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COST ANALYSIS OF SOLAR POWER GENERATION SYSTEM USING HOMER OPTIMIZATION SOFTWARE

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Abstract – *As the most important issues of the world now a days is the depletion of the fossil fuel reserves so we need to find out a solution to conserve such non renewable resource and change them from other renewable resource such as solar power. The next concern is the rising level of the unwanted gases such as carbon dioxide or carbon monoxide. There is a need of controlling the level of such gases. In this paper we discusses that how the level of carbon emission can be controlled by changing the grid supply with the solar panels to power the campus of Uttarakhand Technical University. India today stands number one in terms of solar electricity production per watt installed having a total of 300 sunny days. This gives us a good opportunity to use solar power for electricity generation. The increase in interest in solar energy is due to asset subsidies, duty holidays and government action towards renewable energy playing a big part in nation's energy system therefore solar power plant is used in this study of cost based analysis. HOMER model is used for optimization which shows that the level of carbon emission reduces from 20,520 kg/year to 83.3 kg/year when we install the solar panel in the campus.*

Key Words**: Solar Power Plant, HOMER, Carbon Emission, Systems**

1. INTRODUCTION

Electricity has been around us for centuries, growing and changing day by day. Without electricity the world would have not been the same. The human relies on electricity to be always available and to perform its functions. Usage of electricity has been increased every year since 1949. Not only has electricity usage been rapidly increasing, energy cost is rising and energy possibility is decreasing. With this consecutive growth in electricity usage as well as in its cost, new and unique methods of producing electricity are being developed constantly. Moving to alternative energies to produce electricity is from all the way back to the 18th century but has gained thrust recently. This energy comes from the sources that renew themselves, such as the sun, rivers, wind, ocean waves and tides. Our Uttarakhand Technical University in Dehradun has seen the solar potential and has decided to invest in solar powered systems. This study will determine if it will be beneficial to install solar panels, thus making a sustainable environment. The type of panels needed to power the campus will be determined. It will prove as an analysis not only for the campus investment, but any other institution considering the integration of solar energy.

1.1 Indian Potential

Estimation of the India's Energy Portal states that if only 10% of the land comes into usage for the solar energy then the installed capacity may become 8000GW which is around 50 times more than the current installed capacity of the country. For example, if the conversion efficiency for PV module be only 10% than also it will be thousand times greater than the electricity demand in India. The production during daytime makes it coincide with the electricity demand that is the solar becomes ideal for the supply to grid.

The main strategy of India is to balance the grid (arrest around Rs 5/KWH) by 2022 and balance the coal generation (presently around Rs 4/KWH) by 2030, which will be the most important element in India's long term strategy. If we consider the solar annual isolation then the solar power could easily manage the long term energy requirement of India. Despite it can be cost competitive.

2. HOMER SOFTWARE

The HOMER software is the Hybrid Optimization Modeling software used for creating or comparing two systems which are created by us. The software needs the necessary inputs from us like the equipments to be used, their rating and the quantity. In this modeling software we can design either a system using only one renewable resource or a mix of two termed as hybrid system. The existing system used by the University campus is shown in the Fig- 1. While the proposed model consist of a 20KW PV panel, an EXIDE battery and a converter. These various equipment come all together to form the solar PV system and the optimization result is obtained through entering the values of the specified equipments with their quantity hence a complete system optimization is received after carrying out the process. The model of the proposed system is shown in Fig-2.

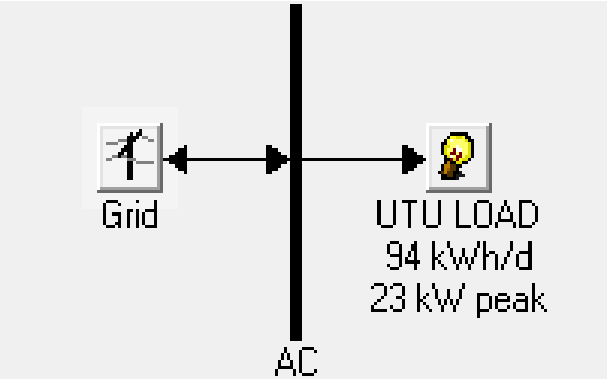

Fig- 1 Model of Load connected to Grid

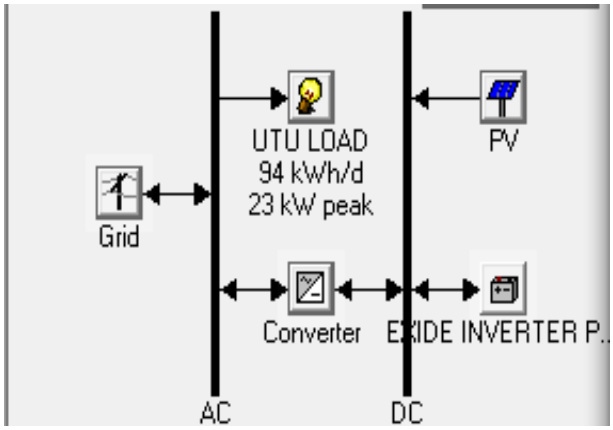

Fig-2 Model of Load connected to Solar PV and Grid

3. ENERGY ANALYSIS

3.1 LOAD PROFILE

The load profile of the assumed load is shown in the Fig- 3 and is based on the main building of the campus. A load of around 1KW remains throughout the day in the 24 hour profile while a maximum load of 13KW appears at the noon. The daily average load is 94KWh.

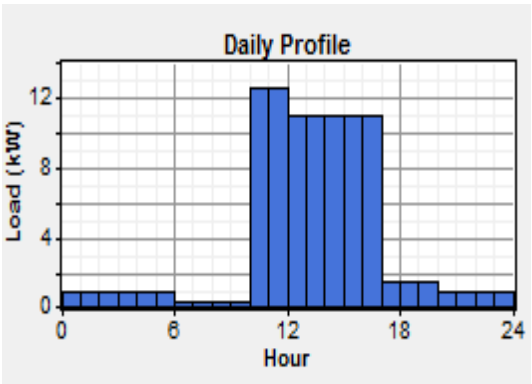

Fig-3 Hourly load profile

3.2 SOLAR RADIATION PROFILE

In the Fig-4, the solar radiation data for a time period of one year for Uttarakhand is shown which is obtained from the NASA surface Meteorology website. The location of Uttarakhand is approximated to 30^0 59' N to 77^0 59' E. The average clearness index is estimated as 0.625 while the average daily radiation is 5.42 KWH/m^2/Day.

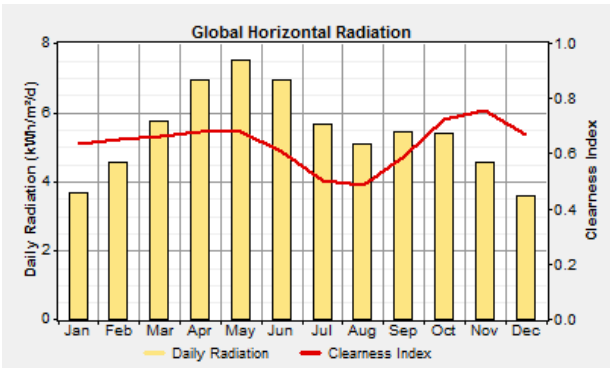

Fig-4 Solar Radiation Profile for Uttarakhand

4. IMPLEMENTATION OF HOMER

4.1 System Layout

The project implemented consists of equipments such as photovoltaic solar cell, a battery, a converter and the load. The cost and size of equipment are entered in the HOMER software as the inputs which are shown in the Table-1 while the Fig-5 shows the various components.

4.2 System Performance

4.2.1 Solar PV system

The capital and replacement cost of the solar PV panels is estimated at $371/KW while the operating and maintenance cost is $10/KW. The derating factor of 80% and life span of 30 years was assumed. The panels are fixed and tilted as specified in the Fig-7

4.2.2 Battery System

A single EXIDE of 12V and capacity of 250Ah is used and shown in Fig- 8

4.2.3 Converter and Inverter

The efficiency of rectifier and inverter varies from 90% to 85% respectively while the size varies from 10KW to 30 KW. The input of converter is shown in Fig- 9

4.2.4 Load Details

The UTU load consists of various tube lights, motors, streetlights etc. The load detail is shown in the Fig-10

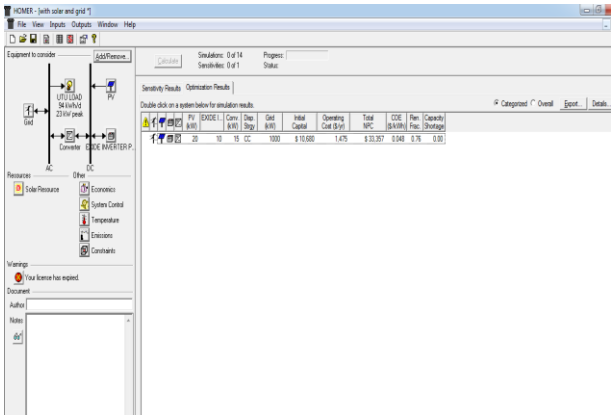

Fig-5 Equipment used in the system

Table -1 System Components

Component	Size	Capital Cost	Replacement Cost	O&M Cost	Lifetime
PV Panel	20KW	$ 371/KW	$ 371/KW	$ 10/ year	30 years
Battery	250Ah/ 12V , 1-10 batteries	$197/battery	$152/battery	$7.20/ year	Lifetime throughput 1000KWH
Converter	10-30 KW	$76/KW	$76/KW	$3/KW	15 years

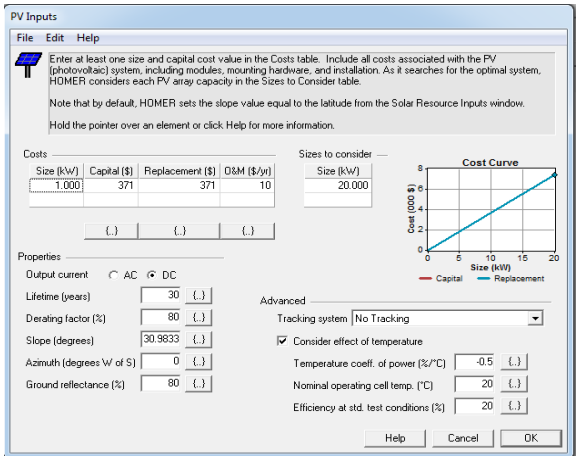

Fig- 7 PV Inputs

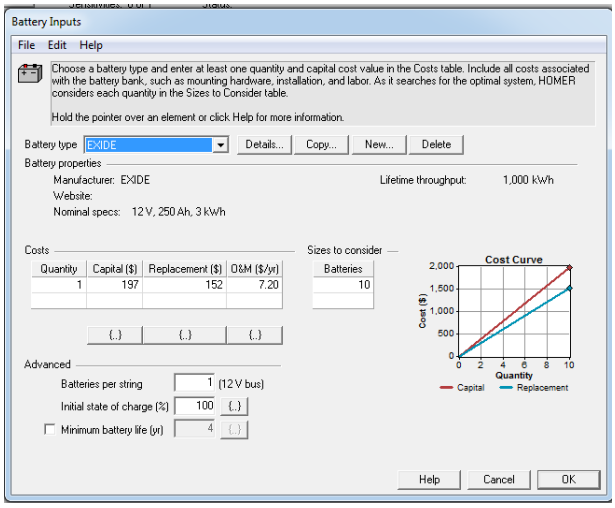

Fig-8 Battery Input

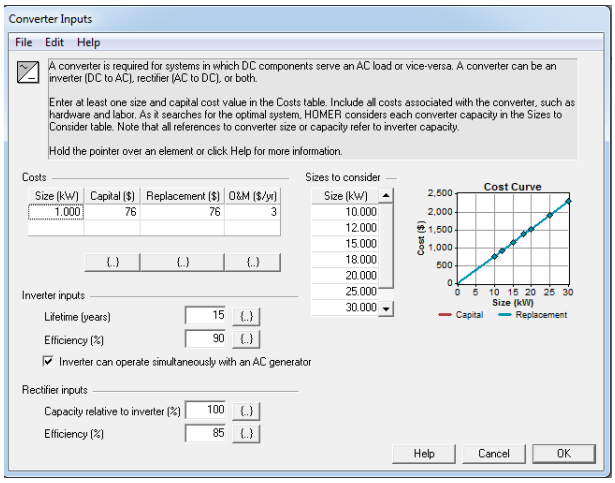

Fig-9 Converter Input

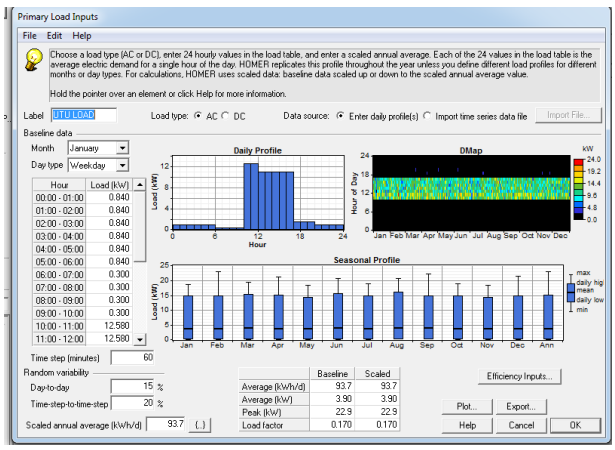

Fig-10 UTU load

The HOMER processes the given input and gives us a comparative result between the existing model and the

proposed model. Here, in this paper we have compared the net present cost and the carbon emission.

Component	Capital ($)	Replacement ($)	O&M ($)	Fuel ($)	Salvage ($)	Total ($)
Grid	0	0	33,876	0	0	33,876
System	0	0	33,876	0	0	33,876

Fig-6 Net Present Cost of the only Grid system

The Net Present Cost of the only grid system is $33,876. While the Net Present cost of the Solar PV system is $33,357.

Component	Capital ($)	Replacement ($)	O&M ($)	Fuel ($)	Salvage ($)	Total ($)
PV	7,420	0	3,074	0	0	10,494
Grid	0	0	12,178	0	0	12,178
EXIDE	1,970	5,254	1,107	0	-176	8,155
Converter	1,140	548	692	0	0	2,380
Other	150	0	0	0	0	150
System	10,680	5,802	17,051	0	-176	33,357

Fig-11 Net Present Cost of the solar and grid system

The overall cash flow analysis of the two systems is showed in the Fig-5 and Fig-6 respectively.

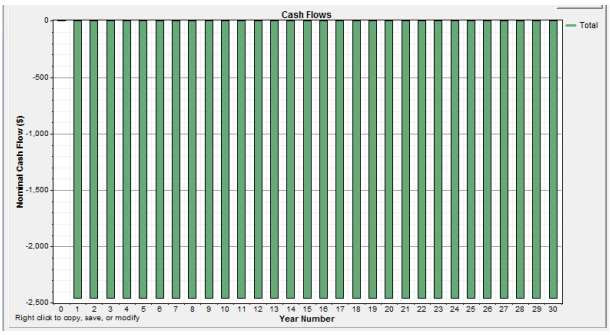

Fig-12 The cash flow of the grid system

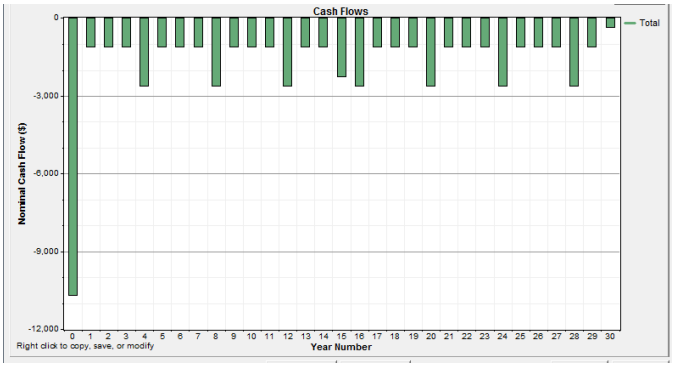

Fig-13 The cash flow of the solar PV system

Pollutant	Emissions (kg/yr)
Carbon dioxide	20,520
Carbon monoxide	2,428
Unburned hydrocarbons	855
Particulate matter	410
Sulfur dioxide	93.7
Nitrogen oxides	45.8

Fig- 14 Emissions in Grid system

Pollutant	Emissions (kg/yr)
Carbon dioxide	83.3
Carbon monoxide	9.86
Unburned hydrocarbons	3.47
Particulate matter	1.67
Sulfur dioxide	0.381
Nitrogen oxides	0.186

Fig- 15 Emission in solar and grid system

5. RESULT DISCUSSION

The total output of the optimization depends on Net Present Cost. All other parameters are defined according to the Net Present Cost and an overall result is obtained. The initial capital cost was $7420 while the total cost comes out to be $33.357 in the solar PV system. The savings in this new system is not only through the cost but also through the carbon emission. The carbon emission result shows a huge difference of 24,254 kg/year.

Table – 2: Comparison of the two systems

Comparison of the two systems			
Particulars	Grid only	With solar and grid	Savings
Net Present Cost	$ 33,876	$ 33,357	$ 510
Operating and Maintenance Cost	2,461 $/yr	2,170 $/yr	246 $/yr
Emission kg/yr	24,353 kg/yr	98.867 kg/yr	24254 kg/yr
Carbon Content	20,520 kg/yr	83.3 kg/yr	20436.7 kg/yr

6. CONCLUSION

In this paper we have done a comparison study of the working of the grid with the solar PV system that is to be installed in the University campus. After the study we conclude that the cost of installing the system will make

the University to save their money after sometime of installation. But the most impactful result is the control of carbon emission which 20,520 kg/year using the grid while it is only 83.3 kg/year if we install the system. This concludes that our system installation will really help in the control of emission which is the most important concerns of the environment in today's world.

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