Journal Homepage: -www.journalijar.com

INTERNATIONAL JOURNAL OF ADVANCED RESEARCH (IJAR)

ISSN NO. 2320-5407

Article DOI:10.21474/IJAR01/16775
DOI URL: http://dx.doi.org/10.21474/IJAR01/16775

RESEARCH ARTICLE

SIMULATION AND MATHEMATICAL MODELING OF HYBRID SYSTEMS(PV/DIESEL) OF THE CITY OF ABÉCHÉ

Abdel-Razik M. Idriss[1,2], Abderahman A. Oumar[1,2], M.S. Abdelkhader[1,2],Abakar M. Tahir[2] and Mahmoud Y. K.[2]

1. Laboratoiredes Energies Renouvelables et Des Matériaux (LERM), Institut National Des Sciences Et Techniques D'abeche (Insta-Tchad).
2. Universite De Ndjamena-Tchad.

……………………………………………………………………………………………………....

Manuscript Info

……………………..

Manuscript History
Received: 28 February 2023
Final Accepted: 31 March 2023
Published: April 2023

Key words:-
Modeling, Dimensioning, Hybrid, Photovoltaic, Homer, Diesel

Abstract

………………………………………………………………

Energy constitutes a vital need solicited in all the aspects for our daily activities, in particular in industry, the servant, the trade, transport, etc.¶The continuous world energy request to increase with the increase in population and the prices of fossil energies are unstable and dubious. The environmental protection becomes a world priority with the inescapable reduction in the fossil resources.¶In this paper, we present a technical modeling of a power station hybrid statement/Diesel of the town of Abéché in order to apprehend contours of appreciations of the technical data.¶The model is developed by taking account of the parameters of the various components of a hybrid system PV/Diesel (sunning, load, design features of the components and a number ¶generators).¶ The results obtained are compared with those obtained by simulation using the software of optimization called Homer.

Copy Right, IJAR, 2023,. All rights reserved.

……………………………………………………………………………………………………....

Introduction:-

In much by African countries, the growth of the request for electricity is not always companied by an increase in the transport and production leading to a large gap between supply and demand in electric power [1]. In Chad, only 6, 4 % of the population have access to electricity, and only less than 1% in the rural zones [2] With an aim of increasing the access to electricity in these rural zones, the Government of the Republic of Chad initiated several projects of electrification.They are thus several cities and villages of the rural zones will profit from the hybrid power stations of which the town of Abéché. There is also similar work in the promotion of hybrid systems that address energy issues [3,4,5,6,7]

Our work relates to the proposal for a Mathematical model of design of a hybrid power station PV/gasoil without batteries. These results so obtained will be compared with those of simulations obtained by HOMER while being based on the data of the power station of Abéché.

Metriels and Methods:-

Solar potential of the town of Abéché ¶

The town of Abéché has a good solar potential energy during all the year. The number of hours of this sunshine per annum varies from 2.850 to 3.750 hours per annum according to seasons'. The intensity of the total radiation varies

Corresponding Author:- Abdel-Razik M. Idriss
Address**:-** Laboratoiredes Energies Renouvelables et Des Matériaux (LERM), Institut National Des Sciences Et Techniques D'abeche (Insta-Tchad).

on average from 4,5 to 7,3 kWh/m2/j. ¶[8] ¶In the literature, there are several configurations of the hybrid power stations. The following configuration (figure 1) is called “flexy energy”, developed by Daniel Yamegueu.¶

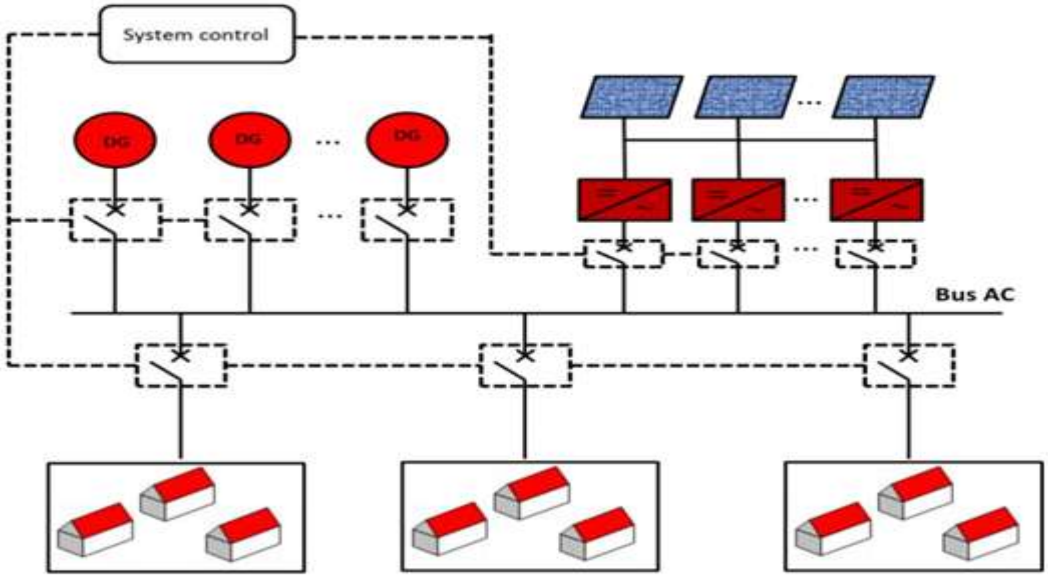


Figure 1:- Structure of the PV/Diesel systems without batteries [5] ¶

Le system presented here is composed of a photovoltaic field, assembled on strings, generating generators, inverters, of a system of control and several types of the loads (critical loads, secondary loads and loads differed).¶

Solar radiation ¶
Figure 2 has the result sunshine the one day called "standard day" on the site.¶

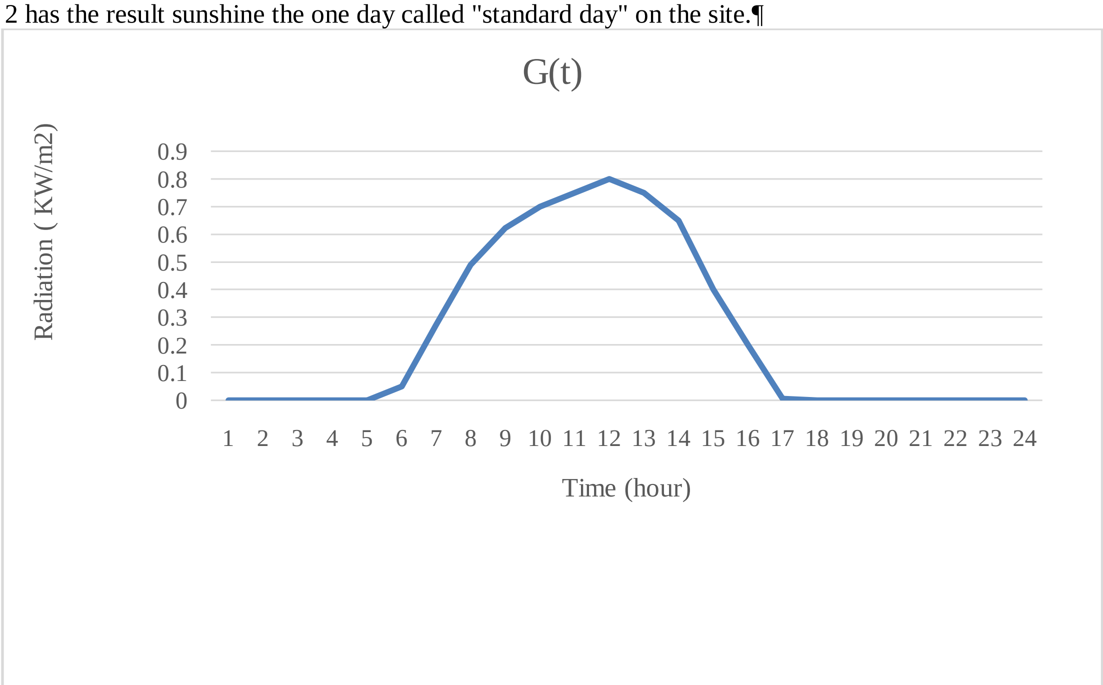


Figure 2:- The one-day standard solar radiation.

We observe on figure 2 that the peak of the sunshine is around 12 hours. To avoid under dimensioning, it is necessary to take into account for calculation the days the least shine upon di site. In the case of Abéché, they is the days of August.¶

Loads

Figure 3 presents the profile of one-day standard load on the site of Abéché ¶

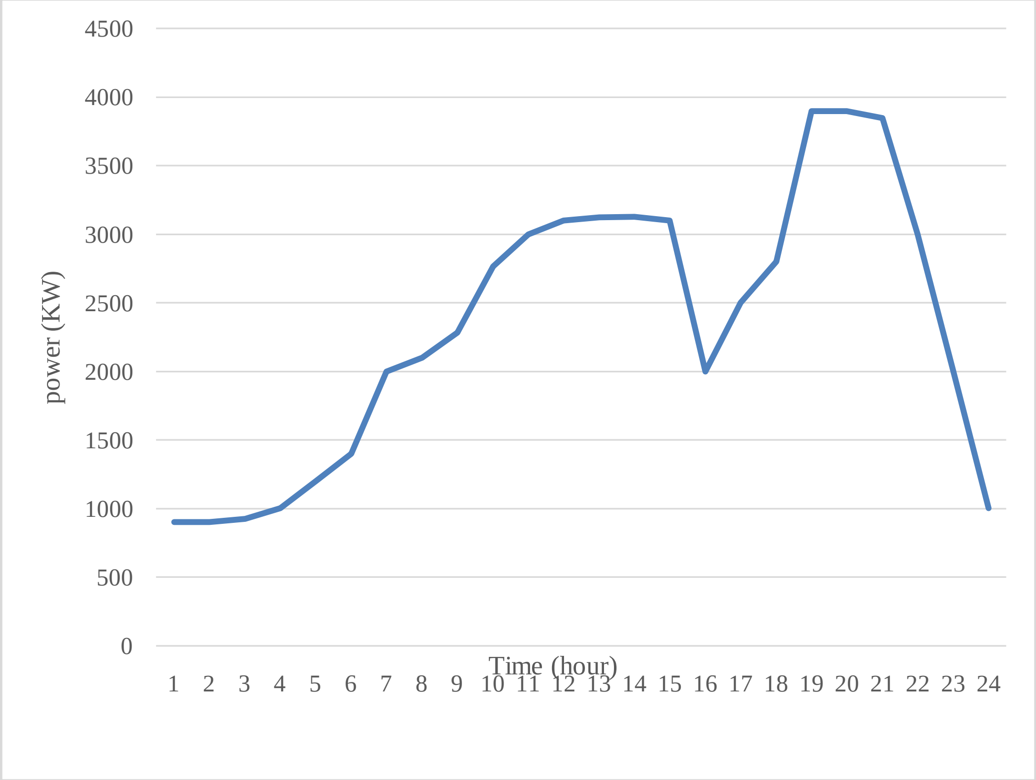


Figure 3:- Profile of one-day standard load ¶

The evolution of this load diagram can be analyzed in the following way:¶

1. In the course of the day (between 6h and 16h), one mainly records activities of the administration, Community infrastructures (schools, centers of health, etc), economic activities through the points of trade, the workshops of craft industry, and others;¶ between 16h and 17h, there is a fall of consumption of energy on the level of the administration.¶
2. From 18h, the major part of the population turns over in the hearths, which creates an increase in consumption in energy with the starting of various electrical appliance. One records also some night points of animation.¶ There is a peak of consumption between 18h and 22h30.¶

Modeling And Simulation

Mathematical Model ¶

Maximum capacity of field photovoltaic

¶We used the following equation for the calculation of the maximum capacity of the field.¶

$$\mathbf{P_{pv}(t) = F_{PV} P_{crete} I_G(t)} \qquad (1)$$

PPV (t): ¶solar power produced by field photovoltaic

¶IG (t): ¶total sunning in W/m2,

¶FPV: ¶factor of losses

¶P Crete: ¶power peak of field photovoltaic.¶

Power of exit of the inverters ¶

The power of exit of the inverters is given by the following expression:¶

$$\mathbf{P_{ond}}(t) = \mathbf{\eta_{ond} F_{PV} P_{crête} I_G(t)} \qquad (\mathbf{2})$$

pond (t):¶Instantaneous power of the inverter ¶

ηond:¶ yield of the inverter ¶

Numbers inverters is given by the following expression: ¶

$$N_{ond} = \left[\frac{P_{crete}\max(I_G\ (t))}{P_{ond}}\right] \quad (3)$$

Nond:¶ numbers inverters ¶

Power delivered by the generators Diesel

¶$P_D(t) = P_{ch}\ (t) - \eta_{ond} F_{PV} P_{crete} I_G(t)$ (4)

PD (t): ¶power delivered by the generators Diesel

¶Pch (t): ¶the load of the installation.¶

Simulation

¶For our work, we chose the Homer software for simulation.¶

The data selected ¶

Table 1:- simultion parameters.

Parameters	Value
Longitude (degree)	20.830
Latitude (degree)	13.830
Generator 1(KW)	1500
Generator 2(KW)	1500
Generator 3(KW)	1500
Power photovoltic (KWc)	1170
Lifespan panels (years)	25
Minimum load factor of the generator(%)	40
Output inverter(%)	90
Power inverter (W)	117
Rate of penetration(%)	30
Factor of the losses(%)	85
Maximum loading (KW)	3900

In figure 4, we present the design of the configuration of the components under the Homer software. ¶

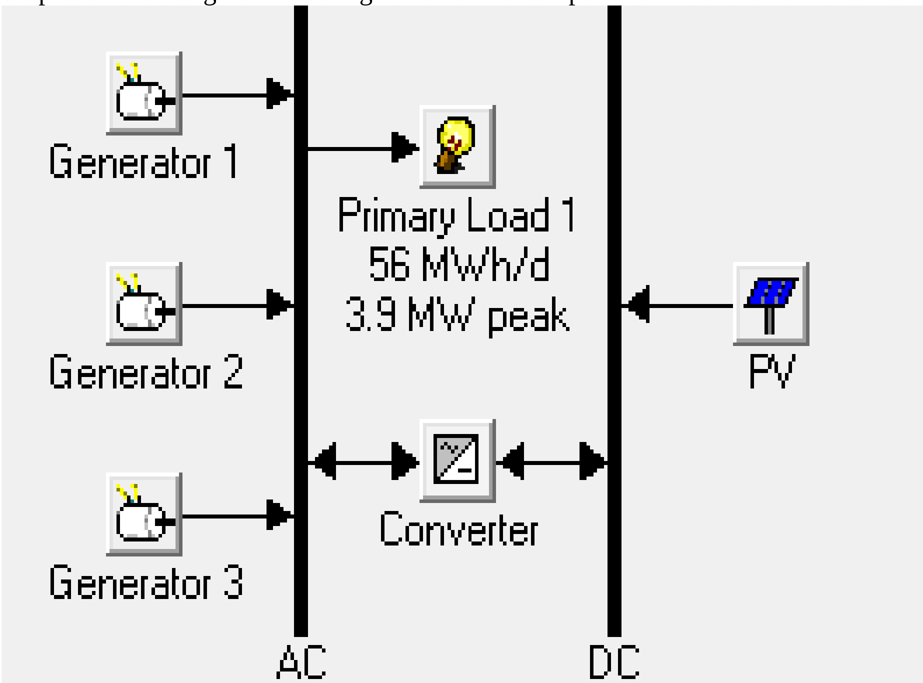


Figure 4:- Design of the configuration on Homer ¶

Results:-

We present in this section, the comparative results of analytical calculations and simulations carried out under Homer.¶ The results relate to the power photovoltaic, Power inverter, generating power, ¶Numbers generators under operation, ¶Total power.

Powers photovoltaic

¶Figure 5 presents the power provided by the photovoltaic obtained by the model ¶and under Homer.

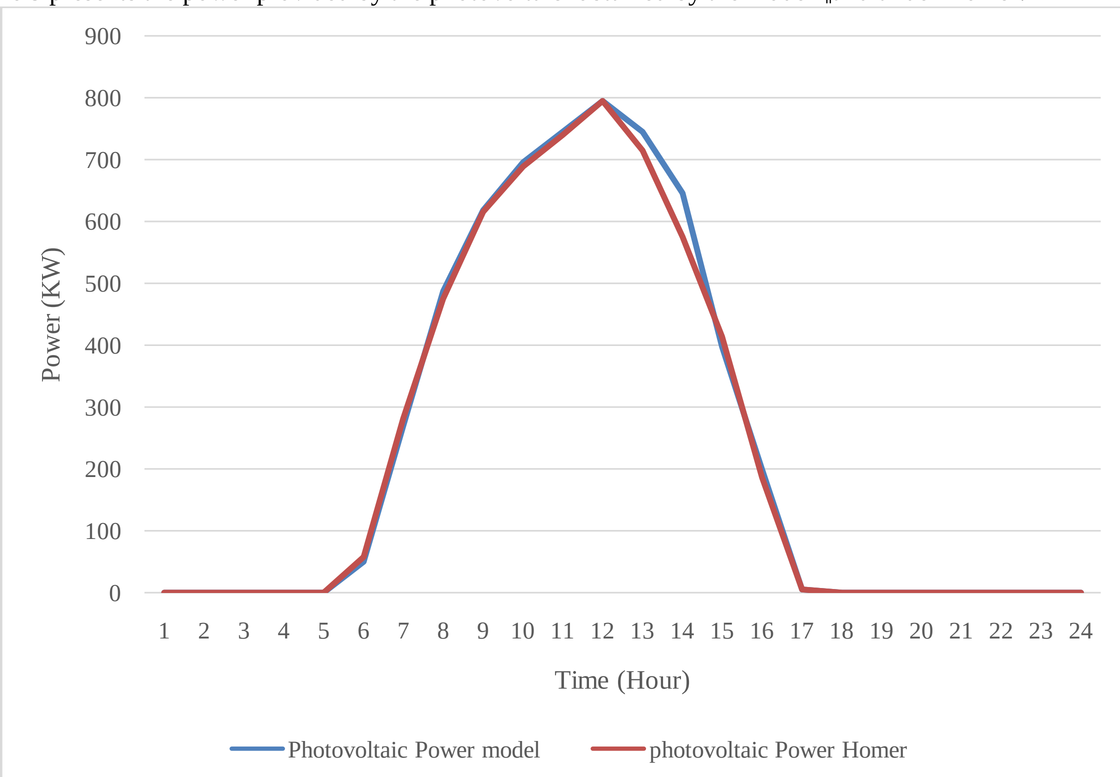
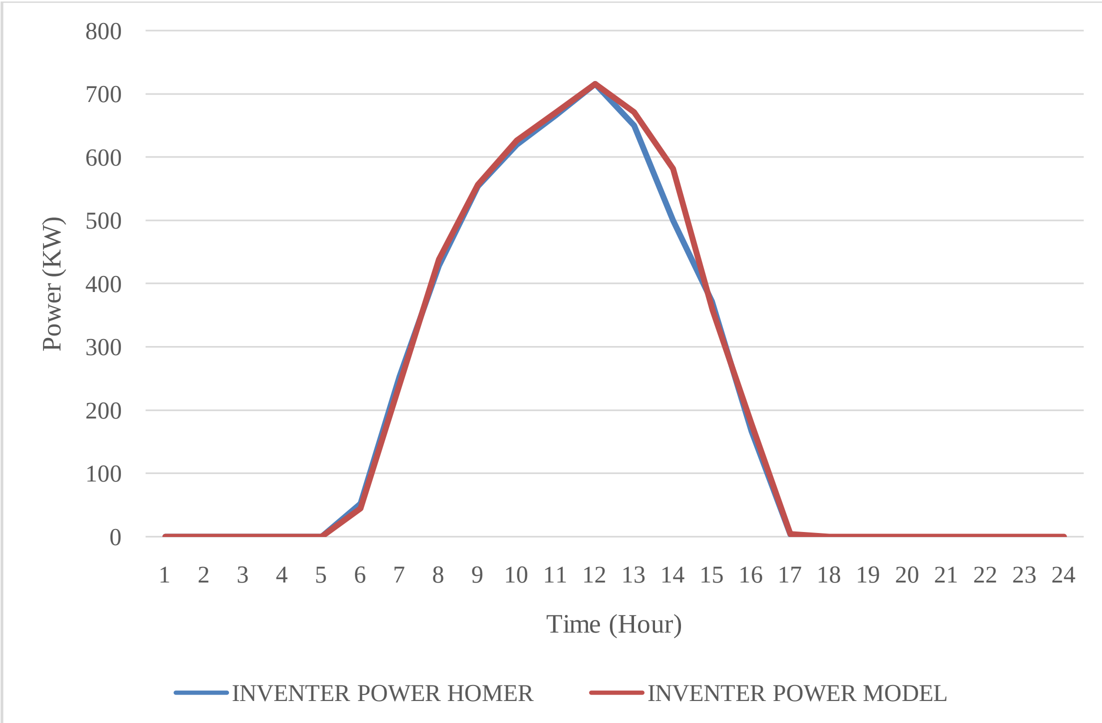


Figure 5:- Power photovoltaic and powerinverter ¶

These results show that the photovoltaic power obtained by the model is identical to those obtained by Homer.

Power inverter ¶

Figure 6 takes the forms of the powers ¶Provided By the inverter obtained by the model ¶and under Homer.



¶

Figure 6:- P¶Power inverter of the model and ¶power inverter of HOMER ¶

These results show that the power of the inverter obtained by the model is similar to those obtained par Homer. ¶

Power generator ¶

Powers provided by the generators obtained by ¶model and under Homer are presented by figure 7.¶

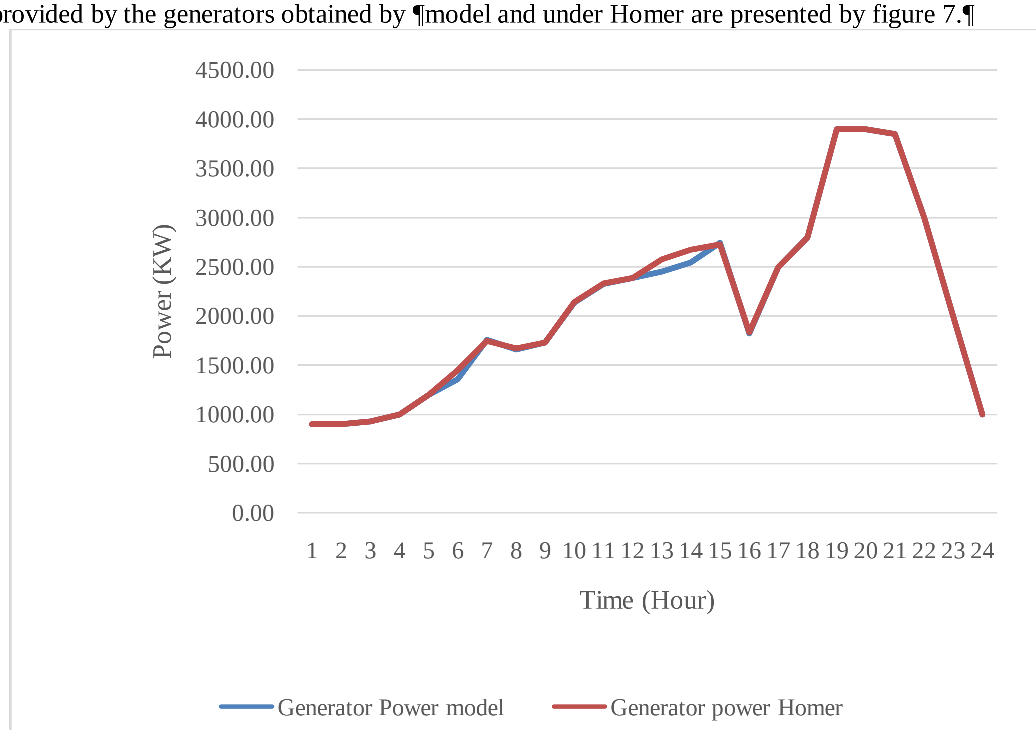
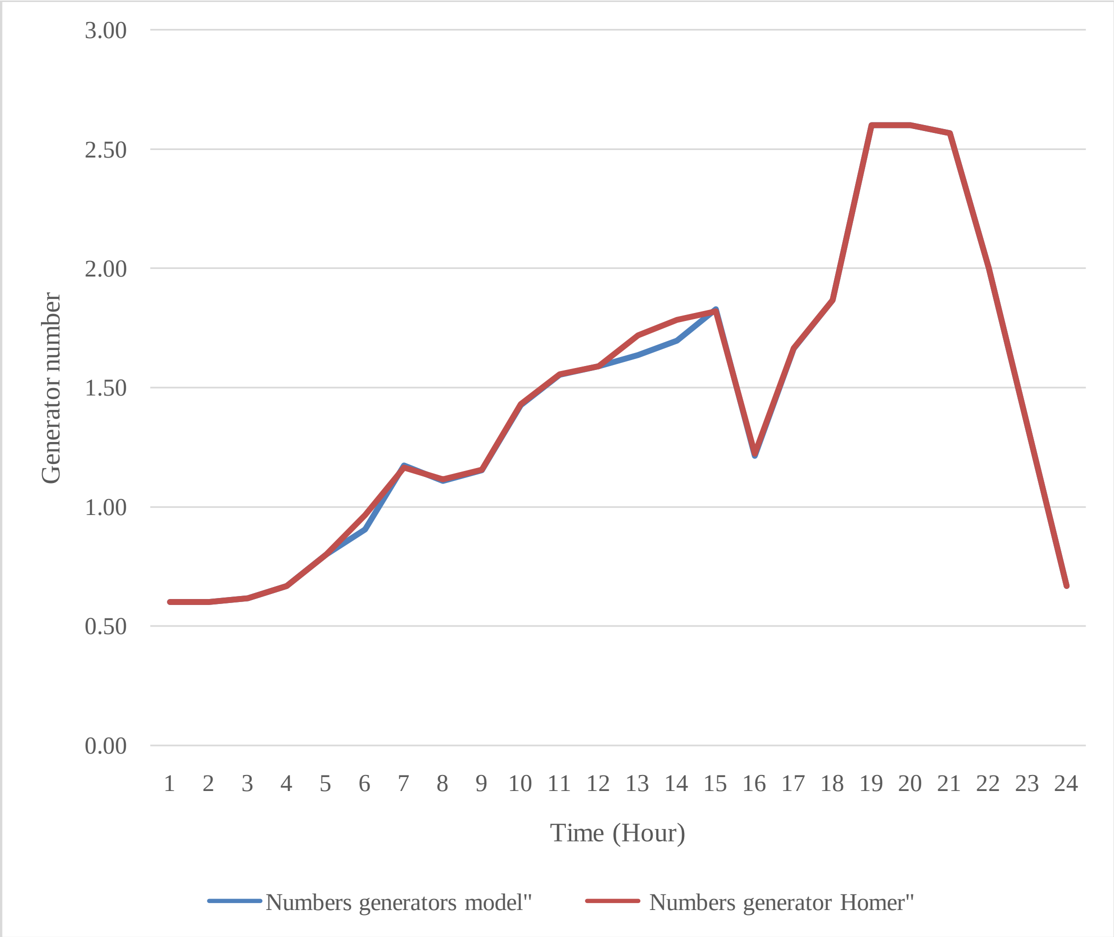


Figure 7: P¶Power generators of the model and power ¶ Generator of HOMER ¶

We notice easily that the results obtained by the mathematical model of the power produced by ¶the generators are straight forwardly superimposed on those obtained by HOMER.

Numbers it groups under operation ¶

Figure 8 presents the two curves of a number of the generators under operation has each time obtained by the model and simulation under Homer.



¶

Figure 8:- ¶Numbers generators under operation bymodel and HOMER ¶

It is noticed that these two curves are almost identical. ¶At every moment, there is a generator, which is in service, which is good for the stability of the network. The load factor of generator is at every moment higher than 60%.¶

Total Powers ¶

Figure 9 presents the total powers obtained by the mathematical model and simulation under Homer.

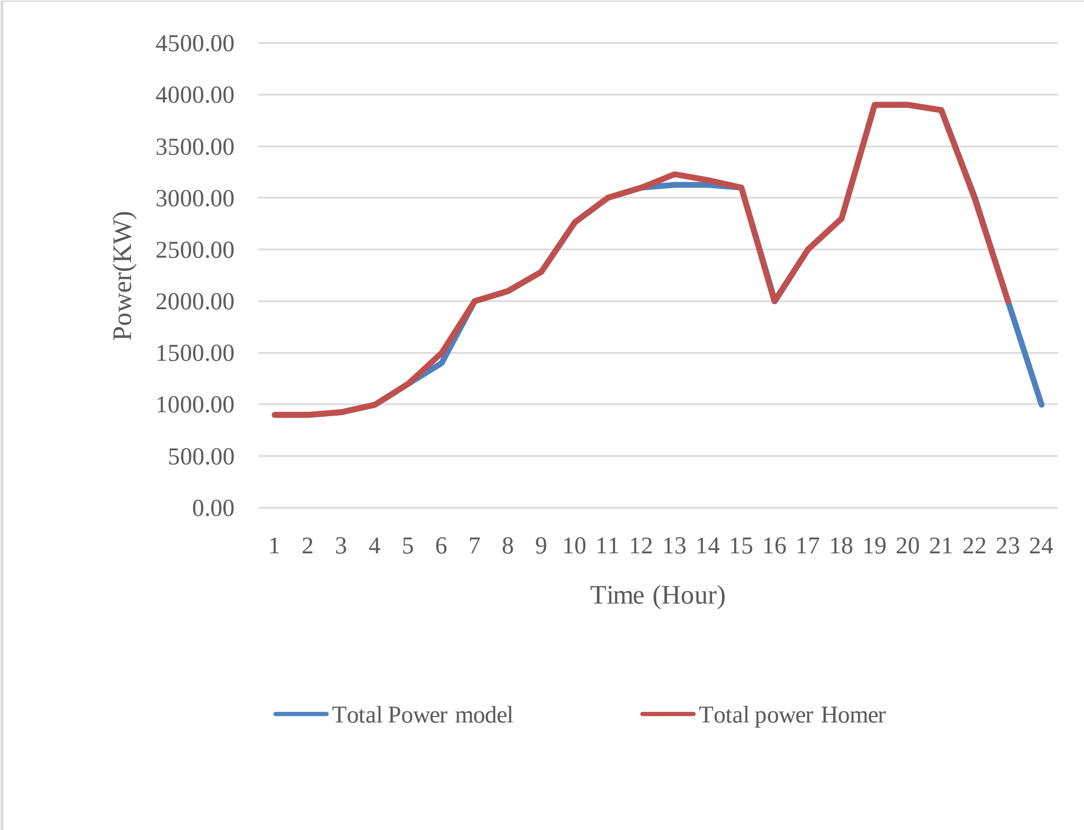


Figure 9:- Total power of the model and Homer ¶

This figure contains the results of the total power produced by the installation obtained by the model in red and blue that of software of optimization HOMER.¶ The results are the same ones.¶

Power generating inverter and power ¶

Figure 10 presents the curves of the power of the inverter and that of the generators.¶

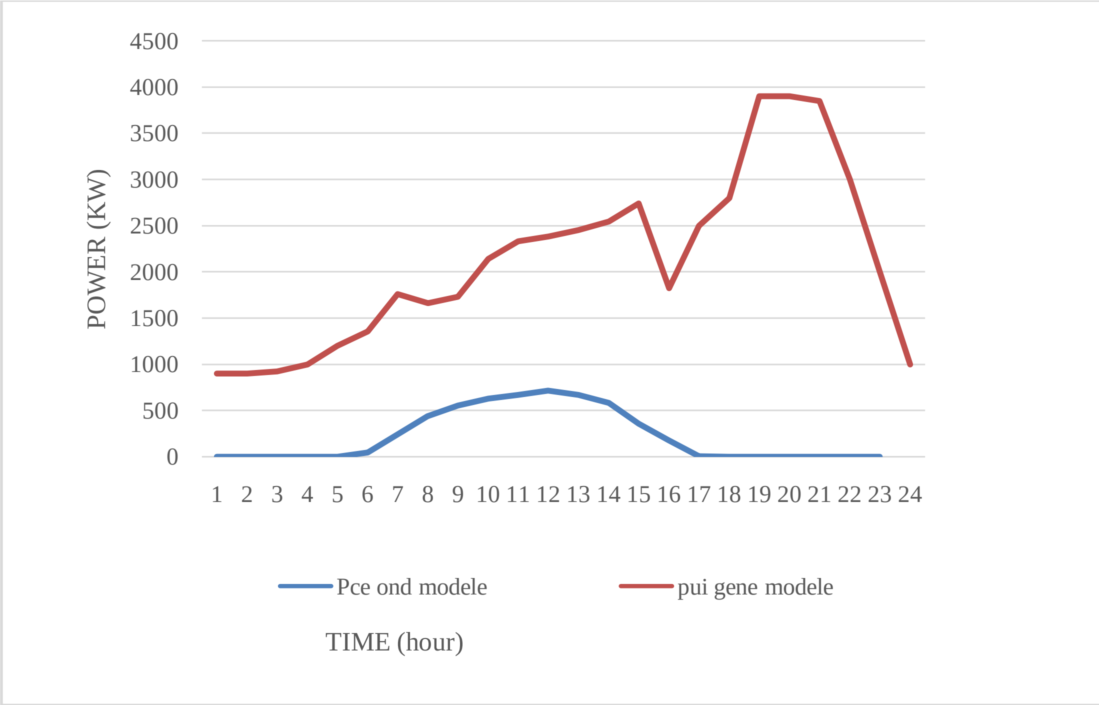


Figure 10:-Powers inverter and generator of the model ¶

The figures show that the generators function during all the day whereas the inverters function that when there is the sunning i.e. between 6h and 17h.

Load and power inverter ¶

The curves representing the load and the Power are illustrated in figure 11.¶

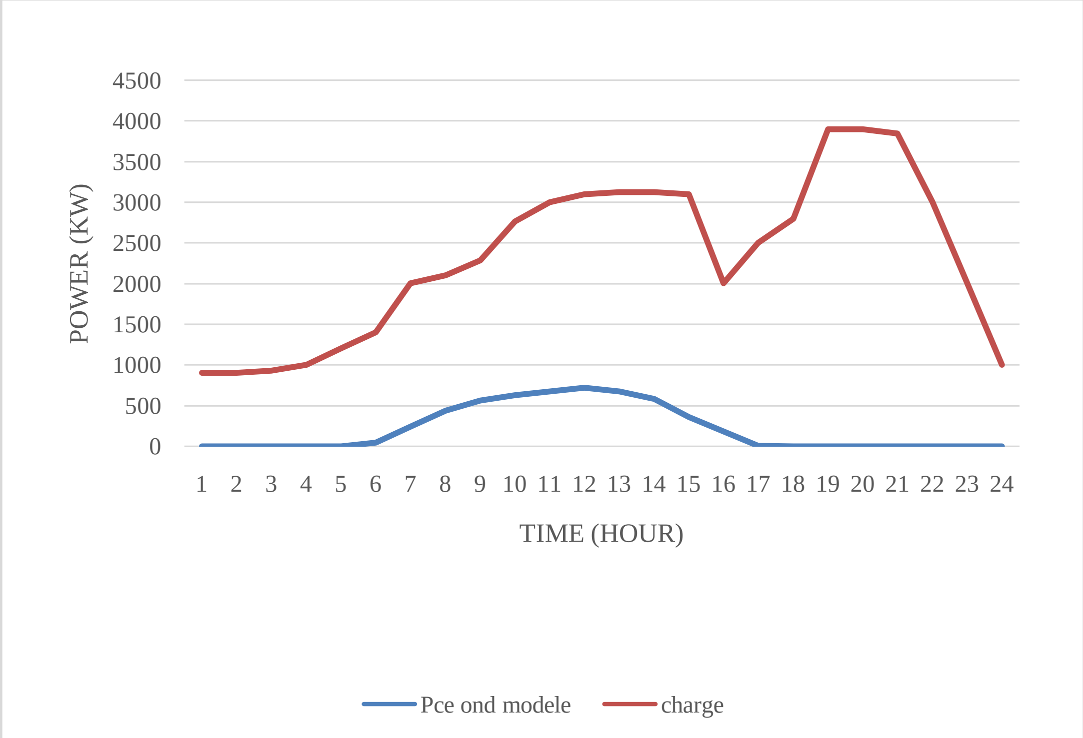


Figure 11:- Power inverter of the model and load.

This figure shows that the inverter functions only between 6 and 17h because it N does not have a system of storage there. Owing to the fact that the network supports only 30 % of the load, the inverter alone cannot satisfy the entire load even for this period.¶

Load and power generator ¶

Figure 12 puts forward the pace of the load and that of the power of the generator ¶

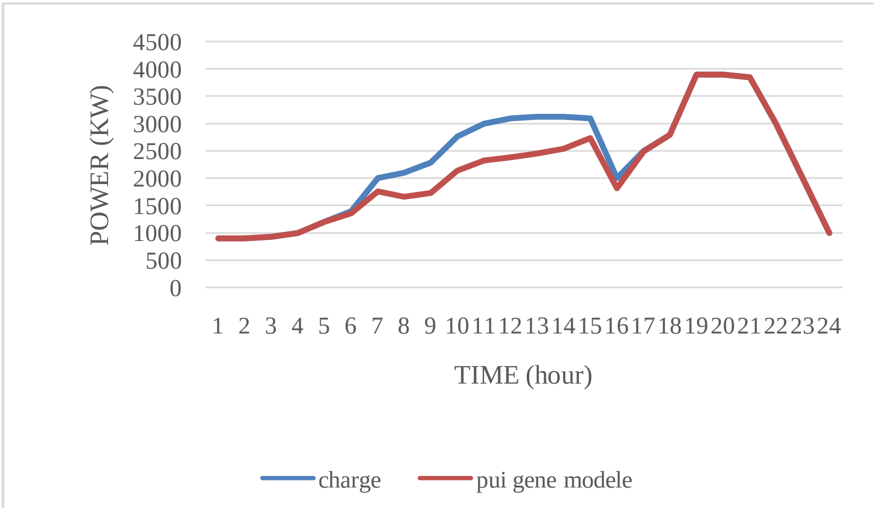
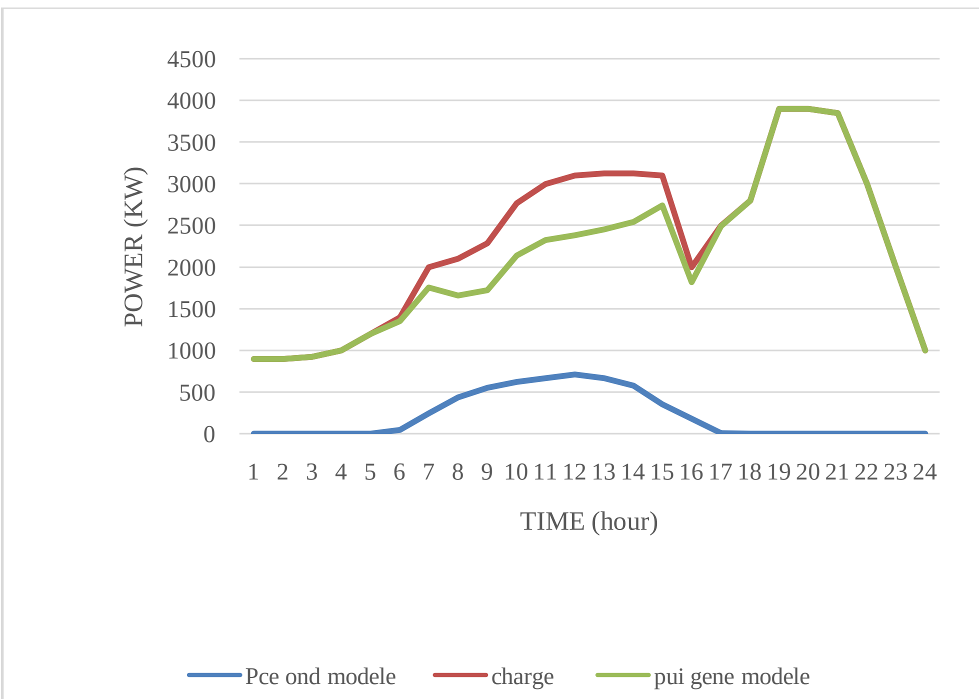


Figure 12:- Power generator of the model and the load.

The variation of the two curves between 6h and 17 hours is due to the presence of the power of statement to satisfy ¶totality of the load.¶

Power inverter, load and power Generator ¶

Figure 13 presents the powers of the inverter and the generators obtained by the data of the model as well as the load ¶



.

Figure 13:- Powers inverter, generator and load.

On this figure, one notices the curves of the powers of the generators and that of the load is identical when the sunning is null.¶ The variation of these curves between 6 hours with 17 is compensated by the power of the inverter.¶

Conclusion:-

In this study we presented a technical method of dimensioning optimal based on mathematical models. ¶The initial parameters are the load and the sunning of the site.¶ The rate of penetration statement retained is 30% and the minimum rate of load is 40%.¶Results of a simulation using one day of solar reference of irradiation and a standard day of load for the site of Abéché. ¶We simulated the data with software HOMER.¶

The results obtained show that the mathematical model elaborate is highly reliable.¶

Acknowledgements:-

The authors of the article thank the managers of the nation electricity company of the abéché power plant (SNE) for providing us with valuable data that enabled us to produce this document.

References:-

[1] Ngundamb E.M., Tchinda R., Modelling of solar/diesel/battery hybrid power systems for far-north Cameroon, Renewable Energy 32, 832-844, (2007).
[2] Plan d'Urgence d'Accès a l'Electricité au Tchad 2021-2023. Ministère de Pétrole et de l'énergie. (juin 2020).
[3] W. Zhou, C. Lou, Z. Li, L. Lu and H. Yang, 'Current Status of Research on Optimum Sizing of Stand-Alone Hybrid Solar–Wind Power Generation Systems', Applied Energy, Vol. 87, N°2, pp. 380 – 389, 2010.
[4] J. L. Bernal-Agustin, R. Dufo-Lopez, 'Simulation and optimization of stand-alone hybrid renewable energy systems', Renewable and Sustainable Energy ReviewsVolume 13, Issue 8, October 2009, Pages 2111–2118.
[5]DanielYAMEGUEU NGUEWO '' Expérimentation et optimisation d'un prototype de centrale hybride solaire PV/diesel sans batteries de stockage : validation du concept « flexy energy » octobre 2012
[6] David Blaise TSUANYO '' Approches technico-économiques d'optimisation des systèmes énergétiques décentralisés : cas des systèmes hybrides PV/diesel '' juin 2015.
[7] Benjamin Pillot ''Planification de l'électrification rurale décentralisée en Afrique subsaharienne à l'aide de sources renouvelables d'énergie : le cas de l'énergie Photovoltaïque en République de Djibouti'' Mai 2015.
[8](Source :http://re.jrc.ec.europa.eu/pvgis/apps4/pvest.php?map=africa) La promotion des Energies renouvelables : une réponse durable à la problématique.