Present and Future of Wastewater Treatment Plant Energy Consumption and Emissions

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Abstract

In the United States, the wastewater treatment sector is responsible for approximately 1.7% and 5.0% of national methane and nitrous oxide emissions, respectively, based on limited greenhouse gas emissions inventories. We have developed an enhanced and comprehensive greenhouse gas inventory of wastewater treatment plant emissions. This inventory is the first for the United States to include upstream emissions associated with providing energy to wastewater treatment plants and downstream emissions associated with biosolids processing along with on-site emissions of CO_2, CH_4, and N_2O. We preliminarily estimate total annual GHG emissions of approximately 36 million metric tons of CO_2e. In addition, we have considered how energy consumption (1,100 million GJ) and greenhouse gas emissions (84 million t CO_2e) will increase as the globe moves towards cutting the amount of untreated wastewater in half to achieve U.N. Sustainable Development Goal 6.3. Moreover, there is a global opportunity to recover more nutrients for wastewater, but this will come at the cost of increased energy consumption while offering the possibility of displacing some production of fertilizer. Finally, we explore the application of integrated assessment models to capture the interconnections among the wastewater, energy, and agricultural sectors and needs for improvement.

Short Biography

Dr. Jennifer Dunn is a Professor in Chemical and Biological Engineering at Northwestern University. She holds a courtesy appointment in Mechanical Engineering. Jennifer is Associate Director of the Northwestern-Argonne Institute of Science and Engineering and the Director of Northwestern's Center for Engineering Sustainability and Resilience. Jennifer studies emerging technologies, their energy and environmental impacts, and their potential to influence greenhouse gas and air pollutant emissions, water consumption, and energy consumption. Her areas of interest include hydrogen, plastics, nutrient recovery from water, biofuels and bioproducts, and sustainable mineral supply chains. Techno-economic, life cycle, and material flow analyses are primary tools in her research. Jennifer holds a Ph.D. in Chemical Engineering from the University of Michigan where she was introduced to life cycle analysis through earning her Master's degree in Sustainable Chemical Engineering Systems. Her undergraduate degree in Chemical Engineering is from Purdue University. Prior to joining Northwestern, she led the Biofuels Analysis group at Argonne National Laboratory.