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Quantum Computing Applications in Waste-to-Energy Bio-Methanation Systems: Revolutionizing Sustainable Practices

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Extended Abstract

Global challenges in energy, climate change, and the environment necessitate a renaissance in anaerobic organic transformation to convert waste, such as methane an energy source. However, the limited availability of energy (electrons) in bio-methanation processes hampers kinetic and thermodynamic efficiency. Harnessing the wave-particle duality of electrons and understanding complex gene regulation in microbial metabolism are crucial for overcoming these limitations. In this talk, quantum computing applications in waste-to-energy bio-methanation systems are introduced. Quantum computing offers unique capabilities such as superposition and entanglement, which differ from classical computing. We present two cases within bio-methanation systems: the first focuses on understanding gene regulation in micro-aeration anaerobic digestion using quantum information techniques, while the second investigates interspecies electron transfer (DIET) in methanogenesis systems, employing quantum tunnelling and hopping. These efforts aim to revolutionize our practices and simultaneously mitigate climate change. We discuss future research directions and implementation strategies to address 21st-century challenges from both scientific and engineering perspectives.