Study of Technical-Economic Analysis of a Hybrid System with Battery Storage in the Off-Grid Case and on-Grid using Homer Pro®

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ABSTRACT

This work deals with a highly relevant and topical subject regarding the integration of renewable energy sources into the electrical grid. The aim of this investigation is to demonstrate the applicability of a grid-connected photovoltaic-wind hybrid system compared with the same architecture in an isolated site. the methodology of this study was carried out in the bejaia region in northern Algeria(12.59°N and 80.14°E). the first part was the MATLAB/Simulink simulation of the wind- photovoltaic hybrid system with batteries to supply a residential daily load profile, under variable weather conditions. Management and supervision were successfully applied to manage the flow ofenergy between the three constituent sources of the off-grid system. The second part of this work, which is the main contribution, was carried out using Homer Pro software, and the results showed an optimal net present cost (NPC) value of $2091 for the grid-connected hybrid system, compared withthe much more expensive stand-alone system, valued at $12177. These results clearly demonstrate the benefits of connecting renewable energy systems to the grid, in order to optimize investment costs and supply the load on a permanent basis, compensating for the intermittent nature of these green energy sources.

Keywords: Photovoltaic, Wind Turbine, Optimization

1 Introduction

Renewable energy seen as a virtually unlimited and widely accessible resource [1]. However, variations in temperature, wind speed and solar radiation have an impact on power generation [2], [3]. In this article, we focus on the integration of renewable energies into the power grid. The problem posed is that of optimizing the technical and economic management of a photovoltaic-wind hybrid system with batterystorage, for either grid-connected or isolated sites. The contribution is of major importance, since it involves a comparative technical-economic study using two software firstly MATLAB/Simulink to implement the management between the different sources, and then Homer Pro in order to optimize thecost of the installation. This study provides a unique contribution, being the first to compare on-grid andoff-grid hybrid systems in Bejaia, Algeria. HOMER Pro used to optimize the supply of a 5.16 kWh residential daily load profile with a grid connection capacity of 10 kW ,This method estimates net presentcost and initial capital required for connecting photovoltaic or wind-based hybrid systems to the local grid in Bejaia, and it provides valuable insights for energy production organizations in meeting the growingpopulation's electricity consumption demands. The various findings are presented and discussed.

2 Methodology

Our research is experimental and simulation-based, and it is based on contemporary literature research. in this paper, we present a MATLAB simulation of a stand-alone hybrid system, as well as a comparative techno-economic analysis of an off-grid and on-grid PV/wind hybrid system with batteries, using HomerPro software Solar irradiance, ambient temperature and wind speed were measured using the different sensors and a data acquisition device in our laboratory. An economical consideration is investigated. The system in Bejaia site had been examined using the Homer program [4].

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3 Results and Discussion

The results from HOMER have shown that the lowest cost of energy (COE) that can be obtained for a residential area is 0.0806$/kWh, with 75% of the energy being generated from renewable sources, with20091$ for the on-grid architecture shown in Figure 2.

3.1 Comparative evaluation of the feasibility of the proposed architectures

The grid connection capacity is about 10 kW with a percentage of 25% and a renewable energy generation fraction of 72.2%, as shown in Table 1.

Table 1: *Fraction Array/Grid Purchases*

Component	Production (kWh/year)	Fraction (%)
CanadianSolarMaxPowerCSU6U-330P	1672	75
Grid Purchased	559	25
Total	2231	100

The total net present cost for an off-grid system is 12177$ as shown in Figure 1.

CS6U-330P (kW)	G1	PowerSafe SBS XC 92F	Converter (kW)	Efficiency1	Dispatch	NPC ($)
0.798	1	13	0.694	1.00	CC	$12,177
0.798	1	13	0.694	1.00	LF	$12,177
0.798	1	13	0.694	0	LF	$12,177
0.798	1	13	0.694	0	CC	$12,177
0.800	1	13	0.694	0	CC	$12,183
0.800	1	13	0.694	0	LF	$12,183

Figure 1: *Optimization results configuration of autonomous system.*

CS6U-330P (kW)	G1	PowerSafe SBS XC 92F	Grid (kW)	Converter (kW)	Efficiency1	Dispatch	NPC ($)	COE ($)
0.733		4	30.0	0.465	0	CC	$2,091	$0.0806
0.733		4	40.0	0.465	1.00	CC	$2,091	$0.0806
0.733		4	20.0	0.465	0	CC	$2,091	$0.0806
0.733		4	10.0	0.465	0	CC	$2,091	$0.0806
0.733		4	50.0	0.465	1.00	CC	$2,091	$0.0806

Figure 2: *Proposed optimized on-grid system configuration*

4 Conclusion

In this work, we have conducted a study of two hybrid renewable energy systems - one connected to the grid and the other off-grid- while taking into consideration the impact of sensitivity variables The results indicate that the grid connected hybrid system is more efficient than the off-grid system, with a system cost of $0.0806 per kWh compared to the residential electricity cost of $0.1 per kWh in Bejaia.

How to Cite

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