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Thermoeconomic appraisal of a novel power and hydrogen cogeneration plant with integration of biomass and geothermal energies

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Abstract

The present research aims at development and design of a new high-efficiency power/hydrogen co-production framework running by biomass/geothermal renewable resources. In this regard, to attain global energy transition goals based on green hydrogen utilization of renewable resources instead of conventional fossil fuel-based routes for hydrogen production is followed. The proposed system structure consists mainly of a gas turbine coupled to a geothermal assisted Rankine unit which extracts the gas turbine wasted heat to run a water electrlyzer for H_2 production. To illustrate a comprehensive performance evaluation, technical (thermodynamic), environmental and economic aspects are considered and assessed. Eight performance indices are evaluated including: power and hydrogen productions, thermal and exergetic efficiencies, environmental damage and emission index, LCOP and overall system cost. In addition, a bi-objective optimization is implemented with respect to efficiency and product cost. Results show that, the cogeneration framework under optimum condition, operates with exergetic efficiency of $42.37\ \%$ and levelized product cost of $68.52\ \$/\mathrm{MWh}$, whose emitted CO_2 is $0.7443\ \mathrm{kg/kWh}$. Also, compared to basic design point conditions, it is found out that optimization leads to performance enhancements by 7.5%, 9.0% and 7.7% for the three mentioned indicators, respectively.