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Techno-economic assessment of biogas to liquid fuels technology via Fisher-Tropsch synthesis

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The global demand for transportation fuels has been increasing everyday due to increase in global population and relative increase in standard of living across the world. Development of transportation fuels from biogas (mainly methane and carbon dioxide) or landfill gases or shale gases could reduce the pressure on petroleum crude oil, while addressing key environmental and waste disposal problems. In this study, we developed a detailed process-based simulation model for the biogas to liquid fuel (BgTL) plant to conduct mass and energy balance and to evaluate techno-economic assessment of producing drop-in F-T fuels. The BgTL plant operations consisted of biogas cleaning, biomethane reforming, F-T synthesis of syngas and hydrocracking and final distillation to produce drop-in liquid fuels. The unconverted syngas was utilized to generate steam and electricity to meet internal plant demand, while the excess power was sold to the grid. The base case BgTL plant (2,000 Nm3/h) produced about 4.6 million gallons per annum of total F-T fuels which consisted of 62% diesel, 32% gasoline, 6% LPG with an overall biogas conversion of 54%. A discounted cash flow rate of return (DCFOROR) approach for the Nth plant was used to estimate the capital and operating costs with the minimum selling price for the F-T drop-in fuels of about $5.67/gal ($5.29/GGE). The increase in plant feed capacity to 20,000 Nm3/h decreased the minimum selling price of F-T fuels to $2.06/gal ($1.92/GGE). The sensitivity analysis conducted on the base case plant demonstrated that the Internal Rate of Return (IRR), F-T conversion rate, plant operating hours and biogas cost were very sensitivity to the minimum selling price. Overall, the BgTL technology is deemed to be economically feasible to meet US biofuels demand. In addition, the methane sources from shale gas or landfill gas at low-cost could drive the technology to near commercialization.

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