Design, construction, and Economic analysis of a Microgrid energy system for Sub-Saharan Africa

In the regions of sub-Saharan Africa (SSA), where electrification rates remain the lowest globally, traditional methods of electrification, such as intermittent grid connections and standby diesel generators, face sustainability challenges in addressing the electricity deficit. A viable solution involves understanding the energy landscape in sub-Saharan Africa and integrating Distributed Energy Resources (DERs) through innovative microgrid systems to tackle electrification issues. The primary aim of this research is to determine the optimal approach to achieve this goal while minimizing environmental impacts and reducing electricity supply costs.

A microgrid system will be designed, and the economic and environmental effects will be analyzed using HOMER software developed by the National Renewable Energy Laboratory in the United States. A three-month load profile collected from a community in sub-Saharan Africa will be used for the analysis. The optimized outcome presented features a microgrid system incorporating a solar photovoltaic system, wind system, Lithium-ion battery for storage, and a diesel generator. Additionally, the report includes comparative results illustrating the analysis over different project life cycles.

The microgrid model developed in this study is adaptable for replication in any community within sub-Saharan Africa, tailored to specific energy requirements, available renewable energy sources, and the topography of the location. The microgrid model holds benefits to developed countries as well in the European, Asian, American Regions as it will reduce load shedding and its negative impacts.

Keywords: Distributed Energy Resources**,** sub-Saharan Africa, microgrid system; economic analysis; HOMER software; rural electrification.