MULTI CRITERION DECISION MAKING BASED ON TECHNO-ECONOMICAL OPTIMIZATION OF STAND-ALONE HYBRID ENERGY SYSTEMS

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DECLARATION

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ABSTRACT

Hybrid Energy System (HES)s areincreasingly becoming popular for standalone electrification due to global concerns on GHG emissions and higher depletion of fossil fuel resources. Simultaneously research work on optimal design of HESs has also made much progess based on progress with numerous optimization techniques while giving special focus to Pareto optimization considering conflicting objectives.

This study comes up with a novel evolutionary algorithm to optimize HESs based on ε-dominance technique. Mathematical modeling of energy flows, cash flows, GHG emissions were carried out in order to support the optimization. Pareto analysis was conducted for two different cases where former analyzes a novel design of a HES and latter analyzes a conversion of existing Internal Combustion Generator (ICG) into a HES in the expansion process. The Levelized Energy Cost (LEC), annual fuel consumption and Initial Capital Cost (ICC) were considered to be objective functions in the first analysis. A sensitivity analysis was followed the mathematical optimization in order to evaluate the impact of power supply reliability on the Pareto front. Furthermore, sensitivity of fuel cost and renewable energy component cost on Pareto front was also investigated considering the present dynamic condition of energy market. LEC, power supply reliability and added renewable energy capacity were taken as objectives to be optimized in the second case. Sensitivity of ICG capacity on the Pareto front was also taken into discussion. Pareto analysis clearly elements such as LEC, power supply reliability and fuel consumption are conflicting to each other. Therefore it is essential to perform multi criterion analysis in order to assist decision making.

In order to assist decision making, Fuzzy-TOPSIS (a multi criterion decision making technique) was combined with Pareto optimization. For that, multi objective optimization was carried out considering Levelized Energy Cost (LEC), unmet load fraction, Wasted Renewable Energy (WRE) and fuel consumption as elements in the objective functions to generate non-dominant set of alternative solutions. Pareto front obtained from the optimization was ranked using Fuzzy-TOPSIS technique and Level Diagrams were used to support this process.

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