Comparative energy efficiency of wastewater treatment technologies: a synthetic index approach

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Abstract

Improving the energy efficiency of wastewater treatment plants (WWTPs) provides notable economic and environmental benefits to society. Several studies have benchmarked the energy performance of WWTPs, but they did not take into account for differences in the wastewater treatment technologies they used, thus obscuring their relative efficiencies in removing harmful pollutants. To overcome this shortcoming, this study assessed and compared the energy efficiencies of five wastewater treatment technologies. To do so, the metafrontier approach was used in order to account for the technological differences among plants in removing pollutants. The results evidenced that energy efficiencies for WWTPs using attached-growth processes were higher than for WWTPs using suspended-growth technologies as secondary treatment. Moreover, higher pollutant removal efficiencies associated with biological removal of nutrients compensated for the higher energy requirements of this technology, making these WWTPs more energy efficient in the removal of pollutants. The results of this study provide essential information for improving the sustainability of current WWTPs and can support decision-making in the planning of new wastewater treatment facilities.