

# To Study and Propose an Appropriate Electrification System for Bhagawatpura Village of Phulera, Jaipur

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**Abstract:** In present energy consumption and energy use pattern scenario conventional energy sources i.e., fossil fuel-based energy sources are used by most of the domestic, commercial and industrial sector in India in order to meet their energy requirements. These fossil fuels are available on the earth in very limited quantity therefore with the increase in demand these are getting costlier. The fossil fuels are polluting in nature therefore with the increase in demand pollution is also increasing day by day. As these fossil fuels reserves are shrinking on the earth, one day in future we will leave with no fuel reserve. Therefore, we have to limit the consumption of these limited resources and also there is a great demand for the clean and abundantly available energy resources in order to meet our energy requirements. One of these clean and unlimited energy resources is the sun. Solar energy is the largest available renewable and clean energy source and it is a very demanding alternative to limit the consumption of fossil fuels and also to prevent pollution. The main objective of this study is the comparative analysis among the options which are to be used for providing energy access to the rural population of few specific villages as per the energy consumption data collected from those selected villages. The goal of the study is to be carried through a survey which will be conducted for the estimation of energy demand as well as energy use pattern at those areas for which the energy access is to be provided. After the collection of energy demand and energy use pattern data, analysis have to be performed on these data collected, in order to find out the most appropriate as well as the economical technological option for solving the energy access problem associating with selected village. Bhagawatpura village is selected for the analyses which are located in Phulera Tehsil, Jaipur district of Rajasthan state. Providing energy access to these selected rural villages in the state of Rajasthan is done by going through a questionnaire-based survey which will be conducted, in those villages in order to find out the exact energy demands as well as the energy use patterns of those villages, based upon which the renewable energy option will be decided. Calculation in terms of installation cost, number of PV module requirement, land requirement, maintenance cost, total project cost, inverter requirement and operation cost have been done for this village.

**Index Terms – Rural electrification, Power plant, SPV**

## 1. INTRODUCTION

Energy has set positive interconnection with economic growth. For improving productivity and abolishing poverty it is necessary to provide suitable, affordable and clean energy. The certain expansion in the utilization of petroleum products close by a nation's financial development presents related reactions of risk to the country's vitality security, just as ecological corruption through environmental change. A suitable option in contrast to the broad consuming of petroleum products lies in the expanded utilization of sustainable power source.

Renewable power source is commonly characterized as vitality that originates from assets which are normally renewed on a human timescale, for example, daylight, wind, downpour, tides, waves and geothermal heat. The most important feature of renewable energy is that it can be utilized without the release of harmful pollutants. It is a clean alternative to fossil fuels and exists continuously in the environment. Major sources of renewable energy are wind energy, solar energy, biomass energy and biogas energy etc.

## 2. LITERATURE REVIEW

Solar energy is abundantly available free of cost. India is ideally located to utilize this large amount of radiant energy because our country is receiving clear solar radiation from the sun around 280 days a year. This energy can be used for heating, cooking, power generation, lighting, drying, cold storage etc.

Sharif and Mithila [1] focused on the prospects, constraints and solution of photovoltaic (PV) market growth in Bangladesh. This paper will be organized in total of seven sections. Section 1 and section 2 present the location and current status of Bangladesh, resource potential, objectives and market development. Sharif and Mithila [1] focused on the prospects, constraints and solution of photovoltaic (PV) market growth in Bangladesh. This paper will be organized in total of seven sections. Section 1 and section 2 present the location and current status of Bangladesh, resource potential, objectives and market development. Bhoje and Sharma [2] proposed a solar PV plant as an option to the industrial loads. In this study it has taken MW solar PV plant which it's all detail designing of inverter, string sizing, battery sizing and land requirement. Zhao et al. [3] recommended an all-inclusive and direct strategy for execution assessment of PVAC. Sixteen situations are recreated by TRNSYS to look at the execution of PVAC in various atmospheres and building types characterized by the Chinese national principles. Granqvist and Niklasson [4] examined there are numerous sorts of sun-powered vitality materials for warm applications. They are in various phases of improvement and range from an early explorative stage right to develop innovation. Sun based vitality materials have properties that are custom

fitted to the attributes of the electromagnetic radiation in our characteristic environment, explicitly its otherworldly circulation, edge of rate and force. Kannan and Vakeesan [5] brought up the need of sun oriented industry with its major ideas, universes vitality situation, features of inquiries about done to update sun-powered industry, its potential applications and hindrances for better sun based industry in future so as to determine vitality emergency. Seshie et al. [6] characterized the records for CSP producing at any rated power for a power go between 1 kWe and 500 kWe. 35 little scale CSP plants have been distinguished. Wang et al. [7] completed examination on a recently structured little scale wind turbine to be specific cross-pivot wind turbine (CAWT), which joins the attributes of even and vertical hub wind turbines (HAWT and VAWT), was analyzed tentatively on the power execution in a low speed, open-circle circuit wind burrow at Reynolds quantities of  $Re = 42900, 57100$  and  $71400$ . Najafi and Paulsen [8] created and utilized an examination based stereo vision framework for vibration and operational modular investigation on a stopped, 1-kW, 3-bladed vertical pivot wind turbine (VAWT), tried in a breeze burrow at high wind. Ward and Jorba [9] utilized PC demonstrate illuminating the Reynolds-Averaged Navier-Stokes conditions for incompressible streams better than an edge are displayed with regards to a contextual investigation. Ahmad et al. [10] investigated wind, PV and Biomass asset capability of a chose to zone in region Punjab. Kallar Kahar is a potential site for the establishment of sustainable power source advances with conceivable nearby and remote speculation.

### 3. IDENTIFICATION OF VILLAGE AND PREPARATION OF QUESTIONNAIRE

The study of comparative analysis among the renewable energy options for the electrification purpose is carried out for the village Bhagwatpura. This village is located in Sambhar subdivision of Jaipur district in Rajasthan (latitude 26.97144 N, longitude 75.83933 E, altitude 377 m). Bhagwatpura village is situated at the distance of 58 km from the Jaipur city and 61 km from district headquarter Jaipur in west direction To provide energy access to the selected rural villages in the state of Rajasthan is to be done by going through a questionnaire-based survey which will be to conducted, in those villages in order to find out the exact energy demands as well as the energy use patterns of those villages, based upon which the renewable energy option will be decided. The questionnaire which is designed for the rural energy survey, required as per the study objective, is consisting of series of questions related to the house-holds basics information as well as the energy consumption data and pattern. The designed format of the questionnaire-based survey is also provided with this study.

### 4. ANALYSIS OF LOAD ESTIMATION

#### 4.1 CALCULATION FOR VILLAGE BHAGWATPURA

Per day consumption of 20 household = 160 kWh

Therefore, per day electricity consumption per family =  $160/20 = 8$  kWh

Total number of families = 280

Therefore, per day consumption of whole village =  $280 \times 8 = 2240$  kWh = 0.00224 MWh

Total population = 1854

Therefore, per day per capita electricity consumption =  $2240/1854 = 1.20$  kWh

#### 4.2 ELECTRICAL ENERGY REQUIRED FROM PV MODULES

Per day electrical energy consumed by 20 families = 160 kWh

For solar photovoltaic power plant losses are considered as 30 % therefore 30 % additional of the total requirements has to be designed.

Electrical energy required from PV modules =  $1.3 \times 160 = 208$  kWh/day

#### 4.3 PV MODULES TOTAL WATT PEAK RATING

Total electrical PV modules total watt peak rating is the ratio of electrical energy required from PV modules and panel generation factor of the location selected.

PV modules total watt peak rating = (Energy required from PV modules)/(Panel generation factor)

PV modules total Watt peak rating =  $208/5.75=36.17$  kW

#### 4.4 PV MODULES REQUIREMENT

PV modules requirement is the total number of the PV panel which is required to generate the desired power and can be calculated by given formula.

Total Number of PV modules required = (Total watt peak rating)/(PV module peak rated output)

Total Number of PV modules required =  $(36.17 \times [10]^3)/250=144.68 \sim 145$  modules

Maximum open circuit dc voltage of string = 600 V

Open circuit voltage of PV module = 37.5 V

Number of PV modules connected in series = (Maximum open circuit dc voltage of string)/(Open circuit voltage of PV module)

Number of PV modules connected in series =  $780/37.5 = 16$  panels

Maximum power dc voltage of PV module = 30.1 V

Maximum power dc voltage at the input terminals of inverter

= Number of PV modules connected in series  $\times$  Maximum power dc voltage of PV module

=  $16 \times 30.1 = 481.6$  V

Number of PV arrays required = (Total number of PV modules required)/(Number of PV modules connected in series)

Number of PV arrays required =  $145/16 = 9.06 \sim 10$  arrays

#### 4.5 INVERTER REQUIREMENT

The size of inverter is the function of the maximum demand occurring at the load side, therefore, inverter size must be selected in accordance with the peak power requirement of the load.

The maximum demand of 20 families = 160 kW

The inverter must be large enough to handle the total amount of watts garment zone will be using at one time. The inverter size should be 25-30% bigger than total watts of appliances and machines.

Inverter size =  $160 \times 1.3 = 208$  kW

APOLLO GTP-503 inverter is considered for the power plant.

Number of APOLLO GTP-506 inverters required = 4

Total wattage supported by the inverter = Number of inverters  $\times$  wattage of inverter

Total wattage supported by the inverter =  $4 \times 60$  kW = 240 kW

#### 4.6 LAND REQUIRED

Number of PV modules required = 145 modules

Width of PV module or panel = 992 mm = 0.992 m

Length of PV module = 164 mm = 1.64 m

Number of modules in an array connected in series = 16 modules

Width of PV array =  $16 \times 0.992 = 15.87$  m  $\sim 16$  m

Length of PV module = 1.64 m

Number of arrays in PV field = 10 arrays

Number of arrays in a row = 1

Width of the solar field =  $1 \times 16 = 16$  meters

Number of Rows in solar field = 9

Distance between two arrays = 3 meters

Length of the solar field =  $9 \times 3 = 27$  meters

Land Required for PV field =  $27 \times 16 = 432$  m<sup>2</sup> = 0.10 Acers = 517 square yards

[1 Acer = 4047 m<sup>2</sup>] [1 square yard = 0.8361 m<sup>2</sup>]

#### 4.7 PROJECT COST

Project of solar photovoltaic power plant for 20 families of village Bhagwatpura is tabulated in Table 1.

TABLE 1. PROJECT COST OF PV POWER PLANT OF 40 kW CAPACITY

Capital Cost for Solar PV Power plant in Rs. Lakh		
S. No.	Particulars/Years	Cost
1	PV Modules Cost	11.06
2	Land Cost	6.78
3	Civil and General Works Cost	4.09
4	Mounting Structures Cost	6.48
5	Power Conditioning Unit Cost	1.80
6	Evacuation Cost up to Inter-connection Point (Cables and Transformers) Cost	7.31
7	Preliminary and Pre-Operative Expenses including IDC and contingency Cost	1.94
8	Capital Cost	<b>39.46</b>
9	Capital cost with 30% capital subsidy	<b>27.62</b>

## 5. CONCLUSION

The present study investigated the technical feasibility and economic viability of renewable energy technology-based energy generation system i.e., solar photovoltaic power (SPV) plants and hybrid power plant (SPV and Wind energy) for Bhagawatpura. The amount of energy required for 20 families by the village Bhagwatpura is estimated as 160 kWh per day and consumption of electricity is 1.20 kWh/day per capita. To meet the requirement of energy, a solar photovoltaic plant of 40 kW will be required and the amount of electrical energy will be harnessed from these SPV is 208 kWh/day. For calculated amount of energy, 145 modules are required which cover 517 square yards of land area and the total subsidized cost of SPV power plant is approximately 27.62 lac rupees.

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