Design optimization of flexible biomass-processing polygeneration plants using characteristic operation periods - DTU Orbit (28/04/2019)

This paper presents a method for including expected operating conditions in the design optimization of flexible biomass-processing polygeneration plants through the definition of characteristic operation periods. The method is verified in a superstructure-based, multi-objective design optimization scheme applied on a conceptual polygeneration plant that considers the integrated production of power, heat, ethanol, and biomethane. The design is optimized with respect to net present value and total CO2 emission impact. The results suggest that the best solution with respect to net present value is the production of heat and power using a gas turbine and a natural gas boiler, while the best solution with respect to CO2 emission savings includes full-scale ethanol and biomethane production, as well as a straw boiler for utility heat production. Solving the same design optimization problem using yearly average operation conditions instead of the characteristic operation periods approach, one of the two efficient solutions obtained was found to be suboptimal when evaluated against the actual operating conditions. Furthermore, the predicted objective function values for the optimal designs were found to differ significantly from what was obtained in the evaluation against actual conditions. These results underline the importance of considering expected operation and operating conditions when designing flexible polygeneration plants.