The path to climate-neutral and resource-optimised wastewater treatment

It is becoming increasingly important for many companies to reduce CO_2 emissions, to help protect the climate and the environment. The aim is to make production less emission-intensive and to continuously improve energy savings and resource efficiency and thus reduce CO_2. In doing so, companies make an important contribution to more sustainability and climate protection, reduce their long-term costs and improve their competitiveness.

Improving the CO_2 balance through optimisation measures

Intelligent water management can make a significant contribution to CO_2 savings. Wastewater often hides overlooked energy and raw material resources that can be utilised through biogas production, heat recovery, and water and recyclable-material recycling. When reported as saved CO_2 equivalents, these measures can contribute to improving the CO_2 balance.

When a plant is in operation, there are opportunities to optimise resource and energy consumption and thus save CO_2 at various levels:

- At a process level, through process optimisation and improved control and utilisation of machinery.
- At a product level, through plant modernisation and predictive maintenance.
- Via digitisation through digital user applications, process networking, intelligent diagnostic systems and intelligent control.

It is important to take a long-term, holistic view here. The implementation of optimisation measures usually consumes resources and energy. However, in daily plant operation these measures contribute to both improving the CO_2 balance and reducing resource consumption, and, in many cases, to optimising operating costs.

Practical example: a continuous optimisation process in plant operation management

EnviroChemie has been responsible for operating the production wastewater treatment plant for a large German food manufacturer in the potato processing sector since November 2012. Every day, up to 1,300 m^3 of starch-containing production wastewater is treated to a quality suitable for direct discharge into the environment. Along the path to climate-neutral and resource-optimised wastewater treatment, the process has gone through various phases over the years (Figure 1).

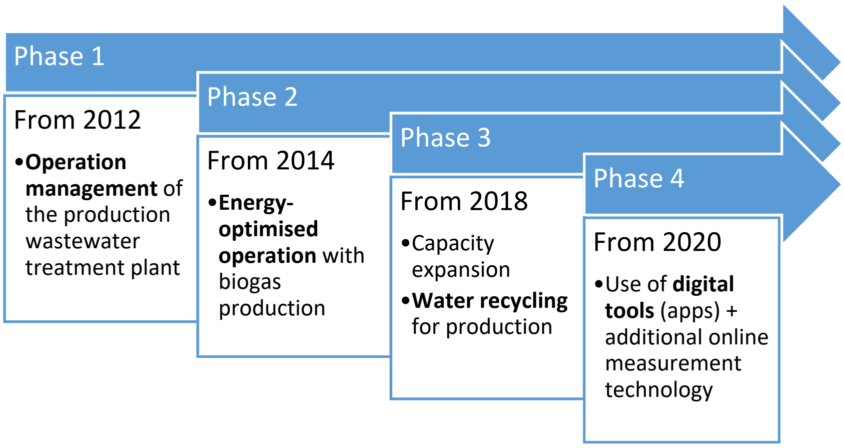

Figure 1: Practical example: phases along the path to climate-neutral and resource-optimised wastewater treatment

Phase 1 – Determining optimisation potential

A continuous improvement process (CIP) was set up as part of taking over the operation management. EnviroChemie first conducted a comprehensive process analysis to identify the potential for optimisation to reduce both CO_2 emissions and operating costs. The following opportunities were identified:

- Changing process technology → Integration of an anaerobic treatment stage to produce biogas from wastewater
- Modernising the plant → Use of less energy-intensive aggregates
- Optimising plant operation → Optimisation of operating parameters (e.g. activation tank aeration) and reduction of running times of energy-intensive units

Phase 2 – Avoiding emissions through energy-optimised operation with biogas production

The existing aerobic treatment plant comfortably complied with the legal limits. However, the plant operation was characterised by high energy consumption, especially in the generation of compressed air for the aerobic treatment stage. In addition, large quantities of excess sludge were produced during operation and had to be disposed of.

With the integration of a Biomar® ASBx anaerobic wastewater treatment stage for biogas production in 2014, both CO_2 emissions and operating costs at the site were significantly reduced(Figure 2).

Subsequently, there were significant savings in electricity consumption and in the amount of sludge to be disposed of, while biogas production was added:

- Biogas production approx. 430,000 Nm^3/year
- Reduction in electricity consumption > 55%
- Reduction in sludge volume ~ 50%

The biogas produced is processed and used in the plant instead of fossil natural gas to generate steam.

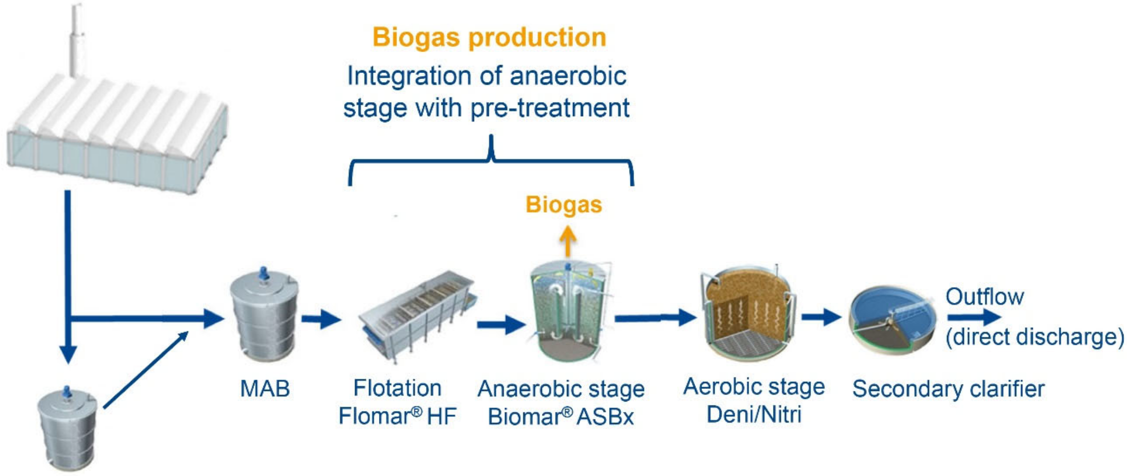

Figure 2: Process diagram after process optimisation (integration of an anaerobic stage for biogas production and pre-treatment with flotation)

If the electricity savings and biogas production are taken into account when calculating emission prevention, there are savings of up to 1,500 t CO_2 equivalents per year compared to the original operating state (Figure 3).

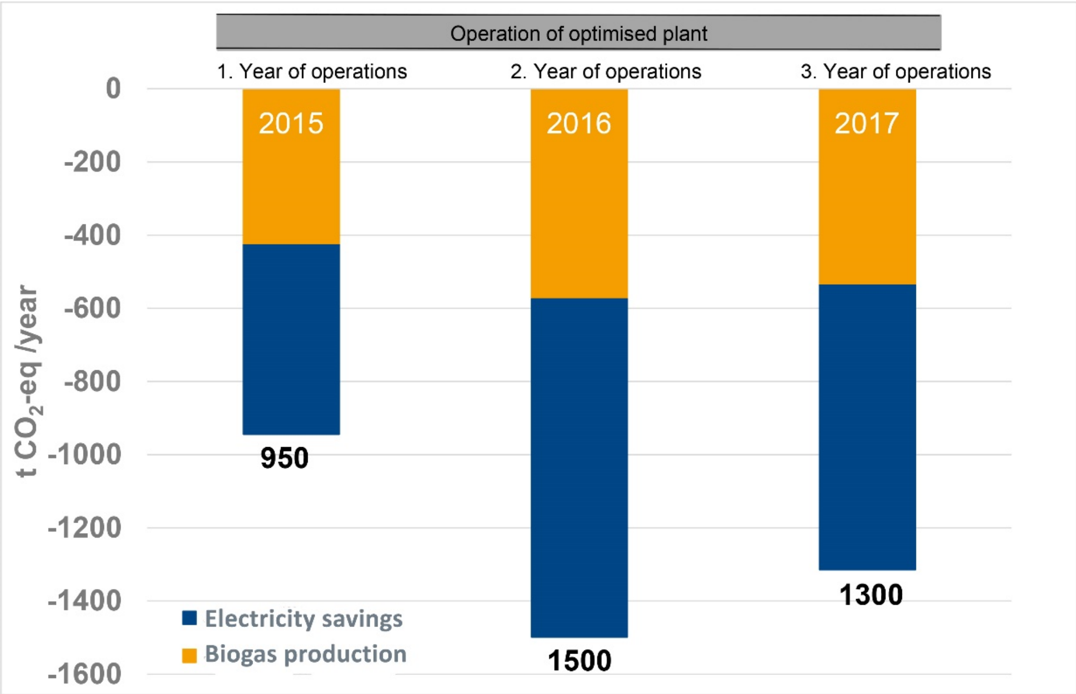

Figure 3: Emission prevention (t CO2-eq) after optimisation compared to the original operating condition

Phase 3 – Improving water footprint through water recycling for production

Due to production expansion at the site, a significant increase in the volume of wastewater was expected, which would have led to the requirements for discharge into the receiving water being exceeded.

By recycling water at the site, in 2018 the company was able to gain greater independence with regard to discharge restrictions and also significantly improve its water footprint (Figure 4). For this, the treated production wastewater is further treated using ultrafiltration and reverse osmosis and disinfected using UV light and chlorine. The germ-free water is finally blended with municipal water and reused in the factory for production purposes.

About 30% of the treated production wastewater is currently treated to a water quality that complies with the German drinking water directive. Every year, about 165,000 m³ of water are recycled in this way. The amount of fresh water saved contributes to a saving in CO_2 equivalents.

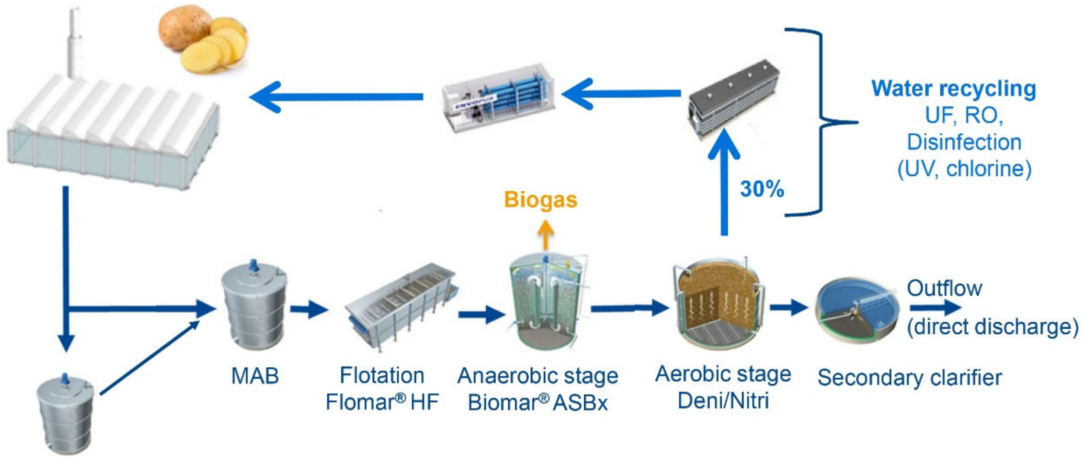

Figure 4: Water recycling as part of production expansion contributes significantly to improving the water footprint

Phase 4 – Using digital tools for plant optimisation

Since 2020, a tool, the WaterExpert™ online platform, has been used to further optimise plant operation and further increase resource and energy efficiency through the targeted use of expert knowledge (Figure 5). Additional online measurement technology is used, among other things, to detect and avoid malfunctions in plant operation at an early stage and to dose water chemicals optimally and in line with requirements.

The WaterExpert™ app provides a complete overview of the entire plant operation simply and easily. Data is stored securely in the cloud, so the WaterExpert™ online platform can be accessed from any location. Data monitoring, and alarm and maintenance management mean the relevant system data is available to all experts in real time. EnviroChemie's experts can connect to the plant remotely via the app and support the operating team on site.

Figure 5: App-supported online platform WaterExpert™ for plant operation digitisation and support

To monitor plant performance, a system of key performance indicators (KPIs) was stored in WaterExpert™, which triggers alerts when critical values are exceeded.

KPIs were created to monitor the following parameters, among others:

- Electricity requirement
- Requirement for chemicals
- Sludge production
- Fresh water production
- Biogas production

By consolidating all the information in the WaterExpert™ online platform, both the on-site operating team and the experts in the EnviroChemie back office have access to all the relevant data at all times, so the operating team can be supported quickly and easily. The adoption of numerous small measures has led to a reduction in energy demand of around 20% within a short period of time.

Carbon footprint in 2020

For the operating year 2020, significant savings were achieved in CO_2, through biogas production, and in fresh water, through water recycling. These add up to a CO_2 credit of -561 t CO2 equivalents per year (Table 1). The list shown in Table 1 does not claim to be an overall carbon footprint for the plant but is intended to serve as an estimate of the order of magnitude. If the electricity requirement of the wastewater treatment and the consumption of chemicals in CO_2 equivalents are set against this, there remains a carbon footprint of -31 t CO_2 equivalents a year. In other words, the CO_2 credit from biogas production and fresh-water savings covers the CO_2 emissions from the consumption of electricity and chemicals. The biggest influencing factors are the biogas production to further increase the CO_2 credit and the electricity requirement to further reduce CO_2 emissions. Work will continue on these factors to achieve further CO_2 savings.

Area	CO_2 emission equivalent [t CO_2-eq/year]
Biogas production	-533
Fresh water savings	-28
∑ CO_2 credit	**-561**
Power consumption	410
Consumption of chemicals	120
∑ CO_2 emissions	**-31**

Table 1: Comparison of CO_2 credit from biogas production and fresh-water savings with CO_2 emissions from the consumption of electricity and chemicals

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