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Thermo-economic and environmental assessment of a combined cycle fueled by MSW and geothermal hybrid energies

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Abstract

The hybrid renewable energy-based power generation systems offer a reliable solution to mitigate the drawbacks of individual energy source. In this respect the biomass and geothermal energies have some well-known advantages (such as continuous provision) over the solar and wind energies. In the present paper, two integration modes are proposed for hybridization of geothermal heat with a biomass-driven gas turbine based combined power cycle. The Mode 1 configuration employs geothermal heat to increase the temperature of feedwater before the deaerator, whereas the Mode 2 structure applies the geothermal energy to generate more steam for the low pressure steam turbine. Detailed exergetic, environmental and economic appraisals are carried out to examine the hybrid systems performances. In order to represent an accurate comparison of the suggested hybridization modes, the systems are optimized to achieve minimum levelized electricity cost. The results have indicated better performance for Mode 2 hybridization scenario over the Mode 1. The former system yields 10.0% greater exergy efficiency with 20.1% less electricity cost compared to Mode 1, while it can generate 22.5% more electricity. Also, it brings about 22.5% lower CO_2 emission. However, the Mode 2 configuration possess one drawback compared to Mode 1, which is its higher overall system cost rate by 17.9%. The results show that, the higher cost rate of Mode 2 configuration is mainly due to larger pressure ratio of the air compressor which causes more costs for the compressor and gas turbine components.