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Predict System Efficiency of 1 MWc Photovoltaic Power Plant Interconnected to the Distribution Network Using PVSYST Software

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***Abstract*— This research is a concept study for a photovoltaic power plant on an Algerian site, this plant is connected to the electrical distribution network of low or medium voltage. It follows that the study of system simulation in its entirety, would be used for this purpose the computer software PVSYST. Our work involves the design of 1 MWc photovoltaic plant in Aïn-melh M'sila where there favorable weather conditions. For system efficiency, we compare between structure with a fixed tilt and structure with Seasonal tilt adjustment. The results show that for fixed tilt There is a production of 1805 MWh/year injected into the grid with specific energy yield, 1744 kWh/kWc/year and performance ratio, 77.8 %, as for Seasonal tilt There is a production of 1893 MWh/year with specific energy yield, 1829 kWh/kWc/year and performance ratio, 77.8 %. This will allow us recover about 5% of production compared to fixed tilt plane.**

Keywords*— photovoltaic; power plant; simulation; PVsyst; specific energy yield; performance ratio;

I. Introduction

Algeria is located in one of the sunniest regions of the world, it has a strong capacity for producing electricity from solar energy. Especially in the desert and high plains which has a giant potential of solar energy can easily cover all the national need in term of electrical energy[1,2]. Furthermore The cost of photovoltaic plants and their components in continuous decrease[3,4]. All this encourages the creation of PV plants and investment in this area. Several configurations can integrate, but it will be retained the more efficient. The PV system is achieved by taking account not only the cost of installation, but also the annual energy production, specific product and performance ratio.

For that, we compare in this work Between fixed tilt plane end seasonal tilt adjustment photovoltaic plant efficiency using PVSYST software [5,6,7].

II. Methodology

The design of Solar power plant depends on many factors As the geographic Location, modules and inverters quality, orientation and inclination of solar panels[8]. The PVSYST software takes into account all these factors for An effective Sizing. System specification is discussed below:

A. Geographic and climatic resource

In this study, we choose the site of Aïn-melh M'sila (Latitude 34.8° N , Longitude 4.2° E).

To estimate the irradiation of the location, we use PVGIS solar resource [9] database, for temperature resource the website Weather Underground [10] provides real-time weather information via the internet.

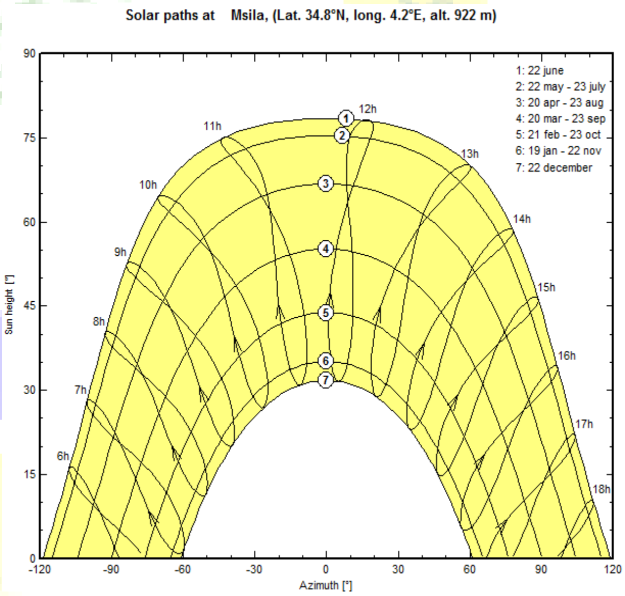

Fig. 1. Trajectory of the sun.

PVSYST uses the Perez model [5] to estimate incident radiation on a tilted plane This needs to enter monthly weather of Ain-melh location at PVSYST tools.

TABLE I represent The monthly weather characteristics which are the global horizontal irradiation (Gh), diffuse horizontal irradiation (Gd), average temperature (Tamp) and the wind speed (Vt).

TABLE I MONTHLY WEATHER

	Gh (kWh/m²)	Gd (kWh/m²)	Tamp (°C)	Vt (m/s)
January	3.05	1.04	10	3.10
February	3.95	1.22	12	2.77
March	5.50	2.03	13	4.16
April	6.26	1.87	19	3.88
May	7.11	2.13	23	2.49
June	7.67	1.84	27	2.77
July	7.53	1.88	31	2.77
August	6.80	1.76	32	1.67
September	5.30	1.69	28	1.40
October	4.52	1.40	22	1.95
November	3.34	1.10	14	3.10
December	2.72	0.92	10	4.45
Year	5.32	1.58	20.1	2.9

B. PV arrays

For optimal sizing we choose Si-poly YL250P-32b YINGLI solar polycrystalline panels with a maximum peak power output of P = 250Wc.

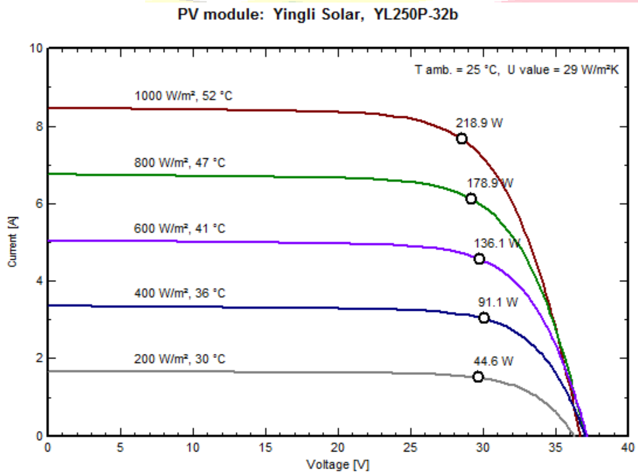

Fig. 2. Current/tension Characteristics

Fig. 3 and Fig. 4 showing irradiation and temperature effect

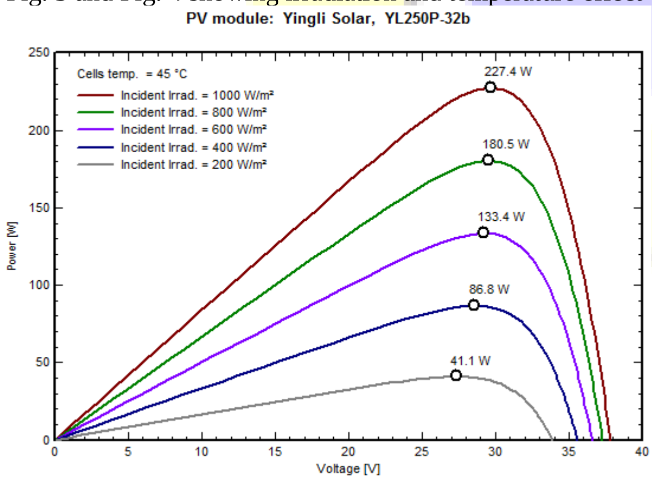

Fig. 3. P-V Characteristics :irradiation effect

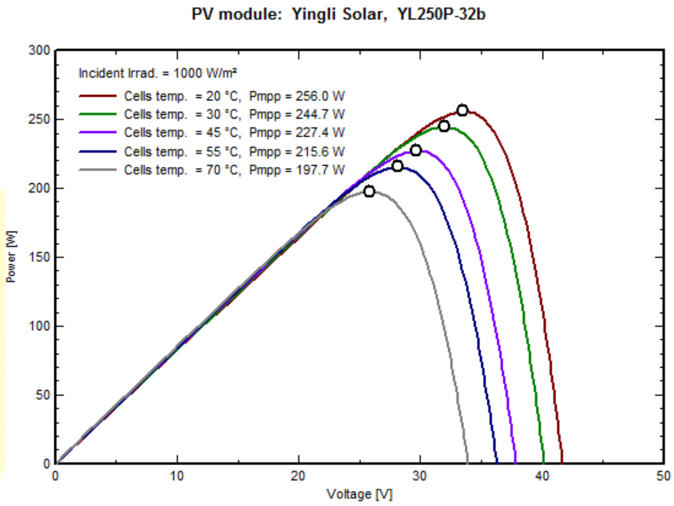

Fig. 4. P-V Characteristics :temperature effect

C. Inverters

For inverters we selected Sunny Central 100 outdoor HE, it's triphased grid-tied inverters from SMA company nominal power of 100 kW with an input voltage range between 450-820 V and maximum efficiency of 98.5 %.

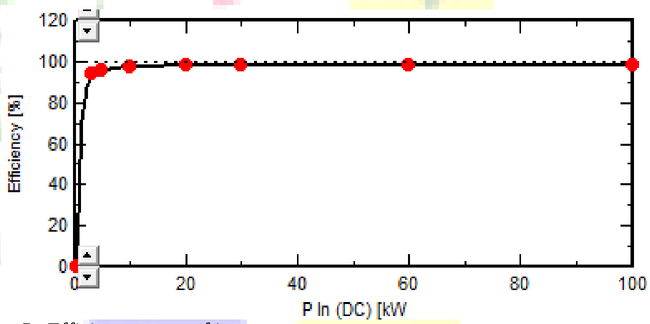

Fig. 5. Efficiency curve of inverter

D. System orientation

PVSYST showing optimization of system orientation for the two Structures studied

Fixed tilt plane : panels are facing south and are tilted with 33°

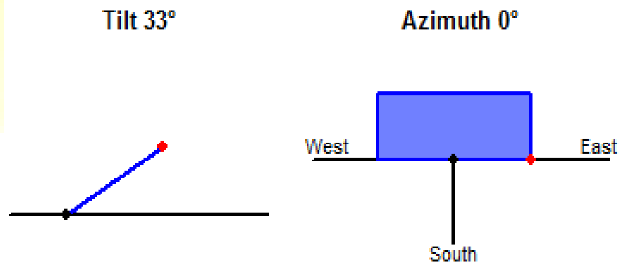

Fig. 6. Fixed tilt plane

Seasonal tilt adjustment : panels are facing south and are tilted with 10° for summer and 52° for winter.

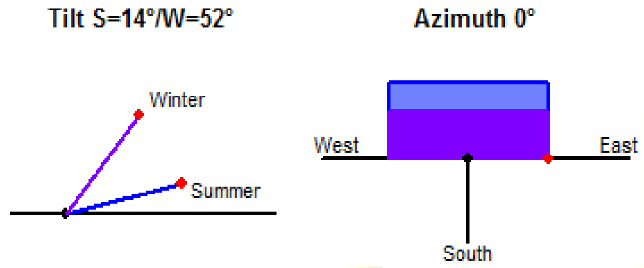

Fig. 7. Seasonal tilt adjustment

E. Description of the Plant

In this work, the proposed model of the plant divided it into 10 sub-systems Each subsystem contains 103.5 kWc : 18 panels in series and 23 string , one inverter of 100 kW. This result a system of 1013 kWc contains of 4140 photovoltaic panels and 10 inverters.

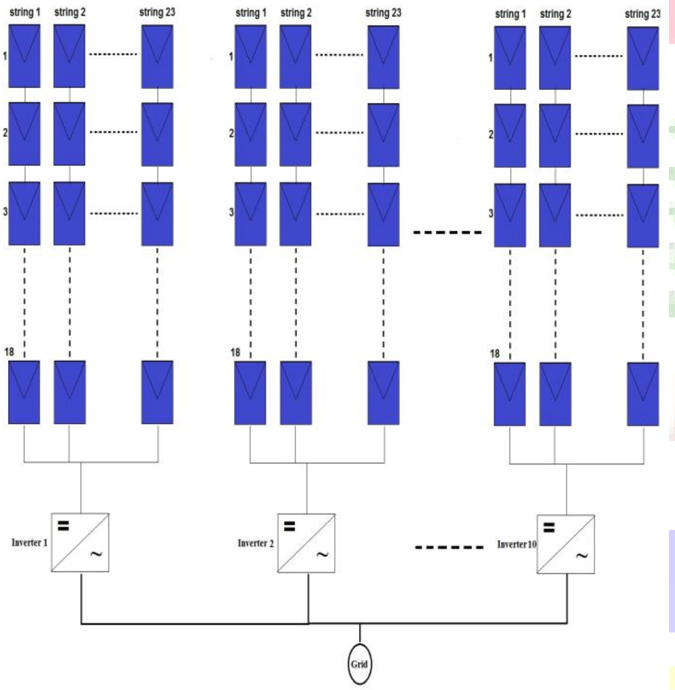

Fig. 8. The proposed model of the plant

III. Analysis of Results

Using PVSYST we carried out a comparative study between two configurations, the two simulations were performed in the same conditions and for the same geographic site. The graphs show the energy produced by each installation as well as the losses.

TABLE II represent a comparison of the main results between plant with fixed panels and seasonal tilt adjustment.

TABLE II COMPARISON OF MAIN RESULTS

	fixed tilt	seasonal tilt
Global Horizontal Irradiation (kWh/m²)	1942	1942
Ambient Temperature (°C)	20.1	20.1
Global incident Irradiation (kWh/m²)	2242	2350
Effective Global ,corr for IAM and shadings (kWh/m²)	2176	2287
Energy at the output of the array (MWh)	1835	1924
Energy injected into grid (MWh)	1805	1883
specific energy yield (kWh/kWc/year)	1744	1829
performance ratio (%)	77.8	77.8
seasonal tilt system compared to fixed tilt (%)	–	4.87

We note that for a fixed tilt plane the energy injected into grid around 1805 MWh/year, which represents approximately 88 MWh/year of difference compared to a system with seasonal tilt adjustment.

The simulations with PVSYST Also identifies the losses at Each part of the system, Fig 9, Fig 10 showing loss factors and Normalized production.

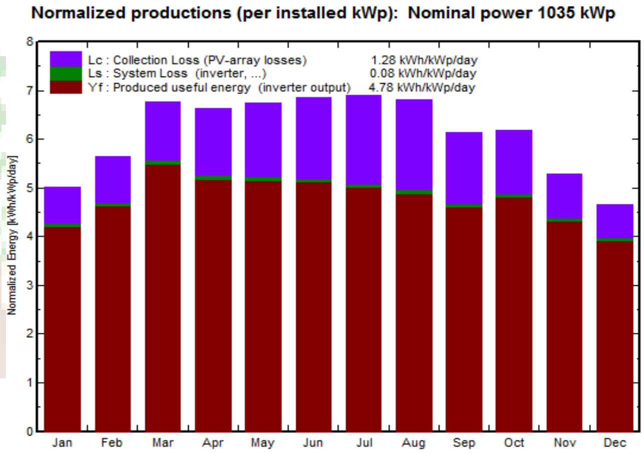

Fig. 9. Loss factors and Normalized production : fixed tilt

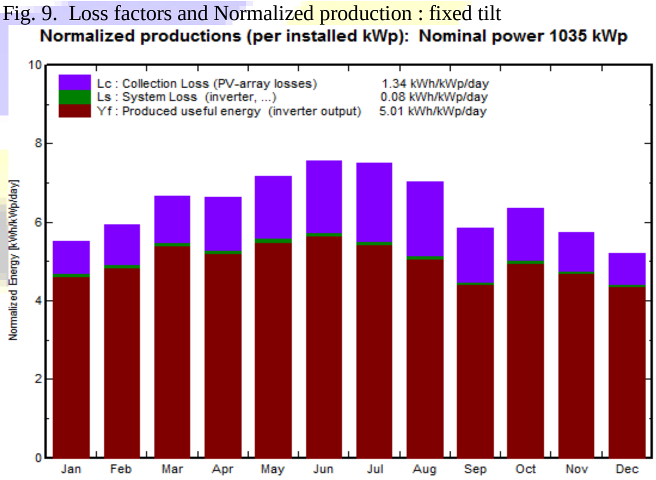

Fig. 10. Loss factors and Normalized production : seasonal tilt

Diagrams below Shows system losses with more precision and detail.

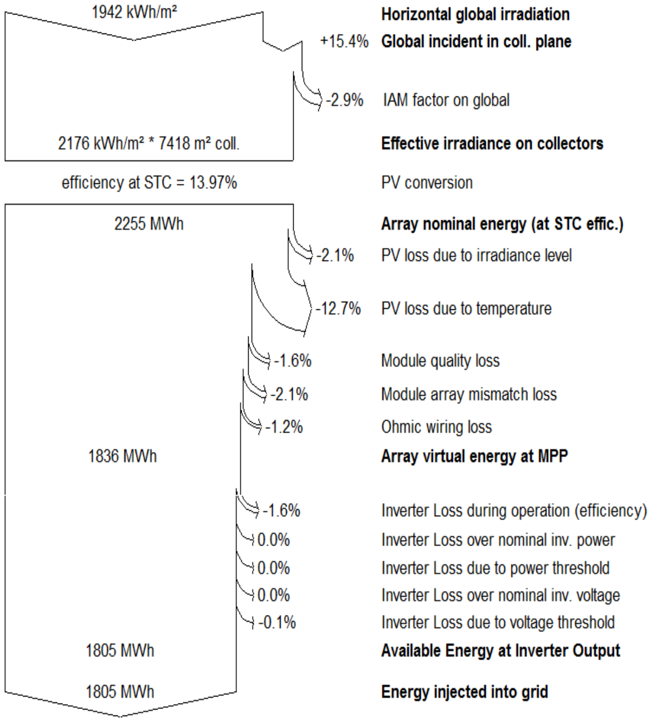

Fig. 11. Diagram of system losses: fixed tilt

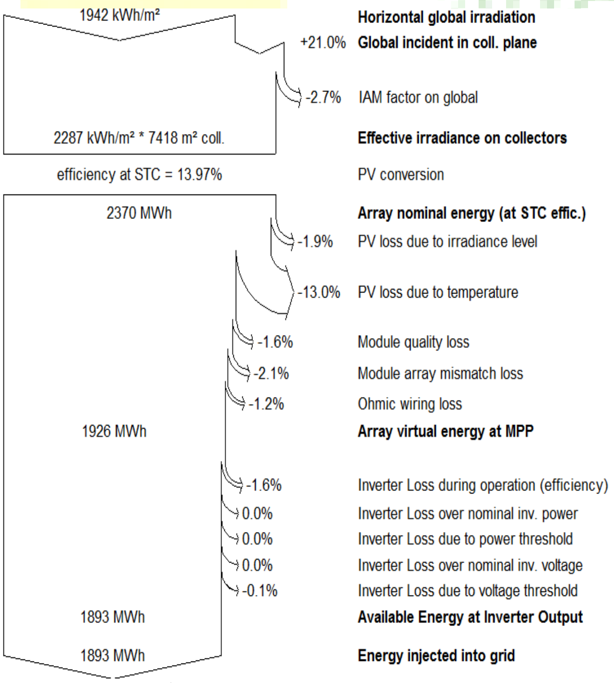

Fig. 12. Diagram of system losses: seasonal tilt

Global incident irradiation on the seasonal tilt adjustment structure is higher than fixed tilted about 6 % .
Due to the effect of Incidence Angle Modifier (IAM) the global incident irradiation reduced for almost of 3 %.

Otherwise, there are an effective loss in the system due to many Factors : quality and mismatch of panels, conduction resistance, inverter losses But primarily because of The effect of The high temperature in the region of Aïn-melh . All these Factors decrease about 20 % of production.

IV. Conclusion

In this work We studied the feasibility of a photovoltaic power plant situated at an Algerian site. The results of PVSYST show that: a PV plant of 1 MW produced significant energy. This because of the giant potential of solar energy. Despite of the losses specially resulting from the high temperature effect.

For more efficiency seasonal tilt adjustment allows us for a different summer and winter tilt in order to maximize production and to allow an increase of 5 % compared to the fixed tilt production.

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