Analyse the Study of a Hybrid Power System in the Case of Refrigeration

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Abstract
This study presents the results of an experimental examination into the feasibility of using a solar-wind hybrid power system (HPS) to generate electricity in the Sahara region of Algeria. Most of the power produced has been put toward refrigeration and cooling. A gasoline generator is built into the system as well for added safety. Unlike the military outpost on the Algerian border, this system is not dependent on traditional energy sources or rooted in a specific geographical location. Two "positive" rooms (with an interior temperature of +2 degrees and an external temperature of 35 degrees) and one "negative" room (with an internal temperature of -20 degrees and an outdoor temperature of 35 degrees) made up the cooling load, which required 45 kWh of energy each day to run. Data on sun radiation, temperature, and wind speed for 2010 were gathered at the Adrar weather station (a particularly breezy region of Algeria). HOMER was used to model the HPS (hybrid power system). The major environmental indicator is the percentage of renewable energy generation in relation to total energy consumption. For financial analysis, we compute the net present cost (NPC) and the cost of energy (COE). It has been determined that the best HPS results for Adrar climates result in a 50% reduction in emissions with a 47% renewable energy share.
Keywords : environment, economy, the Algerian Sahara region, hybrid power systems, refrigeration, and HOMER.

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1.INTRODUCTION

The fact is that in most of Africa's developing countries and the sub-Sahara region more generally, the region's rising energy demand profile is quickly outstripping the available supply. However, the importance of energy as the primary force behind every country's economy cannot be overstated.[1] Since there is a lack of power, many businesses, factories, and homes have begun producing their own electricity. As a result of the power outage, many homes and businesses have turned to diesel

generators to keep running. Unless other steps are taken, the growing gap between electricity generation and demand will not be reduced anytime soon. To this end, it is expected that commercial establishments like the University of Lagos will make efficient use of the energy they draw from the grid. To keep its position as Nigeria's preeminent research university, the university is exploring alternative energy sources. [2]
An existing building's energy profile entails an investigation of the building's present or anticipated energy efficiency. The software evaluates a building's energy consumption and makes recommendations for how the building's proprietors, managers, and tenants might reduce the building's carbon footprint. A quick solution for some buildings' energy needs is to look for supplementary or alternative sources of power. [3] The governments of most developed nations are making large investments in the promotion of sustainable electricity generation through the adoption of the most conservative measures possible. Standardizing energy-using appliances helps minimise energy demand by discouraging the widespread adoption of inefficient models. Solar photovoltaic energy technologies and wind turbine systems are encouraged for use in other regions. Especially in the tropics, where solar irradiation is plentiful, solar energy offers a compelling alternative for all cultures to satisfy their future needs for clean and abundant sources of energy.[4] In addition, solar PV systems can run on zero or almost zero operating expenses, zero fuel expenditures, and zero maintenance. constructed a solar photovoltaic power system for a Haitian school and hospital in Petit-Anse. The design and feasibility research of photovoltaic systems in Kenya were conducted so that fluorescent and incandescent bulbs, as well as a cool box for medical refrigeration, could be run off of the sun's energy at the health centre. A cost-effective, autonomous energy system with good reliability was presented, together with a backup energy system for a grid-connected institution based on preexisting but inoperable solar panels, for a planned new school. [5] A standardised process for the design of large-scale institutional grid-connected solar PV systems utilising building rooftops and parking garage roofs was also developed. Kwame Nkrumah University of Science and Technology (KNUST), Ghana, used the proposed standard approach to successfully construct a 1 MW grid-connected solar PV system. In addition, they used RETScreen Clean Energy Project Analysis software developed by Natural Resources Canada to model the operation of the 1 MW grid-connected solar PV system over the system's guaranteed lifetime. However, the design of a trustworthy renewable energy project is generally preceded by an exhaustive energy audit of the facilities inside the system. [6] Many countries in the tropics have done energy audits of educational buildings, yielding a number of suggestions. Kuwait, a hot climate state, has had its educational buildings audited as well.

The HVAC system uses 87% of the building's total energy, but a similar energy audit technique was used to collect data on the system's baseline consumption and compare it to the building's potential for energy savings. It has been determined that the non-retrofitting recommendations, which primarily involve alterations to the timing of lighting and equipment usage, can save 6.5% of energy. [7] It has been noted that by switching to a different kind of lighting, they were able to reduce their energy use by 2.3%. Ultimately, if all of the suggestions are executed, including the energy conservation opportunities that entail higher expenses, 52% of energy can be saved.

A.Zhang et al. (2020). It demonstrates the need for ROM to plan the storage and flow of water throughout the year to maximise power production, flood prevention, and water supply. The UC also plays a crucial role in decision-makers' quest for efficient reservoir system operation. Water inflows into reservoirs, energy consumption, run-of-river and wind generation, and equipment failures are all factors that can affect the UC of hydropower. While stochastic simulations can help account for this uncertainty, it's more realistic to adjust strategies on a regular basis based on what we learn in the course of action. More effective and efficient solutions for a reservoir multifunctional system can be attained with accurate predictions of reservoir inflows and good optimization techniques. Improvements can also be made to the efficiency and effectiveness of hydropower generation.[8]

Feng and colleagues (2019).For different purposes, reservoirs may serve as water storage, flood control, or even a place to store wildlife. Reliable and sustainable methods to improve the cost-effectiveness of hydropower output for multi-purpose reservoir constructions have been found through a number of studies to be achieved through the integration of effective river inflow forecasting systems with efficient management strategies. Activity in large-scale hydropower and reservoir systems is a classic example of a high-dimensional, nonlinear, multi-stage optimization issue, making its solution particularly challenging or perhaps impossible using conventional methods. Thus, to enhance the computing performance of standard approaches, Feng et al. proposed some potent dimensionality reduction techniques.[9]

Technologies for the Provision of Renewable Energy

Renewable sources of energy production are on the rise. A lot of money has been put in over the past few years, and with the improvement of technology, nations can now create renewable energy at a lower cost. [10] The number of nations producing more than 100 MW of renewable energy is expected to rise dramatically in the coming years. Promoting and developing renewable energy supply technologies is important because of the harmful and irreversible externalities associated with traditional energy generation. Taking into account externalities like environmental and social implications, these technologies may be competitive with traditional fuels despite their higher production costs. It's worth noting that economies of scale can be a significant factor in lowering the per-unit production cost. Neither conventional nor renewable energies differ greatly in terms of transmission and distribution expenses or technologies. To move a country forward, energy must be conserved as effectively as possible. The most efficient use of energy resources should be prioritised with the development of technology to generate power from a wide range of fuels with minimal environmental impact. Development in both the industrial and agricultural sectors can be traced back to one thing: energy. In any case, it's crucial to plan ahead for eventualities in which there is a problem with or total lack of power. The globe is in the midst of an energy crisis. While some developed nations benefit from new technologies, poorer nations like Bangladesh largely miss out. Many places still lack access to energy, while others may be connected to the grid but frequently experience blackouts. [11]

Energy generated solely from the sun

Solar energy's economic viability for household, business, and manufacturing use has been extensively studied during the past two decades. Because of the scarcity of primary natural energy sources, industrialised nations like Japan and Germany are exploring renewable options like solar power. In the early 1990s, Japan was one of the first countries to take advantage of solar photovoltaic (PV) technology for producing electricity on a significant scale. Germany soon followed suit. Both nations are now at the forefront of solar power technology production. Due to cheap labour and government subsidies, China has recently created a large solar power capacity, bringing the price of solar energy generation down worldwide.[12]

2.MATERIALS AND METHOD

An HPS will typically have multiple primary renewable power generation components running in parallel, with a secondary non-renewable component acting as a backup system. In this research, the primary emphasis is on a hybrid power system comprised of photovoltaic wind generators and gasoline-powered generators. The system incorporates a battery and a current converter to provide reliable power at all times. In this study, HOMER is used to optimise a system from a technical and financial perspective. to highlight the vast untapped potential of wind energy in the Adrar region (27.59°N, 0.11°W) for supplementing existing solar power generation. Micropower designers will find the HOMER (hybrid optimization model for electric renewable) software to be a helpful tool for simulating and optimising both off-grid and conventional power sources. It has seen widespread application in the renewable energy sector in recent years. It can be utilised to meet both electric and thermal needs and is compatible with a wide range of renewable energy sources, including wind turbines, PV arrays, run-of-river hydropower, biomass power, generators powered by internal combustion engines, microturbines, batteries, and hydrogen storage. The benefit of HOMER is that it can account for all expenditures, from the initial investment to ongoing maintenance and even penalties for pollution. The smallest time step in the simulation is one minute, and it spans an entire year. By performing a sensitivity analysis, it allows the analyst to explore the implications of uncertainty or changes in input variables and conduct "what-if" assessments. The optimization simulation's goal is to assess the financial and technological viability of numerous technological alternatives, taking into account potential shifts in technology costs and the accessibility of energy sources.

3.RESULTS

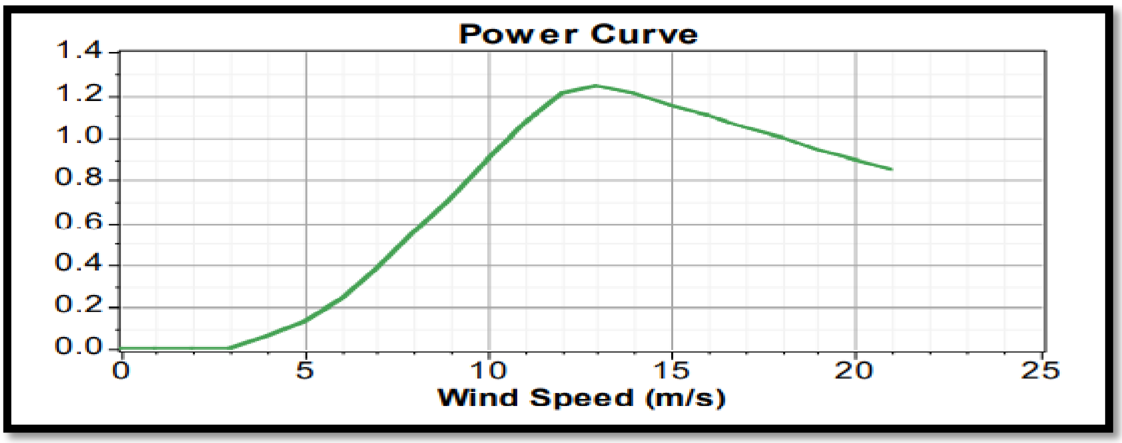

Fig 1. Typical power curve for the BWC XL1 wind turbine

This turbine has a usual price tag of $3,900, with replacement costing the same and O&M expenses coming in at $100 each year.

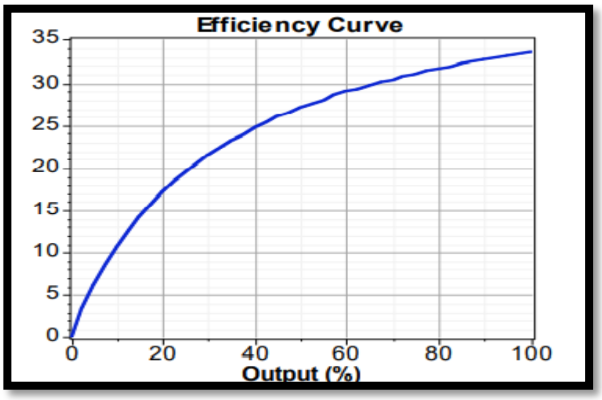

Fig 2. Efficiency curve.

This 2.6 kilowatt gasoline generator has an initial investment cost of $900 and can run for a total of 5000 hours before it needs to be replaced. Once more, we'll assume that the replacement costs are the same as the O&M expenses of $0.04/hour.

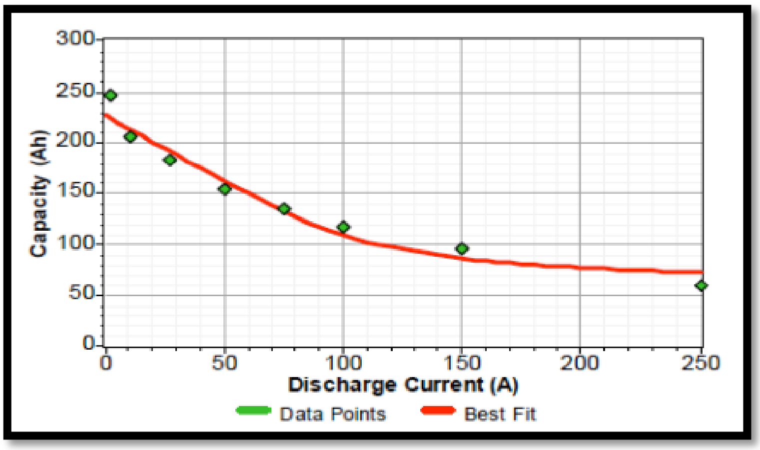

Fig 3. The efficiency of the batteries.

Torjan T-105 batteries (with a nominal voltage of 12 V and a capacity of 125 Ah each).

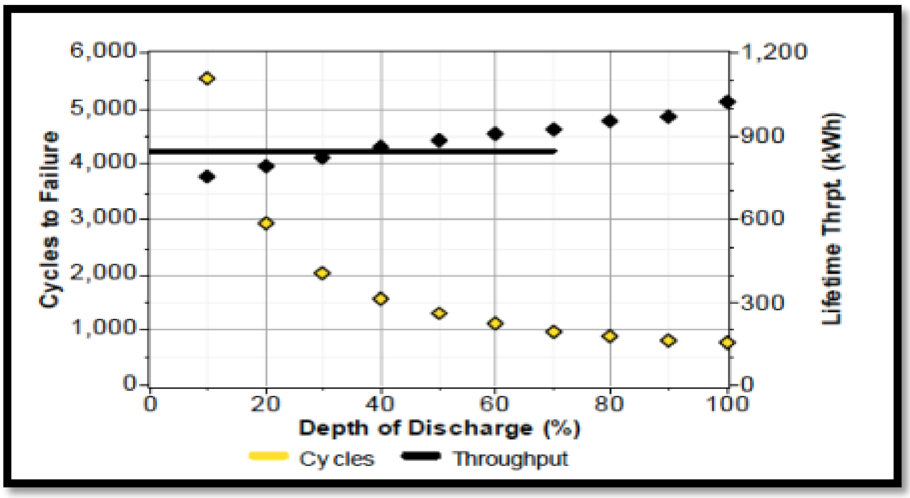

Fig 4. The efficiency of the batteries

The initial investment is $200, with replacement and O&M costs of $45 per year for the controller. It is possible for there to be no such battery or for there to be anything from thirteen (13) to sixteen (16) of them.

4.DISCUSSIONS

The Torjan T-105 batteries are a popular and reliable option (nominal voltage: 12 V for each one with 125 Ah). Their initial investment is $200, and their annual operation and maintenance expenses are $45 plus the cost of a new controller every few years. [13] This type of battery can have anywhere from zero to sixteen cells. This gasoline generator has a 2.6 kilowatt output, a 900-dollar initial investment, and a 5000-hour service life. O&M expenses are estimated to be $0.04/hour, and replacement is also projected to cost the same. We assume that the cost of fuel will remain at 0.2 USD per litre. This price has been permitted to fluctuate upwards up to 0.6 dollars per litre so that we can take into account any economic effects on gasoline prices and examine the effect of these parameters on system choice. [14] The 1.24 kW AC rating of this wind turbine is based on a modified version of the Berge Wind Power BWC XL1 design. Its 25-meter-high hub guarantees reliability over its 20-year lifespan. The normal price of this turbine is $3,900; its replacement is estimated to cost the same amount, and annual operation and maintenance expenditures are estimated to be $100. As many as four turbines can be employed.[15]

5.CONCLUSIONS

An effort was undertaken to investigate the viability of using wind and solar power to generate electricity, thus decreasing reliance on fossil fuels, in order to satisfy the energy needs for refrigeration of a modest house (e.g., a military base) in southern Algeria. Based on a cost-effectiveness analysis, a hybrid wind/solar/gasoline generator system with 43% wind power, 9% solar power, and 47% diesel power was determined to be the most cost-effective power system (Cost of Energy (COE) of 0.533 US$/kWh). Traditional power generation based on fossil fuels is widely thought to be unsustainable in the long run because of the limitations of inexhaustible resources and the environmental difficulties caused by the emissions. Therefore, there are widespread initiatives to increase the share of renewables in the global energy portfolio. Innovative choices for electricity generation and renewable energy resources have the theoretical capacity to supply the world's energy needs several times over. In addition, keeping in mind all the hurdles, the integration of renewable energy resources into the smart grid system will aid in effectively addressing ever-increasing electric energy demands.

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