PHOTOVOLTAIC POTENTIAL FROM SOLAR DATABASE EVALUATION

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Abstract: As it was established by many other researchers, climate and solar radiation has impact both on system supply and on system demand: designers need both solar data and temperature data [1]. In this paper are presented the specific measurements of climate and solar radiation, from Bihor county, near Oradea, in order to determine the photovoltaic potential. The study includes measurements of: temperature, solar radiation, for two summer month: July and August. The result is compared with the one's obtained using simulation soft. Temperature affects the performance of photovoltaic devices per se. Long series of daily data are needed for sizing and modelling of stand-alone systems and effective statistical approaches have to recognize the links between solar radiation data and temperature data.

Key words: solar energy, solar radiation, temperature, photovoltaic potential.

1. INTRODUCTION

Regarding the solar radiation, Romania is placed in the European zone in category "B". In South of Romania the yearly solar radiation is 1450 – 1750 kWh / m^2, being the best value for solar installations. The greater values as 1450 kWh / m^2 are in Oltenia, Muntenia and South of Moldova. Zone of 1300 – 1450 kWh / m^2 are in regions of Carpathians and Muntenia, all part of Transylvania the middle part and North of Moldova and all part of Banat. In regions with mountains the value of the solar radiation is between 1150 – 1300 kWh / m^2. [1].

From analyse of Romanian solar map, results that the average yearly flux of incident solar radiation on horizontal surface generates 5 zones. These zones are different regarding the yearly average incident solar energy. It is seen that a more of half part of the surface has an average annually flux of 1275 kWh m^2. The zones with interest are:

- The first area includes surfaces with the highest potential, covering the zone of Dobrogea, and a part of the Romanian Plain;
- The second area includes the North of Romanian Plain, Getic Plateau, Sub Carpathian in Oltenia and Muntenia, the most part of Danube Plain, the south and the centre of Moldavian Plateau, the West Plain and Hills also the Transylvanian Plain, where the solar radiation is situated between 1300 and 1400 MJ / m^2.
- The third area with moderated potential below of 1300 MJ / m^2, covering the most part of Transylvanian Plain, the North of Moldavia Plateau.

The utilization efficiency of the solar energy is negative influenced by light losses through diffusion, reflection, absorption, in case of precipitation, of the wind and temperature.

The potential of radiation depends on the unit of temporally space where the potential is considered [2,3].

The solar radiation has a spectrum in domain of 200 and 3000 nm:

- Infrared radiation > 780 nm;
- Visible light 380 – 780 nm;
- Ultraviolet radiation < 380 nm.

The factors which influence the solar energy potential are those meteorological and geometrical.

The meteorological factors are:

- Effective time of sunshine, named as insulation period [hours / year];
- Average number of days with sunshine [gays / year];
- Solar radiation intensity Ig, $I_g(E_g) = I_D + I_d$ where, I_D is the diffuse component and I_d is the direct component.

In applications based on thermo conversion are considered both components as in photoelectric applications, only the direct component is considered.

The solar intensity explains the size of the photocurrent that is maximal when the sun shines with 1.0 sun, maximal. In a partial clear day, the photon current decreases direct proportional with the solar intensity.

2. THE INTENSITY OF SOLAR RADIATION

The photocurrent has maximum value when the sun shines clear (1.0 sun). When the sky is partial cloudy, the current of photon decreases with the intensity of the solar radiation. So, the characteristic of current and voltage, I – V, decreases to a low solar intensity. In the open circuit the decreases of the voltage is low (fig.2).

In the cell, the efficiency of the light conversion is insensible to the solar radiation in the operating domain. From fig.1. for example, can be observe, that the efficiency in fact is the same at 500 W/m^2 as at 1000 W/m^2. This means that, the efficiency of the conversion in a day with sun is the same with the efficiency of the conversion in a cloudy day. In a cloudy day, it is obtaining a lower power due to some lower energy that has effect on the cell.

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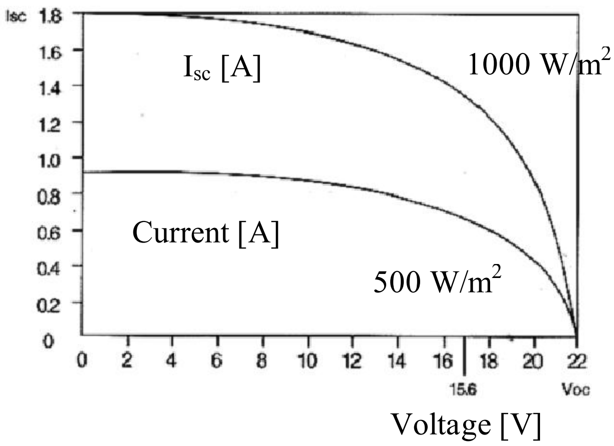

Fig. 1 –Characteristics of the cell when the intensity of the radiation is 1000 W/m^2 and 500 W/m^2, at temperature of 25°C

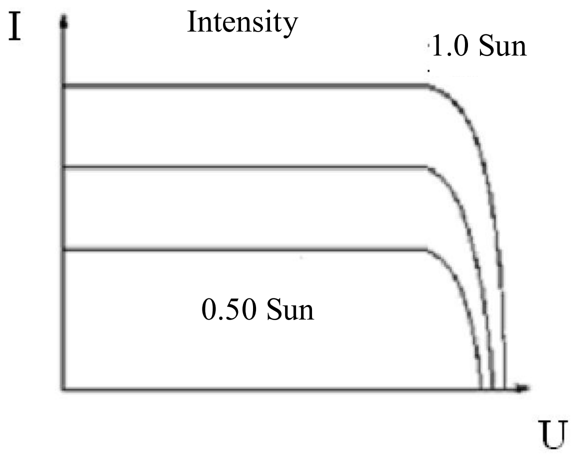

Fig. 2 – Current – voltage characteristic of the cell with a reduced intensity of solar radiation

3. MEASURING THE SOLAR RADIATION IN AREA OF ORADEA

In the following part of the study there are given the measured values obtained with pyrheliometer. The measurements were made in period of July – August 2009. The values were noted then compared with those obtained with software Homer, for the same period.

With the software HOMER, basing on the solar resources is defined the horizontal global radiation in function with the daily radiation and with the index of clearness.

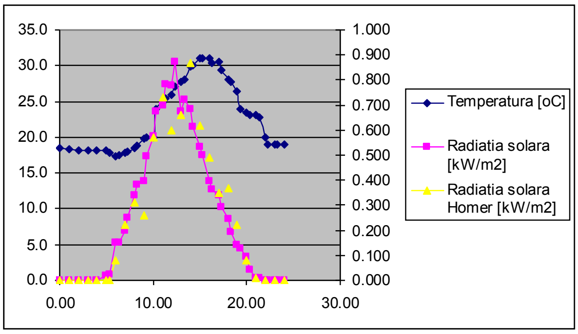

Fig.3 – Variation of the solar radiation and of temperature in 01.07

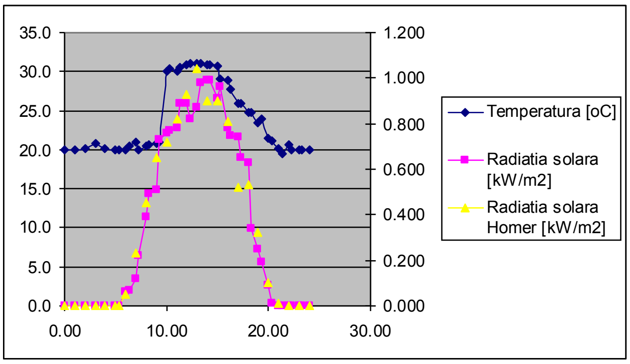

Fig.4 - Variation of the solar radiation and of temperature in 14.07

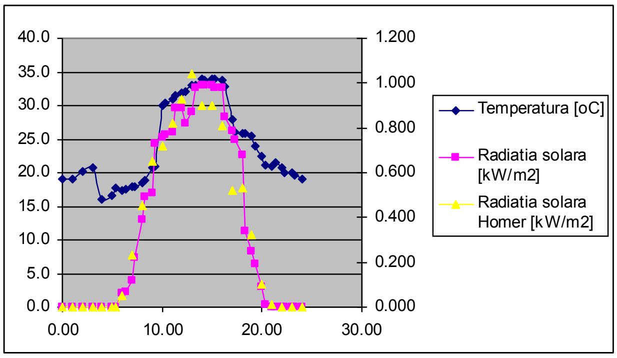

Fig.5 - Variation of the solar radiation and of temperature in 15.07

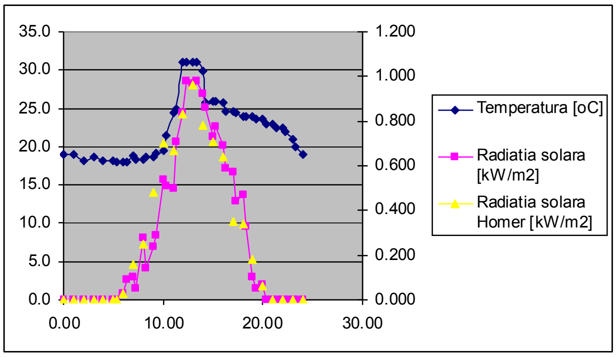

Fig.6 - Variation of the solar radiation and of temperature in 30.07

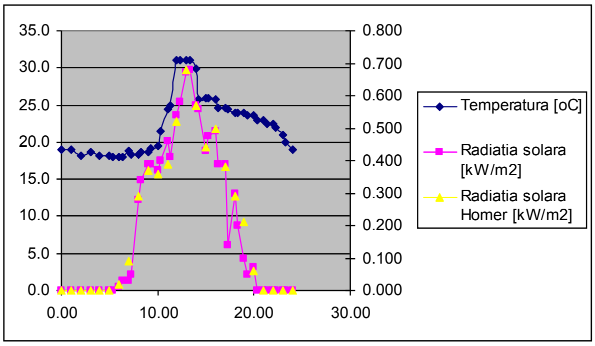

Fig.7 - Variation of the solar radiation and of temperature in 08.01

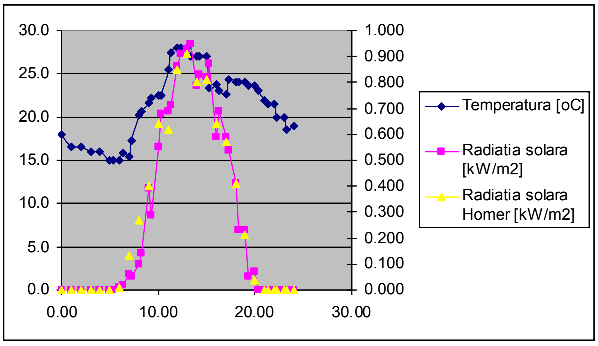

Fig.8 - Variation of the solar radiation and of temperature in 08.14

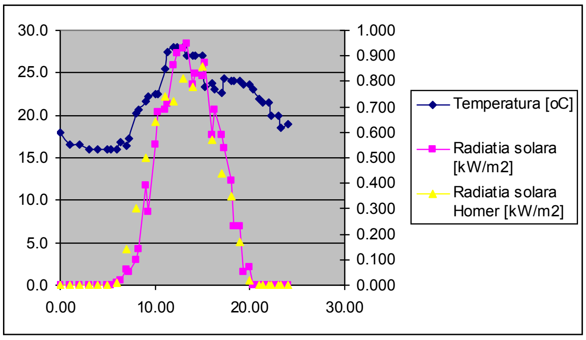

Fig.9 - Variation of the solar radiation and of temperature in 08.15

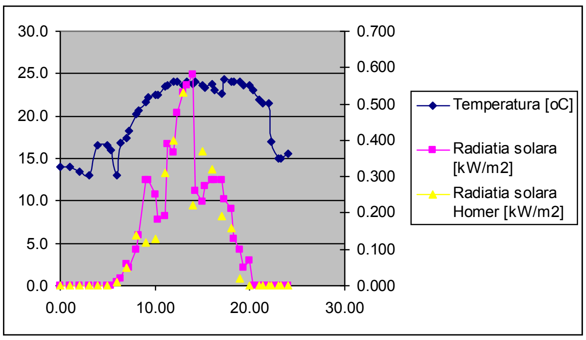

Fig.10 - Variation of the solar radiation and of temperature in 08.31

From the above graphics can be observed the variation of the solar radiation intensity for the days when the measurements were made. The measured values and the values obtained from the simulation are very close each to other, the difference between 0.5 – 0.8%.

The required data in the software are introduced, such as the latitude and longitude for the studied place. In the simulation were introduced the geographical data for Oradea and time zone for GMT + 02 East Europe.

In figure 11, there are given the monthly average values for the clearness index and the daily radiation and basing on these values was plotted the presented graph.

For the daily average radiation it was obtained 3.42 kWh / m^2 / day. In figure 11, near the graph is given the data which refers on the clearness index calculated for each month of the year and it is given the average value for a year, being equal with 0.482.

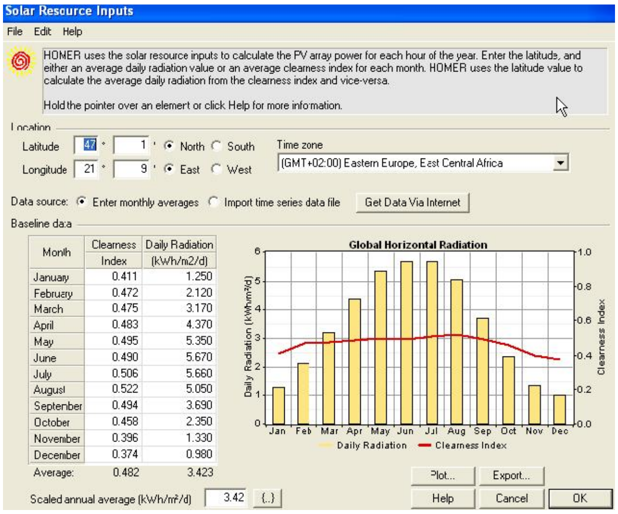

Fig.11 – Average daily value of daily radiation and the clearness index

In figure 12 there is plotted the characteristic of the global solar versus incident solar, measured in July 2009.

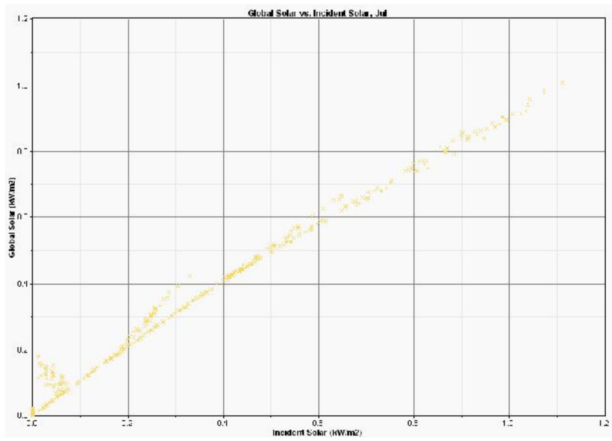

Fig.12 – Representing the solar global radiation versus incident solar for July 2009

In the figure 12 can be seen that the maximum value of 1.0 kW/m^2 the solar irradiation is attained when the irradiation has a value above 1.1 kW/m^2/h.

In figure 13 is given the global radiation for July.

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Fig.13 – Representing the solar global radiation for July 2009

In the following figure, fig.14, is given the value of the solar radiation for two months, July and August. It can observed, that the value of the solar radiation is 1.0 at 0.9 kW/m^2.

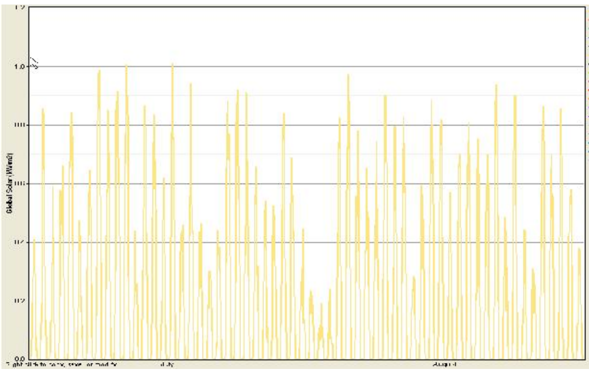

Fig.14 – Representing the solar global radiation for July – August 2009

Making a comparison of the two diagrams representing the global radiation for Region of Oradea, results that for July its value exceeded 1 kW/m^2, as in August has a value under 1.0 kW/m^2.

In the next figure, fig. 15, are plotted the values of solar radiation for a period of one year.

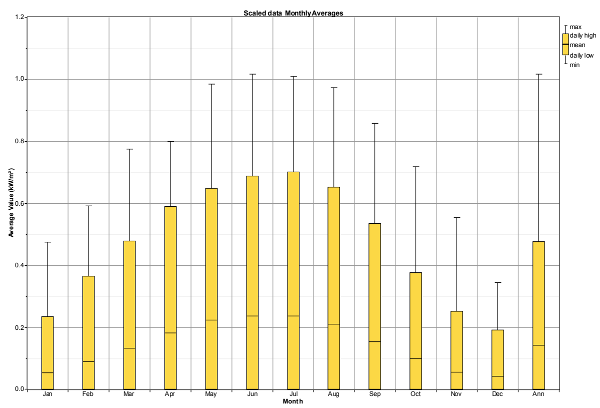

Fig.15 – Representing the yearly solar global radiation

In figure 16, is given the value of the obtained power by a PV versus global horizontal solar radiation for the days of the year.

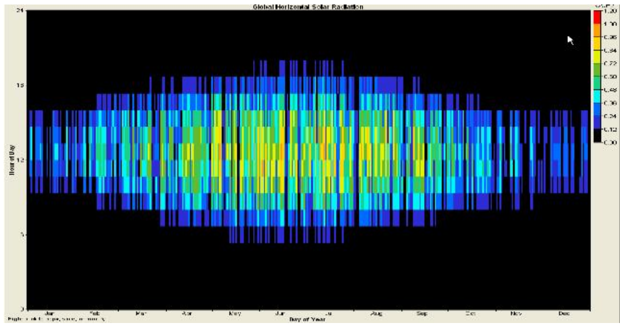

Fig. 16 – Global horizontal solar radiation versus the hour of a day

From the diagram of fig.16, results that for a zone, in our case Oradea, with a longitude of 21^{o}9' and latitude 47^{o}1', the value of the horizontal solar between [0 – 0.96] kW/m^2.

4. CONCLUSIONS

The zone analysed in this study is Oradea, Bihor County, having the following geographical and meteorological characteristics: latitude 47^{o}1′ North, longitude 21^{o}9′ East, annual average clearness index is 0,482, average daily radiation 3.423 kWh / m^2.

Basing on the measurements, made in the zone of study can be observed that the measured values are in concordance with the obtained from the simulation. In some cases, exist difference but these may be neglected.

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