A STAND ALONE SOLAR ENERGY PLANT BY USING PV MODULES

ABHIJEET KUMAR SINGH
Department of Electrical & Power Energy,
University of Petroleum & Energy Studies

ABSTRACT: World is at the age of high energy requirements and leading to the path of SMART world with full of Green energy source available. This paper is the advanced presentation for the methodology of PV modules installation at Dehradun site, INDIA. It will provide the accurate results concerning the number of PV modules, batteries & inverter placements at particular location which will completely fulfill the demand of power consumption of the location .As Solar energy is an renewable energy, this paper also provide an information about the different Solar energy principles ,site selection as Bidholi , Dehradun receives maximum solar irradiance of 5.5 KWh/m2/d which is maximum intensity as per area in Dehradun and accuracy on the basis of power consumption which had been satisfied by Solar system design using low cost PV modules. This paper gives an efficient data of installing solar panels for 15 years as compared to Power supplied from UPCL, also the cost analysis too.

KEYWORDS: SOLAR ENERGY , PV MODULES, INVERTER, BATTERY, LOW COST.

---

1. INTRODUCTION:

Being the largest consumer of fossil fuels such as crude oil, coal etc., there is no surprise in the fact that problem of demand and supply has arisen [1]. Energy demand is increasing day by day and we are mostly dependent on non-renewable sources of energy to satisfy our needs [2] [3]. The dependency on fossil fuels has led to shortage of energy sources forcing us to think of alternate sources of energy [3] [4]. Shortage of fuel has also lead to purchasing of fuel from other countries, for example Uranium and coal from Australia and US, oil and gas from gulf countries etc. Hence there is a need to look at renewable sources of energy which can fill in gaps in future when we won't be having fossil fuels[5][6]. In this paper "SOLAR Energy by PV modules" we discuss that how we can efficiently manage solar power to fulfill our ever growing energy needs [6]. This paper will give an insight on how solar energy can be a useful source of energy and will be able to provide sufficient energy for mankind to survive in future [7] [8]. As the present energy scenario of India is India is a Land of Billion Energy Needs. Current installed generation capacity of India is 2, 09,276.04 MW. India power generation capacity is needed to be scaled up. Presently installed capacity is 209 GW, by 2030 it will be over 460 GW at 6% growth rate [8]. India has abundance of renewable energy resources & hence Indian government has taken up the task to properly utilize renewable energy resources [9][10]. Hence, India is the only country in the world to have a separate ministry for renewable energy development, The Ministry of Non-Conventional Energy Sources (MNES) [11].

1.1 PROCESS OF PHOTOVOLTAIC EFFECT:

Solar is renewable energy because the technology used to converts the sun power into electricity does not produce smoke and does not usually destroy the environment [2]. The agglomeration of light-generated carriers does not itself give rise to power generation so in order to generate power, Power is needed which can be achieved by voltage and current generation only [3]. Voltage is inaugurated in a solar cell by a process known as the "photovoltaic effect. PV modules plays an important role in process of Photovoltaic Effect [4] [5].

2. METHODOLOGY

In our paper analysis we have performed a case study on the power consumption of some particular house located at Bidholi, Dehradun site and to improve the cost efficiency by use of efficient PV modules. A standalone system provides us the information about the geographical site of the selected area that means the longitude, latitudes, Solar Irradiance, Average Daily Solar Radiation, Peak Sun Hours, Solar Radiation[1][3]. The method we approach were we have done a case study on particular house which is located at the Centre of the site selected i.e. Bidholi ,Dehradun .From the site we calculated the energy consumption by the house for an year and also the cost analysis on the basis of total energy consumption per year. So now the advanced methodology of our to improve the efficiency of electricity, cost and energy payback time was to use the exact number of Photovoltaic modules is series and parallel combination so as total number of PV

modules is minimum and also the use of batteries and inverter for the energy storage period and also for the emergency [4] [5].

2.1 NOMENCLATURE:

1. PV module- Si-poly 250Wp 60cells 2. Stand for supporting of the PV panel 3. Battery –Solar 12V/160Ah 4.Regulator.
Stand with micro switch 6.Connecting wires.-

2.2 System Design of Solar Photovoltaic Systems:-

1. Load Analysis	**2. Solar Array Design Collector size:**	**3. Battery Design:**
• Accurate sizing	**• Selection of most appropriate Module**	**Physical and Performance Requirement**
• Worst case scenarios	**• Dust and Other contaminating effects**	**Reserve Capacity**
• Peak current loads	**• Orientation and Tilt issues**	**Temperature and Ageing Deration**
• Plan for future	**• Design of Balance of Systems (BOS)**	**Regulation and Charge Control.**

2.3 CASE STUDY

MODEL-1

PV modules orientation-	Tilt 30	Azimuth 0°
Near concealment-	Linear concealment	
PV Modules CHARACTERISTIC		
PV module	Si-poly model	Poly 250Wp 60cells
Number of PV modules	5modules In Series	4 Strings In parallel
Total number of PV modules	Number of modules20	Unit nominal Power 250Wp
Modules Global Power	Nominal (STC)3420Wp	At operating condition 3068Wp(50)°
Modules operating characteristics	V mpp 32V	Impp 94
Total area	Model area 23.3m2	Cell area 21m2
System parameter	System type-Stand Alone System	
Battery	Model Solar 12V/160Ah	
Battery Pack Characteristics	Voltage 96V	Nominal capacity 1600Ah
	Number of units 8 in series	2 in parallel
Regulator	Model Generic default with MPPT convertor	
	Technology MPPT convertor NOCT 50°	
USERS' Needs	Daily household consumes	Constant over the year
	Average-16.5Kwh/day	

MODEL-2

Geographical site	**BIDHOLI(DEHRADUN)**	**Country-India**
Situation	**Latitude- 30.33 N**	**Longitude-78.66 E**
PV Modules orientations -		
PV module	**Silicon-poly model**	**Poly 250Wp 60cells**
Number of PV modules	**4modules In Series**	**4 Strings In parallel**
Total number of PV modules Modules	**Number of modules12**	**Unit nominal Power 250Wp**
Global Power	**Nominal (STC)4000Wp**	**At operating condition 3579Wp(50)**
Modules operating characteristic	**U mpp 109V**	**Impp 33A**
Total area	**Model area 26.0 m2**	**Cell area 23.3m2**
System parameter Battery	**System type-Stand Alone System**	
Battery	**Solar 12V/160Ah**	
Battery Pack	**Voltage 96V**	**Nominal capacity 320Ah**
	Number of units 8 in series	**2 in parallel**
Regulator	**Model Generic default with MPPT convertor**	
USERS Needs:	**Technology MPPT convertor NOCT 50**	**Constant over the yea**
	Average-15.1 Kwh/day	

2.4 FORMULAS AND PRINCIPLES

☐ Total Power Consumption (Rated) =Rated Power x Number of Loads

☐ Total Average Power = Total Power consumption x Load Duty Factor

☐ Total Energy = Total Average Power x Use Hours

Inverter size =Total energy /inverter efficiency (since, inverter efficiency = 90%) TO DESIGN BATTERY:

☐ Total Supply =Load x (Number of days of storage +1)

☐ Efficiency factors from name plate of battery = Depth of Discharge (DOD) =Battery Efficiency factor (BEF) = Battery AC efficiency (ACEF)

☐ Battery = Supply /(DOD*BEF*ACEF)

☐ Selection of Battery Voltage (VBAT) is done based on system voltage as: Small systems i.e. for (<1KWH) are 12VDC. Mid- range systems for (1-3 KWH)are 24VDC Larger systems for (> 3 KWH)are >= 48-120 VDC

☐ Battery Ah =Battery Wh / VBAT

To design PV Module:

☐ Load (watt hour) = Daily energy requirements

☐ Average peak sun hours (PSH) for a month, for selected tilt and orientation of PV modules = 6hrs of System Efficiency Factor (SYSEF)

☐ Total PV Watts peak = Load Watt hour / (PSH X SYSEF)

☐ Number of PV Modules =Total Watt peak / Module WP.

2.5. CALCULATIONS

Energy consumption of an area for 15years. Average Solar irradiance for the site = **4.0KWh/m2/d**
Maximum Solar irradiance for the site **= 5.5 KWh/m2/d**

MODEL-1

Total number of PV modules required = 16
Number of Battery =16

Total power ratting of Solar PV modules (250Wp, 60cells) (250 x 16) WP =4000Wp Cost per watt energy from PV modules =INR 40

Total cost of PV modules for 4000Wp **= INR 1, 60,000**

Cost of single Battery (12V/160Ah) = INR 12,500(for 7 years warranty)

Total cost of installation of Battery = 16 x 12500 = INR 2, 00,000

Thus, Cost of Battery installation for 15 years **= INR 3, 75,000**

Total cost for Installation = 1, 60,000 +3, 75,000 **= INR 5, 35,000**

MODEL-2

Total number of PV modules required = 20 Number of Battery = 16

Total power ratting of Solar PV modules (250Wp, 60cells) (250 x 20) WP = 5000Wp Cost per watt energy from PV modules =INR 40

Total cost of PV modules for 5000Wp = **INR 2, 00,000**

Cost of single Battery (12V/160Ah) = 12,500(for 7 years warranty) Total cost of installation of Battery =16 x 12500= 2, 00,000

Thus, Cost of Battery installation for 15 years =**INR 3, 75,000** Total cost for Installation = 2, 00,000 +3, 75,000 **= INR 5, 75,000**

3. RESULTS & DISCUSSIONS –

As per the Electricity provided by Uttarakhand Power Corporation limited, the selected site that is Bidholi [2], Dehradun average cost of electricity bill for Model 1 and Model 2 are:

Electricity bill for Model-1 per month= INR (4000-5000) Electricity bill for Model-2 per month= INR 5000

Thus for 15 year expenditure on electricity bill will cost approx. for Model-1 = (4000 x 12 x 15) = INR 7, 20,000

Thus for 15 year expenditure on electricity bill will cost approx. for Model-2 = (5000 x 12 x 15) = INR 9, 00,000

Whereas for installation of Stand Alone of Solar plant for Model-1 for 15 years cost = INR 5, 35,000 And Stand Alone of Solar plant for Model-2 for 15 years cost = INR 5, 75,000

Total cost for expenditure of electricity bill paid for both the model= **INR 1,620,000** Total cost of the installation of Solar plant = 5, 51,000 + 5, 95,000 **= INR 1,146,000**

Therefore Total saving cost for both the model by installing SOLAR PANEL = INR 4, 74,000

This paper provides cost efficient analysis and also as the power generation is economical too. As the average Solar irradiance of site Bidholi, Dehradun is 4.0KWh/m2/d & as in future the solar radiation is going to increase abruptly thus Solar plant by use of PV modules installation is an reasonable idea.

9. CONCLUSION:

Dehradun is one of famous city for the source of Green energy, so the site selection was accurate as it is also one of the place for tourism too. Although the Ministry of Power has set a target of providing Power to all, the solution to long-term energy problems can implementation of renewable energy sources. The potential of renewable Energy is estimated at around 2, 09,276.04 MW, way greater than the current energy generating capacity of India. This Paper presentation can serve a solutions to major problems of extinction of energy system. To have efficient energy system, Government of India has developed a number of projects & conference for adequate and proper utilization of renewable energy resources in future.

FUTURE SCOPE OF SOLAR ENERGY AT SELECTED SITE:

Energy has an everlasting positive co-relation with Economic & potential growth. Providing competent, Economical & immaculate energy is a prerequisite For eradicating poverty and improving productivity. According to our survey at Uttarakhand Power Corporation Limited for generation of electricity, in future generation The cost per units is going to increase due to extinction Of coal and also due to increase of demand per Population growth. Thus, the only possible way to meet The demand of population growth is Use of Renewable Source of energy especially SOLAR Energy. As selected Site Bidholi, Dehradun receives maximum solar irradiance Of 5.5 KWh/m2/d which is maximum intensity as Per area in Dehradun.

10. REFERENCES:

[1] Dr. P. Jayakumar, Solar Photovoltaic, Fundamental of Solar energy (Resource assessment).

[2] Recent advances in the latest Technology of Solar energy, Solanki C.S, (2015), IIT BOMBAY.

[3] Kegley, Charles W., and Shannon L. Blanton. *World Politics: Trend and Transformation, 2016-2017*. Nelson Education, 2015.

[4] Ciriminna, Rosaria, et al. "Solar street lighting: a key technology en route to sustainability." *Wiley Interdisciplinary Reviews: Energy and Environment* (2016).

[5]Brinsmead, T. S., et al. "Future energy storage trends: an assessment of the economic viability, potential uptake and impacts of electrical energy storage on the NEM 2015-2035." *CSIRO, Australia. Report No. EP155039* (2015).

[6]O'Malley, Kathleen, et al. "Applied hydrogen storage research and development: A perspective from the US Department of Energy." *Journal of Alloys and Compounds* 645 (2015): S419-S422.

[7] Alazemi, Jasem, and John Andrews. "Automotive hydrogen fuelling stations: An international review." *Renewable and sustainable energy reviews* 48 (2015): 483-499.

[8] Azevedo, Francisco Diogo Abreu Santos Moniz. *Renewable energy powered desalination systems: technologies and market analysis*. Diss. 2014.

[9] Bahrami, Ali, Shahram Mohammadnejad , and Saeede Soleimaninezhad. "Photovoltaic cells technology: principles and recent developments." *Optical and Quantum Electronics* 45.2 (2013): 161-197.

[10] Romito, Nicola. "ITALEAF: Resoconto intermedio di gestione al 31 marzo 2015 Il Consiglio di Amministrazione ha approvato I risultati al 31 marzo 2015. EBT di Euro 1 milione, utile netto di Euro 0, 7 milioni. Investimenti in startup per Euro 0, 4 milioni. • I ricavi ammontano a Euro 0, 8 milioni (Euro 70, 1 milioni nel bilancio consolidato) • L'EBITDA pari a Euro-0, 2 milioni (Euro 6, 2 milioni nel bilancio consolidato)."

[11] Zhou, Wei, et al. "Current status of research on optimum sizing of stand-alone hybrid solar–wind power generation systems." *Applied Energy* 87.2 (2010): 380-389