

*Optimal Sizing of a Multi-Source Renewable Energy Energy System
(case of southwest Algeria)*

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Article Info	ABSTRACT
Article history: Received , 02/01/2024 Accepted , 22/04/2024 Accepted , 25/05/2024	Energy production is a challenge of great importance for the coming years. Indeed, the energy needs of the country are increasing. The control of energy consumption is certainly a major concern for many countries. World energy consumption will increase by 50% between 2004 and 2030, to support the population and economic growth. No human activity, however, would be possible without energy. Fossil energy sources are made to disappear and can not be renewed before millions of years. Yet solutions exist, increasing the share of renewable energy in our consumption is one of the tracks to follow. The objective of this article is to provide electricity to the city of Beni-ABBES (Bechar) by a multi-sources renewable energy system. .HOMER software is used as a sizing tool and optimization while minimizing the cost of the system and responding to the demand of the load; the system must reduce CO₂ emissions.
Keywords: Hybrid system Renewable energy Homer software Optimisation Polluting gases	

1. Introduction

Renewable energies appear today and in the long term as the appropriate solution that covers this energy need by reducing the major disadvantage emitted by fossil and fossil energies: the greenhouse gas. Algeria enjoys a very favorable geographical situation for the development and development of the use of renewable energy, because these solar and wind potentials are among the most important in the world.

In this article, we undertook an optimal study and sizing of a multi-source energy system with renewable energy. The latter is intended to supply electricity to the city of BENI-ABBES (Bechar) identified geographically by: Latitude: 30 ° 05 'North ; Longitude: - 2 ° 06' West ;Altitude: Min. 459 m Max. 499 m, aiming at the simulation and evaluation of the system performances by the HOMER software.

2. Main Characteristics of the Homer Software

HOMER (Hybrid Optimisation Model for Electric Renewables) is a software for the simulation and optimization of distributed electrical generation systems developed by National Renewable Energy Laboratory (NREL)[5][6]. The model must be informed of available resources, technological options, costs and constraints to be met by the system. First of all, this software makes it possible to make simulations to then optimize the systems and finally to finish with sensitivity analyzes on these optimized systems. The solution obtained by HOMER is the least

expensive solution among different combinations of renewable energy systems, fossil fuels or hybrid systems comprising two or more energy sources.

3. Presentation of the System

This is a hybrid system composed of three sources of energy: Photovoltaic PV - Wind - and Generator, as shown in Figure 1:

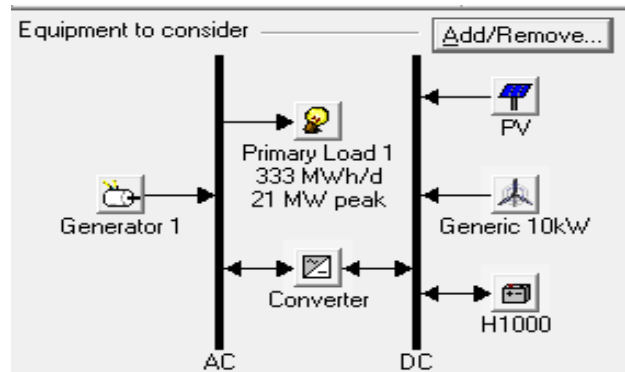


Figure 1. Multi source system studied

3.1 Load Detail

This system will satisfy the load in electricity (primary load1) of the city of BENI-ABBES. Table 1 presents the annual requirements for maximum power achieved by the power station in this city.

Table1. Maximum load (power) in kw reached by the beni-abbes power station (2013)

month	15 jan	5 feb	2march	21april	14 may	20 june
P max	10020	9930	8568	8400	18120	19420
month	12 july	28 aug	7 sept	6 oct	30 nov	7 dec
P max	20900	18210	17450	14930	9850	10350

There is a very important call to power in the summer period. This situation results in considerable consumption; this is due to the air conditioning. Figure 2 shows the solar irradiation profile given by the software.

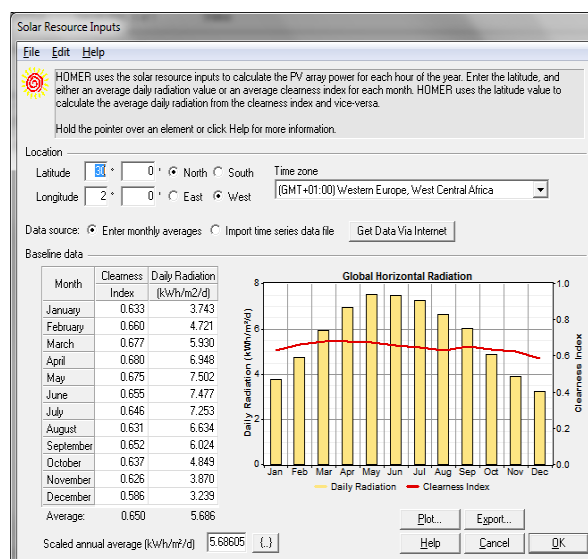


Figure 2.Solar irradiation profile

3.2 Temperature Detail

Figure 3 shows the temperature profile for each month of 2013 for the city of BENIABBES; the temperature data come from the meteorological station of this city. This software uses temperature to calculate electricity production by photovoltaic panels. In fact, the higher the temperature, the lower the efficiency of the photovoltaic panels.

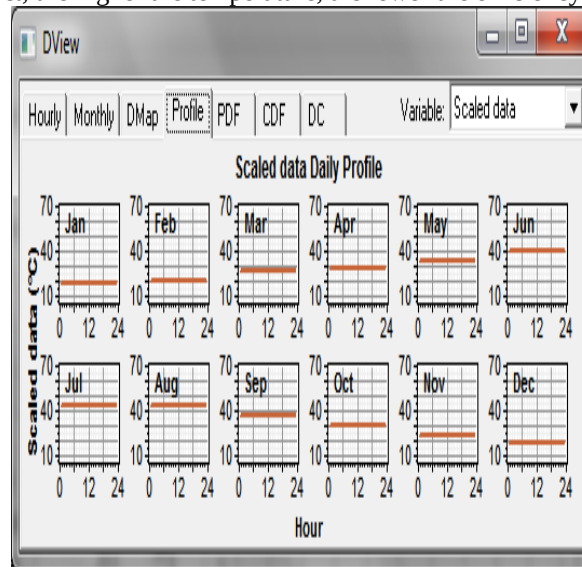


Figure 3. Temperature profile

4. Optimization Results And Discussions

The HOMER software performs system configuration simulations with all combinations of the specified components entered. It eliminates the results of unfeasible systems, which are not in line with the demand for electricity on the one hand and incompatible with the resources and constraints specified on the other hand. Once the calculation is complete without a warning message, the results are ranked according to cost over the lifetime.

Sensitivity Results		Optimization Results								
Double click on a system below for simulation results.										
				PV (kW)	G10	Label (kW)	H1000	Conv. (kW)	Disp. Strgy	Initial Capital
				250...		25...	120	15...	LF	\$ 116,820,560
				250...	1	25...	120	15...	LF	\$ 116,850,560
				250...		25...		15...	CC	\$ 116,720,000
				250...	1	25...		15...	CC	\$ 116,750,000
						25...			CC	\$ 34,650,000
					1	25...		5000	CC	\$ 38,920,000
						25...	24	5000	LF	\$ 38,910,112
					1	25...	24	5000	LF	\$ 38,940,112

Figure 4. Set of solutions

We can see several technical and economic details about each system configuration that HOMER software simulates.

Note in Figure 4 that the best solution to cover the electricity needs of the city considered is the first comprising: photovoltaic panel + G. generator + battery + converter.

4.1 Emissions

Figure 5 shows the amount of pollutants produced annually by the system in kg / year. Note that the pollutants come from the fuel consumption in the generator.

Cost Summary	Cash Flow	Electrical	PV	Label	Battery	Converter	Emissions	Hourly Data
Pollutant								Emissions (kg/yr)
Carbon dioxide								-395,457
Carbon monoxide								251,655
Unburned hydrocarbons								91,511
Particulate matter								0
Sulfur dioxide								0
Nitrogen oxides								428,321

Figure 5. Emissions of polluting gases with renewable system

To quantify the impact of the combustion products in the generator set, we evaluated the amount of gaseous pollutants (CO₂, CO, C_xH_y, PM, SO_x, NO₂) with the generator set alone. Figure 6 represents the value of the polluting gases produced by the latter system.

Cost Summary	Cash Flow	Electrical	Label	Emissions	Hourly Data
				Pollutant	Emissions (kg/yr)
				Carbon dioxide	72,142,992
				Carbon monoxide	178,075
				Unburned hydrocarbons	19,725
				Particulate matter	13,424
				Sulfur dioxide	144,876
				Nitrogen oxides	1,588,975

Figure 6. Emissions of polluting gases with all-fossil system

This initiative allows us to make a comparison between the two systems:

Table 2. Comparison of pollutant emissions (kg / year) between the two systems

pollutants	Hybrid system	fossil system	earnings
CO ₂	395.457	72.142.992	323.314008
C _x H _y	91.511	19.725	71.786
P _M	0	13.424	13.424
SO _x	0	144.876	144.876
NO ₂	428.321	1.588.975	426.732025

For carbon monoxide CO, we have observed that the hybrid system participates in an amount 1.5 times that all fossil system. This situation is explained by the intermittent operation of the photovoltaic panel component + generator system.

5. Conclusion

The work presented in this article concerns, in a general way, the study, the modeling and the simulation of a electricity generation system, from mixed renewable resources (photovoltaic and wind), with a battery storage system and a generator. This system has for role to ensure the needs in electricity of the city of BENI-ABBES.

The simulations carried out by the HOMER software allow us to draw the following conclusions:

-The optimal sizing performed by the software consists of the following equipment: a photovoltaic panel, a generator, a converter, a storage battery.

This means that it is not possible to supply the city of BENI-ABBES with a completely renewable system.

-As regards gas emissions, According to the results we can see a very significant gain on these emissions.

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