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Energy balance and life cycle assessment of a microalgae-based wastewater treatment plant: A focus on alternative biogas uses

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ABSTRACT

The techno-environmental performance of a medium-scale wastewater treatment system using high-rate algal ponds was evaluated through mass and energy balances and life cycle assessment. The system involves wastewater primary treatment, microalgae-based secondary treatment, thermal hydrolysis with steam explosion of microalgae, anaerobic co-digestion of pre-treated microalgal biomass and primary sludge, and biogas cogeneration. Furthermore, two scenarios based on alternative biogas uses were considered: (i) biogas for heat and electricity, and (ii) biogas for heat, electricity, and biomethane. Pumping wastewater to the primary settler arose as the main source of electricity consumption. When compared to conventional activated sludge plants, a large decrease in the energy consumption was observed for the secondary treatment. Moreover, a favourable life-cycle performance was generally found for the microalgae-based systems when displacing conventional energy products. Finally, the preference for a specific scenario on biogas use was found to be highly conditioned by the techno-environmental aspects prioritised by decision-makers.

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