2G Energy manufactures CHP systems with electrical outputs ranging from 20 to 4,500 kW at its company headquarters in Heek/Germany

Source: 2G Energy

Cogeneration and the Heat Pump: What Belongs together, Finally Grows together

Due to the problematic reconciliation of climate protection, security of supply and affordability, the energy transition presents considerable challenges to industries and to society. Consequently, the energy industry requires more than a sprinkle of innovation it also requires efficient technological synergies to overcome these challenges. The combination of cogeneration and heat pumps is gaining momentum for all the right reasons.

Over the past few decades, combined heat and power (CHP) generation has become an efficient decentralised energy supply due to its ability deliver a wide array of projects in a multitude of fuels. Large-scale systems producing multiple megawatts to be fed into vast heating networks, reduce the energy costs of an industrial complex, or in the form of systems with an output of a few hundred kilowatts to supply properties – all can be delivered through the technology of cogeneration.

Then there is the heat pump – a technology for the highly efficient transformation of electricity into heat that is currently experiencing a massive boost in popularity across its output categories. Many pin their hopes on the heat pump technology to drive the urgently needed decarbonisation of the heating markets forward, especially when it comes to policy changes. The discussion around the two technologies was traditionally dominated by the dilemma of choosing one over the other. However, a growing number of successful projects shows just how false the dilemma really is: The most efficient solution is a combination of cogeneration and heat pumps.

Synergies over biases

Both technologies have proven beyond any reasonable doubt that they present massive benefits to their operators and the national economy – nevertheless, they are

still regularly subjected to negative stereotypes and must overcome bias. Sceptics reduce heat pumps to a technology that supposedly only works in new buildings while being unable to reach elevated temperatures whereas CHP generation still must shed the clichéd image of the fossil-fueled, constantly running power system technology that chains operators to a vendor. In recent years, developments in both technologies have proven that these assumptions are false – and emphatically so.

Utilising heat pumps in older buildings and industrial complexes has become as normal as the operation of highly flexible CHP systems on regenerable gases to provide the grid with desperately needed balancing power. And that is where the synergetic effect of the technologies comes into play: CHP systems enable the operation of heat pumps precisely in instances where the grid cannot provide enough renewable energy.

The market demands solutions – not a bunch of individual products

To Christoph Rotthaus (Figure 1), head of Project Management at 2G Energy, fundamental technological debates are rather beside the point anyway. The company, which was founded back in 1995 and is still based in the small town of Heek in western Germany, produces CHP systems with electrical outputs ranging from 20 to 4,500 kW that are sold to customers all across the world – ranging from energy utilities over industries to hospitals. Naturally, Rotthaus views the political debate through the lens of the energy market: "The primary objective of any of our customers is to affordably secure their energy supply while respecting the legal requirements. It's much less significant which product does that. Only one thing matters: Enough affordable energy must be available at all times and the technology that is used must be able to operate purely on renewable energies, at least eventually."

Figure 1. "Only one thing matters: Enough affordable energy must be available at all times and the technology that is used must be able to operate purely on renewable energies, at least eventually", says Christoph Rotthaus

Source: 2G Energy

In this particular context, Rotthaus – a pragmatist at heart – highlights the significance of putting aside technological biases: "As Germans, we live in an industrialised country and, surely, we would like to keep it that way. In my humble opinion, politicians would do well to crack down on existing technological biases and, in doing so, promote innovation in the energy supply sector."

Standardised linkage of different technologies

Looking back at the development he experienced as an employee of a CHP manufacturer, a grin appears on Rotthaus' face: "15 years ago, when I started at 2G, our goal was to manufacture standardised combined heat and power systems in mass production. Although the sales figures and the degree of standardisation actually developed in a positive direction, our growing skill at integrating related technologies into cogeneration projects is at least one of the reasons for this increase." Rotthaus points to the fundamental engineering potential that he sees within the sector, even beyond his employer: "Besides the efficiency advantages that are already known well enough, the primary strength of cogeneration lies in the flexible use of the heat it produces – be that in the food industry's absorption chillers or for high temperature solutions as part of municipal heating networks. With that in mind, it only makes sense to expand the integration of heat pumps in the future."

Heat pumps and CHP systems complement each other

Putting aside the availability of renewable energy for the operation of heat pumps, the ambient tempera-

ture (in the case of air or water heat pumps) and the required supply temperature, or rather operating temperature, have the most significant impact on which of the respective technologies can be operated more efficiently at the given time. Rotthaus speaks of several system combinations where the CHP supports the heat pump as soon as the ambient temperature drops below 10 °C. "Bear in mind that this is merely a general rule of thumb," he goes on to explain. "If you only need a supply temperature of 60 °C, the required ambient temperatures are lower compared to those for a supply temperature of 95 °C. Those are simple consequences of the laws of thermodynamics that we have to account for when planning these projects."

Integrating CHP heat directly into heat pump operation

The synergy of cogeneration and heat pumps already far exceeds the facilitation of temperature-independent operation and intricately links the internal processes of both technologies – and the aforementioned synergetic effect could not be greater. On the one hand, there is the heat pump. It requires a certain temperature level to reach its ideal operating point, which the ambient temperature does not necessarily provide it. On the other hand, there is the CHP system whose mixture cooling process prior to the combustion generates a temperature of approximately 40 °C – which is not exploitable for heating purposes or process heat. The same goes for the waste heat of the CHP. However, these temperature levels are predestined to support heat pumps. Adding an appropriate air intake system while also linking the processes leads to a significant increase in overall efficiency, which ultimately reduces the consumer's energy costs. The public utility of Bad Lauterberg in Germany, for example, is among those who benefit from linked CHP and heat pump technology (Figure 2): They were able to increase the return temperature of their heating network from 60 °C to 63 °C.

An industry with enormous potential for innovative solutions

However, energy supply and heating networks are just two of many applications for the efficient combination of heat pump and CHP technology. Especially in the industrial sector with its multitude of individual processes and various energy intensive requirements, the power of engineering can be harnessed to full advantage. That is why Rotthaus can see a glimpse of positivity in the current energy-political crisis: "In recent years, many companies obviously expressed their intent to take action for the future energy supply. However, in the spring of 2022 at the latest, the subject began to pique the interest of the general public and the pressure to act is growing tangibly. In recent months, we are experiencing enormous creativity and a welcome inventiveness when it comes to the future alignment of the companies, in particular when talking to our industry customers."

This does not only lead to an increased demand for solutions combining heat pumps and CHP systems in general, but also for the integration of further individual temperature-dependent processes in such combinations. A project involving a bakery with a colossal demand for saturated steam that it intends to satisfy using CHP technology is only one of the current examples. "Due to the elevated temperatures required by steam boilers, combining them with CHP technology only exploits the heat from the exhaust system – which amounts to about half of the thermal energy produced overall. By adding a heat pump that exploits heat generated in the mixture and engine cooling processes of the CHP system, the combination can reach total efficiencies of over 90%

Figure 2. Heat pump which is integrated into the CHP project in Bad Lauterberg

Source: 2G Energy

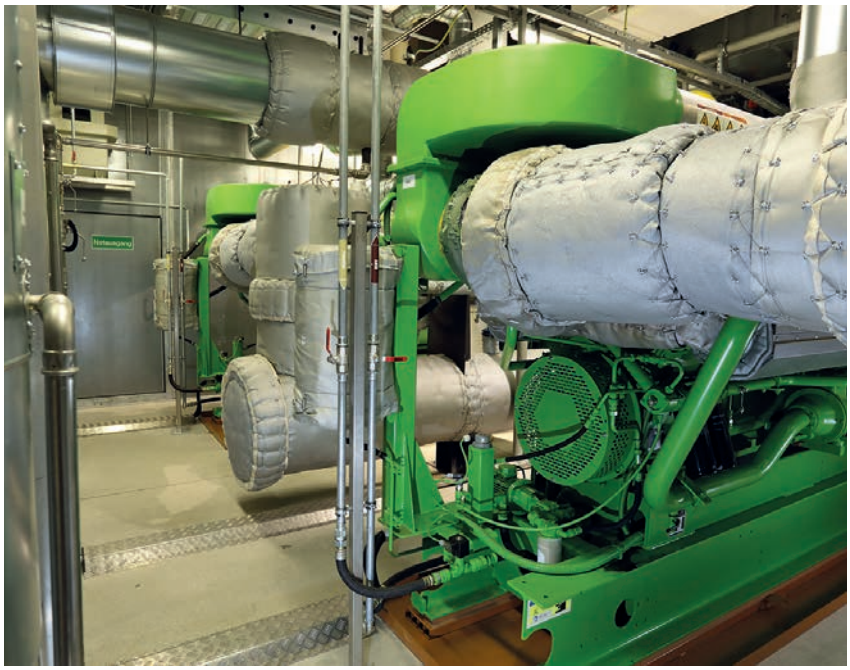

Figure 3. By adding a heat pump that exploits heat generated in the mixture and engine cooling processes of the CHP system, the combination can reach total efficiencies of over 90%

Source: 2G Energy

(Figure 3)." As a side effect of the discussions around a looming energy shortage, the emergency supply capability of CHP systems is increasingly becoming a factor.

Cogeneration: regenerable gases are a natural concomitant

In the medium term, the energy currently produced using coal and nuclear fuel will disappear. Consequently, a considerable demand for stable power generation capacity must increasingly be satisfied by gas molecules. Although heating network operators and industries are still largely dependent on natural gas, measures to accelerate the ramp-up of green gases – regardless of whether it's biogas or hydrogen – are being initiated everywhere. As far as new CHP systems are concerned, this means that the ability to run on biogas or hydrogen has become a matter of course.

2G Energy, which has its roots in the biogas sector, has already successfully realised over 20 projects on multiple continents that operate purely on hydrogen. In Rotthaus' mind, there should have been more already: "We see ourselves as the regenerative backbone of the energy transition, supplying energy with enormous efficiency whenever wind and sun only produce limited amounts of energy. With our products, we strive to exploit the precious green gas molecules as efficiently as possible. Regardless of how quickly the infrastructure for green gases progresses, all of the products delivered by us today are already fit to operate purely on hydrogen."

The energy central of the future

Even though the recent months were a tumultuous for the future energy supply, one thing is certain: the industries and the society at large are only at the threshold of a transformative process, which – regardless of the many fears and challenges – offers an abundance of opportunities. Besides the installation of PV systems on rooftops, a measure that is becoming second nature, Rotthaus anticipates two principal paths for industries and energy suppliers going forward: For one thing, there is the standardised energy central consisting of a local heating network, which is equipped with a large-scale heat pump and a green CHP – with the added benefit of enabling the operator to use the system as yield object on the electricity market. The other path he envisions consists of a multitude of individual, decentral projects that are tailored to the local demand of the respective specialised industry operation, housing complex or anything in between.

Due to the people he works with on a daily basis, Rotthaus is optimistic that the energy transition will succeed one way or another: "Despite all present uncertainties, the masses are electrified by the energy transition – quite literally. Even beyond the combination of cogeneration and heat pump technology, there are so many innovative concepts and ideas on how to implement the energy transition locally. Whether the individual project consists of a combination with energy storage batteries, share schemes for wind park employees or the future integration of decentral electrolysers into the hydrogen infrastructure – all of them show that the individual communities are highly motivated to participate locally in the energy transition."

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