Specific Cost Development of Photovoltaic Solar Systems Depending On the Global Irradiation for M.P. A Study Performed With the Simulation Environment

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***Abstract*— Energy is prime requirement of any Nation and with significant consumption of Fossil fuel one had to find technology improvements and cost reductions for using, renewable Energy. The rate of solar PV is expected to be competitive with peak electricity price by 2020 and with other fossil based generation possibly a few years later. The 'Cumulative Capacity, Grid Parity and specific Costs development' of PV based electricity generation Plant estimates the ever-increasing PV use in the country by using diffusion curves. Standalone or Grid-connected solar PV could range anywhere from 5,000-12,000 MW by 2020. Using Techniques of cost reduction for installing a PV based power plant provide affordability to medium and small enterprises to harness the Energy from Sun. By using learning curves, projecting the cost of solar PV system from today's `Cost (the system cost is an assumption), is ought to come down to by the year 2020 or lower (what we assumed today). India has a large Potential to harness solar Energy but yet the current status of SPV based generation plant in India is very less as compared globally only because of less technical study is made to promote photovoltaic technology to generate electricity; it is difficult to anticipate how this technology will unfold.**

***Index Terms*— Solar irradiation, inclined surfaces, tilting angle, diffuse radiation, Cost assumption.**

I. INTRODUCTION

Solar Photovoltaic Technology today is full with certainties but the increased capacity addition is likely fairly low. Madhya Pradesh Urja Vikas Nigam (MPUVN) has been setting up decentralized solar photovoltaic applications in the rural areas of Madhya Pradesh for the last ten years. MPUVN has set up solar Photovoltaic power plant of 100 KW capacity grid connected system. This is already started and has assigned to M/s Tata B P Solar, India. This project at village Jaitpur Kalan of Rajgarh district in Madhya Pradesh.

A. Global Solar Radiation

The average solar radiation incident over India varies from 4 kWh/day - 7 kWh/day. The solar radiation received over the Indian land area is estimated to be about 5,000 trillion kWh/year. For setting up a solar PV power plant calculation of various parameter of site location are very important, like solar irradiation, Radiation onto horizontal surface, Radiation onto tilted surface and wind speed for particular place. In this paper the work is carried out for 100 kV solar PV plant situated at Rajgarh M.P. Fig 1 shows the total world energy consumption, which emphasis on use of renewable sources of energy.

There are various methods through which one can measure solar radiation for any particular site. The hourly solar radiation data requisite for solar PV system design estimation and performance studies is usually not available for a number of sites especially in interior locations. As such exact determination of hourly solar radiation data, is important both at horizontal; surfaces and inclined surfaces. A model to estimate global solar radiation using sunshine hour data & Temperature has been developed using (Gueymard [2]) which is used to calculate the hourly solar radiation Data. The hourly solar radiation has also been calculated using (Chandel et al. [4]) daily integration approach from the measured daily solar radiation data. When Comparison made predicted hourly solar radiation data values with measured hourly values to test the accuracy of the models. The predictable values are established to be in close agreement with measured values.

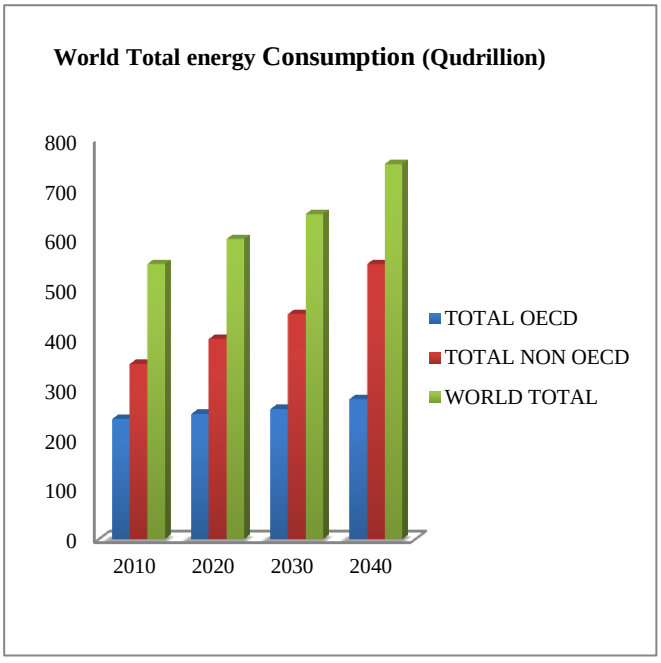

Fig: 1 graph showing energy consumption

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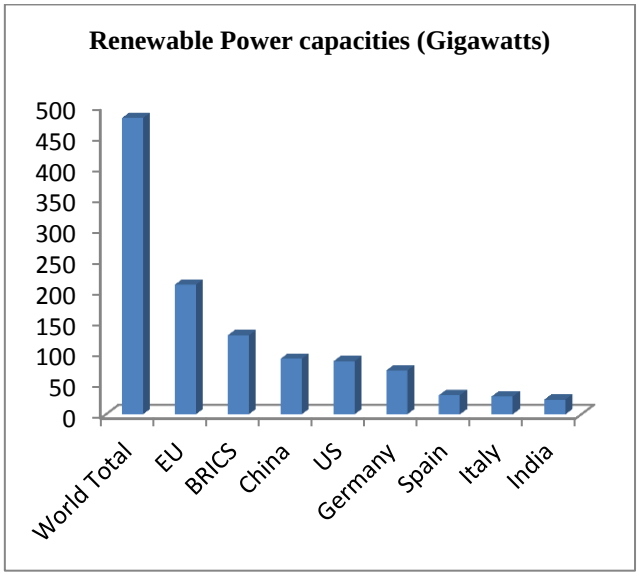

Fig: 2 Graph showing Renewable capacities of different nations

B. Solar power

The best way to deliver maximum cost benefits with minimum fuss is by installing the unique PV Energy Solar system. The photovoltaic cells in the solar panels capture sunlight using semiconductor materials (silicon) and convert it into electricity. Minister of India in January 2010, with a target of 20,000 MW grid solar powers (based on solar thermal power generating systems and solar photovoltaic (SPV) technologies), 2000 MW of Off grid capacity including 20 million solar lighting systems and 20 million sq.m. Solar thermal collector area by 2022.Table 1 shows the capacity addition in solar PV generation plant under JNNSM.

JNNSM Capacity addition target			
	Phase 1 (2009-13)	**Phase 2 (2013-17)**	**Phase 3 (2017-22)**
Utility grid power including roof top (MW)	**1100**	**4000-10000**	**20000**
Off grid installation (MW)	**200**	**1000**	**2000**
Solar collectors (million square meter)	**7**	**15**	**20**

Table: 1 JNNSM Target for year 2020

II. Methods of Investigation

2.1. Measurements of global solar irradiation

2.2. Determination of hourly solar irradiance on an inclined surface.

III. Site, System And Costs Specifications

A. Simulated sites

100 Kw Solar Pv Power Plants situated at village jaitpur Kalan Rajgarh Madhya Pradesh. Rajgarh District extends between the parallels of latitude 230 27' 12" North and 240 17' 20" North and between the meridians of longitude 760 11' 15" and 770 14' East. Project design specifications of site were shown in table 2.Geogripical site parameters were shown in fig 3.

Plant established	July, 1998
Electricity generation	From October,1999
Design company	Tata BP Solar India, Ltd Bangalore
Plant capacity	100 kWp at STC
Total project cost	Rs 370 lac (Central Govt: Rs 200 lac & State Govt: Rs 170 lac)
Nominal peak power	75W
Nominal peak voltage	12V
Peak operating voltage	17V

Table: 2 project site specification

B. Geographical site parameter

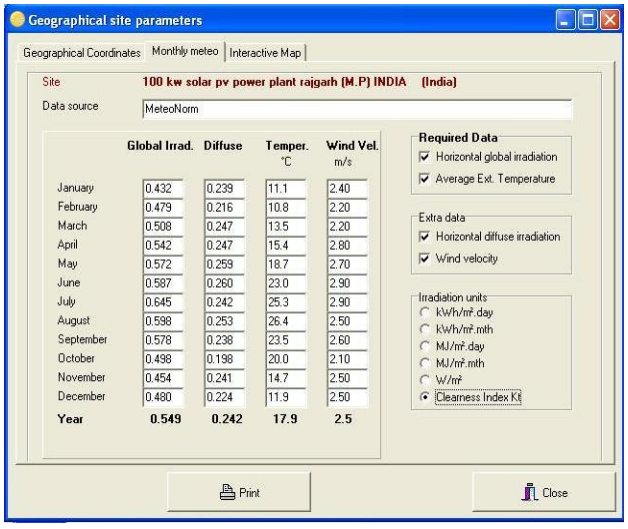

Fig:3 Geographical site parameter for project site

IV. PV System efficiencies: Economic

Efficiency Calculation – Basic Parameters

A. Assessment Period:

Only complete years, not including the year in which the system starts operation, should be entered for the Assessment

Period. The Assessment Period should be based on the investment with the shortest Service Life.

If the Service Life of an investment is less than the Assessment Period, the investment will have to be repurchased.

If the Service Life of an investment is greater than the Assessment Period, the investment will have a residual value at the end of the Assessment Period, which is included in the capital value calculation.

B. Interest on Capital:

The Interest on Capital can be entered as the Rotating Internal Rate of Return. The Rotating Internal Rate of Return is the average yield from fixed interest bonds. The funded Bank determines this from the average yields on outstanding debt securities. The Rotating Internal Rate of Return is therefore a measure of the interest level on the bond market.

C. Value Added Sales Tax

This entry field does not influence the calculation, but is there to make clear that all amounts should be entered either with or without sales tax. As a rule, all amounts should be entered as net sums. However, if you enter a gross amount, you should make sure that all entries are gross.

1) 4.4 Estimating Solar Electric (PV) System Size to Replace a Specified Amount of Utility (grid) electricity

PV System Capacity Required (kW of PV) can be roughly calculated as follows:

Annual electricity usage = Monthly Usage x 12 months. Electricity usage is express in kilowatt hours (kWH)

KW of PV = (Annual Usage) / (78% x kWh/kW-year from Solar Radiance chart below)

Energy production from a solar electric (PV) system is a function of several factors, including the following ... the "78% used above assumes the following losses across the PV system

D. Costs assumptions

FACTOR	ASSUMPTION
SOLAR RESOURCES	ASSUMED SOLAR AVAILABILITY: AS PER PV WATTS
SOILING OR CONTAMINATION OF THE PV PANELS	CLEAN, WASHED FREQUENTLY: 98% DESIGN SUNLIGHT TRANSMISSION
TEMPERATURE	25C, CALM WIND
SYSTEM CONFIGURATION (BATTERY OR NON-BATTERY)	NON-BATTERY
ORIENTATION TO THE SUN	TILTED AT YOUR LATITUDE, SOUTH FACING
PV ENERGY DELIVERED AS % OF MANUFACTURERS RATING	95%
WIRING & POWER POINT TRACKING LOSSES	9% (91% DELIVERED)
INVERTER EFFICIENCY	90%
TOTAL ENERGY DELIVERED	95% X 91% X 90% = 78%

Table: 3 Shows various cost assumption parameters

Renewable energy projects were financed by government and subsidies were provided to encourage use of renewable energy based power plant. Case study is required for site where plant is to be installed which includes all calculation mentioned in this paper. Table 3 shows various cost assumption parameters for particular site.

V. SIMULATION RESULT

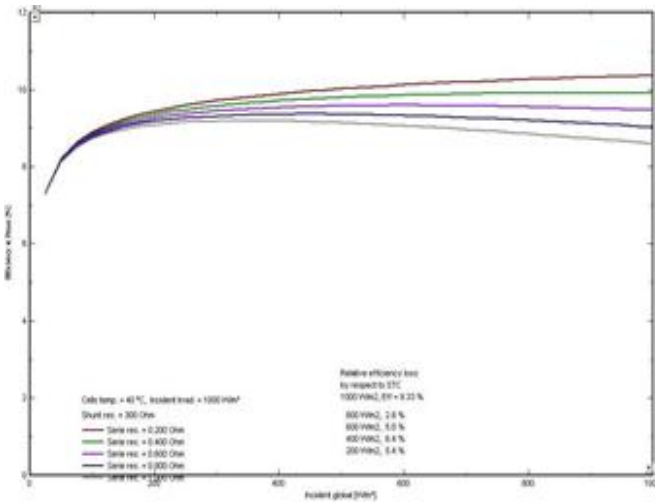

Fig: 4 I-V graph curve parameter incident irradiance

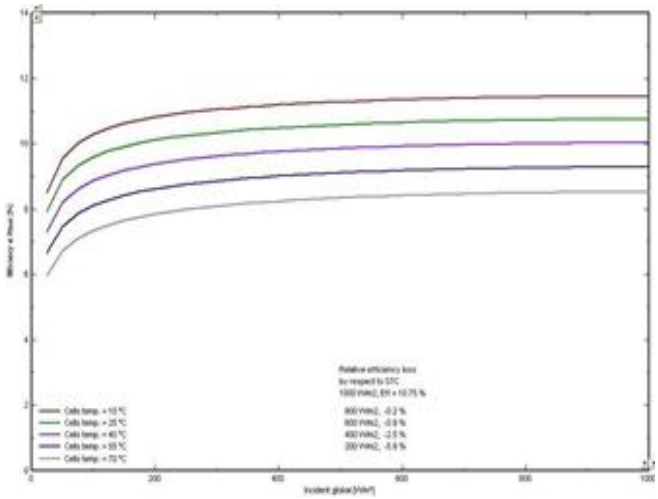

Fig: 5 Efficiency vs. irradiance graph curve parameter temperature

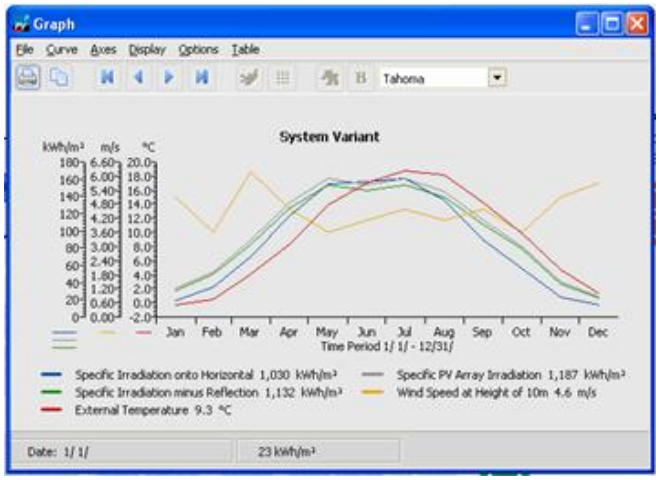

Fig: 6 simulation result based on varying solar isolation for site

VI. CONCLUSIONS

The global solar irradiance on horizontal surfaces has been measured. A computer model has been prepared to calculate the monthly average daily solar irradiance and hourly solar irradiance on inclined surfaces from the global solar irradiance. The hourly diffuse solar radiation and the average monthly daily diffuse solar irradiance are estimated.

The solar radiation values for different tilt for the summer month may-June and winter month November-December From the obtained results, it may be concluded that the maximum hourly solar irradiance on a tilted surface facing south is 1152.97 Wm-2 in March and the minimum hourly solar radiation on a tilting surface facing south is 223.69 Wm-2 in December. The tilt angle has a major impact on the solar radiation incident on a surface. For a fixed tilt angle, the maximum power over the course of a year is obtained when the tilt angle is equal to the latitude of the location. The effect of latitude and module tilt on the solar radiation received throughout the year in W.h.m-2.day-1 without cloud. The Incident Power is the solar radiation perpendicular to the sun's rays. Power on Horizontal is the solar radiation striking the ground and is what would be received for a module lying flat on the ground. These values should be regarded as maximum possible values at the particular location as they do not include the effects of cloud cover. The module is assumed to be facing south in the northern hemisphere and north in the southern hemisphere. For some angles, the light is incident from the rear of the module and in these cases the module power drops to 0 the value of the ground reflected component may be neglected compared to the beam and diffuse components. The maximum value of t H is 29.25 (MJ/m2day) during March. The minimum value of t H is 15.54 (MJ/m2 day) during January. Also, the effective ratio of solar energy incident on a tilted surface to that on a horizontal surface and the monthly average clearness index for the months from August 2013 to December 2013 was estimated. The proposed model is shows closed agreement with predefine models & hence feasibility of solar PV based power plant is calculated based on global solar irradiation for MP.

REFRENCES:

[1] J. E. Hay; D. C. McKay " Estimating Solar Irradiance on Inclined Surfaces: A Review and Assessment of Methodologies, International Journal of Sustainable Energy, Volume 3, Issue 4 & 5, 1985, and Pp: 203 – 240.

[2] C. Gueymard, "Prediction and Performance Assessment of Mean Hourly Global Radiation," Solar Energy, Vol. 68, No. 3, 2000, pp. 285-303.

[3] K. Katiyar and C. K. Panday, "Study of Ground-Reflected Component and Its Contribution in Diffuse Solar Radiation Incident on Inclined Surfaces over India," Interna-tional Journal of Energy and Environment, Vol. 1, No. 3, 2010, pp. 547-554.

[4] S. S. Chandel, R. K. Aggarwal and A. N. Pandey, "New Correlation to Estimate Global Solar Radiation on Horizontal Surfaces Using Sunshine Hour and Temperature Data for Indian Sites," Solar Energy Engineering Journal, Vol. 127, No. 3, 2005, pp. 417- 420. doi:10.1115/1.1877512

[5] K. J. A. Revfein, "A Simple Procedure for Estimating Global Daily Radiation on Any Surfaces," Journal of Applied Meteorology, Vol. 17, No. 8, 1978, pp. 1126-113

[6] A. Ibrahim" Estimation of Solar Irradiance on Inclined Surfaces Facing South in Tanta, Egypt S.M.El-Broullesy Author et al.Vol. 1, No.1, pp.18-25, 2011

[7] Rakesh Pal, Dr. V. K Sethi, Anurag Gour "Modeling and Performance Enhancement of 100kw solar PV Array Power plant situated at village Jaitpurkalan Rajgarh (M.P) India by MPPT Algorithm with Reference to rural electrification" (IJERT) Vol. 2 Issue 12, December - 2013

[8] http://ni.com

[9] http://pveducation.org/pvcdrom.

[10] http://solargis.info/doc/103

[11] R.Ramkumar & J. E. Bigger, "Photovoltaic Systems" Proceedings of IEEE. Volume: 81, Page(s): 365 – 377, 1993.