Study of a hybrid power system (Wind-PV-Diesel) for powering a unit load

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Abstract: *The environmental problems , such as the limits of resources, global warming , air pollution due to the emission of greenhouse gas emissions in the case of hydrocarbons , as well as the production of waste material difficult to treat in for nuclear energy, have raised awareness that ecological and economic development friendly environment in which we live, is required to produce clean energy and it must be very interesting in the future. It is in this context that this article is based on the study of a Hybrid Power System (HPS) combining several renewable energy sources; Wind Turbine Generator (WTG), photovoltaic Generator(PVG), is of great interest for developing countries such as Algeria . This country has many areas, isolated and remote networks such as electricity distribution Adrar city, knowing that the province is considered very windy area and good sunlight. All this leads us to think of hybrid systems in this website, which aims to balance the exploitation of these sources and the permanent transfer of energy between production and consumption (continuity of service).*

To the simulation of hybrid systems combining different energy whether renewable or fossil sources, we used the HOMER (Hybrid Optimization Model for Electric Renewable) software.

Key words: *Hybrid network, Wind, Solar, Diesel Group, Storage Battery, Homer, Charging curves.*

1. Introduction

Electricity is now the most easy to use form of energy. But before consuming it took to produce, usually in units of large electricity power production, transport, and distribute it to each consumer. This represents a significant financial burden for local electrification in remote locations of the country. Install electrical lines hundreds of kilometres cannot solve this problem. This is made by the presence of constraints due to weather including wind sand; temperature gradients between the different seasons and that between night and day for the winter season [1], the costs of connecting to the network are also inflated. To this end, we thought to circumvent the problem by another solution namely the hybrid system (HPS).

Current systems only, wind or solar, require a lot of storage to compensate for the intermittent nature of deposits. Autonomous hybrid systems with photovoltaic solar panels and wind turbines are a potential solution limiting intermittent resources. The analysis of various combinations of systems is carried out in conditions and network connected to the network.

After this introductory Section1, this article is organized as follows: a Section 2: present problem of the production of electricity in Algeria by the group diesel, Section 3: presents location of hybrid power system and the good sites for implementing this system, Section 4: presents operating strategy system, Section 5 presents Estimated resources of wind energy and solar , Section 6 presents the simulation and results. Conclusions have been made in section 7.

2. Broblematique

Energy and economic operation of diesel generators supplying autonomous networks conditions are not optimal and should be improved.

A. Energy

The continued use of diesel consumption causes a considerable pollution caused by fossil fuel, knowing that when because of the lubricating oil viscosity insufficient due to the lack of thermal energy released by engine combustion [2].

B. *Economic*

Diesel generators are relatively expensive and require a preventive and corrective maintenance. The average cost of kWh produced is high enough with important economic losses [3].

3. Selection of a site HPS

For this study, a geographic location is considered in the city of Adrar, located southwest of Algeria with the following coordinates: 0.28 Longitude, Latitude 27.82 and covering a total area of 427,968 km ².The choice of this site was based on the availability of meteorological data (wind speed, sun, temperature, mass area, terrain, ...) of Table I and II. [4] .

Table I Mensuellese a average wind speed ADRAR

MONTH	WIND Vm (m/s)
January	6.2
February	6.4
March	6.5
April	6.5
May	6.9
June	6.1
July	6.7
August	6.2
September	6
October	5.8
November	5.9
December	5.8
Vmoy/ year	**6.25**

Table.II. Solar radiation of ADRAR

MONTH	IRRADIATION (kWh/m²/j)
January	2.086
February	2.771
March	3.864
April	5.183
May	5.746
June	5.751
July	5.941
August	5.093
September	4.510
October	3.290
November	2.486
December	2.013
Irradiation moy/year	**4.067**

The majority of sites in the city of Adrar could be considered remote sites to the vast size and remoteness from the city and with each other "Fig. 1".

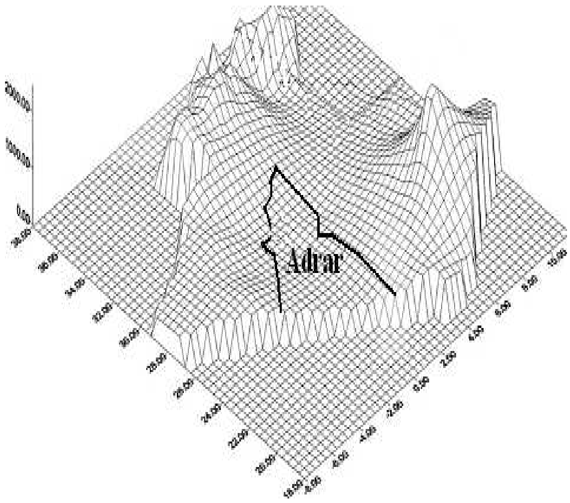

Fig.1. Geography map of Adrar city**.** [6]

4. Operating strategy

This system consists of a wind turbine , Generator Diesel (GD), Photovoltaic Generator (PV) and a Battery based Energy Storage System (BESS) .

Figure 2 shows the block diagram of the hybrid system powered electric charge type AC. The studied system consists of a wind generator Generic type of 20 kW, a PV power generator 18kW a power generator 30kW electric charge on the equipment, whose value is 428 kW with a peak of 21 kW, is powered by batteries vision battery type, rated voltage of 12V and a nominal capacity of 200Ah through a converter nominal power of 25 kW. These batteries are charged by the current charge for each system, the control of their load is secured by a charge controller. The connection of these elements is carried out at a DC voltage bus (DC). This bus has the advantage of more easily interconnect the different components of the hybrid system.

From the DC bus, the network connection is achieved thanks to a power converter DC / AC, which then transferred the energy to the load requirements.

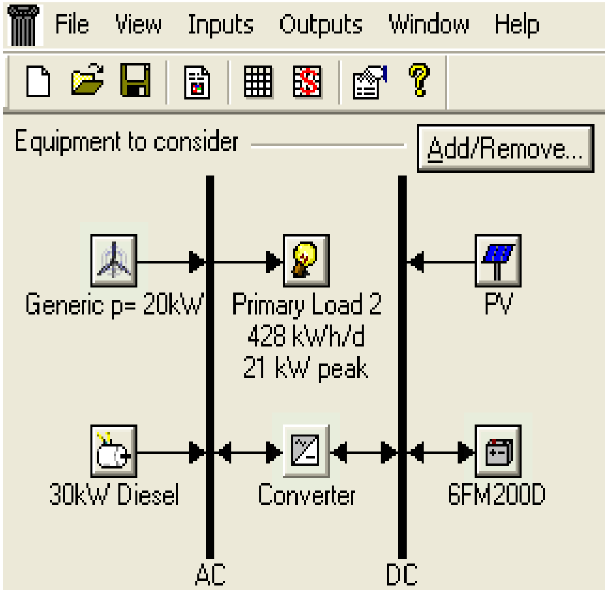

Fig.2. Block diagram of the HPS system.

5. Estimated resources of wind energy and solar

The essential step in the design of a coupled system is the determination of the optimal size, which essentially depends on climatic data site. Generally, the average monthly climate data and / or an estimate of the number of consecutive days of low climate resource (wind, solar irradiation) used to determine the surface of the wind turbine, the size of photovoltaic panels and battery capacity. However, the dynamic behaviour of coupled against the stochastic nature of solar irradiation system affects a remarkable way on the size of the system needed for a specific application [7-8]. The analysis of local resources (wind speed and illuminance) requires a measurement campaign and a preliminary analysis of site conditions. To create a baseline for our study we chose to adopt relevant technical data measurements for one year.

Figures 3 and 4 shows the profiles of wind and lighting with an average value of the wind speed of 6.25 m / s respectively and an average value of 4.067 $kWh/m^2/j$ for illumination. The load profile is to supply power shown in Figure 7. This is a load with an average value of 428 kWh / d and a peak instantaneous power of 21 kW.

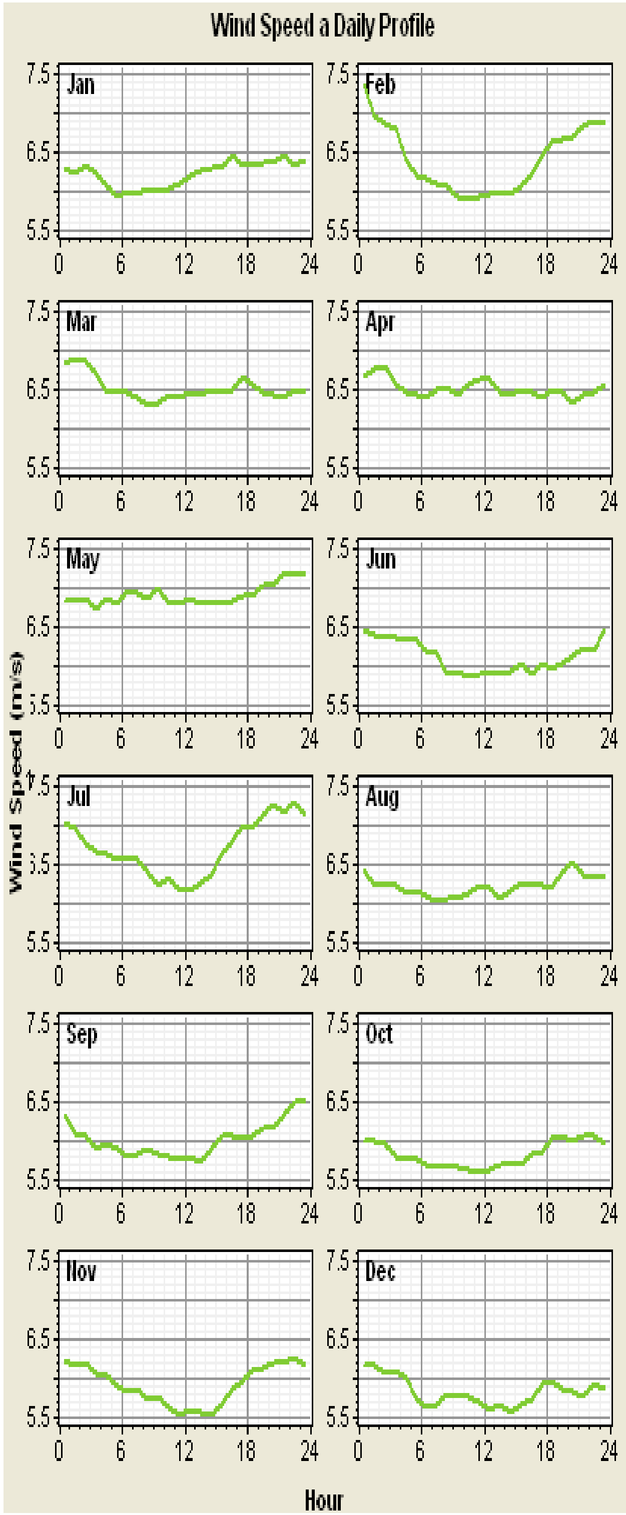

Fig.3. Hourly representations of the average speed for each month.

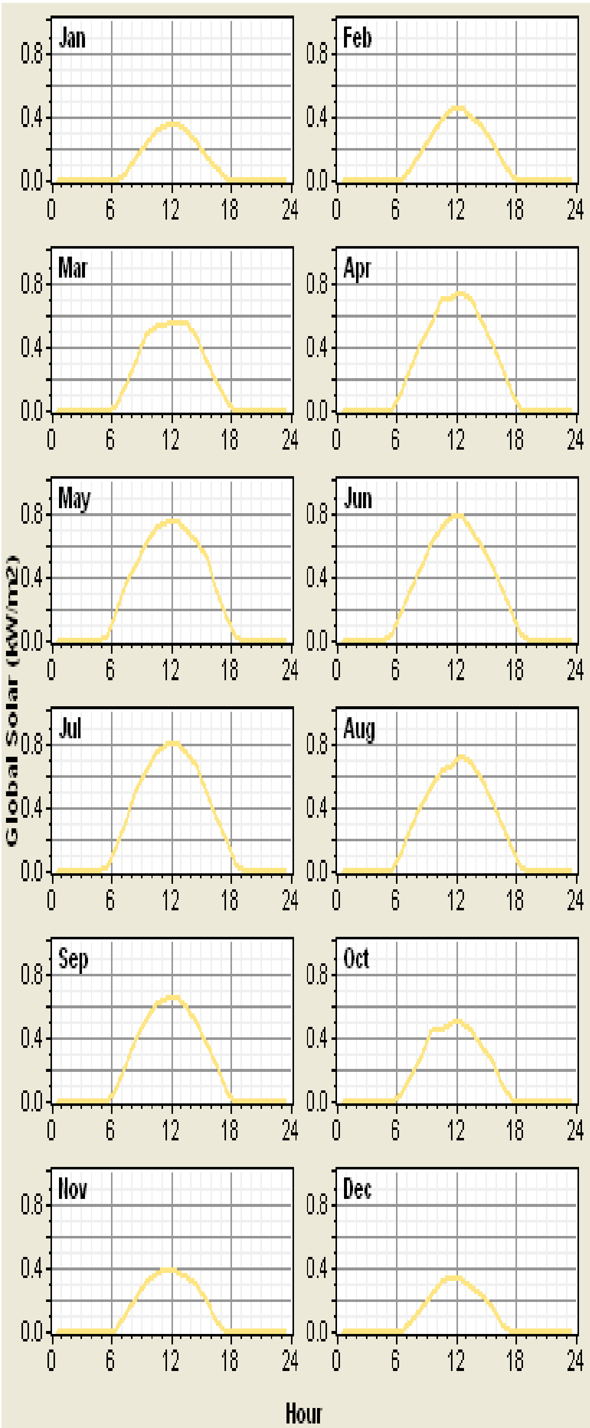

Fig.4. Trend of solar radiation.

A. *Characteristic of the chosen load*

In our study we chose a load [3] type AC runs continuously throughout the year. The daily load profile and the annual change in that during all the year are given respectively in Figures 5 and 6.

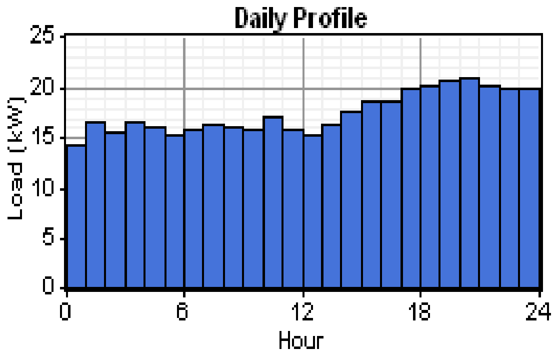

Fig.5. The daily load profile.

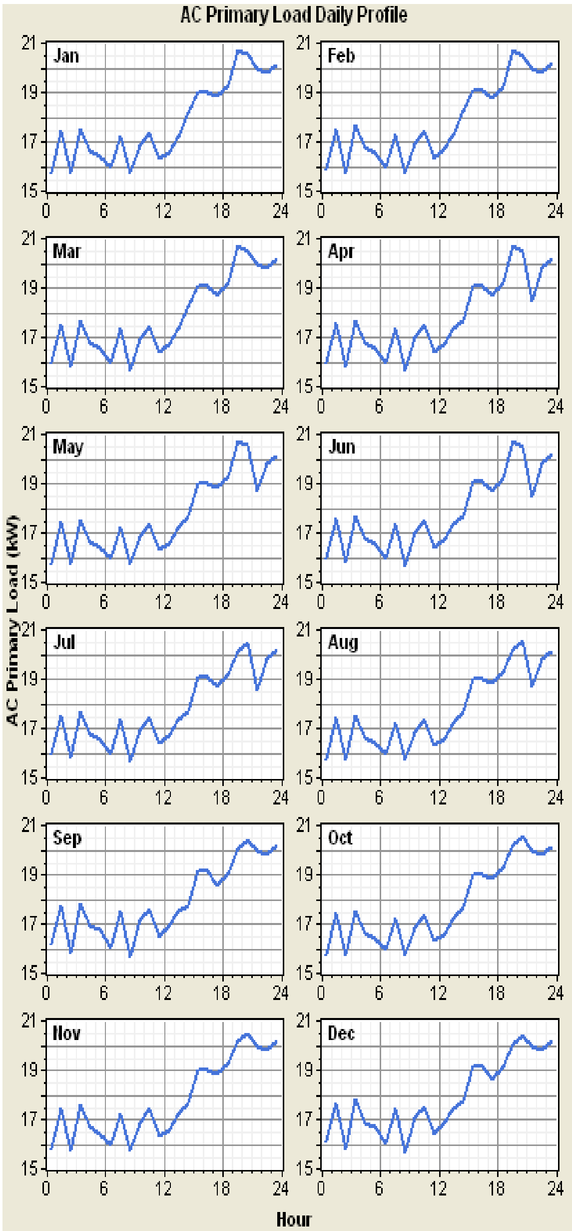

Fig.6. The annual change of the load.

6. Results and discusstions

Simulation results are provided in the form of a list of configurations sorted by net present cost (called the cost of the life cycle). This cost is used to compare the different options for system design.

We give in Figures below the simulation results for wind, photovoltaic and hybrid system as the auxiliary generator.

We note that for the selected website Adrar characterized by an average annual rate of 6.25m / s and solar resource de4.067kW / m² (latitude 27.82 N) with a load of 428 kWh / day with a peak of 21kW.After having entered all the information about the resources (sunlight, wind) for each hour of the year.

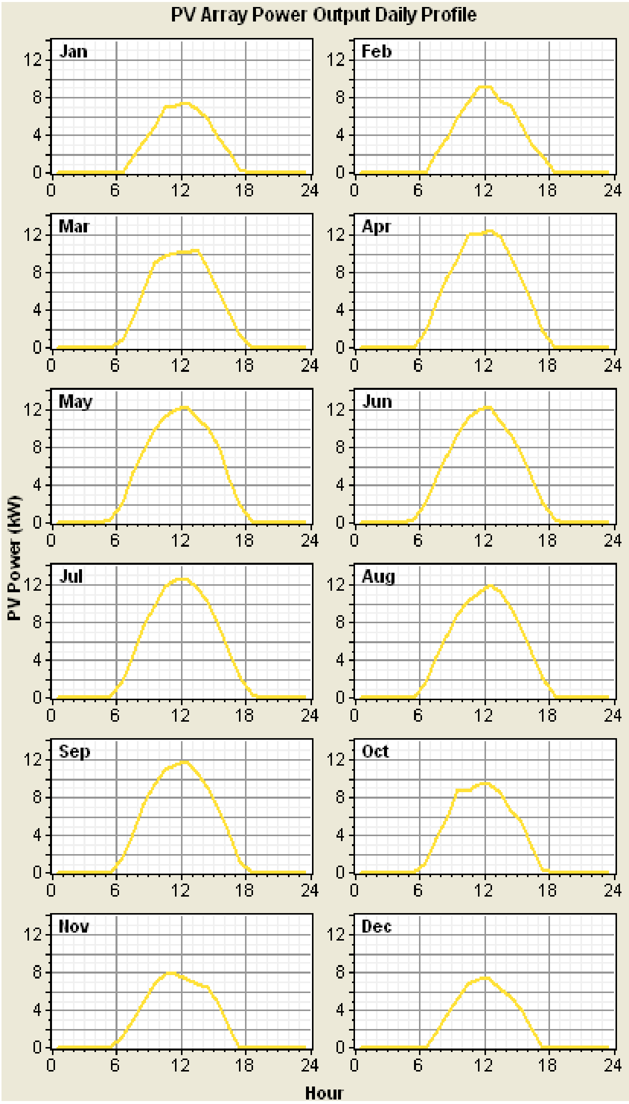

Fig.7. Daily average power delivered by the GPV.

After analyzing the results for the daily averages of PV power" Fig.7", we see that the period of operation of PV is closer during the winter months is approximately between 7 and 17h or 10 hours per day (November, December and January) and vice versa for the summer period. Production by PV is zero, or very low, the peak periods of electricity consumption (between 20 h and 22 h), which requires either the use of other generators.

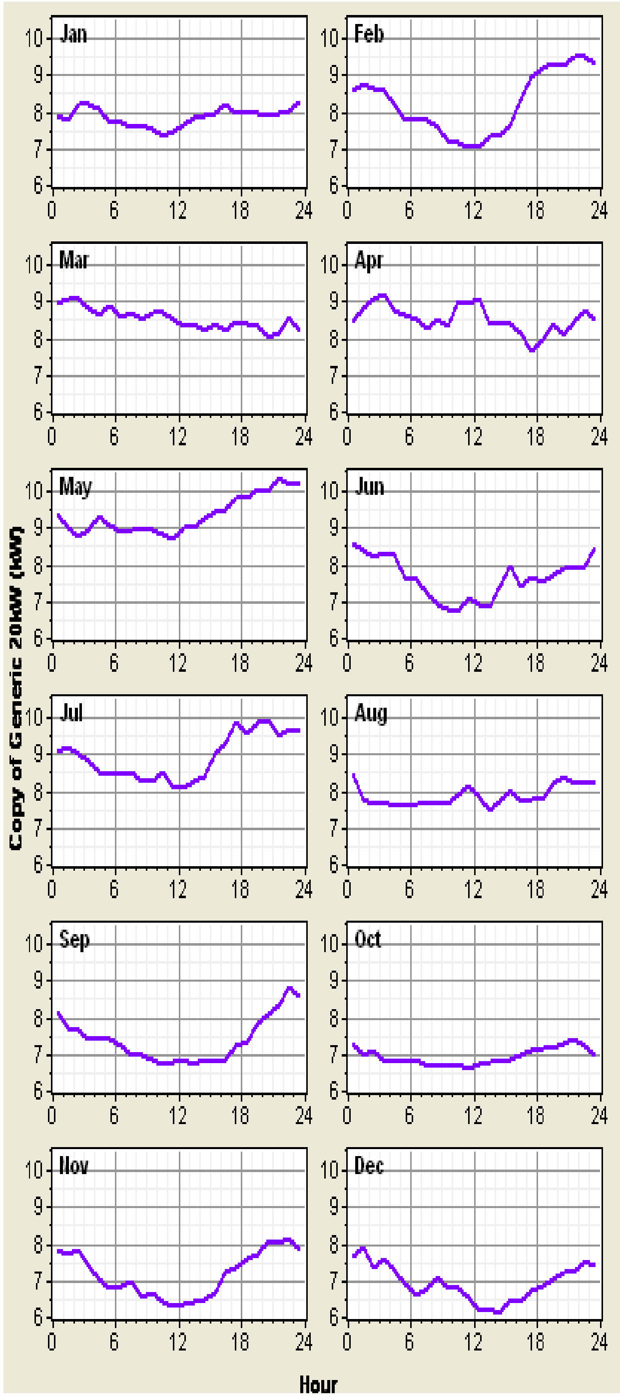

Fig.8. Daily average power delivered by the wind.

We note that the windiest months (March, April, May and June) are characterized by high production and vice versa.

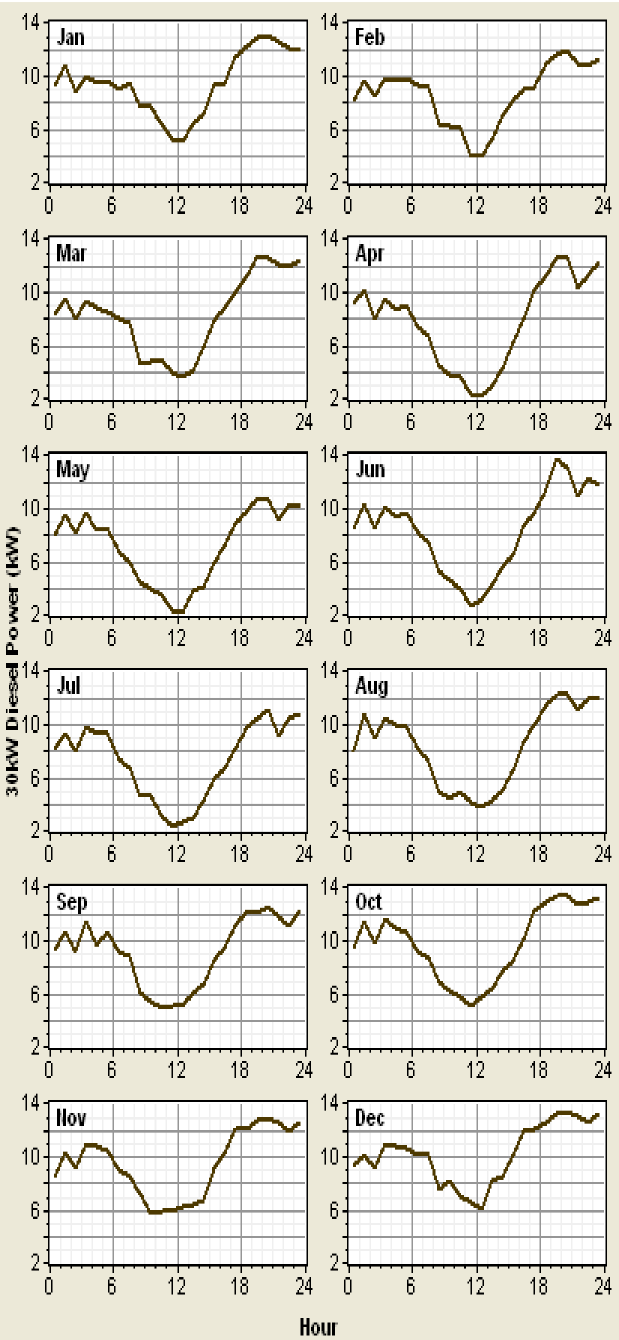

Fig. 9. Daily average powers delivered by GD.

From these curves, we see that the profile of the daily average powers of GD are similar for all months (they look the same), but different values. They are characterized by a minimum (low or zero output) and two peaks. They are characterized by a minimum (low or zero output) and two peaks.

For the minimum which corresponds to the period between 12h and 13h, represents a very small production for all months of the year except April and May which characterized by producing approximately zero. It is justified by the low electric charge in that period or the production of PV is maximum at this time of the journée.par against both peak is justified by:

- An increase in the electrical load.
- Very low production (or zero) PV at this time of the day.
- The state of charge of the batteries is minimal.

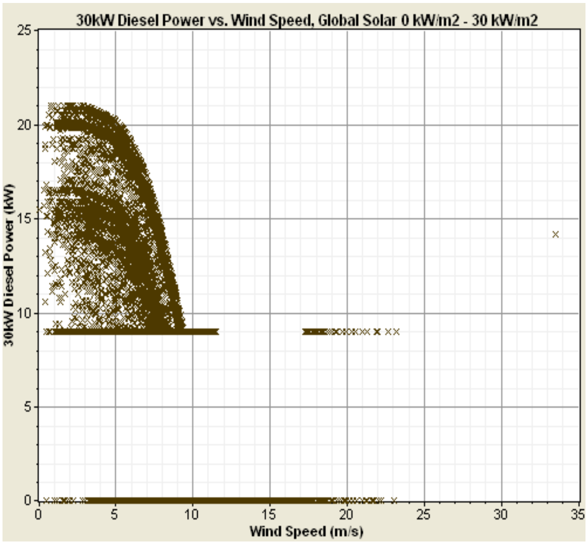

Fig.10. Production of GD in function of the speed of the wind.

The power developed by the GD is inversely proportional to the wind speed, and hence the production of wind. The operation of diesel is more important for speeds below startup speed of wind.

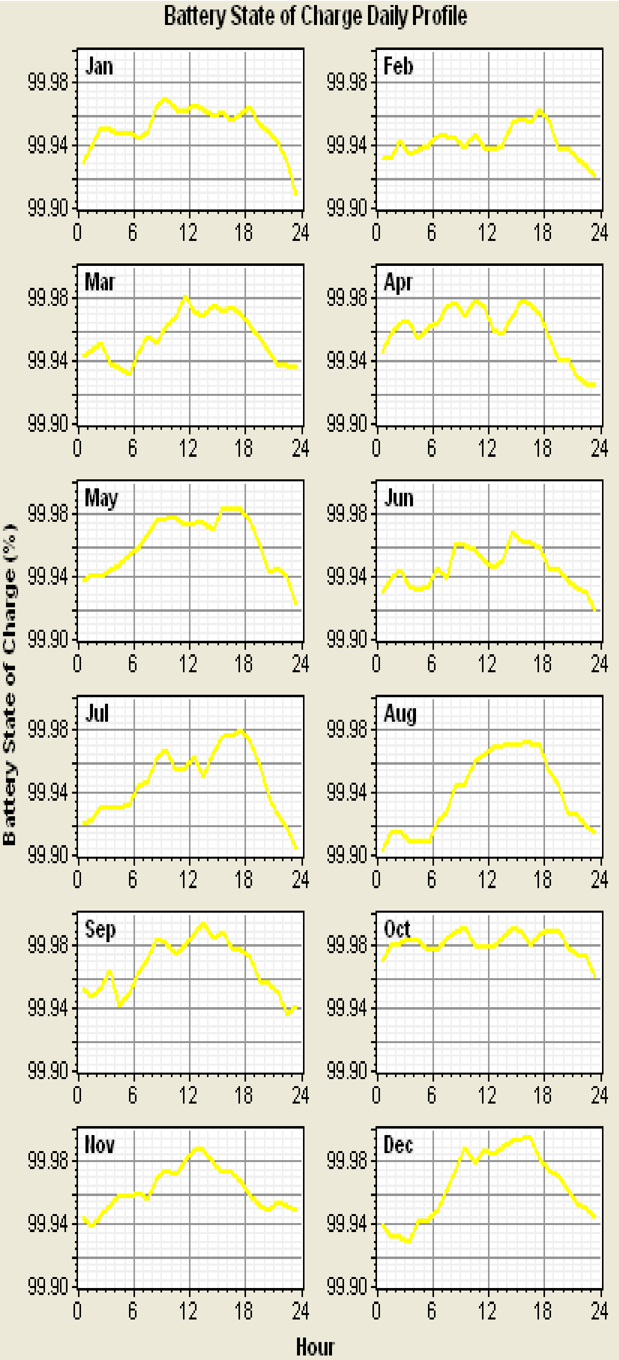

Fig.11 State average daily load of batteries.

The state average daily load is characterized by a minimum at about 5am. This minimum is located just before the first peak of production of diesel " Fig.9". The minimum state of charge means that the storage system has provided power to the AC bus.

The figure12 represent the variation of the load and the power produced by each source according to the operation mode.

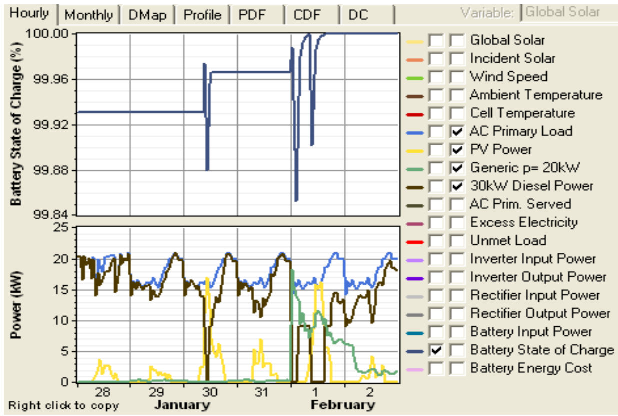

Fig.12 Distribution of the load and the power produced by each of the systems.

7. Conclusion

In recent years, the use of renewable energies such as solar and wind power is growing rapidly for the production of electricity. But these systems must be hybridized with other sources such as storage battery. We present in this article, in general, the study and simulation of decentralized power generation systems, from mixed renewable resources (wind and solar) with a storage system for applications in isolated (unit load).

The example of simulation has been applied to Adrar site where meteorological data (wind speed, temperature, terrain, sun) are available.

The analysis of the results of this paper allowed us to obtain a technical and economic gain carburizing and longevity of the generator, plus the assurance of continuity of service and the elimination of a portion of gas effect emissions when operating in wind.

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