Benchmarking energy efficiency of municipal wastewater treatment plants

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Conventional municipal wastewater treatment to achieve required effluent discharge standards is generally a highly energy intensive process which can account for as much as three per cent of a developed country's electricity usage [1]. As illustrated in Fig. 1, energy is primarily consumed by mechanical equipment such as aerators, pumps and wastewater byproduct (sludge) treatment.

While considerable energy is consumed in the biodegradation of wastewaters, the wastewater sludge generated as a byproduct contains considerable embodied energy much of which can be recovered and used to partially offset the consumed energy through anaerobic digestion of the sludge. In a number of extremely efficient plants, energy neutrality has been achieved[2]. One of the key goals in wastwater treatment plant (WWTP) design is the achievement of minimum energy consumption and maximum energy recovery which is dependent upon the optimisation of the hydraulic and process design of the plant.

This study benchmarked the efficiency of WWTPs in Ireland against best international practice. Measured energy consumption data was used to calibrate a numerical model of energy performance at these plants. Key performance indices such as energy consumption per m^3 of treated wastewater (kW hour/m^3) and energy consumption per unit organic load removed (kW hour/kg Chenical Oxygen Demand) were used in the analysis [3].

The key findings of the study were:

- Specific energy consumption typically decreases as the plant scale increases. This is most likely to economies of scale in larger plants, in addition to better performing plant automation and control.
- Energy can be conserved via design and operational strategies: the use of more efficient mechanical systems (e.g. fine bubble systems) coupled with greater levels of automated control (e.g. variable speed drives to control pumps and air blowers) and real-time online monitoring.
- Benchmarking supports the identification of opportunities for energy conservation and assists in process optimization with targeting measures.

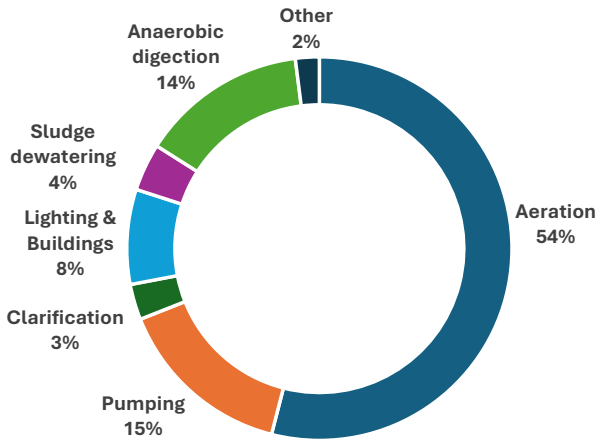

Figure 1: Typical energy consumption in a municipal wastewater treatment plant[1].

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[1]USEPA, EPA 832-R-10-005, 2010
[2]Mojtaba Maktabifard et al., *Rev. Environ. Sci. Biotechnology*, **17**, 655-689, 2018
[3]Foladori P. et al., Water Science Technology, **72(6)**, 1007-15, 2015