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GRID TIED SOLAR PHOTO VOLTAIC POWER GENERATION SYSTEM: A PERFORMANCE EVALUATION

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ABSTRACT

Rapid urbanization, increasing population, developing economy, and increased aspiration of human beings are the main reasons for increase in power consumption in the world. This has lead to the unprecedented pressure on our grids, where main sources of power generation are conventional sources of energies which are almost impossible for future expansion to generate additional power. Increase in power demands and lowering of expansion opportunities has opened up research towards non conventional sources of energy, one such area is solar energy. This research work is aimed towards evaluating performance of the 100 kwp Solar Photo Voltiac System, which is grid tied and main sources of power in the vicinity. In this paper, for the year 2013, the solar photovoltaic behavior as being analyzed for power generation pattern throughout the year. This paper also evaluates and helps us to enlighten the fruits of economic benefits in adopting solar photovoltaic grid tied system in terms of economic benefits and bridging the energy demand and supply gap. This paper will demonstrate economic cost analysis including pay back calculation for the 100kwp Grid Tied Solar PV power Generation.

KEYWORDS: Kilowatt hour [KWH]

INTRODUCTION

India's power demand and supply gap is widening due to rapid urbanization, growing population with decadal growth rate of 17.64%, economic up gradation from primary sector to secondary sector and now towards tertiary sector, rapid expansion of middle class population and modernization of domestic needs. India with rapid rise in population with decadal growth rate of 17.64% with population of 1.21 Billion (as per census 2011) having per capita consumption of electricity at 778.71 kwh which makes our country to stand at 14th place in the world per capita electricity consumption, where USA stands first with 17053 kwh as per 2009-10. Per Capita Electricity Consumption and Per Capita Steel Consumption of any country are the measure of actual growth of that country in terms of per capita consumption per head. At present India stands fifth in the world in terms of installed capacity for power generation at 223.625 GW and generates 876.887 Billion Units [BU] at end of fiscal 2011-12, which can be broken down into Hydro-electrical power generation is 130.510 BU, Thermal power generation is 708.806 BU, Nuclear power generation is 32.286 BU and imports from Bhutan stands at 5.285 BU [1].

India the land of natural resources, which are in the form of forest, river, fertile land, tropical weather condition,

minerals, ocean and many more, which are of natures gift towards Indian Civilization. Among the natural resources, tropical weather condition consists of very rich energy packed solar energy, which is available in the year ranging from normal 200 days to 300 days. The annual global radiation varies from 1600 to 2200kWh/sq.m, this is comparable with radiation received in the tropical and subtropical regions. The equivalent energy potential is about 6,000 million GWh of energy per year. Photovoltaic converters are semiconductor devices that convert part of the incident solar radiation directly into electrical energy. The most common PV cells are made from single crystal silicon but there are many variations in cell material, design and methods of manufacture. Solar PV cells are available as crystalline silicon, amorphous silicon cells such as Cadmium Telluride (Cd-Te), Copper Indium diselenide, and copper indium gallium diselenide (CIGS), dye sensitised solar cells DSSC and other newer technologies such as silicon nano particle ink, carbon nanotube CNT and quantum dots [2][3][4].

Solar Energy can be harvested in two modes namely Off grid and On grid modes. In the Off grid modes, solar energy is trapped and utilized as thermal energy in the form of Solar Water Heaters, Solar Cookers and Solar Distillers, where other Off grid modes of utilizing solar energy are in the form of solar latern, solar street lighting system, solar cars, solar power operated electrical appliances and solar powered agricultural implements. The Solar ON Grid setup works on the principle of generating electricity by using solar PV panel and directly connecting it to the grid via net metering or direct consumption [5][6]. In the present electricity market, solar energy harvesting for generation of electricity is profitable, regular source of income and it works in the way of revenue generation in the dry rain fed area as business also. Gandhi Krishi Vignan Kendra [GKVK] campus which is in the heart of the city of Bangalore, where the entire campus is spread across 1400 acres of land housing many departments, which is having maximum demand of 600 KVA with per month consumption of power in the range of 2 lakh to 2.5 lakh kwh.

Analysis

Solar PV system installed at GKVK campus, Bengaluru has potential of producing 100Kwh of power in an hour, where average solar energy available in a day in around 8 hours. However, due to tropical climatic condition which is having four seasons comprising summer, rainy season, autumn and spring. This seasons would have direct effect on production of solar energy which implies that power generation is seasonal not continous. Hence, Solar Energy available in the year 2013, as been restructured to have data's in the months accounting for the power generated using solar energy through the Photo Voltaic System as illustrated in the figure 1 below. The total power generated in year 2013 is 1,49,478 kWh.

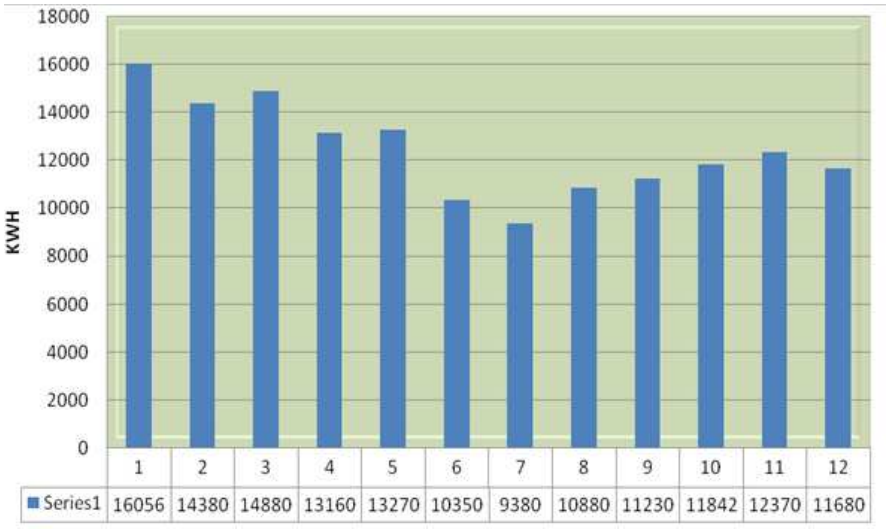

Figure 1: Monthlywise Power Generation Pattern in KWH [Units] for the Year 2013

The figure 1 above clearly illustrates that the Solar Energy Conversion into electricity using Photo Voltaic as medium of conversion is maximum in the month of January, where the January is winter season. Where as March to May months are summer seasons,having maximum intensity of solar energy but the power generated during this months is above average but not the peak for the year 2013.

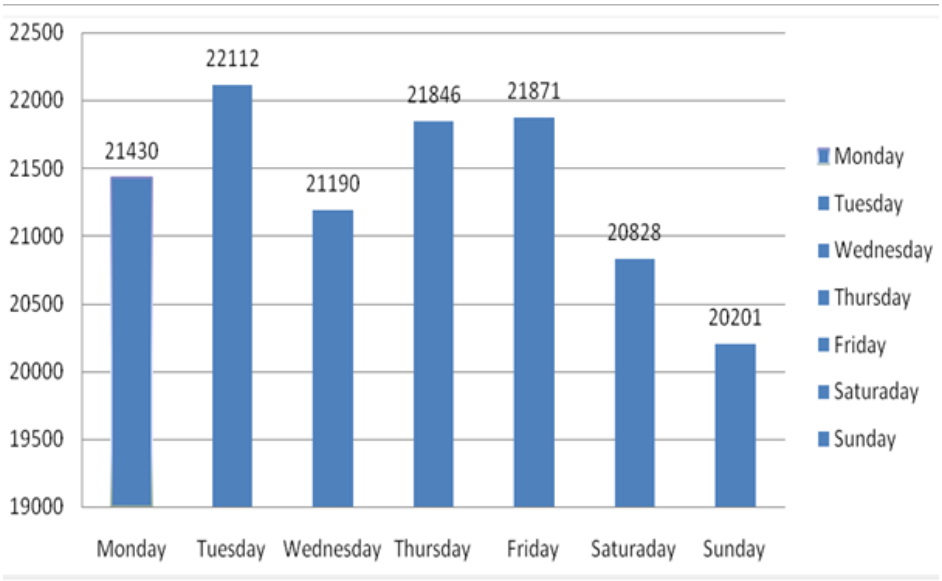

Figure 2: Day-Wise Pattern of Solar Power Generation

The above figure 2 illustrates the Solar Power Generation pattern in Day-wise for the year 2013. Sun the source of electromagnetic radiation, and subsquently produces photon which is packet of light or source of energy for any solar energy activity.. The Solar Energy pattern studied at GKVK campus demonstrates that the useful solar energy in a weak is not uniform. The figure above demonstrates that Maximum Solar Photo Voltiac Conversion is Maximum on Tuesdays as compared to any other days in a weak and also it shows that the during Sunday for the year 2013, the Solar Photo Voltaic Conversion is minimum and below average.

Economic Evaluation

Table 1: Economic Evaluation

Month	Maximum Demand [KVA]	Units Produced [KWH]	Cost of KVA @ Rs 180/KVA	Cost of KWH @ Rs. 5.90/Kwh	Total Savings / Month [INR]
January	80	16056	14400	94730	109130
February	80	14380	14400	84842	99242
March	80	14880	14400	87792	102192
April	80	13160	14400	77644	92044
May	80	13270	14400	78293	92693
June	80	10350	14400	61065	75465
July	80	9380	14400	55342	69742
August	80	10880	14400	64192	78592
September	80	11230	14400	66257	80657
October	80	11842	14400	69868	84268
November	80	12370	14400	72983	87383
December	80	11680	14400	68912	83312
Total	**960**	**149478**	**172800**	**881920**	**1054720**

Alternative Energy Sources in the present era is getting more attention than early is due to its economic benefits. Any Energy Sources utilized for power generation is always concerned with the Apparent Power [KVA] and Power Produced [Kwh]. The apparent power is the maximum demand which as been substituted from the alternative sources of energy from the conventional sources of energy, where as any energy sources utilized for the power generation is measured in terms of units [Kwh] produced. In the figure 3 above demonstrates the economic benefits produced from the Solar PV system installed at the GKVK campus, interms of Maximum Demand which is 960KVA/Annum and Power Produced by Solar PV System is 1,49,720 units. Here both Maximum Demand as well as Power Produced by Solar PV system as brought revenue Rs. 10,54,720/- to the University per annum.

Pay Back Calculation

Pay Back Calculation is done to estimate the maximum period of time which is required to get back the installation cost. Here we are demonstrating the pay back calculation below with the necessary data's as shown below.

Let 'X' be the Cost of Installation of 100 Kwp Solar Photovoltaic GenerationUnit with Li-Ne battery and control system unit along with building at GKVK campus

Let 'Y' be the Average Total Savings per Year and 'Z' be the Pay Back Time.

Hence,

Z = X / Y

Z = Total Installation Cost / Average Total Savings Per Year

Z = Rs. 1,65,00,000 / Rs. 10,54,720

Z = 15.64

Pay Back Time for the Solar PV Power Generation System at GKVK Campus is **15 Years 7 Months 20 Days.**

CONCLUSIONS

Solar Energy-Future Energy for India. The advocacy of utilisation of solar energy for power generation in India can be brought into the mainstream by demonstrating the cost and pay back economics along with the exposing abundant availability of solar energy throughout the year. Solar Photovoltaic Power Generation System installed at GKVK Campus, Bengaluru is the best feild demonstration module which as pay back period of 15 years 7 months 20 days for the investment of Rs. 1,65,00,000/- where the system is producing 1,72,800 kwh/annum and also it demonostrates that at Bengaluru GKVK Campus Solar Photo Voltaic Energy Conversion Rate is maximum at the month of January for the year 2013, where maximum power is generated on Tuesday's.

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