# Optimal design of Saccharina japonica-based biorefinery using sugar platform: economic and environmental assessment

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The superstructure-based optimization was proposed to determine optimal pathway of biorefinery that uses sugar platform to produce bioethanol. To utilize the aforementioned waste streams, processes such as succinic acid, microalgae, wastewater treatment networks, and solid processing were integrated with bioethanol process. Based on the superstructure, technoeconomic and environmental mixed integer non-linear model was formulated. The aim of the present contribution was to determine a more economically and environmentally viable process design than a standalone process. These goals were achieved by two objective functions; maximize net present value and minimize carbon dioxide emissions. To account uncertainties in process parameters, sensitivity analysis was also performed. The results indicate that the minimum ethanol selling price of the integrated design was $1.31/gal, which is 34% lower than that of the standalone bioethanol process. Furthermore, the optimal design achieved 90% reduction in CO2 emissions from 148.7 kt/yr to 13 kt/yr and a 38.6% reduction in freshwater consumption.