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ANALYSING THE ENERGY EFFICIENCY OF WASTEWATER TREATMENT PLANTS

Motivation

Wastewater treatment aims at sanitation in cities and a good ecological status of the receiving water bodies. In order to fight eutrophication, enhanced nutrient reduction is required. For the Baltic Sea region recommendations have been published by HELCOM [1]. While phosphorus removal does not need much electrical energy, the demand for aeration and especially nitrification/denitrification is high. The limited availability of fossil resources for energy production and greenhouse gas mitigation are reasoning enough for energy smart operation of WWTP. Last but not least a noticeable saving of operational costs can be achieved. The complex task is to minimize the energy demand while keeping or improving the nutrient load in the effluent of wastewater treatment plants (WWTPs).

Key figures for energy benchmarking in the baltic sea region

In order to provide an overview about the current situation in the Baltic Sea region incl. Belarus, key figure data is essential and helps to develop a benchmark. Operational data from WWTPs in the region has been collected in the project Interactive Water Management (IWAMA). The evaluation reveals information about the current situation of different scaled wastewater treatment plants (WWTPs) in the BSR, which are operated under different legal requirements and different restrictions for nutrient effluent values. While country-based key figure comparison is an accepted and widely applied method, this novel approach combines transnational information from different legal backgrounds and technological levels.

Nutrient removal efficiencies of 66 WWTP were checked against HELCOM recommendation 28E/5. In average 86 % of N are removed (Figure 1). Median effluent concentration for total nitrogen is 9 mg/l. In regards of phosphorous, an average of 96 % P removal is achieved. Median effluent P concentration was determined at 0.5 mg/l (Figure 2).

Several ratios (flow, COD load removed) have been compared to find the most objective basis for a comparison of different scaled WWTPs. The evaluation revealed differences in inlet concentration depending on the sub-region selected up to factor 2.

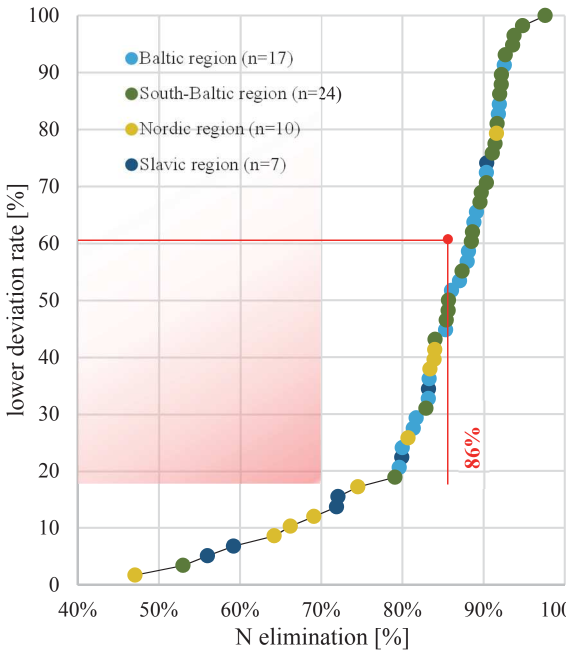

Figure 1 – N removal efficiency

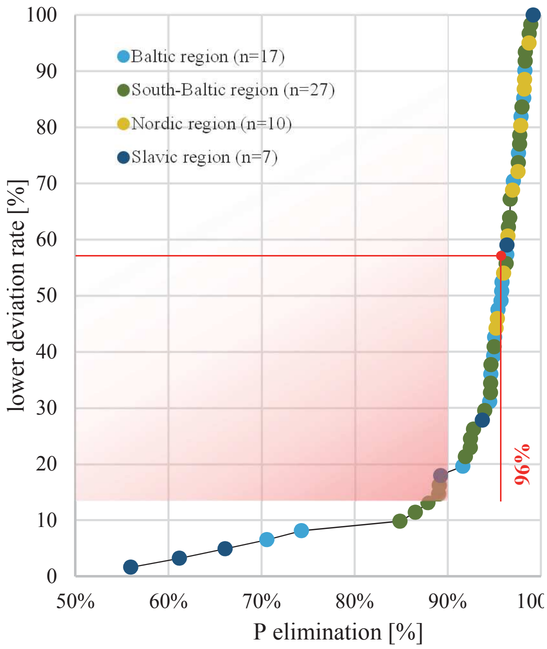

Figure 2 – P removal efficiency

Finally, the population equivalent based on 120 g COD/(PE·d) was chosen as most representative key figure. According to the results of the key figure evaluation the benchmark for energy optimized treatment was set to 23 kWh/$PE_{COD,120}$·a (Figure 3).

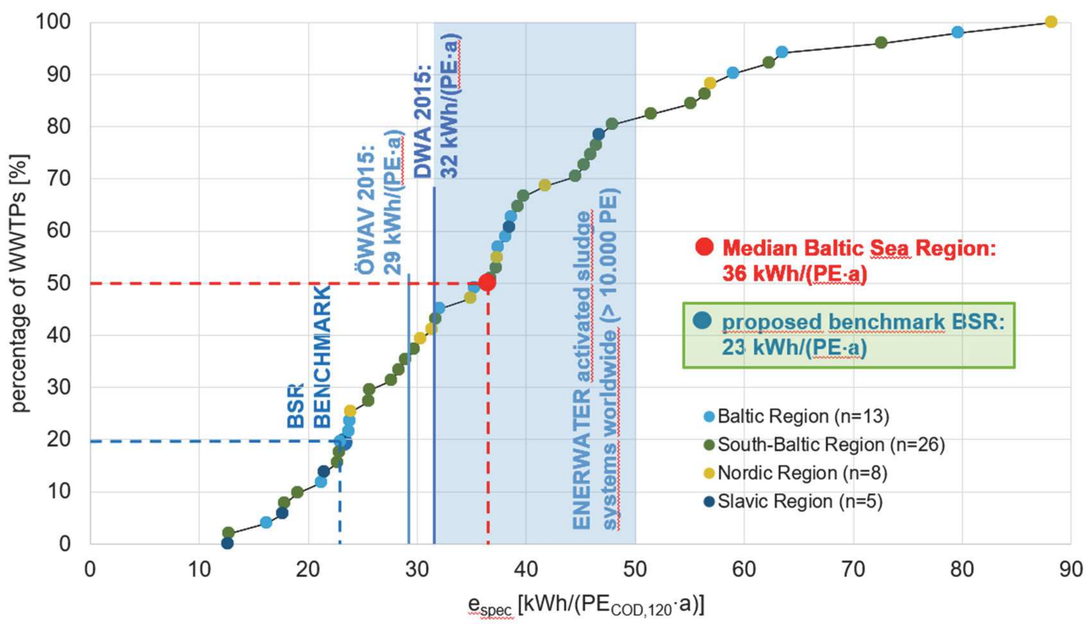

Figure 3 – Specific energy consumption [kWh/(PECOD,120·a)], accumulative

Energy analysis

Influenced by the results of the key figure comparison, an energy self audit tool has been developed. The tool follows the approach published in the Standard A-216 by the German Association for Water, Wastewater and Waste (DWA). The plant specific ideal energy consumption values are calculated automatically by the tool if required process data is provided. With the help of the tool, WWTP operators are enabled to analyze the energy efficiency of their treatment process. Regular (annually repeated) audits help to detect potential problems, preventing losses in both energy and finances. The available options for analysis evolve based on the complexity of the treatment process applied. After an intense data collection phase in the first year, the inventory can easily be updated with information from the respective reporting year. Based on the tool internal evaluation, optimization measures are suggested which can be further investigated, if necessary with the help of external consultants (Figure 4).

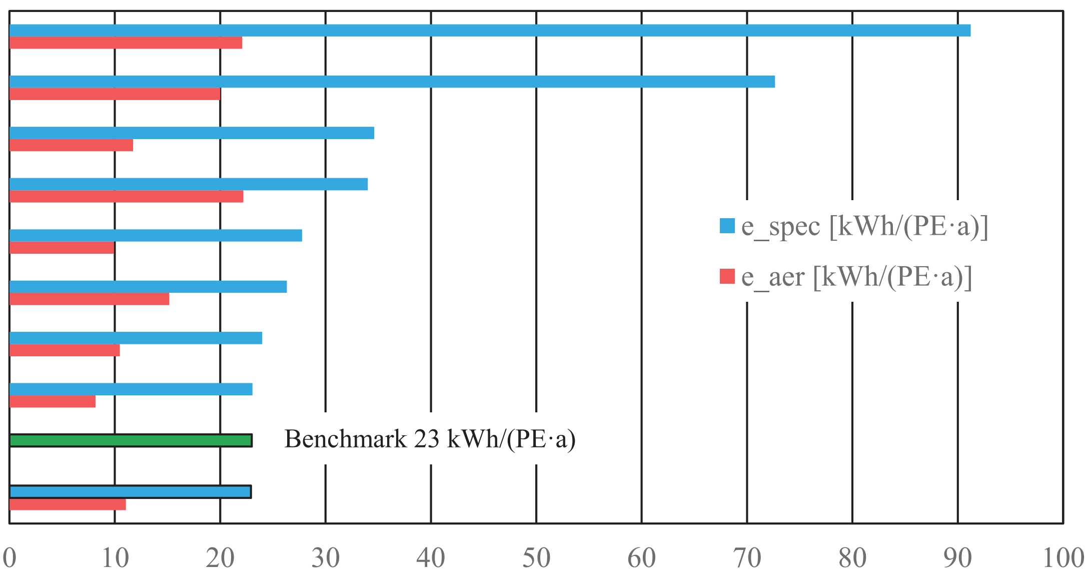

Figure 4 – Specific energy consumption of audit WWPT [total and Aeration]

The tools have been tested at WWTP of varying size and technology. The audits performed at 9 partner WWTPs revealed individual optimization potentials of the treatment processes, sludge management and equipment (Figure 5).

The theoretical reduction of energy consumption ranges from 4 up to 40 % per WWTP. The discussion about the audit process and final results during audit group meetings have been considered beneficial by all audited WWTPs.

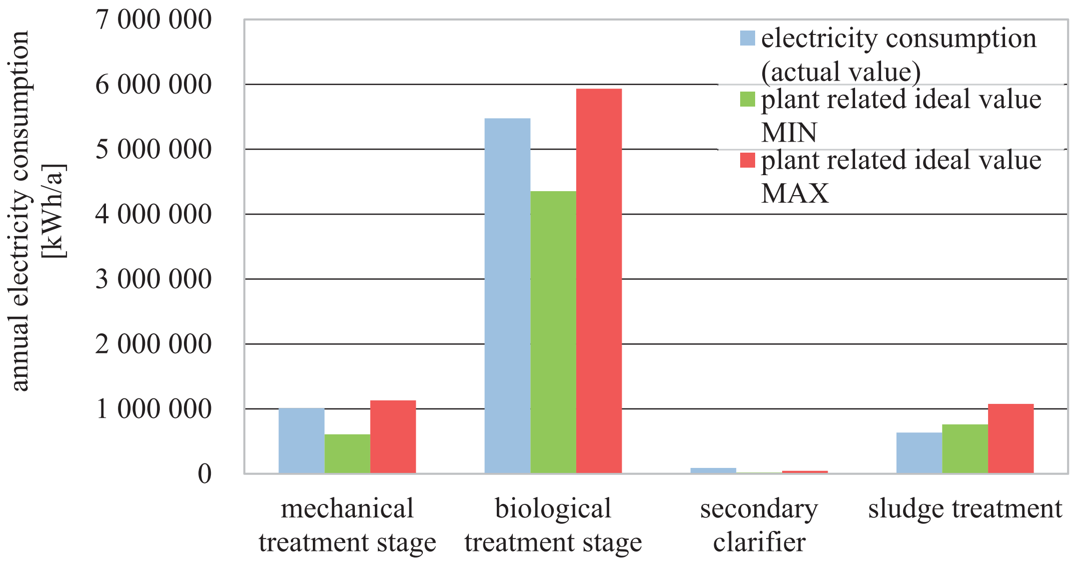

Figure 5 – Total values and ideal values main treatment stages

A peer group-based approach of evaluation offered additional benefits for the partner WWTP, due to the regular international experience exchange. The described tools are publicly available.

Acknowledgements

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References

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