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Design of Solar Energy System to Cater the Electricity Requirement of Institute Orientation hall

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ABSTRACT: Energy consumption in various sectors is growing increasingly which are connected to number of environmental problems. The solution for reducing these types of problems by adapting the renewable energy sources, such as solar energy and wind energy or many more. Using these types of energy system in throughout the sectors is a very cost-effective way to meet the goal.

This research paper is about to analysation between two type of energy system for electrical appliances and air conditioning system. The comparison of these energy system is also compared. One is electrical grid system that operates all the electrical appliances and air conditioning system and the other is solar power energy system. This research is taken for an institutional orientation hall/auditorium hall. Experimentation on both of the system gave us the data during single day and annually.

The initial cost of solar energy system is high as compare to electrical grid energy system. The overall cost of solar energy system is 5062328. In case of electric grid system that is 4929650. The lifespan of solar energy system is 25 years and the cost for this system is considered once, on other hand the cost of electrical grid system for 25 years is near by the cost of solar energy system. This is found to be eco-friendly and economical energy system over the system's lifespan. In short for long term investment the solar energy system is better solution.

KEYWORDS: Solar energy, Electrical energy, Air conditioner, Solar panels, Cooling load estimation.

I. INTRODUCTION

Solar power has gained popularity in recent years due to renewable nature and free availability. Moreover, government is also encouraging the use of solar energy by different policies and laws.

Our planet receives 160,000TW solar energy, while the present global energy demand is about 16TW. This is virtually unlimited but conversion of solar energy into useful energy is expensive process because it requires consideration of energy storage (like battery) as available sun irradiation varies with environment condition.

Many countries are working in this field, these projects serve multiple purposes.

- First, the projects tend to reduce the overall cost of the energy technology as large-scale utilization of a technology, in general, tends to reduce the cost of that technology. This has also encouraged the entrepreneurs to invest in solar energy technologies
- second, these projects are engaging the academic institutions in long-term solar energy research, development, and pedagogical activities.
- Third, these projects aware more person about green energy source and their advantages.

None of the project has the capability to replace the fossil fuel, as in India energy requirement is growing, only solar energy can help to complete this energy requirement. The geographical location of India is also quite favourable for solar energy implementation. To further strengthen the contribution to the National Solar Mission, it is felt that a broader inter disciplinary group can be formed at the institute level aiming to develop short- and long-term technology in the area of power electronics component and system design, solar energy materials, supplementary energy storage and conversion devices.

In the recent development in this field India had been a target of installing of 20 GW solar panel up to 2022 and it was achieved 4 year before. Currently India has a capacity of 31.101 GW by solar panel.

In this project we understood the various aspect required for design of a solar system and propose a model for design of solar panel system for auditorium. In today world the total amount of

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electricity that is consumed in household and residential buildings is dependent on basic needs like heating of households during winters and cooling during summers as well as light, fans, blowers etc. Out of this the major amount of electricity consumption is that which is used in heating of water for various purposes like bathing, washing utensils clothes and various other purposes. As we all know that in the current era there is a huge crisis of the availability of fossil fuels and this requires a great attention as we cannot allow the complete depletion of these. so in order to reduce the consumption of fossil fuels the whole world is shifting to the use of renewable sources of energy, and this shift is not only because these recourses are never depleting but also because they are cleaner source of energy, that is they do not pollute the environment in our work we have to find an efficient means for fulfilling the hot water requirements in the hostels so as to safe the consumption of electricity and also to manage it in such a way to avoid the wastage of water.

Usually the solar water heaters are designed in a such a manner that the designed capacity of these solar water heater is much more than the demand capacity this leads to a wastage of energy also there are requirements such as reheating of water which is also a means of over consumptions. So, in order to solve this, we need to design a system in such a manner that the difference between the demand of hot water required and the design capacity of solar water heaters should be minimum. And also, the requirements such as reheating are to be minimized so as to design an efficient system.

The all setup for this experiment is located at the basement of management building of Bahra University (orientation hall). The unit produces large amount of heat and needs constant regulation of temperature for its efficient performance and safety. Currently there are no cooling or heating units. For the future aspects these units are installed for the useful purpose. Our project aims to design solar photovoltaic (PV) system to support the cooling & heating system and reduce the electricity cost.

II. PROBLEM FORMULATION

Theirs are many systematic ways to overcome the rate of using electricity in various sectors. To create the electricity, natural resources compromises. If these sources are compromises rapidly then whole ecological system is disturbed and all-natural resources getting depleted, so we need to use the green energy, which is comes from without depleting any natural resources, solar energy is one of green energy.

A case study of educational institutional system, where many of seminars or functions is organized, and every each of single function consume electrical energy in large amount, which causes for high cost of it. If reduction of cost is done by without harming ecological system and without spending more money, than we will create a renewable energy system in the institution.

Annually, there are many of functions organized, i.e. seminars, cultural fest, placement drives or many more, during these functions many of electrical equipment's are used for completion. As per the data provided by the Himachal Pradesh State Electricity Board Limited, the energy charge for the non-domestic non-commercial supply is Rs 4.70/ kWh for contract demand greater than 20 kVA. As per data collected, annually electricity consumption in this institution, especially for orientation hall is 3-4 million units approximately. That much of consumption leads to high electricity cost for particular orientation hall is 15000 (annually) approximate.

The main motive of this project is to reduce the electrical usage or their cost, and in addition, to also reduce the cost of electrical energy for heat ventilation or air conditioning system.

III. OBJECTIVES

- To identify the load of different electrical appliance fitted in orientation hall.
- To calculate the estimate due to occupancy.
- Determine the required capacity of HVAC plant in tons of refrigeration.
- To identify the best energy system for HVAC plant or electrical equipment's.
- Determine the area required of solar panels.

IV. METHODOLOGY

For this research, all the operations are performed according to the process flow diagram to analysation of errors occur in particular process. Usage of electrical energy in particular research area is find out manually and via calculations. The comparison between both of these help us to find the best economically or eco-friendly system.

Problem definition and planning

- Power requirement
- Site evaluation
- Mounting location
- Required area
- Orientation

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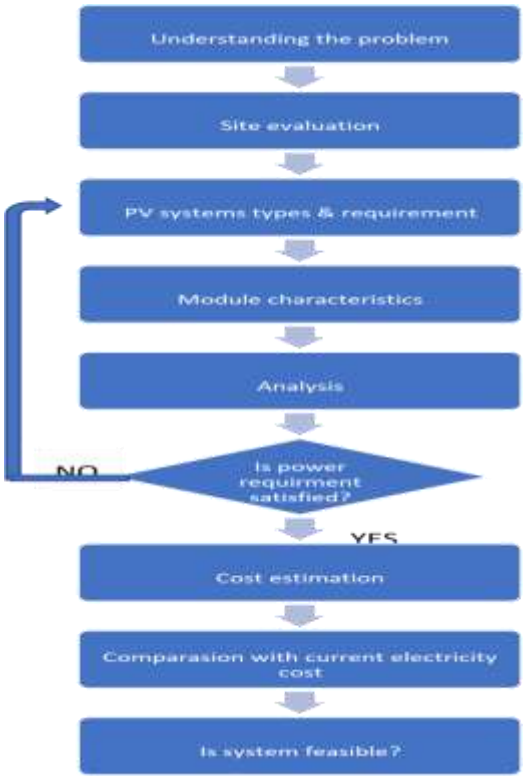
Figure 1 Work flow process diagram



PV Systems Types & Requirement

- Is battery required or not?
- Is grid connectivity required?
- Requirement of invertor rectifier?
- Addressing AC and DC power supply
- Backup by diesel, gasoline or grid electricity

Module characteristics

- Rated Power (RP)
- PV system voltage
- Module cost per watt
- Module efficiency

Analysis

- Power required (P_{req})
- Number of modules required (N)
- $N = \frac{P_{req}}{RP}$
- Area required (A_{req})

$$A_{req} = N \times Area\,of\,one\,module \times arrangement\,efficiency$$

IRRADIANCE AT THE SITE LOCATION

Irradiance data in the proximity of site location is collected using the 'My solar panel Lite' android application. Figure shows the irradiance at site over the period of one year. Maximum irradiation occurs in the month of July as shown in the figure. Average irradiance over the year is 5.129 kWh/m^2/day.

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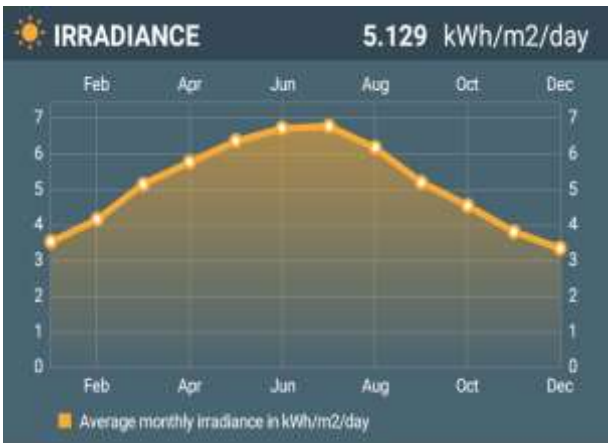

Figure 2Irradiance data of site over a period of 1 year

Average irradiance = 5.129 kWh/m^2/day
= 5.129 × 1000 / 8 (Assuming 8 hours of sunlight)
= 641.12 W/m^2

This value of irradiance is for the per meter square of ground at the location. But the solar panels will be installed at an angle facing south. Therefore, the irradiance per square meter of PV module will be more than this value. The effect of tilt on irradiation is described below.

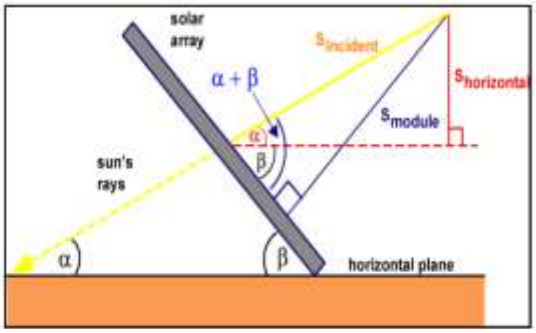

Figure 3Effect of tilt on irradiance

$S_{horizontal} = S_{incident} \sin\alpha$
$S_{module} = S_{incident} \sin(\alpha+\beta)$
$S_{module} = \frac{S_{horizontal} \sin\alpha}{\sin\alpha}$
Here α = 90 – latitude = 90 - 31.78 = 58.22°
If we adjust solar panels at β = 31.78° facing south, then,
Average irradiance at module, S_{module} = 641.12 sin (90°) / sin (58.22°)
= 754.19 W/m2

Power output of single solar panel = 325 W × (754.19/1000)
= 245.11 W

We obtain 245.11 W of energy according to the location and the tilt angle of the solar panel. The tilt angle has a significant effect on the surface of solar radiation. The maximal power over the course of one year is obtained for a fixed tilt angle when the tilt angle is equal to the latitude of the location.

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Figure 4 Area for solar panels

Total number of solar panels = 334
Area for solar panels = 658 Square meter

ELECTRICAL DRIVEN AIR CONDITIONING SYSTEM

In this case, source of the air conditioning system is electrical grid, and also for the appliances and for cooling system. As per the cost of electricity in this state (Himachal Pradesh), the annually cost is raising too high, so this is the main task to choose the powerful and efficient air conditioner system which lowering down the annually budget.

Description	**Cost (□)**
11 A.C units	363000
Other (wiring, cables, etc)	10000
Installation cost (20% of A.C & other)	9260
Electricity cost/year	182266
Total	**□ 564526**

Table 1 Cost details of electrical A.C system

SOLAR PV DRIVEN AIR CONDITIONING SYSTEM

In solar photovoltaic system, the elements of the panels convert sunlight's into useful electrical energy. It is also known as clean or green energy, because it harms nobody else in the ecosystem or in environment. Solar energy plants are increasingly day by day and control its price and make them a more efficient plant.

There is many type of solar panels, i.e. Polycrystalline solar panels (p-Si), Monocrystalline solar panels (Mono-Si), Thin film amorphous Silicon solar panels (A-Si) and Concentrated PV cells (CVP). The selection of better solar panel is depending upon better life span with better efficiency in low cost. The (p-Si) panel have ~15% of efficiency with lower price market value with the lifespan of 20-25 years. In case of (Mono-Si) panel, it is very expensive in market with ~20 % of efficiency rate and also have long lifespan. (A-Si) have ~ 7-10% of efficiency with low cost value in market and have very short lifespan. The (CVP) panels need more accurate irradiance angle to reach the better performance because this panel have better efficiency rate with high expensive cost in market.

Description	**Cost (□)**
Solar PV modules	3690700
Inverters (AIMS, 8kW, 66 Amps)	52328
Battery (Luminous, 500ah,12v (2), 220 ah,24v (3)	74500
A.C units & other things	382260
Other (wiring, cables, etc)	50000
Installation cost (20% of the cost)	738140
Maintenance cost yearly	74400

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Total	**5062328**

Table 2 Cost details of solar PV A.C system

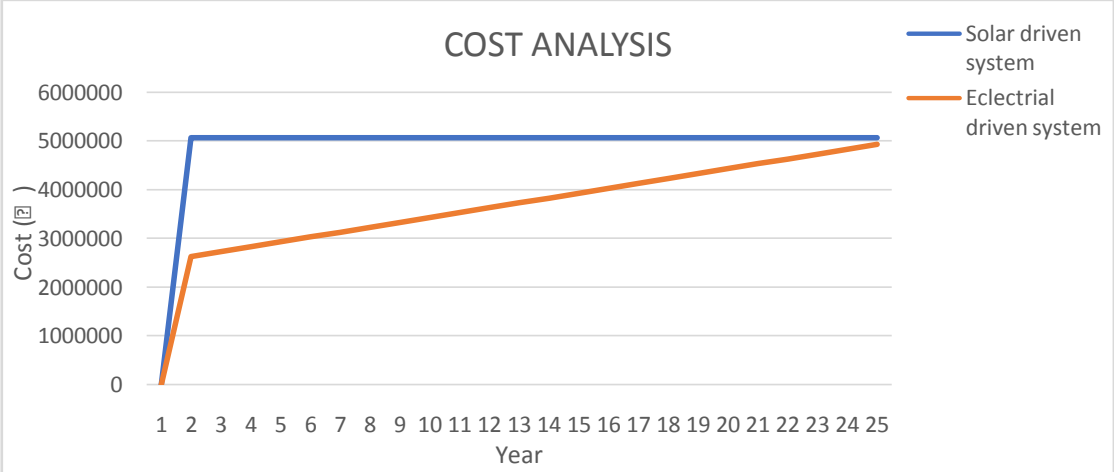

Figure 5 Cost analysis for solar driven system and electrical driven system

This graph shows us the variation in cost for different energy methods. In case of electrical energy system, the initial cost is low but with respect to time the cost is increasing yearly. On other hand solar energy system, the initial cost is very high but with respect to time very less of fluctuations is seen in cost. The overall cost for setup of solar energy system is recovered in 25 years and electricity cost is reduce yearly after this span.

V. RESULT

The purpose of this above calculations is to know how much of electrical energy is used in the institution's orientation hall with annual consumption. During function days there is lot of electrical energy is consumed in hall and according to the HPSEBL charges, the cost of this energy is increases with respect to time and days, because the HPSEBL charges also increases. 11 RT (refrigeration tonnes) were found to be needed for the cooling system of the orientation hall of the institute based on the specific dimensions. Conversion of tonnage of energy into kW gave the overall consumption of the electricity.

Nowadays every sector is suffering from electrical energy crises, weather it is business sector, industrial or textile sector, banking sector and educational sector. Electrical energy is widely use in all of these sectors and consumed in very huge amount, which causes to pay the very huge cost for it. I'm currently seeing this problem in the institute where I'm pursuing this research. As the two cases are considered in this research, one is electrical energy system and other is PV solar energy system. In electrical energy system there is consumption of 780 kWh of energy per annum according to the academic calendar, worth of 3785.72. COP was found to be 3 for this system. If A.C system is also run with this energy then consumption of electricity is increases and cost also, because there are 11 units of A.C are found out on the basis of required area. The approximate cost of electricity for A.C system is 182266.4/year. The initial cost for settling for this system (A.C) with electricity cost is 4929650/year.

In other case, there is renewable source of energy is selected in the term of PV modules, because it generates green and clean energy which is collected from the sun radiations and stored in the batteries for further usage. There is only installation cost is considered for this energy system. 334 solar panels are selected on the basis of energy usage. 5 batteries and 1 inverter are settled up with 334 solar panels. The initial cost for all of this system is 5062328 with their yearly maintenance cost.

So, PV modules looks very cheaper than the electrical system for the long-term investment. If the solar energy system is settled up then 4556650 are saved for 25 years because this is the amount which is consumed in electrical energy system for 25 years. In solar energy system the electricity cost is reduced and makes the huge difference for 25 years in cost analysis.

In summary, the cost analysis shows us the solar power cooling system have the high initial cost as compared to electrical power cooling system, but the solar power cooling system have

greater economic feasibility then the electricity power cooling system because the price of HPSEBL is increasingly year by year. When 25 year of lifespan is considered then the capital cost of solar power cooling system is recovered in 20 year, and making it the most economical and eco-friendly.

VI. CONCLUSION

The main objective of this study is to describe the variation in different network of air conditioning system for institutional orientation hall. Electrical energy and solar energy system are taken into consideration for analysis of energy usage and their cost. According to the location, solar panels are best suited to meet the rising demand of electricity for orientation hall and their cooling system. The use of renewable energy sources is very beneficial for environmental point of view because of low carbon emissions. Advantages of this system is, there is no need of fuel to generate the energy and no pollution is occurred. Electricity cost is reduced and no harm for ecological system or environmental system. In this educational institute electricity is consumed most and the cost of that consumption leads to very high expensive value, so PV solar panels are the best solution for reducing the electrical usage cost.

It is clear from this study that the PV solar panels are the best replacement for the electrical grid system, because it is one-time investment project and the cost of electrical usage is deducted in every year and recovery of overall settlement amount is done in 20-25 years. Initial cost for the PV solar energy system is very high, but in few years it is recoverable. This system has low maintenance cost, only need to be clean and replacement/repair of batteries in couple of years. During rainy or cloudy day, the efficiency of solar system decreases, they are totally dependent on sunlight, but these days solar energy is still collected. It needs lot of space on rooftop where sunlight is strike directly on the panels. Solar energy is stored in large batteries or if not stored then used in right way.

In conclusion and taking economy analysis, each system has his own lifespan and its efficiency according to the principle usage. The renewable source of energy is better solution from the environmental point of view or economical point of view.

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