Performance of Distributed Photovoltaic System at a Commercial Building

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ABSTRACT

Limited fossil fuel resources have directed the mankind to find alternative ways to satisfy the future energy needs and optimizing the utilization of the existing resources. The renewable energy technologies, in this regard, are likely to be the potential solution for future energy requirements. They not only provide energy, but also help in reducing effect of the green house gases. Various renewable energy sources such as wind, photovoltaic cell (PV cell), hydro, biomass, biofuel, etc., are going to play an important role in sustainable energy development. The renewable energy sources are going to become the long-term solution for future energy. This paper presents the study and analysis of photovoltaic system at a commercial building. In this work, the case study of Commercial Building (Community Centre Gidderbaha, Sri Muktsar Sahib, Punjab) has been considered. The design and analysis of photovoltaic system for commercial building is discussed. During the analysis it has been found that placements of PV panels are a viable option irrespective of the high initial installation cost. Depending upon the payback period, the photovoltaic system is economical.

Keywords: - Growth of non-conventional sources, Photovoltaic systems, Commercial PV systems

I. INTRODUCTION

With the increasing demand of energy via greener methods and the gradual depletion of fossil fuels, solar energy conversion has regained the spotlight of the global energy activities. Our planet receives 160000 TW solar energy, while the present global energy demand is about 16 TW. While the solar resource is virtually unlimited, conversion of solar energy to readily usable form. Furthermore, reliable solar technology has to be complemented by energy storage system to accommodate the daily and seasonal variations in the solar radiation.

The idea presented in this paper for the development of the solar energy in developing country like India. Different issues related to the development of solar energy are discussed here in India. A case study is presented of photovoltaic system for commercial building in Punjab (India). During the analysis it is found that the photovoltaic system is economical then other non-conventional sources and also it is free from the environmental pollution.

Today Energy has become the necessity and basic need of human being. With the advancement of technology, the consumption of energy is increasing day by day. The fuels are depleting day by day there is a need to adopt the alternatives of energy. The paper explains the growth of the non –conventional sources worldwide in section II. The paper explains the issue of solar energy in world and growth of the solar energy uses with the time in section III. The section IV represents the development of the solar energy and the PV system used in India for various purposes. The general discussion about the photovoltaic system and the case study and analysis of the building is discussed in the section V where the cost analysis and the development of solar energy in India are discussed.

II Growth of Non –Conventional Sources World Wide

Possible uncertainty of the fossil fuel based resources in coming decades and market price hikes of the fuel have renewed interest into the green power generation. From this perspective, many countries have formulated their long term solar energy utilization roadmap. These projects serve multiple purposes. The graph shown in figure 1 shows the growth of the different renewable energy sources used worldwide.

Figure 1 Renewable energy cost trends

III Growth of the Solar Energy in the World

As this paper presents the study on the photovoltaic system. In this section we will study about the growth of the photovoltaic system worldwide. World primary energy consumption – including oil, natural gas, and coal, nuclear and hydro power–fell by 1.1% in 2009 shown in figure 2. Hydro electric power generation increased by 1.5%.Over the last decade; PV technology has shown the potential to become a major source of power generation for the world with robust and continuous growth even during times of financial and economic crisis. That growth is expected to continue in the years ahead as worldwide awareness of the advantages of PV increases. Figure 3, at the end of 2009, the world's PV cumulative installed capacity was approaching 23 GW. One year later it was 40 GW. In 2011, more than 69 GW are installed globally and could produce 85 TWh of electricity every year. This energy volume is sufficient to cover the annual power supply needs of over 20 million households.

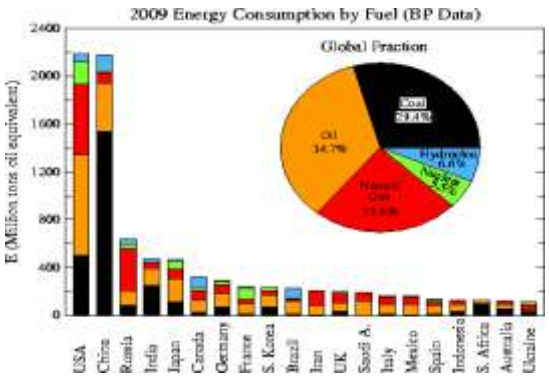

Figure 2 Power generation capacities in world by source, 2009

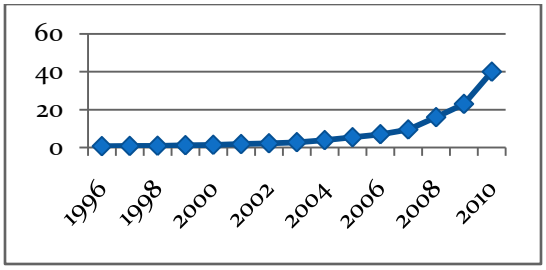

Figure 3 World PV Production Growths

IV Growth of the Solar energy in India

Being a developing country with a huge burden of fuel import, the need of solar energy research and development in India cannot be over-emphasized. The geographical location of India is also quite favorable for solar energy implementation. However, a densely-populated country like India, with a fragmented electricity market, poses endless challenges to the scientists and entrepreneurs. The nature of Indian electricity market is quite unique, and cannot be compared directly with other countries. Unlike USA or Japan, India has numerous villages and islands unconnected from the main grid, spatial and seasonal variation in agricultural demand, and cottage- to large-scale industrial sectors. Our country, therefore, requires solar energy development at different scales such as, small wattage to mega watts, grid-connected, supplemented with some energy-storage to no-storage capabilities. Also important is the hybridization of solar energy with other renewable sources. Considering this socio-economic scenario, the present state of solar energy technology in India stands far from being adequate, but several initiatives are being planned. On 30th June 2008 the Prime minister of India, Dr. Manmohan Singh, announced the National Plan for Climate Change. This includes a National Solar Mission to "significantly increase the share of solar energy in the total energy resources.

By end of year 2008, India had power generation capacity of about 152GW. Even with such an installed base, about 17% of the villages in India are non-electrified, which would translate to about 450 million. With a growing economy, the demand for power is growing at about 6% every year and the peak load demand is expected to reach 176 GW by 2012. The Indian power sector is highly dependent on coal as a fuel, with 53% of the total installed capacity being coal based generation. Given the current scenario, coal consumption by the power sector is likely to reach level so for 173mn Metric Tons by 2012. According to the Ministry of Coal, the existing coal reserves are estimated to last for another 40-45 years. Figure 4 represents the growth of photovoltaic system by the years.

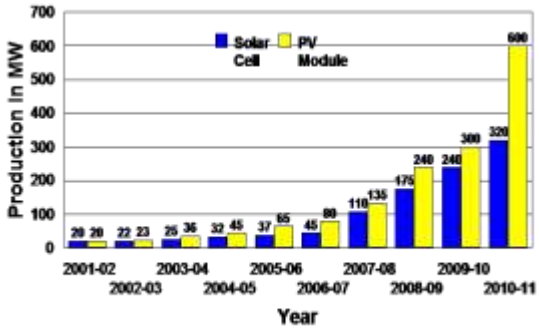

Figure 4 Growths in Indian PV Production

and figure 5 represents the installation of photovoltaic system for different uses in India and its installed capacity with its numbers.

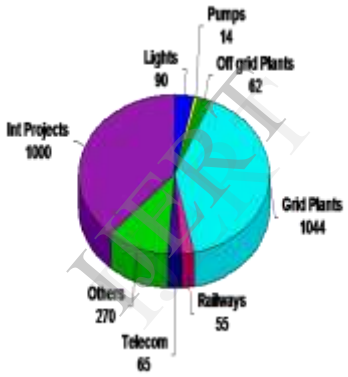

Figure 5Status of PV in India 2600 MW : 53,00,000 SYSTEMS

V Photovoltaic System

Photovoltaic's (**PV**) is the field of technology and research related to the application of solar cells for energy by converting sun energy (sunlight, including sun ultra violet radiation) directly into electricity. A Photovoltaic cell is a smallest basic solar electric device which generates electricity when exposed to sunlight. In other words the direct conversion of solar radiation into electricity is often described as a photovoltaic (PV) energy conversion because it is based on the photovoltaic effect. Direct conversion into electricity that takes place in semiconductor devices called solar cells. In general, the photovoltaic effect means the generation of a potential difference at the junction of two different materials in response to visible or other

radiation. The whole field of solar energy conversion into electricity is therefore denoted as the **"Photovoltaic's".** The solar energy conversion into electricity takes place in a semiconductor device that is called a solar cell. A solar cell is a unit that delivers a certain amount of electrical power that is characterized by an output voltage and current. In order to use solar electricity for practical devices, which require a particular voltage or current for their operation, a number of solar cells are connected together to form a solar panel, also called a PV module. For large scale generation of solar electricity the solar panels are connected together into a Solar array. Photovoltaic is the field of technology and research related to the application of solar cell in producing electricity for practical use. The energy generated this way is an example of solar energy.

Due to the growing demand for clean sources of energy, the manufacture of solar cells and photovoltaic arrays has expanded dramatically in recent years. Photovoltaic production has been doubling every 2 years, increasing by an average of 48% each year since 2002, making it the world's fastest-growing energy technology. The sun delivers its energy to us in two main forms: heat and light. There are two main types of solar power systems, namely, solar thermal systems that trap heat to warm up water, and solar PV systems that convert sunlight directly into electricity. When the PV modules are exposed to sunlight, they generate direct current electricity. An inverter then converts the DC into alternating current. Because it is non-polluting, free in its availability, and is of high reliability. Therefore, these facts make the PV energy resource attractive for many applications, especially in rural and urban areas of most of the developing countries. This paper presents study of Photovoltaic system in commercial building. The location for the dissertation to study and analysis the photovoltaic system is a community centre situated at Gidderbaha (Sri Muktsar Sahib), Punjab in India.

A. Study and Analysis of PV System on commercial Building (Community Centre)

THE COMMUNITY CENTRE DATA**,** Table 1 shows the load data of the commercial building. Solar PV is a semiconductor device which converts sunlight directly into electricity. The operation of light to electricity conversion requires a built-in electric field, normally obtained by making P-N junction structures. A solar PV panel or a solar PV module when exposed to sunlight generates voltage and current at its output terminal. This voltage and current can be used for our electricity requirements. The amount of electricity a solar PV module can generate

depends on the amount of sunlight falling on it. The higher is the intensity of the sunlight the more will be the electricity generated from it. When no sunlight falls on a solar PV module, no electricity is generated. Where, the function of the Photovoltaic array is to convert the sunlight directly into DC electrical power and that of the battery is to store the excess power through using the battery charger. The inverter is used to convert the DC electrical power into AC power to match the requirements of the common AC appliances.

Table 1. The Community Centre Load Data

S.No.	Electrical Load	No. of Units	Operating hours per day	Wattage/Unit Used
1.	Lighting Lamp	131	10	30.130
2.	Fan	52	06	24.960
3.	Air Conditioner	07	05	50.750
4.	Exhaust Fan	04	10	14.880
5.	Water Cooler	01	10	02
6.	Centralized Cooler	04	08	32
7.	Flush Light	02	04	02
8.	Pump Motor	02	02	06
9.	Pump Motor	01	02	0.750
10.	5 Amps. Socket	62	06	37.200
11.	15 Amps. Socket	02	04	08

B. PHOTOVOLTAIC SYSTEM DESIGN –

To design a Grid connected distributed Photovoltaic system for the considered commercial Building; the following steps are required to be taken.

1. Determine power consumption demands

1.1 Calculate total Watt-hours per day for each appliance used.

1.2 Calculate total Watt-hours per day needed from the PV modules.

2. Size the PV modules

2.1 Calculate the total Watt-peak rating needed for PV modules

2.2 Calculate the number of PV panels for the system

3. Inverter sizing

3.1 To find out the size of the inverter.

4. Battery Sizing

4.1 To find out the size of battery.

5. Solar charge controller sizing

5.1 To find out the size of battery.

6. Estimating the cost of PV system

After calculating all the above things the cost of Photovoltaic system for given application can be calculated.

C. Calculations for given application are below – Table -2

1.	**Determine Power Consumption Demands**	
	1.1 Total Watt-hours per day for each appliance used.	208670.00 Wh/day
	1.2 Total PV Panels energy needed	271271.00 Wh /day
2.	**Size the PV modules**	
	2.1 Total Wp of PV panel Capacity needed	87,506.7742 Wp
	2.2 Number of PV panels needed	364.6115 OR 365 Modules
3.	**Inverter Sizing**	37 KW
4.	**Battery Sizing**	51,144.6078 Ah OR 52000 Ah
5.	**Solar Charge Controller Sizing**	4218.305 A
6.	**Estimating the total Cost**	Rs.88, 30,700
7.	**Subsidies Estimated total Cost**	Rs. 61, 81, 490

CONCLUSION - Electrification of remote and rural sites worldwide is very important especially in the developing countries like India. Solar PV is a technology that offers a solution for a number of problems associated with fossil fuels. It is clean decentralized, indigenous and does not need continuous import of a resource. On top of that, India has among the highest solar irradiance in the world which makes Solar PV all the more attractive for India. The photovoltaic systems are considered as the most promising energy sources for these sites, due to their high reliability and safety. They represent, at the same time, a vital and economic alternative to the

conventional energy generators. An electrification study for a single Commercial Site of Punjab, India is carried out using a Photovoltaic system. The calculations are carried out where the energy consumption of building is found out. According to the consumption of the building, the proposals are given for the installation of photovoltaic system with its ratings and at the end cost of the system is also calculated. The suggestions are given for the roof top installation. it is found that the initial cost of the photovoltaic system is more than that of the conventional system. But keeping in view the increasing demand of the consumer and also the photovoltaic system is distributed system by which the transmission losses can be reduced and also transmission cost can be reduced as we know that cost of transmission line in the power system is major point to keep in view. The main factor that the photovoltaic system is non-polluting and not harmful to the environment. As the cost of the per unit is also increasing day by day in Punjab (India) the payback period of the photovoltaic system is less and it is economical for long term.

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