Optimization of Biomass-to-Liquid Plant Setups and Capacity Using Nonlinear Programming

Abstract

From both an economic and ecological perspective, the continued consumption of mineral oil is disputed. Economically competitive as well as technically feasible biofuel production processes may contribute to developing feasible substitutes. 2nd generation biofuel production pathways such as Biomass-to-Liquid (BtL), which convert lignocellulosic material into liquid hydrocarbons using Fischer-Tropsch synthesis, are superior to their 1st generation counterparts from a yield-per-hectare-perspective and cause less competition for agricultural soils. The significant investment-related costs affect the competitiveness of 2nd generation biofuels negatively, leaving it in doubt whether BtL fuels can become an economically viable option. Increasing plant sizes to improve economies of scale is problematic for BtL plants as larger plants are associated with higher specific transportation costs, as biomass needs to be transported over larger distances. In this work, the nonlinear effects of economies of scale and biomass transportation costs for increasing Biomass-to-Liquid plant capacities have been modeled on a product-upgrading-process basis for the first time. Potential investors and plant operators of Biomass-to-Liquid plants are thus enabled to determine both the optimal plant size and the most promising choice of products in order to maximize the prospective competitiveness of the plant.