# Cameroon residential energy storage

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The literature extensively discusses the optimal design of Hybrid Renewable Energy Systems (HRESs), which integrate various energy sources such as solar panels, wind turbines, diesel generators, biogas generators, and storage systems. These systems are designed to provide a reliable and sustainable energy supply by leveraging the complementary nature of different energy sources. For instance, solar panels generate electricity during the day, while wind turbines can produce power both day and night, depending on wind conditions. Diesel and biogas generators serve as backup power sources, ensuring a continuous energy supply even when renewable sources are insufficient.

Determining the appropriate size and configuration of these HRESs is a complex task that involves balancing cost, efficiency, and reliability. Effective methods for sizing these systems often utilize advanced software tools like HOMER (Hybrid Optimization of Multiple Energy Resources)6,7. HOMER allows users to simulate and optimize the performance of various HRES configurations under different scenarios, helping to identify the most cost-effective and reliable setup8.

Additionally, metaheuristic algorithms, such as genetic algorithms, particle swarm optimization, and simulated annealing, are frequently employed to solve the optimization problems associated with HRES design9,10. These algorithms can efficiently search through large solution spaces to find near-optimal configurations that might be impractical to identify through traditional methods11. By combining these tools and techniques, researchers and engineers can design HRESs that meet specific energy demands, minimize costs, and enhance sustainability.

Rashid et al.13 sought to develop and assess the feasibility of hybrid energy systems that incorporate biomass energy sources in a remote part of Bangladesh. The study looked at different hybrid system configurations, optimized their sizing and components, and evaluated their techno-economic aspects using a genetic algorithm. The findings show that a solar-based photovoltaic (PV) system with wind, diesel, and biomass backup sources has the lowest levelized cost of energy (LCOE). Furthermore, the study demonstrates that the genetic algorithm (GA) method delivers long-term and cost-effective results when contrasted with HOMER Pro software.

As reported by Ferrari et al.14, HRESs have the potential to reduce supply costs and incorporate renewable energy sources for remote off-grid users. By implementing a new sizing strategy for hybrid PV-wind-diesel systems that considers real-world constraints and machine data, the authors were able to optimize the energy mix configurations. This study contributes to the development of dependable techniques for designing hybrid systems, including renewables, energy-storage batteries, and fossil fuel generators. Olatomiwa et al.15 found that the PV/diesel/battery combination was the most economically feasible choice, exhibiting the smallest fuel consumption and CO2 emissions.

Based on insights gained from an extensive review of the current literature, this study reveals a key gap in solving the energy challenges faced by residential areas in Buea, Cameroon. Despite the abundance of renewable energy resources, the region continues to grapple with an unreliable and unstable electricity grid, leading to frequent power outages and hindered socio-economic development. Existing studies have highlighted the potential of Hybrid Renewable Energy Systems (HRES) to mitigate these issues by harnessing solar energy alongside other renewable sources.

Therefore, the research problem addressed in this study revolves around the formulation of an optimal HRES configuration that balances cost-effectiveness, reliability, and environmental sustainability. By integrating insights from the literature review with empirical data and advanced optimization techniques, this research aims to contribute a tailored solution to the energy challenges faced by residential communities in Buea. The study seeks to bridge the gap between theoretical knowledge and practical implementation, thereby offering valuable insights for policymakers, energy planners, and stakeholders involved in sustainable development initiatives in the region.

This study sought to figure out the optimal dimension of an autonomous PV/Battery/Diesel hybrid system for residential use in Buea, Cameroon, with the goal of enhancing the community"s access to dependable and quality energy. This study utilized the cost of energy as a decision criterion and the loss of power supply probability as a system dependability criterion.

This work makes the following contributions to the literature:

A PV/Battery/Diesel hybrid system was suggested for residential use in Buea, southwest Cameroon. An energy management approach has been proposed to boost the proportion of renewable energy in order to meet demand and restrict greenhouse gas emissions.

The suggested HRES"s size was optimized using the COA meta heuristic in accordance with LPSP and energy cost criteria. Following that, the results were examined in relation to those given by the WOA, SCA, and GOA algorithms.