CERIS Civil Engineering Research and Innovation for Sustainability

Assessment and improvement of energy use in wastewater systems

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Summary

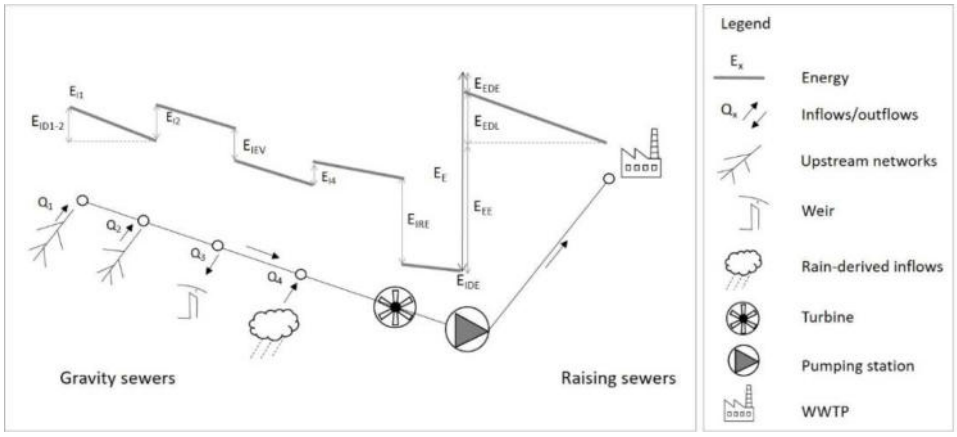
This research aims at developing a comprehensive approach for assessing the energy use and efficiency in wastewater systems, considering the water-energy-greenhouse gas (W-E-G) emissions nexus supported by methods and tools, such as a tailored energy balance and a performance assessment system (PAS). This approach is aligned with continuous improvement principles and allows carrying out the diagnosis of energy efficiency in wastewater systems supporting the building of a portfolio of energy use improvement measures responding to strategic objectives and attending to the systems' characteristics and factors influencing performance. The impact of undue inflows into these systems is addressed specifically. This approach is intended to support utility managers in managing the referred nexus.

The first step was the development of an energy balance scheme for assessing energy efficiency in wastewater systems. It provides a consistent method to calculate the energy components associated with wastewater transport processes, allowing the quantification of the main waterenergy inefficiencies. Three assessment levels (macro, meso and micro-level) can be used for applying the energy balance, depending on available information and scope. As a second step, a comprehensive PAS to assess energy efficiency was developed, incorporating criteria related to energy consumption, undue inflows, operation and maintenance costs, and environmental impacts, such as untreated discharges and W-E-G nexus, among others. A comprehensive diagnosis of wastewater systems can be carried out by combining both developed tools (the energy balance and the PAS). As a third step, a portfolio of measures for energy use improvement in wastewater systems was developed based on literature and on a survey of the wastewater utilities. This portfolio facilitates the identification of the measures by the wastewater utilities. The proposed global framework allows to carry out the diagnoses of the current situation, to evaluate the applicable measures, using the referred tools, to set priorities and to prepare an implementation plan. The approach requires operational data; when data are limited, it enables a simple analysis, whereas when data are complete, an advanced analysis with the option of mathematical modelling is carried out. The current research is novel and innovative, adopting a holistic view of the energy efficiency in wastewater systems, and addressing significant gaps in the literature and current practice.

The main outcomes of this research are: i) an integrated approach for the energy efficiency diagnosis in wastewater systems; ii) a novel energy balance for wastewater systems with different assessment levels; iii) a tailored and objective-oriented PAS composed of several new metrics; and iv) a portfolio of energy efficiency improvement measures for wastewater systems. The developed tools have been applied to real case studies to explore the applicability and the advantages and disadvantages of different calculation methods and metrics, attending to the limitations faced by the wastewater sector.

Keywords

Energy balance, energy efficiency, performance assessment, water-energy-greenhouse gas emissions nexus, wastewater systems.



Water energy interactions scheme for wastewater systems.