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Hybrid Power System Optimization of the Emission Antenna of Beni Chograne FM-Radio (Cherb-Errih, Mascara, Algeria)

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***Abstract*— Electricity originating from solar is nowadays one of the main contributors of electrical power to energy systems in the future, but solar technology needs support to find its way to the market. Since photovoltaic electricity always involves very high costs compared to electricity from other sources, a striking question is: how can photovoltaic achieve competitiveness? There are different strategies for promoting applied photovoltaic electricity generation around the world. In this work, we simulated and designed a 40Kwp injected photovoltaic power plant, evaluating the energy of the incident photon flux, the energy produced by the photovoltaic panels and the energy injected into the electricity grid. And this is to judge whether the installation.**

***Keywords*— Photovoltaic system, grid injection, solar inverter, photon energy, injected energy.**

I. INTRODUCTION

Energy sources like wind, solar or hydro became more and more popular mainly because they don't produce emissions and are inexhaustible. PV energy is the fastest growing renewable source with a history dating since it has been first used as power supply for space satellites. Currently, electricity is almost entirely supplied to cold rooms by conventional hydroelectric or thermal power plants [1]. Greenhouse gas emissions and other environmental pollution issues, for ex., are of increasing concern [2]. Renewable energy technologies, such as photovoltaic cells, are recommended for electricity production [1]. The photovoltaic (PV) systems performances depend on geographical locations and types of PV modules used [4]. PV systems are useful in areas highly exposed to incident solar radiation [5]. Designing an optimal hybrid (Wind/PV), a standalone system has been analysed, based on environmental and economic aspects. When such design is accepted our findings are so as CO_2 emission can be mostly reduced, compared to other existing Diesel-only systems [6-8]. Different configurations types have been analysed, showing that based on the energy cost, a hybrid PV-Diesel-Battery system is more cost-efficient than Diesel only and PV-Diesel without storage [9-11]. It has also shown that a rural village is economically best suited for a PV-Diesel power generation system when energy storage systems are absent [12-14]. To identify an optimum model of PV-Diesel-Battery system in various climatic areas, we developed other models (not studied here) using Homer software.

Fig. 1 Geographical parameters of Chareb-Errih (radio relay) solar resource.

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II. SIMULATION MODEL

HOMER model is used here to size the proposed system and determine the optimum configuration [15]. HOMER, due to its flexibility, is useful in evaluating design issues in the planning and early decision-making phase of rural electrification projects. It evaluates a range of equipment options over varying constraints and sensitivities to optimize small power systems [16-19]. HOMER's optimization and sensitivity analysis algorithms make it easier to evaluate many possible system configurations. To use this software, the model is provided with inputs, which describe technology options, component costs, and resource availability [20-22]. These inputs are used by HOMER to simulate system configurations (or combinations of components) and generate results that can be seen as a list of feasible configurations sorted by net present cost. It also displays simulation results, compares configurations and evaluates them on economic and technical basis. When we need to explore changes' effects in resource availability and economic conditions might have on the cost-effectiveness of different system configurations, it is possible to use the model to perform sensitivity analyses [23-25]. Sensitivity analysis results can be used to identify the factors that have the greatest impact on the design and operation of a power system. HOMER Pro is used to design and find optimized configurations of a hybrid power system in terms of stability, low cost, size and number of components, prior to installation. Fig. 2 shows a schematic of the System architecture.

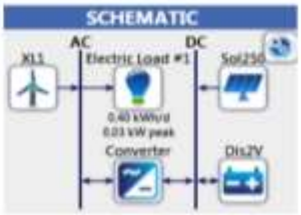

Fig. 2 Schematic of the System Architecture (parameters are listed below.

TABLE I.
SYSTEM ARCHITECTURE PARAMETERS

01	Solar World 250 SW 250 Mono (0.145 KW)
02	Discover 2VRE – 1600TG (2.00 strings)
03	System Converter (0.0371 kW)
04	Homer Combined Dispatch

III. RESULTS AND DISCUSSIONS

Concerning the average variation solar irradiation confirms an excellent compatibility with the changing seasons of the region the maximum irradiation during summer and the minimum during winter as shown in the figure below:

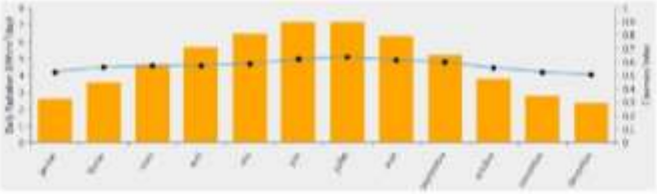

Fig. 3 Monthly average solar global horizontal irradiance (ghi) data. the annual average (kWh/m^2/day) is 4. 80.

According to the simulation of the studied system, which is shown in Table II, where the results show different configurations of combinations between the main PV, wind and storage components. The sensitivity cases are:

TABLE II.
SIMULATION OF THE STUDIED SYSTEM

Sol250 (kW)	XL1	Dis2V	Converter (kW)	Dispatch
0.145		2	0.0371	CD

To optimize our results, the architecture of our system is as shown in Tables III, IV and V, below.

TABLE III.
ARCHITECTURE OF THE OPTIMIZED SYSTEM

Sol250 (kW)	XL1	Dis2V	Converter (kW)	Dispatch
0,145		2	0,0371	CD

Sol250 (kW)	XL1	Dis2V	Converter (kW)	Dispatch
0,145		2	0,0371	CD
	1	1	0,0948	CD
0,117	1	1	0,104	CD

TABLE IV. RESULTS OF THE OPTIMIZED SYSTEM

Component	Discover 2VRE-1600TG	Homer Combined Dispatch	Solar world 250 SW 250 Mono	System Converter	System
Capital (DA)	60000.00	160000.00	55084.32	556.12	275640.43
Replacement (DA	89156.84	0.00	0.00	784.46	89905.30
OM (DA)	6534.18	1966025.43	473.59	0.00	203033.21
Salvage(DA)	73827.27	0.00	0.00	-304.12	-74131.39
Total (DA)	81863.76	356025.43	55557.91	1000.45	494447.55

TABLE V. OTHER RESULTS

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Discover 2VRE-1600TG	Capital (DA)	Replacement (DA)	OM (DA)	Salvage (DA)	Total (DA)
Discover 2VRE-1600TG	60000.00	89156.84	6534.18	-73827.27	81863.76
Homer Combined Dispatch	160000.00	0.00	196025.43	0.00	356025.43
Solar world 250 SW 250 Mono	55084.32	0.00	473.59	0.00	55557.91
System Converter	556.12	784.46	0.00	-304.12	1000.45
System	275640.43	89941.30	203033.21	-74131.39	494447.55

Here, we have chosen the optimal choice for our study is the use of solar panels with batteries. The system architecture (SolarWord250SW 250 Mono (0.145kW)) is so that 0.0371 kW was converted, using Homer Combined Dispatch (Discover 2VRE-1600TG (2.00 strings). Total costs (such as NPC) are as follows :

- Total NPC :494447,60DA,
- Levelized COE : 102.83DA,
- Operating Cost : 6697.31DA.

The total net present cost (NPC) of a system is the present value of all the costs the system incurs over its lifetime, minus the present value of all the revenue it earns over its lifetime. Costs include capital costs, replacement costs, O&M costs, fuel costs, emissions penalties, and the costs of buying power from the grid. Revenues include salvage value and grid sales revenue. HOMER calculates the total NPC by summing the total discounted cash flows in each year of the project lifetime. The total NPC is HOMER's main economic output, the value by which it ranks all system configurations in the optimization results, and the basis from which it calculates the total annualized cost and the levelized cost of energy. To calculate the COE, HOMER divides the annualized cost of producing electricity (the total annualized cost minus the cost of serving the thermal load) by the total electric load served, using the following equation (1):

$$COE = \frac{C_{ann.tot} - C_{boiler} H_{served}}{E_{served}} \qquad (1)$$

Where, $C_{ann,\ tot}$, C_{boiler}, H_{served} and E_{seved} are the total annualized and boiler marginal costs, and total thermal and electrical load served, respectively. The second term in the numerator is the portion of the annualized cost that results from serving the thermal load. In systems, such as wind or PV, that do not serve a thermal load ($H_{thermal}$=0), this term is zero. COE is a convenient metric with which to compare systems, but HOMER does not rank systems based on COE. Operating costs are annualized values of all costs and revenues other than initial capital costs.

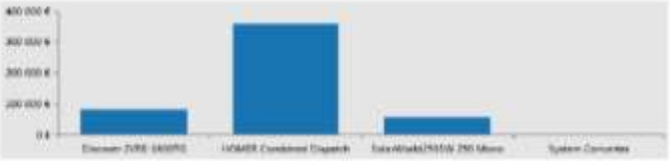

Fig. 4 Total NPC for hybrid PV/storage system.

The current net cost for 25 years is 494447.60 DA (Fig. 4) and a COE is 102.83 DA, the battery takes first place, with a cost of 60 00000,00 DA, the second place the control cost (Combined Dispatch CD) 160 000.00 DA; the PV system with a cost of 55 084.32 DA. The last place converter with a cost of 556.12 DA. Economically, Fig. 5 gives the results

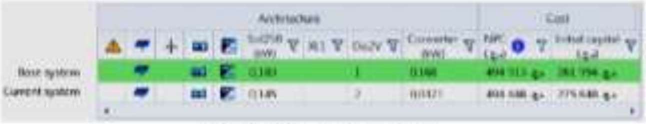

Fig. 5 Economic results.

Different parameters originating from the simulation are obtained: the present and annual worths are 465 € and 14€ respectively, the return on investment is –1.4%, internal rate of return (%) is *n/a*, simple and discounted payback (a year) are respectively 13.50 and 13.39. Results of electrical production and consumption are listed in Table VI, below :

TABLES VI. OUTPUT PARAMETERS

Production	**kWh/y**	**%**
Solar World 250 SW 250 Mono	221	100
Total	**221**	**100**

Consumption	**kWh/y**	**%**
AC Primary Load	147	100
DC Primary Load	0	0
Total	**147**	**100**

Quantity	**kWh/y**	**%**
Excess Electricity	45.4	20.5
Unmet Electric Load	0.0342	0.0232
Capacity Shortage	0.0589	0.0400

Quantity	**Value**
Renewable Fraction	100
Max. Renew. Renetration	1089

The mean monthly electricity production of our PV system is shown in Fig. 5 and Tables VII, below.

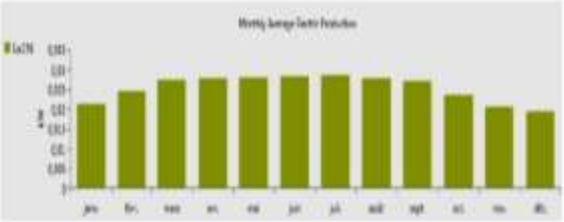

Fig. 5 Average monthly electricity production of the PV system.

TABLES VII. OTHER OUTPUT PARAMETERS

Capacity-based metrics	**Value**	**Units**
Nominal Renewable capacity divided total nominal capacity	100	%
Usable Renewable capacity divided total capacity	100	%

Energy-based metrics	**Value**	**Units**
Total Renewable production divided by load	150	%
Total Renewable production divided by generation	100	%
One minus total nonrenewable production divided by load	100	%

Peak values	**Value**	**Units**
Renewable output divided by load (Homer standard)	150	%
Renewable output divided by total generation	100	%
One minus nonrenewable output divided by total load	100	%

IV. CONCLUSIONS

In this paper a solution to the lack of electricity and energy conversion technologies is proposed. HOMER was found to be a very helpful tool for the microgrid planning and dispatching, so that distributed sources of energy. Analysis reveal that although a fully renewable-based microgrid, which has no carbon footprint, is the most preferred, the net present cost (NPC) is higher. It is worth to mention that when the microgrid is connected to the external grid, it is the most economically favorable option. Also, the most environmentally friendly microgrid is the renewable energy microgrid, and there is still much work to be done in terms of renewable energy and mixed system development, because of their high initial capital and replacement costs. Allowing a small amount of annual load to be left unmet makes the microgrid more cost-effective. Also, the break-even distance presented in this work shows that for isolated microgrids, far away from the external grid connectivity point, the mixed microgrid, is the most economic optimal choice. In this paper we analysed a hybrid system that can be used as a guideline on designing and implementing grid-connected PV-based power systems in Algeria. Similar approaches could be applied to other regions in this country, so that optimum results might be different from the current ones depending on the local data.

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