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The technology selection analysis based on bi-level environo-economic optimization of a biomass-powered CHP

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Purpose: Reliable energy supply and clean fuels are the most challenging issues for societies. The research carried out on the optimization of renewable energy systems by investigating fuel types and operating cycles to provide various energy sorts. However, challenges in theory and practice such as availability of systems over a long time, uncertainties in supply and generation or simplifying assumptions overshadow their practicality in real situations. The research purpose is to

- 1- Model biomass-fueled energy system including biomass-powered units to generate heat and power. It entails chemical, economic and thermodynamic modeling.
- 2- Optimization of the model to manage the cost, pollutions and consumer energy demand.
- 3- Definition of the alternative scenarios in the case of emergency or supply failure.

Methodology: In this research, a three-phase bi-level environo-economic model for biomass-powered systems' optimization is introduced. 40 scenarios are evaluated based on eight biomasses with five technologies under two strategies for delivering the optimized operating and performance parameters. The multi-objective nonlinear optimization coupled with multiple criteria decision making (MCDM) technique is used for this methodology.

Four objective functions (annualized capital cost, Biomass purchase cost, CO₂ generation, and SO₂ generation) as the functions of the operating parameters are optimized to deliver Pareto front of minimum cost and pollutions. They have been selected to explicitly express both sides of the environmental and economic sides of the study. At the first level of this approach minimum cost and pollution of numerous scenarios along with their optimal operating parameters such as generated power, utilization times are derived. At the second level, the alternative optimal scenarios by MCDM techniques are prioritized. By this method, optimal scenarios are identified and ranked in various strategies to increase system availability. VEGA multi-evolutionary method coupled with MCDM technique called TOPSIS is used for this purpose.

Results: the results of the model, besides the finalized performance values of the biomass-powered energy systems, such as finalized cost and emissions, delivers the system configuration for the delivering the products in a reliable manner. The lowest cost and emission biomass-technology scenarios in optimized and reliable configuration with their optimal operating values in minimum cost and emissions are the results of this paper.