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Estimated study of the production of electricity from different types of PV in two Algerian sites

Mohamed SALMI[#1], Derradji MEDERREG[*2], Djamal FRIDJA[#1]
[#]Department of Physics, University of M'sila , Algeria
[1]mohamed.salmi@univ-msila.dz
[3]frid.djamal@gmail.com
[*]Department of Mechanics, University of M'sila , Algeria
[2]Derradji.MEDERREG@univ-msila.dz

Abstract— We present an estimation study on photovoltaic systems in Algeria, for the conversion of solar energy into electrical energy. We used a simulation software "RETS Screen". To make this study, we chose two areas taken into consideration by the "RETS Screen" software, namely: Algiers and Tamanrasset. These sites have measured solar global radiation data as well as values of the duration of sunshine for a period of six years (2000-2005).

The results of estimation of the power supplied and the yield of the PV system obtained by simulation with the RETScreen software for Algiers and Tamanrasset are respectively 5884 and 7565 KWh ; 8 and 7.8%.

Keywords- ***Solar energy - Photovoltaic - Simulation - RETS Screen – Algeria.***

I. INTRODUCTION

The solar energy is the most powerful and the most promising renewable energy. This clean energy is inexhaustible and is quite available for profitable applications. Indeed, the power of solar radiation on the ground is about 950W/m^2. The total amount of solar energy received at the ground during a week overtakes the energy produced by the world's reserves of petrol, coal, gas and Uranium. But in most cases, an electric conversion of the solar radiation energy is necessary. The photovoltaic electricity is obtained by the direct transformation of the solar radiation to electricity by photovoltaic cells. The photovoltaic electricity production is in a significant growth since the last years, to over 700MW[1].

The surface area of Algeria is over 2 million km^2. It receives what is the equivalent of 300 billion of Tep a year in the form of solar energy. In term of sunshine duration the daily energy received upon a horizontal surface of 1m^2 is of the order of 5kWh on almost the totality of the national territory. The annual solar sunshine duration overtakes 2000 hours and may achieve 3900 in the high plateaus and the Sahara, which represents a high average compared with other countries in the world[2].

The idea of using solar energy in Algeria is not new, its existence dates back at least to 1870 when the famous physicist Auguste Mouchot had proposed the creation of a lot of thermal machines for industrial and agronomic purposes. A century later in 1951 a famous engineer; Maurice Touchais had installed the first solar concentrator on the site Bouzareah Algiers.

To contribute to the photovoltaic system development in Algeria and for the conversion of solar energy into electric one, we have used the RETscreen software to estimate the electric power generated by the photovoltaic (PV) systems installed in the regions of Algiers and Tamanrasset.

II. DIFFERENT TYPES OF SOLAR CELLS

II.1. Monocrystalline cells**:** are the first-generation solar cells, they are developed from a block of crystallized silicon in a single crystal. Its manufacturing process is long and demanding in energy; more expensive, it is however more effective than polycrystalline silicon. Silicon in its raw state is melted to create a bar. When the silicon cooling is slow and controlled, a single crystal is obtained. A wafer (silicon wafer) is then cut in the silicon bar. After various treatments (acid surface treatment, doping and creation of the P-N junction, deposition of antireflection layer, installation of collectors), the wafer becomes a cell. The cells are round or nearly square and, when viewed closely, have a uniform color. They have a yield of 12 to 18%, but the production method is laborious [3].
II.2. Polycrystalline cells: are produced from a block of crystallized silicon in the form of multiple crystals. Viewed closely, you can see the different orientations of the crystals (different tones). They have a yield of 11 to 15%, but their cost of production is lower than monocrystalline cells. These cells, thanks to their productivity-enhancing potential, have today imposed themselves. The advantage of these cells over monocrystalline silicon is that they produce little cutting waste and require 2-3 times less energy for their manufacture. The wafer is sawn into a silicon bar whose forced cooling has created a poly-crystalline structure. Estimated life: 30 years. A crystal is a solid with polygonal facades, more or less bright, with a regular and periodic structure, formed of an ordered stack of a large number of atoms, molecules or ions [4].

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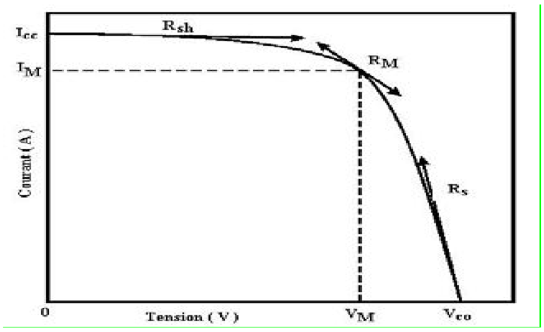
II.3. Amorphous cells: have a much lower cost of production, but unfortunately their yield is only 6-8% currently. This technology makes it possible to use very thin layers of silicon which are applied to glass, flexible plastic or metal by a vacuum vaporization process. The performance of these panels is less good than that of polycrystalline or monocrystalline technologies. However, amorphous silicon makes it possible to produce large-area panels at low cost using little raw material. Note: In chemistry, an amorphous compound is a compound in which the atoms do not respect any order at medium or long distance, which distinguishes it from crystallized compounds. Glasses are amorphous compounds [4].

We represent in Figure 1, an example of the I-V characteristic of a solar cell under the influence of illumination [5].

FIGURE 1: I-V CHARACTERISTIC OF A SOLAR CELL



III. RETSCREEN SOFTWARE

III.1.Description

The RETScreen software [6] is a program which can be easily used to estimate the energy production and the cost of PV project for three basic applications: inside and outside electric network, and in water pumping.

For the evaluation of PV projects, the RETScreen contains three worksheets:

-Energy model,

-Solar resource evaluation and calculation of the charge,

-Cost analysis.

III.2. Product data

Some of the model requirements for product data are presented in the database of these products. These provide information on the equipment associated with the project.

- The product database sort routine starts using the "PV Module Type" selected in the Energy Model worksheet. From the dialog box we select the site chosen for the study, followed by the supplier, the model and the number of PV modules. The data can be pasted from the dialog box into the worksheets.

- Note: To access the full list of suppliers contained in the RETScreen Online Product Database, and their contact information, the user must select the "All" option from the "PV Module Type" drop-down list. From the dialog box.

III.3. Energy model

In this section of the RETScreen Software, there are three parts:

- Characteristics of the site which contains the name and place of the project and meteorological station.

Parameters of the system that contains the PV field and the conditioning of the energy.

Annual energy production which contains the output and the power supplied.

III.4. Overall efficiency of the PV system

The model allows the calculation of the overall efficiency of the PV system, in%. This value is the amount of renewable energy supplied relative to the solar energy captured by the module. Typically, this value can vary from 3 to 13%, depending on the type of module, the performance of the energy conditioning equipment and the quality of the solar radiation.

III.5.Monthly data

In this section we have inserted in the database of the software the following data:

Average monthly temperature.

Average monthly global solar radiation.

IV. APPLICATION TO ALGERIAN SITES

In application of the above study for Algerian case, we have chosen four cities which represent four different regions (North, South). They are respectively: Algiers and Tamanrasset. These areas are prototypes of the different climates of Algeria. The measured values of temperatures and solar radiation are obtained from the National meteorological Office - Algeria. The geographic coordinates of those sites are given in the table below:

TABLE I. GEOGRAPHICAL COORDINATES OF SITES

Location	Latitude (deg)(N)	Altitude (m)	Longitude (deg)
Algiers	36,43	450	2.83 E
Tamanrasset	22.47	1378	5.31 E

The average values of the measured temperature and global solar radiation for the different sites are given in the figures 2 and 3 below:

FIGURE 2 : GLOBAL SOLAR RADIATION

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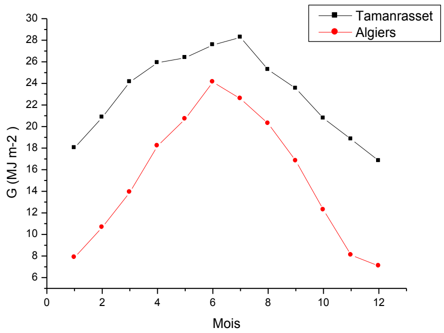
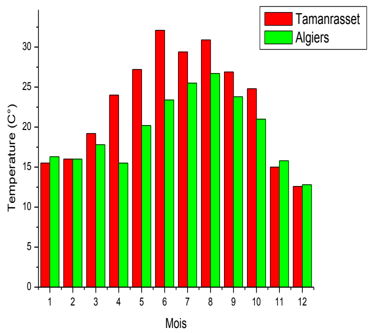
FIGURE 3 : TEMPERATURE OF SITES





V. RESULTS

5.1.Production of energy

Tables 2, 3 and 4 show the results obtained using the RETScreen software from the sites selected in our study using PV Module Manufacturer - ABC Inc.

a)- PV module type: Mono-Si

TABLE 2: OBTAINED RESULTS USING RETSCREEN SOFTWARE (**Mono-si**)

Energy model	Alg.	Tam.
Nominal efficiency of the PV module (%)	10.3	11,7
Nominal temperature of the operating cells(C°)	45	45
Annual solar radiation (Mwh/m^2)	6,01	8,65
Annual average temperature (°C)	19,6	22,8
Average efficiency of the inverter (%)	90	90
Various losses in PV field (%)	10	10
Absorption rate of energy (%)	95	95,0
Global efficiency of PV system (%)	8,0	7,8
Captured energy (MWh)	2 ,932	3,891
Energy supplied(MWh)	2,506	3,327

b)- PV module type: Poly-Si

TABLE 3: OBTAINED RESULTS USING RETSCREEN SOFTWARE (**Poly-si**)

Energy model	Alg.	Tam.
Nominal efficiency of the PV module (%)	10	11
Nominal temperature of the operating cells(C°)	45	45
Annual solar radiation (Mwh/m^2)	5,99	8,65
Annual average temperature (°C)	19,6	22,8
Average efficiency of the inverter (%)	90	90
Various losses in PV field (%)	10	10
Absorption rate of energy (%)	95	95
Global efficiency of PV system (%)	7,5	7.5
Captured energy (MWh)	6,882	8,848
Energy supplied(MWh)	5,884	7,565

b)- PV module type: a-si

TABLE 4: OBTAINED RESULTS USING RETSCREEN SOFTWARE (**a-si**)

Energy model	Alg.	Tam.
Nominal efficiency of the PV module (%)	9.2	10
Nominal temperature of the operating cells(C°)	45	45
Annual solar radiation (Mwh/m^2)	5,99	8,65
Annual average temperature (°C)	19,6	22,8
Average efficiency of the inverter (%)	90	90
Various losses in PV field (%)	10	10
Absorption rate of energy (%)	95	95
Global efficiency of PV system (%)	7,4	3,7
Captured energy (MWh)	1,943	2,647
Energy supplied(MWh)	1,661	2,263

The most important of the result for us is the annual value of the energy supplied, the maximum value of the electric

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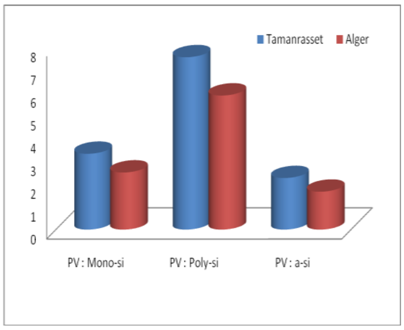
energy supplied (fig.5): (7,565MWh) was produced by the mono module if at Tamanrasset and the minimum value (1,661MWh) was produced by the a-si module for the Algiers site.

FIGURE 4: PRODUCED ANNUAL AVERAGE ENERGY GIVEN BY THE THREE PV TYPES



VI. CONCLUSION

We have presented the fundamentals of the principle of the photovoltaic effect and the various basic constituents of a conventional photovoltaic cell, which make it possible to calculate the efficiency of a solar cell from the current-voltage characteristic and the different constituents of a conventional photovoltaic cell.

A brief description has been made of the RETScreen software used in estimating the efficiency of a photovoltaic system. We chose two typical cities representing the north and the south of the Algerian territory. These cities are respectively: Algiers and Tamanrasset.

The results of estimation of the power supplied and the yield of the PV system obtained by simulation with the software RETScreen for Tamanrasset and Algiers are respectively: 7565, 5884 KWh by the type PV module (Mono-si) and the best efficiency is 8 and 7.8%.

The performance of photovoltaic systems is strongly affected by the incident radiation and temperature.

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