A biogas facility and a CHP system are part of the sophisticated energy concept for the production of snacks

Source: The Lorenz Bahlsen Snack-World Germany

From Waste to Heat and Electricity

To many people, chips and other potato- or peanut-based snacks are a staple of an exiting evening of television on the family couch. However, most probably don't know that the energy supply concepts behind snack production can be as interesting as many TV shows – as exemplified by the Lorenz Snack World factory in Neunburg vorm Wald, Germany. The factory uses 100% of its waste and residual materials for energy purposes, turning waste into a pillar of the factory's energy concept.

For many years, energy policy has undoubtedly been at the forefront of political discussions. These discussions commonly focus on the most efficient combination of climate protection and affordable energy prices. To nobody's surprise, clashing ideological perspectives on this issue often result in heated fundamental disputes. However, the discussions on the big stage of politics are mostly a reflection of what is happening in many industries across the country. Besides partially growing competition from foreign markets, companies face increased wage and material costs while legal sustainability requirements for production processes grow stricter and the public environmental consciousness increases. Therefore, companies must combine the development of innovative production processes and sustainable energy concepts to stay competitive on the market.

Sustainability is far from a new subject at the food producer Lorenz Snack-World. The snack company with headquarters in Neu-Isenburg has exclusively been using regenerative electricity in its three German factories in Bavaria, Lower-Saxony, and Saxony for many years already. Among the factories, however, the one in Neunburg vorm Wald excels with a particularly groundbreaking concept. Potato peels as well as corn and dough waste are being

collected to produce biogas which then efficiently fuels a combined heat and power system (CHP) that produces heat and electricity. The concept really isn't new: the biogas facility required to ferment the waste materials was built in 2005 and complemented by a CHP to utilise the biogas. Additionally, there's an energy center on the premises which contains steam production, compressors, and transformers. Having proven its worth over many years, the system was modernised in 2021 and equipped with a new CHP built by 2G Energy AG (electrical output: 404 kW, thermal output: 474 kW; Figure 1) which further increases the efficiency of the entire system.

From production waste to precious energy

Although the concept of using waste for energy purposes seems obvious at first glance, it is based on a sophisticated process that Lorenz steadily optimised throughout the years. Thomas Beer, head of the water treatment department at the factory in Neunburg vorm Wald, has already been involved in the factory's energy concept for many years and provides an insight into the workings of the overall system: "At its core, the gas production process consists of two types of reactors where the different production wastes end up. The first is a traditional biogas facility where firm wastes such as potato peels or corn and dough waste are being fermented into a biogas with a methane content of about 50% (Figure 2). Simultaneously, the wastewater from production processes which also contains many residual organic materials streams into an Upflow Anaerobic Sludge Blanket (UASB) reactor. This technology is used to process mostly liquid materials, like the wastewater from the washing processes in our production. This technology produces biogas with a methane content even higher than 70% – although it shows far more variation than traditional waste biogas produced by a fermenter."

Figure 1. Avus 500plus from 2G Energy in use at Lorenz

Source: The Lorenz Bahlsen Snack-World Germany

Figure 2. Biogas facility with fermenter

Source: The Lorenz Bahlsen Snack-World Germany

After fermentation, the gas produced by both processes streams into a 350 m^2 gas tank before continuing to the dehumidification or rather the desulfurisation. This is a critical aspect in the stability of the

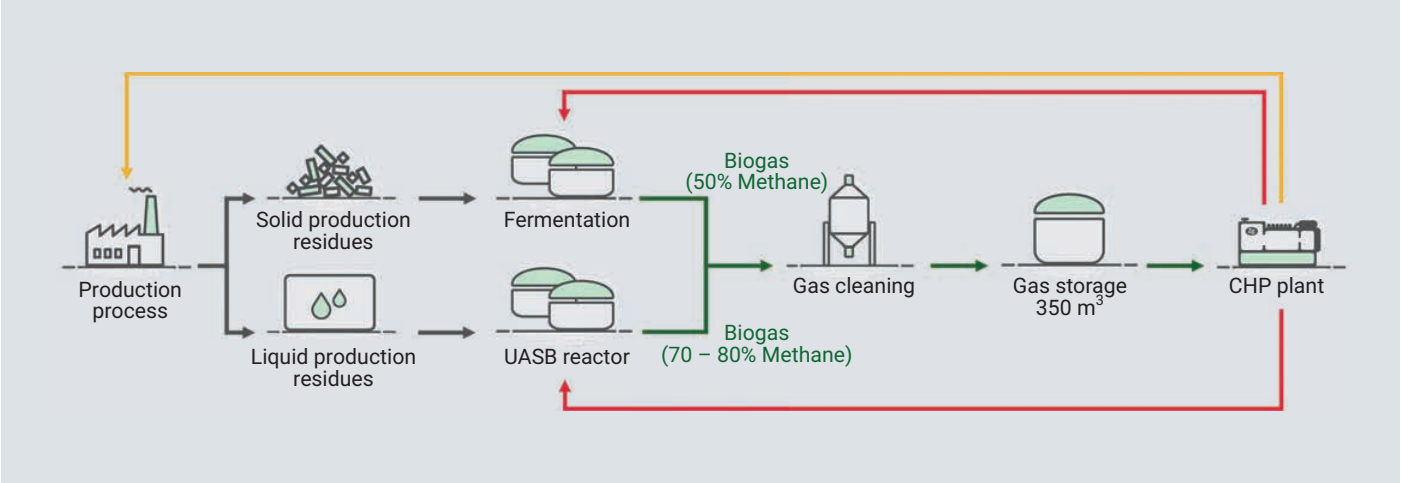

Figure 3. From production waste to valuable energy

Source: 2G Energy

process, as Beer explains: "Although the UASB technology produces a very energy-rich gas, the gas also has a sulfur content of up to 2,000 ppm. Consequently, it is critical for the overall process to ensure quality desulfurisation."

Only after this crucial step, the CHP can transform the gas into heat and electricity for production processes and by that closes the energetic loop (Figure 3). The system produces about 1.1 million m^3 of biogas per year which cogeneration transforms into 2.3 GWh of electricity and 2.5 GWh of thermal energy. As far as the electricity demand of production is concerned, this corresponds to a coverage of 17% due to the factory's own waste. A direct contribution to lowered energy expenses, although only a part of the overall cost reductions.

Other side effects also positively impact economic efficiency, as Beer explains: "Due to the rising stress on electrical grids, grid operators reward reduced electricity purchases during peak load phases since that relieves the grid. So, it only makes sense to let the CHP run during these times in particular to benefit from the financial incentives."

What's more, Lorenz was able to further optimise the production processes, improving sustainability and economic efficiency. Beer offers further insight on this aspect: "The process of washing and peeling the potatoes releases substantial amounts of starch. That starch must be filtered from the wastewater no matter what. We see that as an opportunity to go a step further and refine the starch to a point where it can be reused in production."

Last but not least, the company can also cut costs on logistics: "Since we use the waste, we avoid having to pay for an expensive disposal by a third party and transporting it there. Once again, our economic and sustainability goals go hand in hand."

Realisation possible due to experience with renewable gases in CHP systems

For 2G Energy, a CHP manufacturer from the town of Heek in the western German Münsterland region, projects like this are a delight since they are part of the company's DNA. As an explanation, Frank Grewe, Chief Technical Officer at 2G, looks back on the history of the company founded in 1995: "Agricultural applications – biogas applications in particular – were the hotbed of our company. With the introduction of the EEG (German law; Renewable Energy Sources Act) and the corresponding feed-in compensations for operators of biogas CHP systems we were already forced to consider the quality of biogas. The feed-in compensation applies to the dairy

farmer with a manure plant the same way it does to an operator that mostly feeds the system with regenerative resources. The molecular composition varies, depending on the source. Not all biogas is the same."

At the same time that also means that the origin of the biogas isn't decisive for the compensation, meaning that the food industry in particular has huge dormant potential. Therefore, 2G has always focused on designing its products in a way that they operate reliably and efficiently regardless of the individual gas quality. According to Grewe, the measures taken to this end comprised modifications to the combustion chamber, the ignition timings, the composition of the air-gas mixtures and the various heat extraction methods for differing gas types.

Another factor, however, is the gas quality before it ever reaches the system. Treating and cleaning the gas before it even reaches the CHP is therefore of critical importance, explains Grewe: "Examples, such as the UASB reactor at Lorenz, show that the sulfur contents in biogas can rise up to multiple thousand ppm. The absence of high-quality gas treatment or desulfurisation, to be precise, would quickly lead to considerable damage on the CHP as well as the exhaust tract. Consequently, regenerative gases always require precise analysis and the derivation of appropriate measures on that basis." The development of 2G over the past few years proves that the company's efforts are bearing fruit. Besides being involved in biogas and waste processing, 2G was the first manufacturer to make hydrogen a big topic on its agenda. By now, the company has realised over thirty projects on three continents successfully running purely on hydrogen. "This accomplishment of research and development in the use of hydrogen would have been impossible without our experience in the biogas sector," as Grewe summarises.

Hydrogen and biogenic gases are indispensable

Successfully operating for many years, the system is more than an economic competitive advantage for Lorenz. Projects like this also provide a blueprint for the energy supply system as a whole which is increasingly designed and implemented in decentralised structures. Despite the underlying trend to electrify the heating and mobility sector, molecule-based fuels will continue to play an extremely significant role in the future energy system – albeit in a different form.

Grewe attempts to describe the shift: "In the past, cheap gas, often of a fossil nature, was predominantly used to cover electricity and, above all, heating demand as economically as possible – regardless of the availability of renewable energies in the system. Wind and sun will secure the energy supply of the future on more and more days of the year – but naturally not on all of them. This raises two key questions: where do we get as much renewable gas as possible and how can we use it most efficiently? The Lorenz project provides an answer to both questions."

In future, Grewe would like to see a comprehensive approach to the topic from political decision-makers: "Current discussions focus on the need to build new large H_2-ready systems, including the associated hydrogen infrastructure, which is by no means wrong. However, there is still a lot of low-hanging fruit, both in traditional agricultural biogas applications and in industrial projects nut unlike Lorenz, which politicians could use to incentivise regenerative flexibility at low short-term cost to the national economy. True to the motto: do one thing, don't leave out the other."

What's next for the Lorenz project?

Compared to many other companies, Lorenz already did its homework in the form of implementing a sustainable and economic energy concept in recent years. Nevertheless, continuous optimisations and additions will continue to take place at the various locations. For example, a further photovoltaic system with a peak electrical output of 999 kW will be installed in Neunburg by the end of 2024. Beer is therefore issuing an open appeal to all decision-makers in the industry: "The need for a climate-neutral industry is now a social and political consensus. Investing in sustainability is therefore always the right way to go. The only question is: how can this path be made as cost-effective as possible for my company?" Lorenz themselves seem to deliver the perfect answer to this.

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