



Circular Economy in practice at the Budapest Central WWTP



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INTRODUCTION

The Danube River is a unique geographical link between Central and Eastern Europe, famously flowing through four capital cities: Vienna (Austria), Bratislava (Slovakia), Budapest (Hungary), and Belgrade (Serbia). Its vast basin covers approximately 20% of EU territory and extends across 20 countries in total.

Budapest maintains a sophisticated "circular" relationship with the Danube, by using bank filtration for its potable water supply while relying on its well-designed wastewater treatment systems to return treated water to the same source.

A key infrastructure element in preserving the Danube water quality is the Budapest Central Wastewater Treatment Plant (BCWWTP) located on Csepel Island in the south of Budapest along the Danube River. Findings from the Joint Danube Surveys (JDS), conducted by the International Commission for the Protection of the Danube River (ICPDR) reveals the tangible impact of the Budapest Central Wastewater Treatment Plant, commissioned in 2009. The most significant shift observed between the JDS 2 (2007) and JDS 4 (2019) is lower faecal pollution levels, specifically E. coli and intestinal enterococci, and the diminution of the eutrophication (algal blooms) in the Hungarian reaches of the river.

At the same time, BCWWTP is a prime example of circular economy in practice, transforming wastewater and the treatment derivatives from a waste product into a valuable source of energy and raw materials. This ability has gained higher importance recently, as in the freshly revised Urban Wastewater Treatment Directive (UWWTD) (Directive (EU) 2024/3019), – that came into force on January 1, 2025 – the transition of WWTPs to a circular economy is a core objective.

NUTRIENT RECOVERY

To be in compliance with the Directive (EU) 2024/3019 a combined minimum reuse and recycling rate for phosphorus from sludge and from urban wastewater has to be respected. The precise reuse targets will be established by national legislation by mid-2027.

Around 89% of produced sewage sludge in Hungary goes to composting, which is higher than the EU average of 47%. A licensed composting company manages the sludge disposal of the BCWWTP's stabilized dewatered sewage sludge (55,000 tons/year, 25-26% DS).

As a result of the highly efficient pathogenic elimination capacity of thermophilic digestion, (which also inactivates COVID-19 virus) it meets all the criteria of a 'Class A' sludge, known as 'exceptional' quality. The thermally conditioned sewage sludge is an excellent fertilizer to improve soil properties as it is rich in phosphorus (30-35 g P/kg DS) and nitrogen (40-45 g N/kg DS) and has a high (65% VS) organic matter content. Its major advantage over commercial fertilizers is the sustainable reuse of essential and finite phosphorus resources.



BCWWTP produces 1,300 tons per year of grit with 70-90 m/m% solids content, as the major solid waste arising from the preliminary treatment stage. The grit is removed as the mineral particles are abrasives and can damage equipment and the drains. Our partner for grit delivery also processes the recovery of inorganic construction debris at their site. The recovered grit is recycled as construction material e.g. for pipe or road bedding.



Like most wastewater treatment plants, BCWWTP uses screening as the initial mechanical pre-treatment step to extract floating debris. The 500 tons of screening waste produced each year, is composted at a facility that utilizes landfill gas for energy recovery. The quality of the extracted screening waste is highly variable with an organic content between 3,000 to 15,000 mg DOC /kg DS.



WATER REUSE

With the new directive, Member States are now required to systematically promote the reuse of treated wastewater from urban treatment plants, especially in water-stressed areas. As the Danube is a high-volume river, the pressure for water reuse in Budapest is low.



The core mission of BCWWTP is to return high-quality treated water to the Danube, ensuring the protection of the river's ecosystem and supporting the natural water cycle. But above that, as part of sustainable water management, industrial water is produced from the treated wastewater to reduce the demand for fresh water and to minimize environmental impact. Access to this water is limited to closed-loop systems to ensure that personnel are protected from accidental exposure.

The quality of industrial water is defined by the specific requirements of the technological process it serves. Up to 600 m³/h filtered industrial water is available to wash the equipment (e.g. fine screens, compactors, sludge dewatering equipment) to operate the biological odour control system and to condition the biogas (cooling/drying).

In a yearly average 82% of the Plant's water need is covered by industrial water. The wastewater reuse at the Plant is approximately 1%, which corresponds to the CEE regional average, but less than the EU average which is 2.4%.

ENERGY PRODUCTION

According to the revised UWWTD wastewater treatment plants (above 10,000 p.e.) must balance their energy consumption by producing the same amount of renewable energy by the end of the year 2045. At BCWWTP the level of energy neutrality is at 79% in respect of the total (electric and thermic) energy consumption.



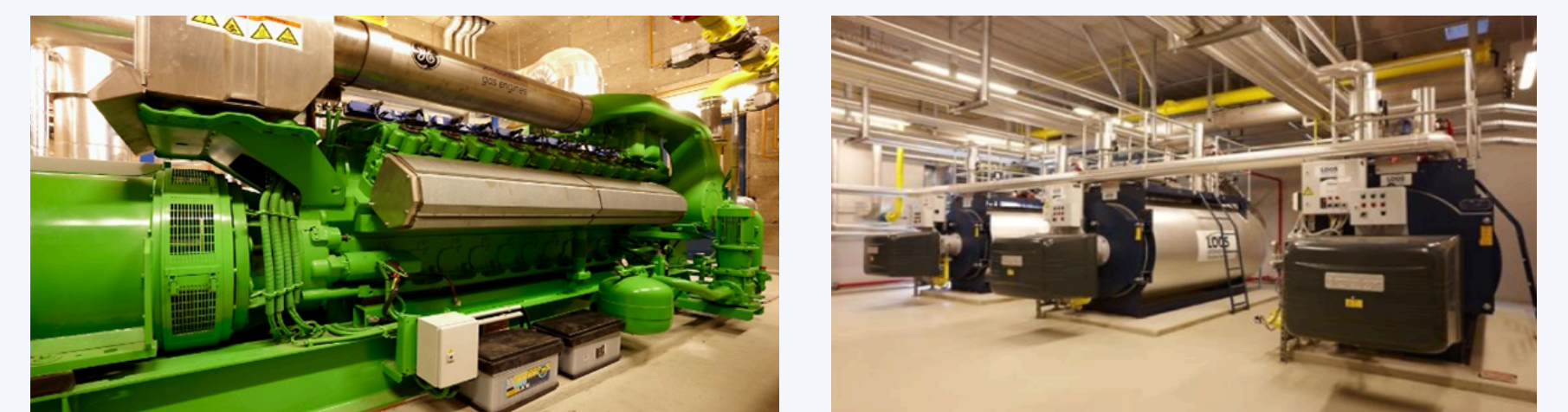
Energy production from water

At BCWWTP an Archimedes screw turbine is integrated into the outlet channel of the treated effluent to recover kinetic energy of the flow. This minor hydroelectric unit accounts for an average of 0.5% of the treatment facility's annual electricity consumption, enhancing the plant's overall energy autonomy.



Energy production from sludge

BCWWTP utilizes anaerobic thermophilic digestion to stabilize the produced sewage sludge and recover biogas for energy production. Through Combined Heat and Power (CHP) cogeneration, the plant achieves significant energy recovery, supplying over 60% of its 95 MWh daily electrical need and meeting more than 95% of its 96 MWh thermal requirements on an annual basis.



FUTURE PLANS

We plan to meet further the UWWTD requirements through struvite recovery. This process effectively prevents the clogging of pipes and downstream equipment, ensuring both compliance and process stability.

