Evaluation of energy performance of drinking water treatment plants: use of energy intensity and energy efficiency metrics

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Abstract

One of the United Nations Sustainable Development Goals is to provide access to safe and clean drinking water. However, treating raw water in facilities currently involves using a non-negligible amount of energy, and the fossil fuels used are both expensive and emit greenhouse gases when combusted. Previous studies have evaluated the energy performance of drinking water treatment plants by estimating the amount of energy consumed per volume of water. However, such studies have not accounted for differences between treatment technologies and have assumed a common standard water treatment technology. To overcome these limitations, this study employed metafrontier data envelopment analysis to evaluate and compare the energy performance of four types of treatment technologies. This approach integrates energy intensity with pollutant removal efficiency into a single, synthetic index to deliver an energy-efficiency score. A comparison of the four treatment technologies showed that facilities using rapid-gravity filtration and coagulation-flocculation processes provided the highest energy efficiencies. However, energy intensity and energy efficiency metrics delivered contradictory results, which thus illustrates the importance of including pollutant removal efficiency data in performance assessments. This study provides valuable information for policy-makers when planning and developing new drinking water treatment plants and for water utility managers when identifying energy reduction opportunities in plants.

Keywords

Energy intensity, Energy efficiency, Drinking water treatment, Performance, Data envelopment analysis, Metafrontier