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Energy savings and reduced emissions in combined natural and engineered systems for wastewater treatment and reuse: the WWTP of Antiparos Island, Greece

P.-M. Stathatou[a,*], P. Dedousis[a], G. Arampatzis[b], H. Grigoropoulou[a], D. Assimacopoulos[a]

[a]*School of Chemical Engineering, National Technical University of Athens, Zografou, Athens, 15780, Greece, Tel. +30 2107721024, +30 2107723135; emails: pstathatou@chemeng.ntua.gr (P.-M. Stathatou), dedousis_p@hotmail.com (P. Dedousis), lenag@chemeng.ntua.gr (H. Grigoropoulou) assim@chemeng.ntua.gr (Assimacopoulos)*
[b]*School of Production Engineering and Management, Technical University of Crete, 73100 Chania, Greece, email: garampatzis@pem.tuc.gr*

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ABSTRACT

Europe's water service providers are under increasing pressure to deliver improved and affordable water services to a growing population, whilst reducing the amount of energy used, lowering the environmental impact of water and wastewater treatment processes, and coping with climate change. These challenges have prompted research on natural processes for wastewater treatment, such as constructed wetlands (CWs), providing low-energy treatment potential and storage capacity. As the performance of natural treatment processes may be limited by several factors (e.g. climatic conditions, space restrictions), considerable research concentrates on investigating their combination with engineered pre- or post-treatment processes to improve their performance and increase their treatment resilience. The aim of this paper is to assess and demonstrate the advantages of combined natural and engineered systems (cNES) over purely engineered treatment systems with regard to energy savings and reduced environmental impacts. The case of a cNES located in the island of Antiparos in Greece for the treatment and reuse of municipal effluents is investigated, focusing on the energy savings and the reduction of greenhouse gas (GHG) emissions from the natural treatment process. The performance of the system, which involves CWs for the secondary treatment of effluents, was assessed using an integrated modelling and simulation environment (baseline scenario). An alternative scenario was also built, substituting the CWs with a conventional activated sludge (CAS) process for the secondary treatment of effluents to achieve the same effluent quality as in the baseline scenario. Energy consumption and generation of GHG emissions was assessed for both scenarios, and a comparison between the two systems was conducted, highlighting the significant energy savings and the reduced GHG emissions produced by the cNES: the CAS system consumed about 3,000 times more energy, producing about 50 times more total GHG emissions compared with CWs. The results of the current analysis demonstrated that cNES involving CWs can provide a competitive alternative to purely engineered systems for wastewater treatment and reuse in isolated insular communities and small municipalities, also contributing to water scarcity reduction.

Keywords: Constructed wetlands; Activated sludge; Wastewater treatment and reuse; Energy savings; Greenhouse gas emissions; Antiparos Island

* Corresponding author.

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