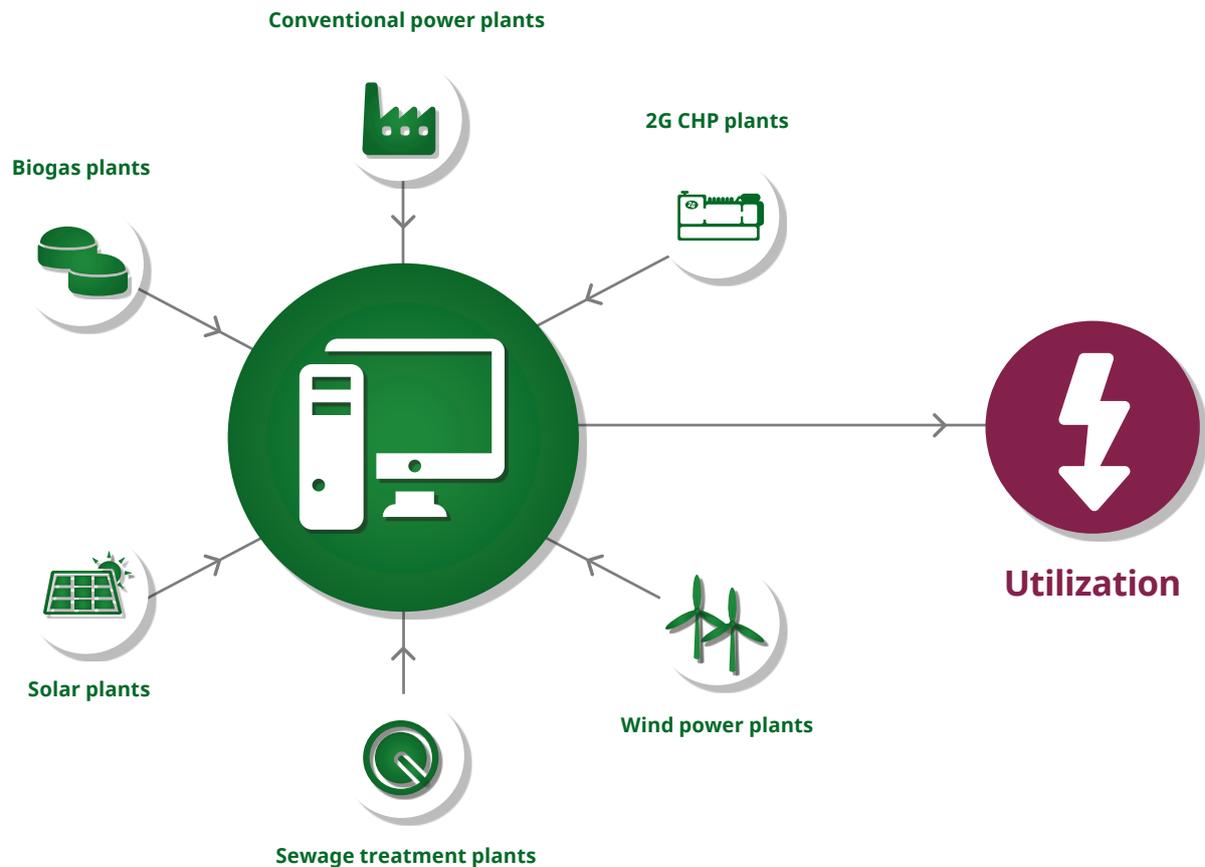
The QUIRINUS project team consists of a regional association of distribution grid operators, energy suppliers, manufacturers and operators of data communication systems, flywheel generators and cogeneration systems as well as two research institutes. The project was proposed and led as a consortium by Regionetz GmbH with headquarters in Eschweiler, Germany.

Once the design phase was completed in 2017, the project rollout began in March 2018 with the analysis and definition of test scenarios. The simulation and setup of the prototype test center followed in autumn of the same year. From 2018 to the end of 2019, the project goals of a total of seven work packages could be successfully implemented.

### Focus on scenario 3: microgrid

The "design" work package was completed in December 2017. With the result that three different scenarios were to be examined, each of which focused on the different challenges of the energy revolution: "Grid management according to the traffic light concept", "Flexibility" and "Microgrid". Each of the scenarios places its own particular demands on a vkw++ whereby this article intends to focus on the third scenario "Microgrid".

In the event of a blackout, the microgrid supports the recovery of the grid. When a system-relevant error is detected, the selected local area of the grid is disconnected from the distribution grid and stable operation is continued in the microgrid. The result is an autonomous grid which is then used to actively support the recovery of the macrogrid system from the distributor grid level. The hybrid, a



combination of a combined heat and power plant (CHP) and dynamic rotary storage device, stabilizes the system-related parameters of frequency and voltage.

Due to flexible, decentralized plants, the vkw++, similar to a storage unit, can be used as required by the system. For this purpose, it is simulated in models as a storage system and integrated in the node power price model to analyze the system benefits of a virtual power plant. Part of the flexible capacities of the virtual power plant are reserved for distribution grid use and the available capacities used to optimize system costs.

The QUIRINUS project is therefore aimed at upgrading the design of the power grids so that, if and when needed, areas of the grid can switch to microgrid operation to

ensure the continued and safe supply of power to the connected grid user while maintaining the same standard of quality. This is necessary, for example, if there is an extensive blackout but also in the event of local grid outages. Considering the fact that conventional large-scale power plants are decreasing in number, stable microgrids that can be flexibly transferred to distributed grid operation ("honeycomb concept") could be used for future concepts of grid recovery (black start reserves).

The focus of operations in 2018 was on the design and implementation of microgrid trials on the premises of the Inden open-pit mine of RWE Power GmbH. In 2019, the key components of the microgrid such as the CHP and flywheel generator were transported from the Inden mine to Gangelt to verify the

positive results collected in Inden in a more complex power grid structure.

### **Pilot phase 1 in open-pit mine with controllable loads**

The aim of the development work conducted in pilot phase 1 in the RWE power grid network was the technical rollout of the hybridization of a CHP and a flywheel-based high-capacity storage as a prototype. The intention was to demonstrate that, by using appropriate generation capacities and loads based on demand and topological grid design, the local quality of supply and supply reliability can be significantly increased on a distribution grid level despite volatile and intermittent energy feed-in.

Decentralized control management strategies and highly dynamic load flow compensation are intended to compensate on a local level for the difficulties expected in power grid stability caused by the lack of large-scale conventional power suppliers and the resulting drop in available power reserves. An example of how this has been practically implemented is the hybridization of an avus 500plus CHP from 2G Energy AG with a flywheel storage system DuraStor250 from Stornetic GmbH.

The avus 500plus CHP delivers, with a total volumetric efficiency of over 87 percent, performance data of 550 kW<sub>el</sub> at 578 kW<sub>th</sub> and is therefore a particularly efficient power supplier. The CHP plant can be operated according to power need – i.e. flexible to the power grid. In combination with the flywheel storage unit, the operation of the CHP is “harmonized” by the ability of the storage unit to deliver effective power quickly or act as the load.

The DuraStor 250 features 24 flywheel storage units in which the flywheels can be accelerated to speeds of up to 45,000 revolutions per minute. This transforms electrical energy into mechanical energy and vice versa. In the regeneration, the engine acts as a generator and generates electricity with the braking of the rotor. Christoph Schäfer highlights the advantages of split-second availability of the storage unit: “The fast response time of the flywheels is decisive for use in stabilizing the power grid. Fluctuations in power and output can be stabilized extremely quickly. In the hybrid solution, the CHP and storage unit complement each other perfectly.”

The “Brunnen Viehöven” power grid area operated by RWE Power AG was chosen to conduct the operational pilot tests. The area is located at the northeast border of the Inden open-pit mine in the Rhineland region between Eschweiler and Jülich. |

# More Transparency and Efficiency

## Digital my.2-g.com toolbox creates added value for plant operators

Plant operators are kept well informed with my.2-g.com: These digital solution tools offer maximum transparency and help to increase the availability and efficiency of your 2G plants – at no extra cost.

The technology behind my.2-g.com is based on the 2G POWER PLANT which is also required for the 2G premium service. This allows a plant availability of over 95 percent and continual plant optimization. 2G POWER PLANT works by receiving operating data and error messages from 2G plants.

### Automated troubleshooting management

In the event of an irregularity, the fault will appear in the Tool Plant Manager and 2G POWER PLANT automatically triggers a service order at the same time. Subsequently, plant operation will either be restored by 2G Service by remote login or – if this isn't possible – a service technician in the area will be notified so that the fault can be rectified asap. To speed up the troubleshooting procedure, 2G POWER PLANT sends the operator and the service technician possible suggestions on how to repair the malfunction. This minimizes any downtimes.

### Plant Manager makes performance more transparent

The Plant Manager is not only an information platform for status and error messages, it also provides performance reports. Important data such as operating hours, capacities, temperatures and status messages provide the user with a quick overview on the performance

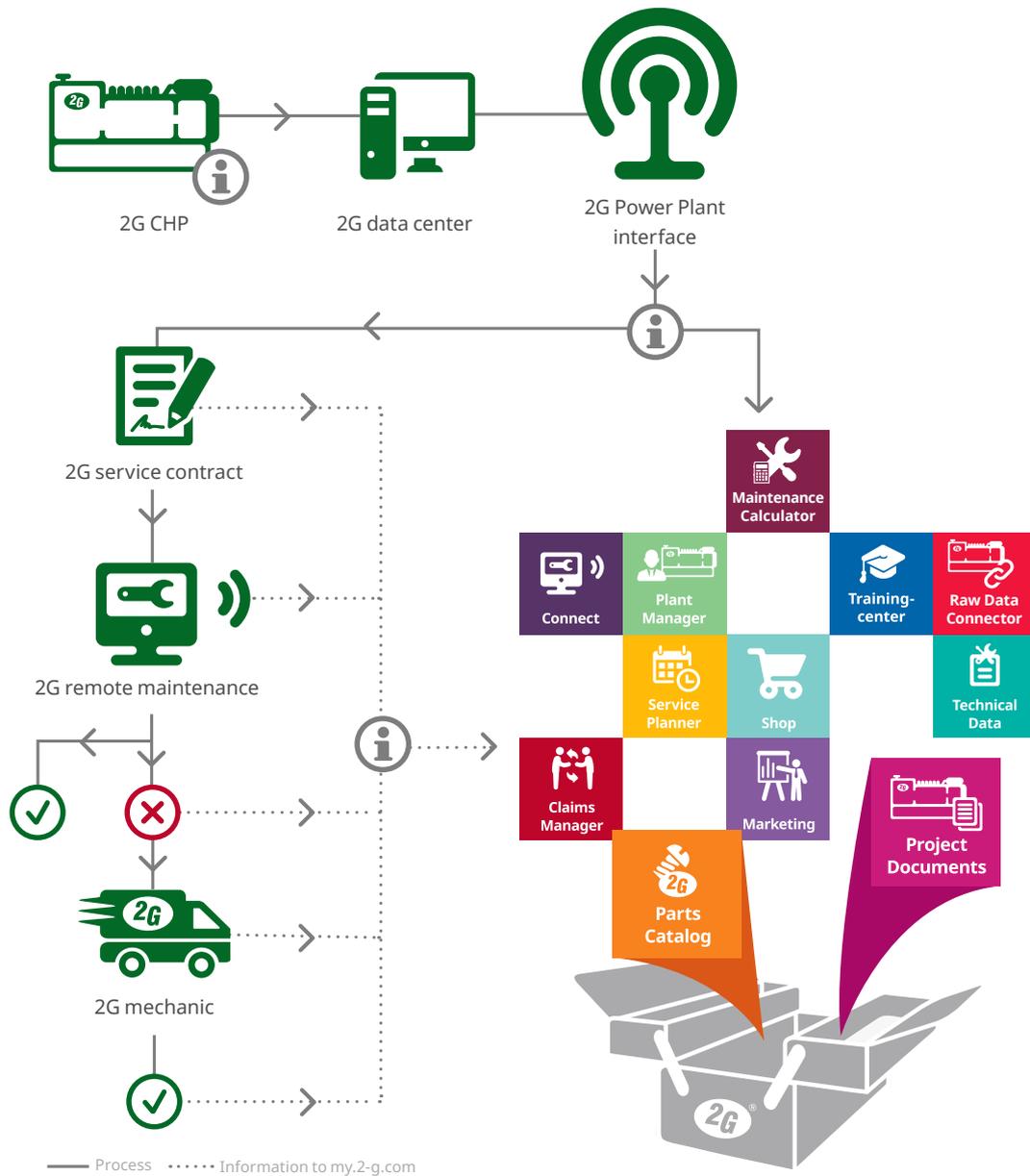
of their plants. Filter functions support users by helping them quickly detect which plants have irregular parameters, if maintenance is due soon or if, for example, the connection to the plant is damaged.

### Monthly reports sent by e-mail

The Plant Manager also includes the energy reporting service with which users can create reports from last month's key figures. Plant operators can subscribe to these reports free of charge and then regularly receive these reports by e-mail. The supplied data can be exported easily into a standardized file format which makes further processing and evaluation easier. This helps Plant Manager users to prepare information on the amount of generated power for the German Federal Statistics Office or other institutions. The transparent morning coffee dashboard also delivers information about current irregularities during plant operation.

### All important documents in one location

The Project Documents tool also included in the free-of-charge basic package of my.2-g.com offer users the opportunity to save all important documents and data on a 2G plant in one central location and to view and download them – from operating manuals, technical drawings and electrical circuit diagrams to maintenance reports and assembly reports. The Training tool is also available as an option. It contains the planning and booking platform for operator and service training courses.



### Remote control management with my.2-g.com Connect

The add-on Connect tool is for subscription at a cost and can be used by operators for the remote control management of their 2G plants from a computer. The plants can be started up by remote access as well as stopped or current values and status messages can be viewed. Important plant data such as the amount of electrical power produced or operating status can be accessed with Connect from a smartphone.

As an operator, you can now also benefit from I.R.I.S, the Intelligent Report Information System which has been available for a year now. We have summarized the benefits of I.R.I.S in another article (see page 15). |

# I.R.I.S. Predicts Plant Operation for the Future

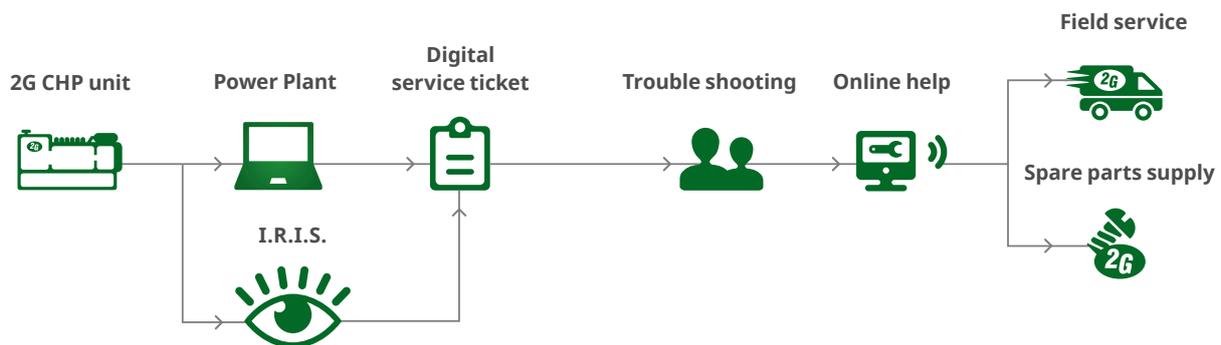
## Predictive maintenance minimizes downtimes and maintenance costs

Identifying faults and malfunctions before they occur can increase plant availability. This is precisely the purpose of I.R.I.S, the Intelligent Report Information System, which 2G Energy has been operating since the start of 2019. The system is the logical continuation of the 2G Power Plant software which automatically analyzes malfunction signals and triggers service incidents.

With Power Plant alone, 70 percent of all faults could be rectified online in the past without requiring a technician to be present on-site.

current operation and predictions for future plant behavior.

The system can also monitor plant operation over a longer period in order to better diagnose error patterns based on current and historic data. When I.R.I.S. detects an irregularity during operation, the software automatically sends all the relevant information and recommendations for action to the service team. I.R.I.S. is therefore a virtual assistant which is supported by experienced service colleagues.



However, even remote troubleshooting costs the plant operator both time and money. Predictive maintenance systems such as I.R.I.S. look to the future and allow operating irregularities to be detected quickly and avoid potential malfunctions or damages.

The software designed by 2G Energy constantly monitors plants for potential irregularities in operation. I.R.I.S. imports around 400 million sensor values every week and analyzes them. Thanks to cutting-edge realtime analyses and predictions, the results are available immediately. The comparisons and trend analyses collected by I.R.I.S. deliver insight information on the

The combination of machine and human intelligence helps to increase the level of remote maintenance, organize more efficient and on-demand on-site maintenance and avoid unscheduled downtimes – a real added value for plant operators. The use of I.R.I.S. requires no additional hardware for operators. An online connection is all that is needed to transfer sensor values. All customers, who use the 2G service via a service or maintenance agreement, can now profit from the “watchful eye” that I.R.I.S. has over your plants. |

# Intelligent Approach to Compliance with the 44th Federal Immission Control Ordinance (BImSchV)

## Clever technical upgrades make existing plants fit for the future

Plant operators of older biogas CHPs have been faced with a dilemma ever since the 44th Federal Immission Control Ordinance (BImSchV) took effect on June 20, 2019. On the one hand, the eligibility period has not yet expired, on the other, the law stipulates compliance with nitrogen oxide (NO<sub>x</sub>) emission values which need to be measured for verification and, in practice, many of the plants do not fulfill the high level of electrical efficiency which is targeted.

For an entire series of engines such as the 28th series of MAN lean-burn engines, MDE generators as turbo engines or most of the MAN replicas and Mercedes industrial engines, the CHP manufacturer 2G Energy in Heek has now developed a solution which not only complies with the limit of 500 mg/Nm<sup>3</sup> NO<sub>x</sub> set out in the 44th Federal Immission Control Ordinance (BImSchV), it clearly falls below the threshold limit: the V36 cylinder head.

Frank Grewe, CTO of 2G Energy AG, commissioned a series of measurements in the field which recorded values of around 400 mg/Nm<sup>3</sup> NO<sub>x</sub> at full load in compliance with the required efficiency standards: "The cylinder head has been designed by an in-house development team with optimized cooling and a tried-and-tested component from our own agenitor series, several thousands of which have already proved their reliability and stability on the market."

With a service life of up to 40,000 operating hours, the company sees the economic advantages in doubling the valve clearance setting intervals for the cylinder head to 4,000 operating hours and in the service life of a conventional hook spark plug by up to 8,000 operating hours by improving the heat transmission in the cylinder head.

## The V36 cylinder head can also be used for third-party products

The first agenitor 206 to be designed by the in-house development team was connected to the German power grid in biogas operation in 2008. The new CHP – fitted with a spark-



The V36 cylinder head from 2G is a key component in ensuring compliance with the 44th Federal Immission Control Ordinance (BImSchV) under economical conditions and with reduced maintenance costs.

ignition petrol engine – caused a sensation on the market because the unit was the first CHP in its output class to feature an adapted combustion concept with a high compression ratio. Thanks to these features, its capacity could be increased by 16 percent in this first step.

This in-house development was based on the 28th engine series from MAN. Today, this engine is predominantly still used for diesel applications in the maritime sector but also for trucks, buses and generators. In contrast, the market for gas applications is far smaller which is why most engine manufacturers in the truck performance class do not make a distinction between the different types of gas. For this reason, construction features such as compression ratio and combustion chamber geometry – and the associated combustion speed – are generalized and are not specifically adapted to the particular gas type.

2G, in contrast, adapted the design of its agenitor series to the relevant fuels (natural gas, biogas and other lean gases). As a result, the second generation of the company's 6-cylinder unit (agenitor 206) has already delivered impressively high electrical efficiency. Adapting and optimizing the combustion required the use of the best-quality materials and components because, from the very start of development, the focus was on delivering a long service life and stability in the optimization of the agenitor components. One of the results of this development work is the V36 cylinder head.

The cylinder head's cast iron body is made of EN-JL 1050, a cast iron with lamellar graphite. This graphite is an iron-carbon-silicon alloy. The advantages of this lamellar structure in this alloy are its damping properties (graphite lamellae act like tiny shock absorbers), thermal conductivity and inherent stability. The lamellae

can provide the cast iron with self-lubricating properties if they are cut during processing because lubricant is stored in the cavities which are created when the lamellae are cut.

### **The key to success is to optimize the entire cylinder head system**

The V36 cylinder head implements the findings of the 2G R&D work by using two cooling sections. For Frank Grewe, the overall examination of the thermal conditions inside the cylinder head is key to its development: "The hotspots such as the spark plugs and valve fitting are first cooled. The coolant is then fed into the upper part of the cylinder head. The intermediate level creates specific flow conditions everywhere inside the cooling system of the cylinder heads. The use of individual components such as the M18 spark plug instead of the M14 standard size does not solve the problem of optimizing heat dissipation." Simply optimizing the transfer of heat from the warm component to the coolant helped to demonstrably extend the service life of moving components such as the valve, valve fitting and the V36 cylinder head.

Another measure taken to extend the service life was to avoid the build-up of deposits on the valves and valve fitting. RotoCap components were fitted to cause a forced rotation of the valves (inlet and outlet valve). On each valve stroke, the valves rotate by approximately 2° causing the valves to turn 4 revolutions a minute. This means the valve disks always come to rest in a different position on the valve fitting and scrape any deposits off the valve disk and valve fitting. Harmful deposits, which prevent or reduce the transfer of heat from the hot valve disk to the water-cooled valve fitting, are therefore avoided. This rotation also helps to extend the service life of the cylinder head considerably.

Maintenance activity	4,000 operating hours	8,000 operating hours	40,000 operating hours
Compression pressure checked		x	
Valve recess measurement performed	x		
Valve clearance adjusted	x		
Valve cover gasket replaced	x		
Rocker arm and bearing checked		x	
Pushrods inspected		x	
Pushrods cleaned		x	
Cylinder heads replaced			x

The advantage of the M18 spark plug in the V36 cylinder heads is that the large lateral surface of the spark plug thread ensures an optimized transfer of heat to the water-cooled inner thread of the cylinder head. Combinations of material required to maintain the service life for both the electrodes as well as the selection of insulators help to extend operation by up to 8,000 operating hours and more.

### Economic efficiency and compliance with emission levels

From the point of view of 2G Sales Manager Jörg Lösing, the question of economic efficiency of the technical engine upgrade is just as important to the plant operator as its compliance with emission limits: "We are increasingly hearing the demand from the market for a more economically viable and safer solution to comply with the 44th Federal Immission Control Ordinance (BImSchV) in view of the significant remaining periods of operation of plants and new possible changes to EEG funding. The further developments to cylinder heads described above will help to significantly extend time between the usual maintenance intervals of the respective engine manufacturer (see table above). This obviously has a major impact on maintenance costs and

the total cost of ownership (TCO). The V36 cylinder head solution is a tested method of ensuring that investments made years ago do not have to suffer as a result.

According to Jörg Lösing, the replacement of the cylinder head on existing plants is not only interesting from an economical perspective, it is a refit measure which is extremely simple to carry out: "With a limited investment and without any changes to the basic design, the entire system can in practice comply with the legal standards without any difficulty. There



The 2G NO<sub>x</sub> box

is no need for a time-consuming conversion phase and the engine know-how of our development team is a guarantee for the long-term operational safety required after installation of the V36 cylinder heads.”

### **Measurement and documentation of emissions**

First emission reduction and then follows the documentation of compliance with the limits. To complete the package, 2G has developed its own product: the NO<sub>x</sub> box. The robust and compact metal unit can be installed in units of all CHP manufacturers and ensures the permanent monitoring of NO<sub>x</sub> emissions. 2G can also provide data backup with the cloud storage of measurement values on a German 2G server. A remote storage solution is also possible with the use of a mobile data storage (USB interface) by the plant operator. According to Jörg Lösing, it is often the minor details

sensor needs to be replaced. This is why we call the part in the exhaust pipe the “service flange”. And of course we offer all customers with a full servicing agreement the security that the causes for measurement deviations recorded by the NO<sub>x</sub> box can be analyzed via remote maintenance – with the option of troubleshooting machine malfunctions directly online.” |



***The engine know-how of our development team is a guarantee for the long-term operational safety required after installation of the V36 cylinder heads.***

Jörg Lösing | Sales Manager at 2G Energy AG

which help to avoid downtimes and costs in practice: “For example, we focused on making sure that the NO<sub>x</sub> sensor was flanged and screwed when attached to the exhaust pipe so as to avoid complicated welding work if the



# Hydrogen CHP: The Future Has Begun

## Trailblazer Stadtwerk Haßfurt has international followers

“The energy revolution starts small” – Norbert Zösch, CEO of the Stadtwerk Haßfurt GmbH utility company, sums up in a nutshell the philosophy of his company which supplies approximately 14,000 inhabitants of the Haßfurt community situated in the Lower Franconia region of Bavaria. “Think big” has however been the motto of this company in terms of its transformation of its structure and services for a future based on renewable energy sources. Working together with the Städtische Betriebe GmbH (municipal services responsible for local heating and public leisure services) as well as the data center Rechenzentrum Haßfurt GmbH, the Stadtwerk Haßfurt GmbH is part of the triad responsible for operating public services.

The focus in adapting to the challenges of the energy revolution was on the four megatrends: demography, digitization, decarbonization and last but not least decentralization. Stadtwerk Haßfurt recognizes that the process of decentralization, which is regarded as necessary to secure future compatibility, poses its own major challenges. Firstly, the indisputable fact is that a safe and economically competitive power supply based on renewable energies is achievable with cogeneration technologies by using storage units. However, the issue of heat supply has not been overlooked because a significant part of the heating needs for local heating in the municipality is supplied by regenerative sources by using waste heat from the biogas plant (2.35 MW), the solar panels and other renewable energy plants.



2G hydrogen CHP agenitor 406

## Mixture of generation technologies with power to gas

The electricity balance of the municipal utility company of Haßfurt from 2010 to 2017 recorded an exponential growth in renewable power generation. The figure started at 29 percent but by 2015 had reached 100 percent and with approximately 85,000 MWh generated in 2017, the figure had increased to 208 percent. Around 70,000 MWh of the total was generated by solar and wind energy. In terms of maintaining a safe supply of power, the quantum leap in power generated by wind power, which increased from 2,400 MWh in 2010 to approximately 61,000 MWh in 2017, meant that Stadtwerk Haßfurt faced new challenges.

Back in October 2016, the Windgas Haßfurt GmbH & Co. KG – a joint venture between Stadtwerk Haßfurt and the Greenpeace Energy eco-energy association in Hamburg –

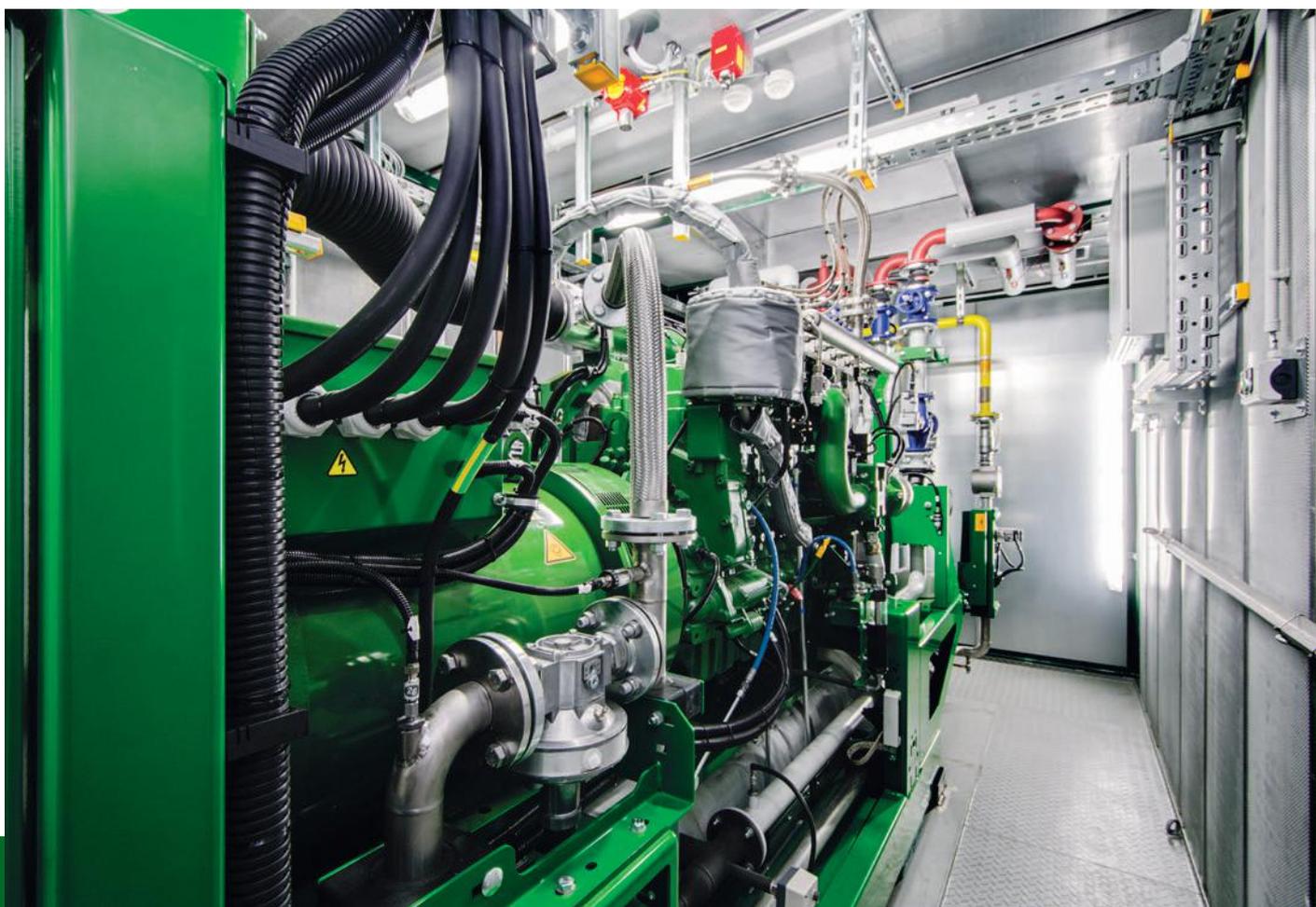


commissioned a new power-to-gas plant (PtG). At the heart of this plant is a container-size PEM electrolyzer, type Silyzer 200 from Siemens with a 1.25 MW peak output. The cutting-edge plant located at the Mainhafen converts excess power from the nearby community wind park in Sailershäuser Wald as well as from other wind energy and solar plants into renewable hydrogen, otherwise known as wind gas. The electrolyzer produces one million kilowatt hours of eco gas each year which is fed into the gas grid for almost 20.000 pro-wind gas customers of Greenpeace Energy. It can be stored there for a relatively long time and converted into electricity again later.

In this respect, wind gas plants like the one in Haßfurt is an important element in securing a successful energy revolution: They allow the long-term storage of enormous quantities of renewable energies and ensure

a safe supply even with large volumes of renewable energies. Elektrolyzern based on PEM technology (PEM = polymer electrolyte membrane) convert excess wind and solar power with an efficiency of approximately 70 percent into hydrogen and therefore ensure that every single kilowatt hour of green electricity is used and the renewable plants do not have to be shut off if the amount of power exceeds demand or the grid cannot save the power.

The container-size PEM plants react extremely quickly because the electrolyzer is capable of automatically changing its output within milliseconds to stabilize the frequency in the grid to prevent, for example, blackouts caused by a grid overload. In Haßfurt, the electrolyzer is able to provide this power as part of a "virtual power plant" operated by the partner Next Kraftwerke where several





plants are connected together. This “balancing power service” allows electrolyzers to not only produce hydrogen but to generate revenue as well. The plant, which did not receive any funding, cost around two million euros in total. “The business model of Windgas Haßfurt GmbH is based on the idea that the investment costs are amortized within ten years”, Norbert Zösch, CEO of Stadtwerk Haßfurt GmbH, explains the economic principle behind the investment.

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

### **Advent of a new era of technology with the commissioning of the first-ever hydrogen CHP**

The successful commissioning of a highly innovative hydrogen combined heat and power plant (H<sub>2</sub> CHP) for the reconversion of regenerative hydrogen in June 2019 enabled Stadtwerk Haßfurt to extend its 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 agenerator 406 H<sub>2</sub> from 2G with an electrical output of 140 kW operated with hydrogen. Project partners include Stadtwerk Haßfurt GmbH, 2G Energy AG based in Heek and the Institute for Energy Technology (IfE) at the University of Applied



2G hydrogen injection ports

Sciences in Amberg-Weiden, East Bavaria. In contrast to the previous method of the addition of hydrogen into the natural gas grid with a regeneration using conventional CHPs, the new combined heat and power plant enables operation with pure hydrogen without the addition of any fossil fuels. For the first time, a hydrogen-based and zero-CO<sub>2</sub> storage network has been created for regenerative electricity for communal use. Now that the plant has been in operation for over a year, it can be confirmed that the system meets all the high expectations in terms of availability and profitability.

The storage ‘chain’ starts with the generation of power from wind energy, proceeds to the



conversion into hydrogen by electrolysis and storage in pressure tanks and ends with the regeneration of power from combined power and heat generation. The hydrogen storage unit allows for a continuous operation of the CHP for approx. 15 hours thus increasing the system's overall flexibility considerably.

### **Flexible response to excess or low power supply**

Norbert Zösch evaluates this completion of the storage chain as an important contribution to balancing power generation with demand: "Both the PtG plant and the H<sub>2</sub> CHP deliver dynamic results which mean that the entire system, electrolyzer – storage – H<sub>2</sub> CHP, can compensate for surplus and low amounts of power from renewable power generation by balancing power locally or, on the higher level, with balancing energy in the distribution grid."

2G Energy AG delivered the CHP agenerator 406 H<sub>2</sub> as a turnkey container solution. Frank Grewe, CTO of 2G Energy AG, expects an increase in demand for the H<sub>2</sub> CHP: "After the first installation of a H<sub>2</sub> CHP at the BER airport in Berlin in 2012, we took the next step in Haßfurt of installing a standard CHP from the agenerator series which can be adapted at low cost for use of either pure hydrogen, a hydrogen/natural gas mixture or just natural gas. The safe and flexible operation as part of a wider use of PtG concepts with CHPs in the future is an integral part of the development work at 2G."

Other contracts such as the commissioning of a H<sub>2</sub> CHP for Siemens in 2019 for a project on the Arabian peninsula and for the plant specialist APEX based in Rostock as well as for the "Neue Weststadt Esslingen" housing development

site in 2020 all confirm this expectation with regard to market development.

The H<sub>2</sub> CHP in Haßfurt is fitted with a second gas connection for a switch to natural gas operation where the electrical nominal output is 200 kW. Frank Grewe sees even further development potential for H<sub>2</sub> CHPs in comparison to natural gas operation: "One short-term development goal is to significantly increase the nominal output in hydrogen operation up to the same level as engines operated with natural gas. Besides safer plant availability, development at 2G also focuses on the further reduction of specific production and operating costs of H<sub>2</sub> CHPs."

”

*The safe and flexible operation as part of a wider use of PtG concepts with CHPs in the future is an integral part of the development work at 2G."*

Frank Grewe | CTO of 2G Energy AG

In terms of scientific and technology input, the project is supervised by the Institute for Energy Technology at the University of Applied Sciences in Amberg-Weiden, East Bavaria. What do the researchers hope to gain from this project? Well, on the one hand, practical knowledge and long-term experience on hydrogen operation of combined heat and power plants, and on the other, the module is intended to be used as a research platform in



the consortium for further developments to H<sub>2</sub> CHP technology and was therefore fitted with special measurement access points.

### **Awarded for trailblazing in the industry**

Although on a national scale the energy revolution has lost ground or come up against obstacles in many different areas along the way, such as with regard to the installation of wind power plants or the expansion of distribution grid networks, a relatively small public utility service such as in Haßfurt shows that the energy revolution is possible by taking a decentralized approach. This concept has

helped raise the acceptance amongst citizens. Without this high level of acceptance among customers, it would surely not have been possible to be a trailblazer in the energy revolution. Haßfurt has a right to be proud of the numerous awards it has received including the Bavarian Energy Prize in 2018 or being named as the “Pearl of the Energy Revolution” by the Heinrich Böll Foundation. The “icing on the cake” was the “CHP of 2019” award voted by the jury of the B.KWK Bundesverband Kraft-Wärme-Kopplung e. V. (National Cogeneration Association) and the ‘Energie & Management’ trade magazine in recognition for the future-oriented investment decision of Stadtwerk



2G hydrogen technology

proved a success because it not only involves the suppliers but the consumers as well via the public heating network. So-called blackouts can be avoided effectively using a battery storage (8 MWh) and two other storage units. The extensive rollout of 10,000 smart meters between 2008-2011 and the integration of household grids as part of “prosumer” projects with “electricity-generating heating systems”

Haßfurt.

### **H<sub>2</sub> CHP for the hydrogen power center in Northern Germany**

At its location in Rostock-Laage within view of the airport, APEX Energy operates the hydrogen power center for Northern Germany. Together with a local partner, Europe’s



largest grid-connected hydrogen plant is expected to be put into operation in 2020 and supply the entire location with CO<sub>2</sub>-neutral energy. Mathias Hehmann, CEO of APEX Energy Teterow GmbH, regards hydrogen CHPs as an important cornerstone for an environmentally-friendly supply of power for the future: "As a full-service specialist, we deliver tailor-made system solutions designed for the energy of tomorrow. For industry and commerce, housing associations, for the intermediate storage of balancing energy, mobility solutions or for the connection of remote locations – hydrogen is the driving power behind a zero-emission future. The combined generation of power and heat in the H<sub>2</sub> CHP is an important component in this equation."

APEX Energy uses the CHP for the generation of power and heat for its own consumption at its location in Rostock-Laage. APEXIS energy storage units are produced in the factory. Hydrogen, which is produced using an electrolyzer, is required to operate these units. The hydrogen is generated based on power from photovoltaic and wind energy plants. APEXIS storage units are designed as modular systems and offer safe and comfortable power storage at a location selected by the customer. The standard system is designed for 60 bar pressure and features market-leading permeability and patented connection technology.

At its opening in June 2020, the expansion phase of the APEX hydrogen plant in Rostock-Laage has an electrolysis capacity of 2 MW, its own hydrogen storage system, a combustion cell with an electrical output of 100 kW and a 115 kW H<sub>2</sub> combined power and heat plant as well as a battery storage unit with 1 MWh

capacity. The plant concept is made complete with a hydrogen filling station. |



## Innovative Hydrogen Combined Heat and Power Plant Awarded “CHP of 2019”

### Excellent cooperation between operator, manufacturer and science

The hydrogen combined power and heat plant in Haßfurt is voted “CHP of 2019”. The plant was voted unanimously by an expert jury made up of the Bundesverband Kraft-Wärme-Kopplung e. V. (National Cogeneration Association) and the ‘Energie & Management’ trade magazine (E&M) from the eleven submitted proposals. The CHP was installed as part of a project of the municipal utility services in Haßfurt (Städtische Betriebe Haßfurt GmbH) with funding from the Bavarian State Ministry for Economic Affairs, Regional Development and Energy (StMWi). Project partners include Stadtwerk Haßfurt GmbH, 2G Energy AG based in Heek and the Institute for Energy Technology (IfE) at the University of Applied Sciences in Amberg-Weiden, East Bavaria. The excellent cooperation

between operator, manufacturer and the field of science convinced the jury. According to the jury’s assessment, the energy supply concept for the extension and redesign of an existing electrolysis plant could have a role model effect for plants in the energy revolution. This concept also offers exemplary solutions for planning new CHP plants in accordance with the scientific findings gathered from the test plant.

As part of the celebrations held in the Bavarian State Ministry for Economic Affairs, Regional Development and Energy in Munich on June 22, 2020, State Minister Hubert Aiwanger presented the certificate to the three partners involved in the project. The three partners were represented by Norbert Zösch, CEO of Stadtwerk



From left to right: Stefan Sagmeister, editor in chief of the Energie & Management magazine, Heidi Roeder, editor at Energie & Management, Claus-Heinrich Stahl, President of the Bundesverband KWK (National Cogeneration Association), Hubert Aiwanger, Bavarian State Minister for Economic Affairs, Regional Development and Energy, Prof. Dr. Markus Brautsch, CEO of the Institute for Energy Technology, Günther Werner, Mayor of the town of Haßfurt, Frank Grewe, CTO of 2G Energy AG, Norbert Zösch, CEO of Stadtwerk Haßfurt GmbH and Raphael Lechner, CEO of the KWK (power cogeneration association) performance center

Haßfurt GmbH, Günther Werner, Mayor of the town of Haßfurt, Frank Grewe, CTO of 2G Energy AG as well as Prof. Dr.-Ing. Markus Brautsch, CEO and Raphael Lechner, Head of Research at the Institute for Energy Technology (IfE) at the University of Applied Sciences in Amberg-Weiden, East Bavaria. The congratulatory speech was made by Claus-Heinrich Stahl, President of the Bundesverband Kraft-Wärme-Kopplung e. V. (National Cogeneration Association) as the chairperson of the expert jury and Stefan Sagmeister, editor in chief of the Energie & Management journal that organized the award.

“Combined heat and power generation has many advantages: It ensures the decentralized and flexible supply of stored power. With the

simultaneous generation of power and heat, cogeneration systems are highly efficient and therefore very environmentally-friendly. This example, shown by Stadtwerk Haßfurt, is also forward-looking for another reason: Surplus wind power is converted into hydrogen by electrolysis and saved as energy. The combined heat and power plant converts this green hydrogen back into power. This is a sensible way of using excess regenerative energy on site without any long transport routes”, emphasized State Minister Hubert Aiwanger. |

## Brand Loyalty

After eight years in continuous operation, g-box 50 is replaced with g-box 50 plus



<b>Location:</b>	Heating headquarters "Averwetters Feld" in Georgsmarienhütte, Lower Saxony, Germany
<b>Operator:</b>	Stadtwerke Georgs- marienhütte GmbH (municipal utility services)
<b>CHP type:</b>	g-box 50 plus (H0579)
<b>Gas type:</b>	Natural gas
<b>Electrical output:</b>	50 kW
<b>Thermal output:</b>	104 kW
<b>Installation:</b>	Engine room

The g-box 50 plus in the "Averwetters Feld" energy plant in Georgsmarienhütte.



*We were always satisfied  
with the g-box 50.*

Stefan Rohling | Stadtwerke Georgsmarienhütte

When 2G service technician Christian Hüsing traveled to Georgsmarienhütte in Lower Saxony on May 14, 2020, he had two jobs to carry out: install a new CHP after he had removed the old one. Installed at the Averwetters Feld heating plant in 2012, the final hours of the g-box 50 had arrived and the compact CHP was taken out of operation after eight years in use to make way for the new plant. We would have been curious to find out whether the old g-box 50 would have kept going for 100,000 hours. Since it was commissioned eight years ago, it had completed two thirds of this total (67,000 operating hours) because it had been in continuous operation virtually without any interruption.

### Power and heat around the clock

Eight years in continuous operation is not unusual for a CHP, some plants under similar conditions are in operation for ten or even 15 years and last considerably longer than a passenger car with a similar output. If a car were to drive 67,000 hours at 50 km/h, it could circle the equator approximately 80 times in this period – in theory that is. In reality, the continuous operation of a car is virtually impossible. In contrast, the g-boxes have demonstrated their durability in many practical applications where – except for oil changes and maintenance work – they were in continuous use.

### Tons of CO<sub>2</sub> saved year on year

“We had always been satisfied with the g-box 50”, was the judgment of Stefan Rohling, who is responsible for the heating plant at the municipal utility services in Georgsmarienhütte. “The CHP covered the thermal baseload for the 85 detached houses and apartment blocks connected to the grid and reliably provided energy for warm water supply or for heating purposes.” This cogeneration of power and heat had helped the municipal utility services save several thousand tons of CO<sub>2</sub> each year if compared to a separate generation of power and supply of heat with a gas boiler.

### g-box 50 plus replaces the long-serving g-box 50

To ensure the continued economical and environmentally-friendly supply of power to the estate supplied by the heating plant, those responsible for the plant decided to purchase the new CHP. “Because of the plant’s high operating performance since 2012, we wanted to make 100% sure which is why we made the replacement investment”, explains Rohling. This is already the fourth CHP to be installed in this heating plant. From 1997 to

2012, other brands of CHP had been installed. Since May 2012, the g-box 50 had been running smoothly in Averwettters Feld without any major malfunctions.

### The “plus package”: more modern and efficient

In total, this was the fourth g-box 50 to be purchased by the municipal utility services. “We had the first one installed in our Panoramabad swimming pool in 2009”, reports the heating expert. “The plant was in operation for over nine years until we replaced it the winter before last with the successor model currently in operation.”

The g-box 50 plus installed in the Averwettters Feld heating plant is more cutting-edge and economical to operate than the CHP in the Panorama swimming pool. The latest model delivers 50 kW<sub>el</sub> and 104 kW<sub>th</sub> and, thanks to its standard combustion exhaust heat exchanger, reaches a high overall volumetric efficiency of 106%. It therefore exceeds the overall efficiency of the 2012 model by a few percentage points. Besides this boost in performance, the g-box 50 plus also offers other features such as the option to operate it in a microgrid or by remote control or variably control its output between

The energy plant in Averwettters Feld in Georgsmarienhütte, Lower Saxony supplies the surrounding houses and apartment blocks with district heating – and, thanks to the g-box 50 plus also generates 50 kW of power.



partial and full load. The latter, however, only plays a minor role in the heating plant because, with a heat output of 104 kW, the g-box 50 plus adapts well to the baseload demand of the 100 households connected to the grid.

### **More output, more technical comfort**

In terms of the equipment, the new g-box 50 plus leaves nothing to be desired. Besides the standard combustion exhaust heat exchanger, it also offers a water-cooled synchronous generator, a speed-controlled heating circuit pump, a constant supply temperature control and it does not need a return temperature riser. Regrouping the temperature-sensitive components of the CHP plant in the “cold” part of the generator reduces their thermal load and, at the same time, has a positive effect on service friendliness and space requirements; space-saving wall installation is also possible.

The water-cooled g-box 50 plus does not require additional air cooling. This means less technology and helps to comply with the stringent noise requirements. Combined with its smooth running courtesy of dual vibration isolation and the compact outer dimensions, there are many good reasons to choose the compact CHP.

### **High on output, low on space required**

Its size – or more accurately its small size – was also an advantage when it was installed in the heating plant. It was important that the old box could be replaced quickly with the new one because the machine operates as a baseload plant. “Although we could have used the peak load gas boiler for a while longer during the replacement, every day we use power cogeneration saves us money and CO<sub>2</sub>”, is the opinion of Rohling and mentions the advantage of its compact design: “A larger generator would

have meant structural changes to the heating plant. The g-box 50 plus is only slightly longer and, together with its new control cabinet, fits into the same space as its predecessor model.” This is why it took only four working days to remove the old CHP and install the new one.

The time had come on the afternoon of May 19: The electricians had been connected, the engine had been topped up with oil and our 2G technician could start up the new generator in the presence of Stefan Rohling. The machine has already completed the first few operating hours in the many thousands of hours it is expected to operate in its long service life. |



The new Rulantica water world

## Supplying Heat to the Europa Park's New Water World

Follow-up order five years after the first

<b>Location:</b>	Rust
<b>Operator:</b>	Europa-Park GmbH & Co Mack KG
<b>CHP type:</b>	2 x avus 500b
<b>Gas type:</b>	Natural gas
<b>Electrical output:</b>	2 x 670 kW
<b>Thermal output:</b>	2 x 933 kW
<b>Installation:</b>	Energy plant with sound hood

Follow-up order for Europa Park theme park: Following the successful installation of two 2G plants in Germany's largest theme park in 2014, the family-owned company commissioned the new installation of two other CHPs for its new Rulantica water world experience. To optimize their efficiency, they use combined heat, power and cooling and, thanks to the additional heat extraction on the mixture cooler and a combustion heat exchanger, the CHPs offer an overall volumetric efficiency of almost 95 percent.

**EUROPA**  **PARK**

The Rulantica water world experience is the latest attraction to be added to Germany's largest theme park, Europa Park in November 2019. This water world with its Scandinavian



One of the two avus 500b modules in Europa Park



*The heat generated by the CHPs can be effectively utilized all year round.*

Thomas Renner-Boh | Europa-Park

charm awaits guests with nine themed areas and 25 attractions. The central feature is its 20-meter high, shell-shaped hall with a 32,600 m<sup>2</sup> indoor water world for families to enjoy – and presenting a large and all-year-round thermal load due to the enormous quantities of water and air in the building. Other consumers of heat include an outdoor pool, a heated wild water stream and – alongside other attractions – the on-site gastronomy services as well as the 4-star superior hotel “Krønasår – The Museum Hotel”.

### **All-year-round utilization of thermal energy**

In order to cover the heating requirements in a profitable and environmentally-friendly way, those responsible at the theme park decided to purchase two natural gas CHPs which cover the baseload and three boilers to cover peak loads. The CHPs from 2G not only deliver the heat required for warm water supply, they also provide heating energy. In summer, when no heat is required for heating and less energy is needed for heating water, the thermal energy

is also used: The hotel’s air-conditioning also benefits because an absorption chiller has been installed to ensure efficient combined heat, power and cooling. “In this way, we can use the heat generated by the CHPs efficiently the whole year round”, says Thomas Renner-Boh, who was one of those responsible for the construction of the new water world at Europa Park. The power generated by the power plants is used directly in the water world.

To meet the high thermal baseload of the water world, two avus 500b motors are used in the CHPs. They provide a maximum electrical output of 670 kW each and 933 kW thermal power. Besides waste heat, the additional extraction of heat from the mixture cooler and a combustion heat exchanger, the plant offers an extremely high volumetric efficiency of almost 95 percent.

### **Additional heat extraction for more efficiency**

An efficient use of fuel was very important to Europa Park for two reasons: The all-year-round use of the CHP as well as the company’s

own sustainability targets were convincing arguments for an extremely efficient use of natural gas. The company decided to pursue an economical yet climate-friendly energy supply. In Europa Park for example, the use of geothermal power, photovoltaic systems and a water power plant generate a high volume of regenerative energy. The energy plants at Europa Park were supplemented with two CHPs which were also supplied by 2G in 2014 (2 x agentitor 206 each with approx. 220 kWel and 260 kWth) and by the simultaneous generation of power and heat which deliver a significantly lower CO<sub>2</sub> footprint than heat generation in boiler plants with the purchase of electricity.

### High thermal load caused by warm water treatment

The decision to commission 2G again with the project was partly due to the positive experience with the existing plants in Europa Park. Renner-Boh: "Both of the agentitor generators are running extremely smoothly. This has strengthened our trust in 2G. Obviously when awarding the contract for the CHPs for the water world, excellent value for money and high efficiency were also factors influencing our decision."

### Silent in operation: The CHP is under cover

Another criterion was that 2G understands how to construct quiet combined heat and power plants which the company had already put to the test with the existing systems. In the water world, the aspect of noise is particularly important because the energy plant is just ten meters away from the Krønasår Hotel. On the building's cover, the engine noises of the CHPs should be virtually unnoticeable. 35 decibels at a ten meter distance was the specified limit, virtually no louder than a quiet whisper. "The need for silent operation of the CHP engine was

realized with a noise hood which was custom-made by 2G", reports Renner-Boh who praises the design: "It has such spacious dimensions that the service technicians can move around under the cover without any problem."

### Full service for maximum availability

The all-year-round use of the CHP highlights the importance of another aspect, namely reliability. To ensure the 24x7 availability of the plant, Europa Park signed a full service agreement with 2G. 2G is not only responsible for regular maintenance but for on-call services as well. To ensure any irregularities from standard operation can be rectified as quickly as possible, the operating data and status messages of the CHP are sent to the 2G headquarters in Heek. Irregular operating conditions can be detected easily and the parameters can be corrected from the remote location. This optimization reduces costs and increases operational readiness. This is not the only reason why Renner-Boh is confident that the CHP will meet or indeed exceed the expectations of the theme park owners. "I'm in no doubt that our plants in the water world will be kept in constant operation for 8,000 or more operating hours a year." |

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