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Levelized Electricity Cost of Five Solar Photovoltaic Plants of Different Capacities

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Abstract

This paper deals with the calculation of Levelized Electricity Cost (LEC) of five Solar Photovoltaic power (SPV) plants of different capacities 1MW, 5MW, 10MW, 25MW and 151MW. The calculation has been performed from the power generated data of the year 2014. The effect of different parameters like interest rate, inflation rate, depreciation time (plant life) and cumulative utilization factor (CUF), on LEC have been analyzed. A comparative study of the plants is done by varying these parameters. Operation and maintenance cost has been assumed 1% of the capital cost. It has been observed that LEC increases with increase in both inflation rate and interest rate. However, the influence of inflation rate on LEC is more. LEC decreases with increase in plant life and cumulative utilization factor. SPV plants established earlier have higher LEC compared to that of plants established later due to reduction in cost of SPV module prices over the years.

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Keywords: Solar photovoltaic plant; Levelized electricity cost; cumulative utilization factor; inflation rate; interest rate; depreciation time (plant life)

1. Introduction

Solar photovoltaic (SPV) electric power generation is a promising clean technology with vast potential. India is one of the best recipients of solar energy due to its favorable location (8^o N to 38^o N, Latitude) in the global solar belt (40^o S to 40^o N Latitude). India receives nearly 3000 hrs of sunshine every year which is equivalent to 5000 trillion kWh of energy per annum with 300 days of good sunshine [1].

The cost of energy produced by SPV power plant is decreased significantly, in the recent years due to sharp fall in the PV module prices, improved performance (efficiency) and reliability of PV modules leading to reduced initial investment [2].

Further, Govt. polices also helped in the deployment of renewable energy systems and rapidly increased the installed capacity of solar photovoltaic (PV) power plants. During the last decade utility-scale PV plants in the range of tens of MW have been installed and currently operating all over the world [3].

India has achieved more than 4,000 MW of grid connected renewable energy power projects set up in 2014–15 [4], surpassing the targets by 8.5 percent. Renewable energy installed capacity in India reached 35,777 MW [5], by the end of July 2015. Grid connected solar power capacity stood at 4096.648 MW [6]. India scaled up to install a total of 100 GW solar power by 2021-22 [7]. As SPV module prices are falling down rapidly, power produced from SPV technology is becoming financially competitive to the power produced by fossil fuels and even better than some of the fossil fuel power plants such as diesel power plant. Solar photovoltaic (SPV) power plants have added advantage with long working life (20 to 30 years) with zero fuel cost and negligible maintenance cost, which encouraged the technology more popular with the investors [8].

Nomenclature

C_a	Equivalent annual cost
C_{cap}	Annual capital cost
C_{pe}	Present equivalent cost
C_{om}	Operation & Maintenance cost
CUF	Capacity utilization factor
f	Inflation rate
i	Interest rate
LEC	Levelized electricity cost
N	Plant life
P_a	Power generation
SPV	Solar photovoltaic

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2. Details of SPV plants

The five plants located are:

- 1 MW Tail End Grid Interactive SPV of Rajasthan Renewable Energy Corporation Limited (Jaipur, Rajasthan).
- 5 MW Bhardesh trading corporation SPV (Susner, Madhya Pradesh).
- 10 MW NVR Infrastructures and Services Pvt. Ltd. (Bikaner, Rajasthan).
- 25 MW ACME Solar energy Pvt. Ltd. (Khilchipur, Madhya Pradesh).
- 151 MW Welsun Ratangarh Neemuch plant (Diken, Neemuch, Madhya Pradesh).

General, Technical and economical specification of power plants are shown in Table.1 to Table. 5. Table. 1 shows the general specification of 5 SPV power plants. Table. 2 shows the technical specification of power condition unit of all the SPV power plants. Table.3, Table.4 and Table.5, shows the module specifications.

Table 1. General specification of the different SPV power plants.

Plant capacity	1 MW	5MW	10MW	25MW	151 MW
Location	Phagi, Jaipur, Rajasthan	Susner, Agar, Madhya Pradesh	Kolayat, Bikaner, Rajasthan	Khilchipur, Madhya Pradesh	Bhagwanpura, Diken, Neemuch
Longitude/Latitude	26° 55' N, 75° 55' E	23° 44' N, 76° 04' E	27° 83' 72° 95' E	24° 02' N, 76° 37' E	24° 69' N, 75° 13' E
Commission date	Mar. 2012	Aug. 2013	Jan. 2013	Dec. 2013	Aug. 2013
Total area	6.25 acres	26.03 acres	60 acres	240 acres	600 acres

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