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# Optimal Sizing and Simulation of PV System Production for Residential Building in Algeria

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***Abstract*— In recent years, the demand of energy electric for building is increased significantly. The using of photovoltaic (PV) energy will provide a substantial contribution to satisfy energy building. In this paper, we use a tool for sizing and simulation (SOLAIRE) for assessing and estimating PV production for a residential building at Skikda, Algeria (Latitude: 37.034°N, Longitude: 6.415°E).**

***Keywords*— Photovoltaic; optimal sizing; simulation; building; Solaire software.**

## I. Introduction

Today, the power consumption in the residential and tertiary sector occupies the largest part is approximately (60%) of total electricity consumption. As well as, with increasing emission of greenhouse gases due to fossil sources, it's imperative for us to search for new and clean sources, to reduce gas emission and satisfy the high demand of energy.

Photovoltaic energy considered free renewable source non-polluting which depends essentially on sunlight. Earth receives about $3.8 \times 10^{24}$ J of solar energy on an average which is 6000 times greater than what we consume in the word [1]. This whole amount of energy attracted attention of scientists and researchers for exploitation this energy. The photovoltaic energy is based on conversion of irradiation to electricity by using solar panel [2]. However, the photovoltaic power generation and its availability require a phase of simulation and sizing, which allow us to estimate end enhance the efficiency of this energy. [2] Use of Solar PV Planner software as a tool to analyze the performance of 110 $kW_p$ grid-connected photovoltaic system for residential building, in [3] the simulation of a PV system was performed to optimize its performance through parametric analysis.

## II. Site presentation

The site selected for the study is located in rural region in west of Skikda, Algeria (Latitude: 37.034°N, Longitude: 6.415°E).


Fig.1. Photographer of the region of Skikda.

## III. Global Irradiation Data

There is tow essentials parameters must take into consideration before performing the PV simulation on the preselected site [4].

- Site Parameters: irradiation and site temperature.
- Technical Parameters: Provided by PV Planner user, otherwise default values are taken into consideration.

TABLE I
Monthly Data of Global Irradiation

| month | Eh(0°) (wh /m²/j) | E Optimal (wh/m²/j) | E(30°) (wh/m²/j) | Optimal Angle(°) |
|---|---|---|---|---|
| **Jan** | 2280 | 3510 | 3490 | 60 |
| **Feb** | 3080 | 4230 | 4210 | 52 |
| **Mar** | 4740 | 5710 | 5700 | 40 |
| **April** | 5470 | 5830 | 5840 | 24 |
| **Mai** | 6080 | 6480 | 6510 | 11 |
| **Juin** | 7770 | 7170 | 7210 | 5 |
| **July** | 7950 | 7510 | 7550 | 8 |
| **Aout** | 6960 | 7170 | 7190 | 19 |
| **Sept** | 5240 | 6100 | 6090 | 35 |
| **Oct** | 3930 | 5240 | 5210 | 48 |
| **Nov** | 5210 | 3750 | 3720 | 58 |
| **Dec** | 2010 | 3210 | 3180 | 62 |

A. *Average Daily Solar Irradiance*

Inclination of plane: 30 deg.
Orientation (azimuth) of plane: 0 deg.

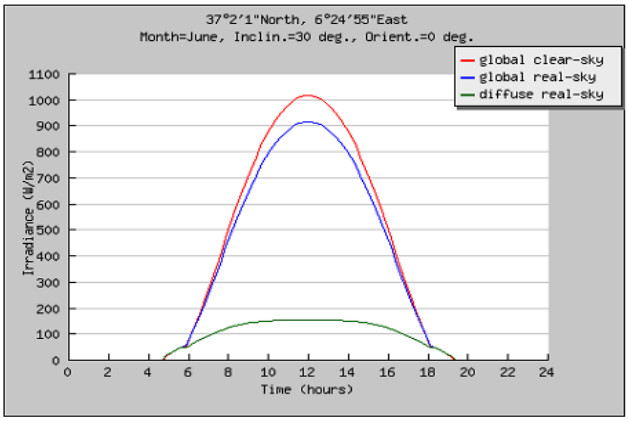


Fig.2 Daily Irradiance on a fixed plane

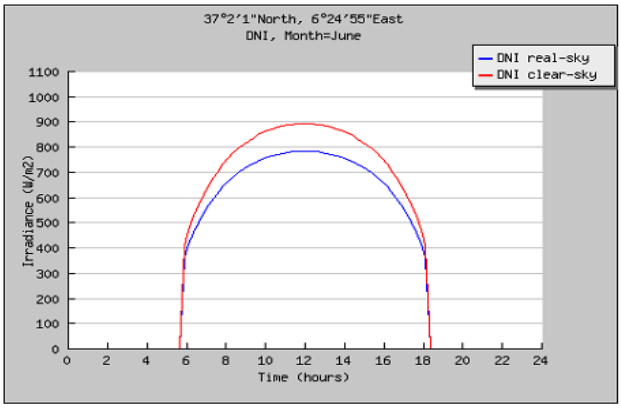


Fig.3 Direct normal irradiance

A. *Average Monthly Solar Irradiance*

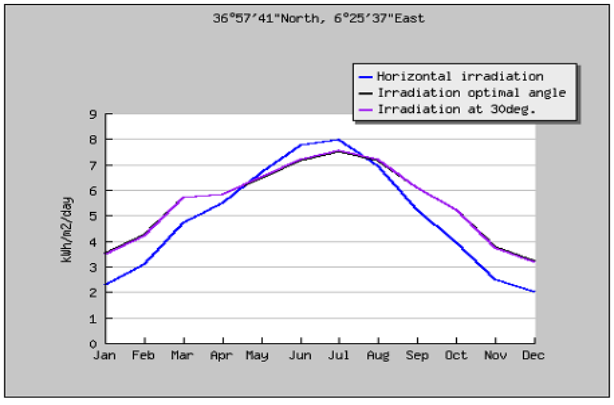


Fig.4 Annual irradiation at different inclination angle

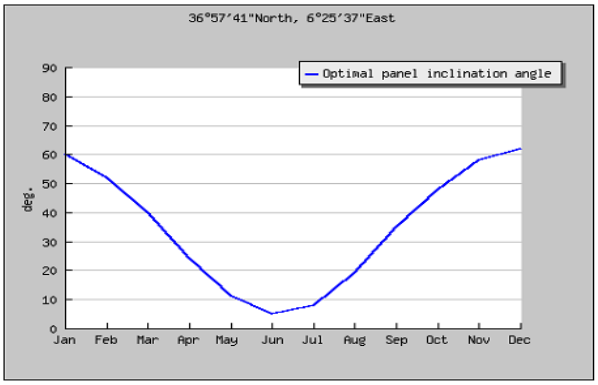


Fig.5 Optimal inclination angle of the solar panel

## IV. Estimate the Photovoltaic Power Generation

TABLE III
DATASHEET OF PV PANEL GENERATOR

| | |
|---|---|
| **Solar data base used** | PVGIS-CMSAF |
| **Nominal power of the PV system** | 4.0 kw |
| **Estimated losses due to temperature and low irradiance** | 14.3% |
| **Estimated losses due to angular reflectance effects** | 3.3% |
| **Combined PVsystem losses** | 28.7% |
| **Other losses (cables,inverter ect)** | 14% |

One of the main factors that affect on performance of the power photovoltaic produced is the inclination panels. In our study, we did the simulation at different angle of inclination, the obtained results are summarized the table (III).

TABLE IIIII
ESTIMATING MONTHLY POWER GENERATION

| month | P (0°) (kwh/j) | P (0°) (kwh/m) | $P_{optimal}$ (kwh/j) | $P_{optimal}$ (kwh/m) |
|---|---|---|---|---|
| **Jan** | 6.33 | 196 | 11.30 | 351 |
| **Feb** | 8.57 | 240 | 13.80 | 608 |
| **Mars** | 13.30 | 414 | 19.60 | 618 |
| **April** | 15.40 | 461 | 20.60 | 737 |
| **Mai** | 18.50 | 573 | 23.80 | 814 |
| **Juin** | 21.10 | 633 | 27.10 | 862 |
| **July** | 21.20 | 658 | 27.80 | 809 |
| **Aout** | 18.60 | 577 | 26.10 | 631 |
| **Sept** | 14.30 | 430 | 21.00 | 545 |
| **Oct** | 10.90 | 337 | 17.60 | 367 |
| **Nov** | 6 .96 | 209 | 12.2 | 335 |
| **Dec** | 5.67 | 176 | 10.80 | 589 |

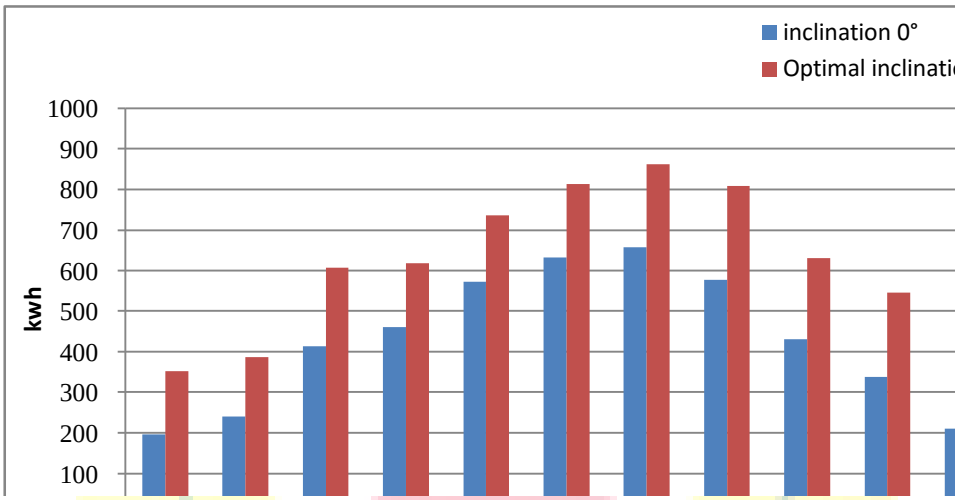


Fig.6 Comparing the power generation on optimal inclination and angle (0°)

## V. Estimate the Need of Electrical Loads

In our study, we chose an apartment at region of Collo (west of Skikda) which the majority of loads are powered by electrical energy. The table (IVV) summary and describe the loads provided in this apartment and their nominal power for each load.

For calculate the power consumption on Kwh for each electrical appliance, it must take into account tow parameters:

- The power of our electrical appliance expressed on watt (W).
- The number of hours per day that the device works (h).

*Daily consumption= [number of hours of use]x[power of device]*

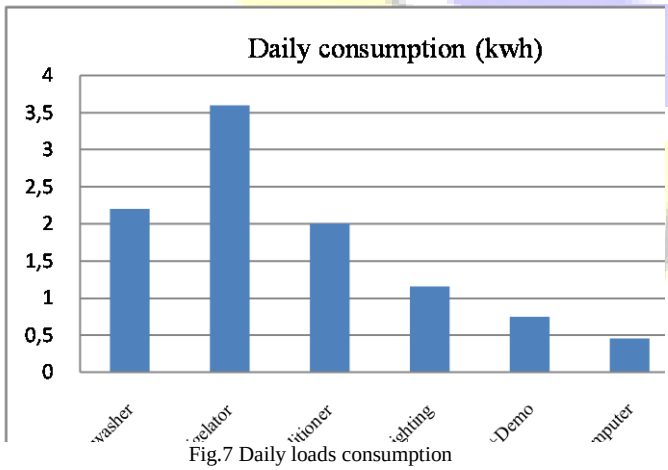


Fig.7 Daily loads consumption

TABLE VV
Estimated Daily Energy Consumption

| | | Power(w) | Time of use (h) | Consom jour (wh) |
|---|---|---|---|---|
| Lighting | **Room1** | 50 | 4 | 200 |
| | **Room2** | 50 | 4 | 200 |
| | **Kitchen** | 50 | 6 | 300 |
| | **Living room** | 3X18 | 4 | 216 |
| | **Hallway** | 2X34 | 2 | 136 |
| | **Bathroom** | 50 | 1 | 50 |
| | **WC** | 50 | 1 | 50 |
| Equipement | **Air-conditioner** | 1000 | 2 | 2000 |
| | **Refrigelator** | 150 | 24 | 3600 |
| | **Washer** | 2200 | 1 | 2200 |
| | **TV LCD** | 110 | 5 | 550 |
| | **Demodulator** | 40 | 5 | 200 |
| | **Computer** | 150 | 3 | 450 |
| | **Other** | 200 | 2 | 400 |
| | **Total** | 10.55kwh/day | | |

## VI. Results and Discussion

The irradiation data play an important role for sizing and estimate the production of PV system. Data monthly irradiation represented on figure (4), which shows that the month of July is the sunniest (7.55kwh/m²) and the month of December the least sunny (3.18kwh/m²). The figure (6) illustrates the variation inclination angle which allows improving the efficiency of PV power production about (30%) then the fixed plan. The figure (8) represents the estimated monthly production of (4KW) of photovoltaic energy in the chosen region, which chows that energy is

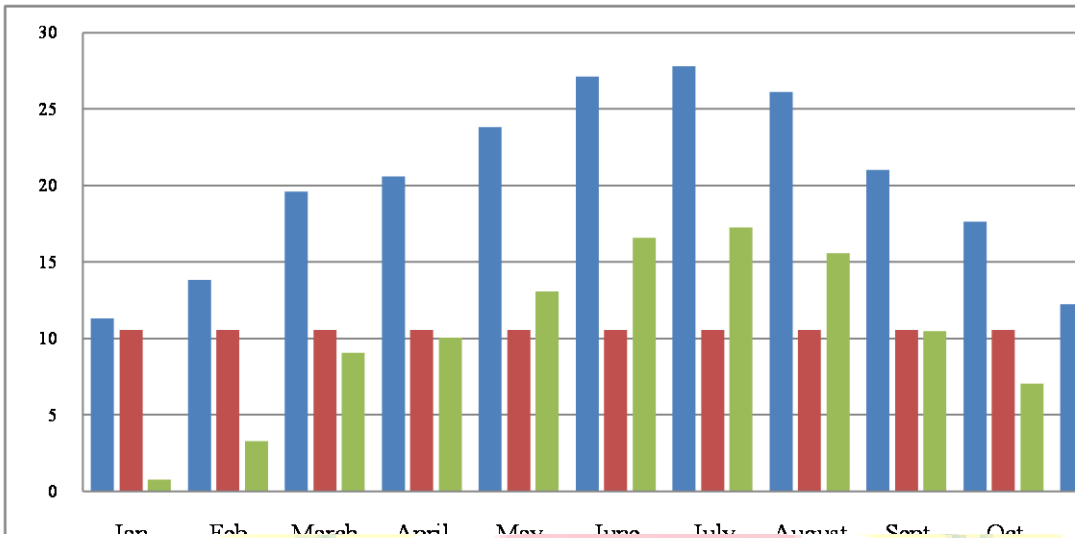


Fig.8 Estimate monthly production of (4KW) of photovoltaic energy.

sufficient to cover our need for the load energy demand of our building and also to store the surplus for using it during the absence of the sun.

## VII. CONCLUSION

The study that we have done in this paper is for estimating and evaluating the power generation of photovoltaic system in a rural area. In this study we have seen that the optimal inclination of photovoltaic panels improve the yield of power generation and this amount of energy sufficient to cover the demand of energy the residential building located in the region west of Skikda.

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