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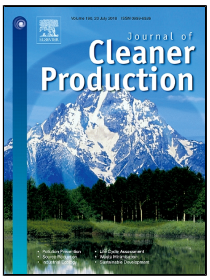


A novel Solar-Biomass Based Multi-Generation Energy System Including Water Desalination and Liquefaction of Natural Gas System: Thermodynamic and Thermoeconomic optimization

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# A novel Solar-Biomass Based Multi-Generation Energy System Including Water Desalination and Liquefaction of Natural Gas System: Thermodynamic and Thermoeconomic optimization

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## Abstract

In this study, an inventive multi-generation energy system utilizing solar and biomass energy as a complementary fuel are proposed and analyzed, by means of a thermodynamic and thermoeconomic investigation and multi-objective optimization. For supplying electricity, heating and cooling power, a Rankine cycle including a turbine, a heater and a double effect absorption chiller, for liquefaction of natural gas, a Linde-Hampson cycle, for desalination of sea water, a multi-effect desalination system, for solar energy exploitation, a parabolic Trough solar collector and for combustion of biomass, a burner is utilized. Results outline that, the studied system has potential to generate 16.11kW electricity, 28.94 kW heating power, 23.41 kW cooling power, 8.8 kg/h fresh water and 0.02 $m^3$/h liquefied natural gas with the energy and exergy efficiencies of 46.8 %, 11.2%, and product cost rate of 15.16 $/h. A comprehensive modeling is accomplished by applying mass, energy, exergy and thermoeconomic balances to all component of the multi-generation energy system. The investigation becomes more comprehensive with a sensitivity analysis in order to survey the dependency of the thermodynamic and thermoeconomic performance upon the decision variables such as stack gasses temperature, temperature difference of evaporator1, evaporator2 temperature and Turbine inlet temperature. Finally, optimized performance of the system is determined using Genetic Algorithm and deriving Pareto front considering the exergy efficiency and product cost rate as objective functions. The optimized multi-generation energy system could yield the exergy efficiency of 9.9% and the product cost rate of 13.32 $/h.

**Keywords:** Multi-Generation Energy System, Exergy, Thermoeconomic, Desalination, Liquefaction of Natural Gas System

## 1. Introduction

Increasing energy consumption, as well as mitigation of greenhouse gasses as a primary reason for global warming, has lead the industry, building, transportation and other sections to utilize more efficient alternative energy systems. In this regard, multi-generation energy systems due to their key role in improving energy efficiency and prevention of greenhouse gas emissions have been in the spotlight over the last years (Narvaez et al., 2014). Multi-generation energy systems providing multiple products such as electric power, heating power, cooling power, distilled water and synthetic