ESTIMATION OF COST ANALYSIS FOR POSSIBLE 306 KW GRID CONNECTED SOLAR PHOTOVOLTAIC PLANT AT U.I.E.T, K.U.K

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ABSTRACT
The depletion of fossil fuel resources on a worldwide basis has necessitated an urgent search for alternative energy sources to meet up the present day demands. Solar energy is a clean, inexhaustible and environment-friendly potential resource among all renewable energy options. But in the present scenario, there is a need of continuous supply of energy, which cannot be full filled by alone wind energy system or solar photovoltaic system due to seasonal and periodic variations. Therefore, in order to satisfy the load demand the combination of solar and conventional conversion units are now being implemented as Grid connected energy systems. The objective of this work is to estimate the cost analysis for possible 306 KW grid connected solar photovoltaic plant and developed a system based on the potential estimations made for available area. The specifications of equipment are provided based on the availability of the component in India. Annual energy generation by proposed Grid connected SPV power plant is calculated.

KEYWORDS: Solar energy, Grid connected SPV system

I. INTRODUCTION
Photovoltaic’s offer consumers the ability to generate electricity in a clean, quiet and reliable way. Photovoltaic systems are comprised of photovoltaic cells, devices that convert light energy directly into electricity. It is anticipated that photovoltaic systems will experience an enormous increase in the decades to come. However, a successful integration of solar energy technologies into the existing energy structure depends also on a detailed knowledge of the solar resource. It is essential to state that the amount of literature on solar energy, the solar energy system and PV grid connected system is enormous. The calculation of electricity generation potential by contemporary PV technology is a basic step in analyzing scenarios for the future energy supply and for a rational implementation of legal and financial frameworks to support the developing industrial production of PV. Grid interconnection of photovoltaic (PV) power generation system has the advantage of more effective utilization of generated power. However, the technical requirements from both the utility power system grid side and the PV system side need to be satisfied to ensure the safety of the PV installer and the reliability of the utility grid. For this survey we have gone through different books, journals and papers to get its keen knowledge.

II. LITERATURE REVIEW
Souvik Ganguli et.al (2009) [1] presented a Estimation of Grid Quality Solar Photovoltaic Power Generation Potential and its Cost Analysis in Some Districts of West Bengal. The objective of their work was to estimate the potential of grid quality solar photovoltaic power in some districts of West Bengal (Birbhum, Burdwan, Hooghly, Howrah and Kolkata), study the solar radiation level and potential of the above mentioned districts and finally develop a system corresponding to the potential. Equipment specifications were provided based on the system developed and finally cost analysis was also carried out. A.S. Elhodeiby et.al (2011) [2] presented a performance analysis of 3.6 kW Rooftop grid connected solar photovoltaic system in Egypt. The system was monitored for one year and all the electricity generated was fed into the 220 V, 50 Hz low voltage grid to the consumer.

D.Picault et.al (2009) [3] presented an over view of current architectures used in grid connected systems, five key points for comparison based on topology upgradeability, performance under shaded conditions, degraded mode operation, investment costs and ancillary service participation. The proposed method can be adapted to the user’s particular needs and expectations of the photovoltaic plant. These evaluation guidelines may assist grid-tied PV system users to choose the most convenient topology for their application by weighting the evaluation criteria. Phil Bolduc et.al [4] presented a paper about performance of a grid –connected PV system with energy storage. One kilowatt amorphous photovoltaic system has been operated in a grid-connected mode with energy storage. The purpose of the system development and performance experiment is to investigate the additional value a grid connected system garners with dispatchable battery energy storage. These values are then weighed against the added cost of the system and inefficiencies incurred in the charging and discharging of the battery.
R. Ram kumar et.al (1993) [5] presented a paper of photovoltaic systems including a discussion of major U.S. and international activities. After a brief review of system types and output characteristics, various system configurations were discussed and a classification based on photovoltaic (PV) system rating was provided. Modeling, design, and economic Considerations were briefly discussed. The worldwide status of PV system technology was discussed with a view to making an assessment of the future. The assessment presented includes some specific areas for further research and development. Eduardo Romanet al (2006) [6] presented a performance of a grid connected PV system with energy storage. Three kilo watt amorphous photovoltaic system has been operated in a grid-connected mode with energy storage. The purpose of the system development and performance experiment is to investigate the additional value a grid connected system garners with dispatchable battery energy storage. These values are then weighed against the added cost of the system and inefficiencies incurred in the charging and discharging of the battery. Evert Nieuwlaar (1997) [7] presented an over view of
current power generation used in grid connected systems, the points for comparison based on, performance under shaded conditions, degraded mode operation, investment costs and ancillary service participation. The proposed method can be adapted to the user’s particular needs and expectations of the photovoltaic plant. These evaluation guidelines may assist grid-tied PV system users to choose the most convenient topology for their application by weighting the evaluation criteria. Kosuke Kurokawa et.al (2002) [8] presented paper about the cost analysis of very large scale PV system on the world desert. a 100 MW very large scale photovoltaic power generation (VLS-PV) system was estimated assuming that it is installed on the would deserts, which are Sahara, Negev, Sonora, Great Sandy and Gobi desert. PV array was dimensioned in detail in terms of array layout, support, foundation, wiring and so on.

III. METHODOLOGY
To find out the cost analysis for possible 306 KW Grid connected solar PV plant in Kurukshetra, India, the solar radiation over different months is measured. To estimate the possible solar photovoltaic generation potential, the solar radiation over one year (Jan - Dec 2012) is taken based on the data of mean global solar radiant exposure over Kurukshetra district of Haryana and following the methods discussed in [9-10]. Then the related graph is plotted for showing the variation in different seasons. Terms Input solar radiation means how much amount of solar radiation is coming from sun and Output solar radiation means how much amount of solar radiation we can utilize to generate electricity which is depends upon the efficiency of the PV module. Also For calculating the output the efficiency of the PV module is taken as 14.3% [11]. Finally a grid connected photovoltaic system is designed with the available technologies for the estimated plant capacity on available area. The method of design is shown with the existing equipments available in the market.

3.1 Table for Monthly Solar Radiant Exposure (Jan to Dec 2012) The mean global solar radiant exposure varies from 3.34 KWh/m²/day in the month of December to 7.35 KWh/m²/day in the month of May. We can take these readings from HAREDA, Sec-26 Chandigar & solar data sites available. The month wise mean global solar radiant exposure in Kurukshetra district of Haryana for year 2012 is given in Table 1.

<table>
<thead>
<tr>
<th>Months</th>
<th>Daily Solar radiation in KWh/m²/day</th>
</tr>
</thead>
<tbody>
<tr>
<td>Jan.</td>
<td>3.41</td>
</tr>
<tr>
<td>Feb.</td>
<td>4.41</td>
</tr>
<tr>
<td>March</td>
<td>5.77</td>
</tr>
<tr>
<td>Apr.</td>
<td>6.77</td>
</tr>
<tr>
<td>May</td>
<td>7.35</td>
</tr>
<tr>
<td>June</td>
<td>6.81</td>
</tr>
<tr>
<td>July</td>
<td>6.29</td>
</tr>
<tr>
<td>Aug.</td>
<td>5.78</td>
</tr>
<tr>
<td>Sep.</td>
<td>5.45</td>
</tr>
<tr>
<td>Oct.</td>
<td>5.30</td>
</tr>
<tr>
<td>Nov.</td>
<td>4.16</td>
</tr>
<tr>
<td>Dec.</td>
<td>3.34</td>
</tr>
<tr>
<td>Annual</td>
<td>5.40</td>
</tr>
</tbody>
</table>

3.2 Graph for Monthly Variations (Jan to Dec 2012) The Graph showing the variation for different months (Jan - Dec 2012) is shown in Fig. 1. Graph is plotted between average solar radiation available in KWh/m²/day and different months. Then using the values for average annual solar insolation, the possible plant capacity is estimated considering the PV module efficiency as 14.3%.

So, average annual solar insolation in Kurukshetra

- 5.40 KWh/m²/day.
- 900 W/m²/day

![Average solar insolation data](image)

Fig.1: Variation of Mean Global Solar Radiant Exposure Kurukshetra (in KWh/ m²/day)

We have assumed in our study that the solar energy is available for about 6 hours during the normal day. After estimating the potential, the design of grid connected solar PV power plant is made. The methodology adopted seems satisfactory for determining the possible plant capacity for available area.

IV. TOTAL POTENTIAL
Here the average yearly energy output is calculated by multiplying average monthly energy output with total number of months. The daily energy output can also be calculated for various months. Monthly energy output is calculated by multiplying the number of days of month with the daily energy output for various months. Kilowatt-Hour (KWh) means 1,000 watts acting over a period of 1 hour. The KWh is a unit of energy. 1 kWh=3600kJ. The Graphs showing the energy potential for daily, monthly periods are shown in fig 2, 3. Also the Monthly energy potential for U.I.E.T is shown in fig 4.

![Daily Energy Potential in Watts-h/m²](image)

Fig.2: Variation of Daily Energy Potential (in Watts-h/ m²)
V. COST ANALYSIS FOR 306 KW GRID CONNECTED SOLAR PV PLANT

A. Cost of Solar panels: - we use the BP 5128 most powerful module manufactured by BP Solar; cost of solar panel is Rs.160 per watt. So cost of 180 watt panel is $(180 \times 160) = Rs.28,800$.

We use 1700 numbers of panels so Cost estimate for total panels used $(1700 \times 28800) = Rs.4,89,60,000$.

B. Cost of 3-φ Inverter: - Only one piece of 330 KVA or 306 KW of an inverter / Power Conditioning Unit is used; multiply the size of the inverter by Rs. 25 per rated watt.

Cost estimate for Inverter $(25 \times 3,06,000)=Rs. 76,50,000$.

C. Cost of 3-φ step up Transformer: - Only one piece of 330 KVA or 306 KW of a step up transformer is used; multiply the size of the transformer by Rs. 20 per rated watt.

Cost estimate for Inverter $(20 \times 3,06,000)=Rs. 61,20,000$.

Subtotal = Rs 6,27,30,000.

D. Multiply the subtotal above by 0.1 (10%) to cover balance of system costs (wire, fuses, switches, etc.).

Cost Estimate for Balance of System: $(6,27,30,000 \times 0.1) = Rs 62,73,000$.

Total Estimated PV System Cost is Rs. 6,90,03,000 approximately.

VI. CONCLUSION

The design described is based on the potential measured. System sizing and specifications are provided based on the design made. Finally, cost analysis is carried out for the proposed design. Total Estimated PV System Cost is 69003000.

VII. ACKNOWLEDGEMENT

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