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Original Research Article

DEPLOYMENT OF GRID CONNECTED PV SYSTEM FOR REDUCTION IN ELECTRICITY BILL: CASE STUDY

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Abstract:

Saving Electricity & making renewable sources of energy the alternatives for electricity generation is perhaps the biggest problem the world is facing now. Looking at current electricity generation requirements and the declining supply of non-renewable sources of energy, Solar energy & solar enabled devices are the only hope for the future generations to meet the rising electricity demands. This paper focuses on a very innovative technique used nowadays called the grid connected PV systems in which one can take a benefit of both, the solar generated electricity and the usual grid system as per the requirements. This paper analyzes the cost of installing grid connected PV systems and the monthly savings on electricity bills after installation and the approximate time required to recover all the invested money. This paper also compares the electricity bills of every month generated before and after installation of solar panels with the grid system. For this analysis, we obtained electricity bills from 2017 till date for every month and studied the electrical units, bill amounts, electricity exported from solar panels to grid system & electricity imported from grid system to the actual utility. It was observed that the electricity bill reduced substantially after installation of grid connected PV systems and hence grid connected PV systems can be a good alternative in the near future.

Keywords: *Non-Renewable Sources, Solar Energy, Solar Enabled Devices, Grid Connected PV Systems.*

Introduction:

In recent times, electrical energy has become a fundamental need of human beings. Human beings are reliant on electrical energy for all kinds of purposes; right from charging a cell phone to powering giant machineries. Generally, this electrical energy is supplied to homes & industries by a local electricity board at a certain cost depending upon the purpose; whether home or industry. There are various ways in which electricity can be generated; but most of the electricity that we use is generated by burning coal for rotating the turbines of a generator. Hence, the electricity we use comes at the cost of degradation of coal on earth. Coal is a non-renewable source of energy. Its supply is reducing day after day, and a day will come when there will be no coal for electricity generation. Hence, the use of renewable sources of energy like solar energy, wind energy, geo-thermal energy, biomass energy, tidal energy, etc. is a need of the hour.

Among all, solar energy is the most convenient & reliable form of renewable energy which is obviously available at no cost and definitely has the capacity to produce enough electrical energy to fulfil the energy requirements of human beings. The solar energy can be converted into electrical energy by using solar cells which are nothing but P-N junction diodes. Solar cells work on an effect called the Photovoltaic Effect in which electricity is generated when

sunlight falls on the solar cells. An array of solar cells connected in series & parallel forms a solar panel. Many such solar panels have to be installed on the rooftop of a building for producing electricity from the sunlight. The electrical energy generated by solar panels is stored with the help of batteries and used for powering appliances at home. The Use of solar generated electricity cuts short the electricity bill by an appreciable amount. Installation of solar panels is a one-time investment and costs a lot of money; but once installed, it provides a lifetime of free electricity and it is also very eco-friendly.

In recent times, a very innovative technique has revolutionised the way we use solar energy. This is called the Grid Connected PV System. On some really hot days or during the summer, the solar panels produce electricity much more than actually needed or consumed. If not utilized properly, it will be wasted anyway. Therefore, this surplus electricity is either stored in batteries or is fed directly to the electrical grid network. The latter is called the Grid Connected PV System which has solar panels providing some or most of their power needs during the day time and connected to the local electrical grid network during the night time. The Grid Connected PV System is very advantageous because of its simplicity, low operating and maintenance costs, no need for expensive back-up batteries and reduced electricity bills.

Literature Review:

1. Research work was carried out on microgrid's roles to deliver the necessary clean electricity to the individual dwellings to satisfy the electricity requirements of a small scale dwelling with a maximum power delivering capability of 9 kW.
2. Fatima-Ezzahra Riakhi designed a grid- connected photovoltaic (PV) solar carport system able to supply electricity to electric cars which produce energy of 42150 KWh which declines yearly by a rate of 0.5%. Its results of the developed design can further be used in other applications for solar PV system sizing.
3. Sagar Pandey worked on a case study of a grid type solar panel of 2 KW installed on the rooftop at chandigarh university in 2019 to utilize renewable energy which reduces the cost of electricity and provides a better electrical supply to the department.
4. In Malaysia, Solar panel with a 500 W inverter was installed to give output of 400 W in Off Grid Solar powered Technology to electrify the electric bus at the existing bus stop at Melaka, Malaysia was studied by C. F. Tan
5. In Kuwait, Abdullah Almutairi aimed to design and implement a PV solar energy home system for electrification in the Kuwaiti desert during eco-tourism in winter & address several critical issues which are appropriate for the PV solar system.
6. Riya paul in her conference paper introduced renewable energy with grid system through smart grid system to dispatch excess generated power from the solar panel to a common grid system through a digitally monitoring and controlling system through the IoT.
7. Maheshkumar Narsayya Bhairi, Shubhangi Shital Kangle, V. B. Bhosale, in the International Conference on Trends in Electronics and Informatics (ICEI), presented the advantages of using automatic controlled, self-powered, efficient solar LED street lights by saying that such streetlights can be operated free of cost.
8. Research work carried out by Peter Tillmann found that in winter, solar panel configurations give up to 23 % lower LCOE compared to the established configuration with the module tilt angle equal to the latitude and the module distance chosen such that no mutual shading of neighbouring solar panels occurs at winter solstice.
9. Kristina Berzina observed and concluded with her research paper on application of DSM in reducing the communal space's illumination power consumption, in turn helping to reduce the needed PV generating power and energy storage.
10. Muhammad Saad Khan investigated that Monocrystalline PV panels are more efficient than Polycrystalline PV
11. panels and they generate more units of electricity under same temperature conditions during its complete life.

12. To enhance the electrical efficiency of solar PV panels, cooling systems must be provided across it.
13. A case study from northern Nigeria, concluded that dust accumulation on the surface of PV panels can reduce solar panel system efficiency by up to 30-50%. It was noticed that the output power of the solar panel after cleaning with pressurized water and soap is 2.31 W, with water and surfactant is 2.295 W, while the output power for the solar panel surface coated with thin glass nano-structure is 2.43 W. The results clearly show that coating the surface of a PV panel with conducting material is the best method to mitigate dust accumulation.
14. The research work of D. Naimah, D. Novitasari, E. Wulandari, from Indonesia evaluates techno economic and environment assessment of solar photovoltaic (PV) system in Parang Island, Indonesia. In economic assessment, it shows the LCOE is at USD 0.11 per kWh which is higher than retail electricity price (USD 0.09/kWh).
15. It was examined by Sumadi that annual energy savings are estimated to be 9315.61 kWh, which equates to a savings of over 3200 USD per year on the electricity bill by use of photovoltaic solar cells in Jordan's national grid.
16. M. Chakravarthy noted in a research paper that 200 Kwp solar power plant at Ibrahimbagh, Hyderabad generates on average 25,000 units per month resulting in a saving of Rs 2.5 lakhs per month in the electricity bill.

Objectives:

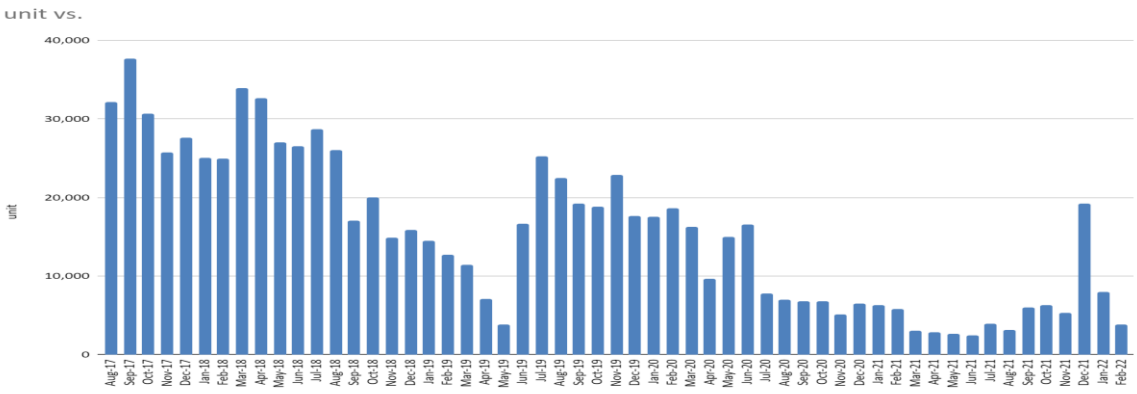
Lot of work has been done to identify & overcome the shortage of electricity as well as to get optimum utilization of solar energy using solar panels. [18][19][20][21][22][23][24][25][26]. This work motivated us to carry the research work forward on the grid connected PV system which is also installed in our institute.

1. To study the units consumed from period Aug 2017 till March 2021.
2. To analyse the Electricity bill amount before & after Solar Panel installation.
3. To estimate the yearly amount saved by installation of Solar panel.

Methodology:

C K Thakur ACS College, New Panvel, Navi Mumbai, Maharashtra, India (Autonomous) has installed 452 solar panels, Alpex Solar Diamond model make, generating 150 kW power with total voltage 452 V along with 3 inverters of SMA SOLID – Q 50 covering total rooftop area 7500 Sq. Feet of the institute. The total cost of purchase, installation & maintenance is Rs. 6,000,000/-. For the analysis, electricity bills for the period from August 2017 till date were collected. From these bills, the electrical units consumed every month and the electricity bill amount for every month before & after the installation of grid connected PV system was compared.

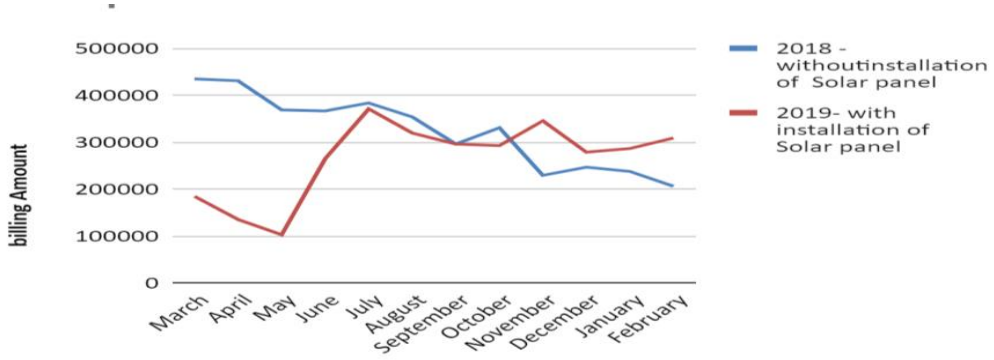
Observations:



Graph 1: electrical units consumed from Aug-17 to Feb-22

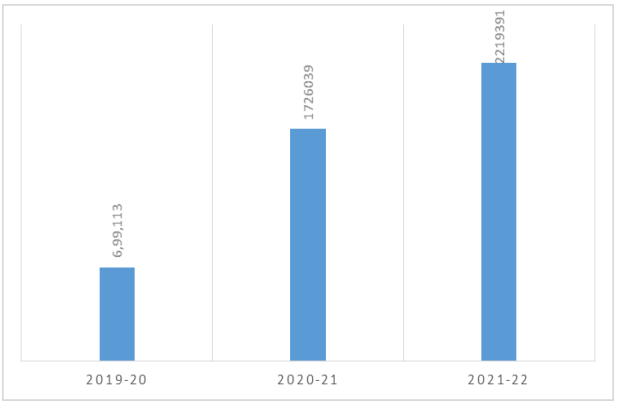
The graph above shows the electrical units consumed every month from Aug-17 to Feb-22. From Graph 1 it is observed that more electrical units are consumed in the rainy season & in the summer season as compared to that in the winter season. C K Thakur ACS College, New Panvel, Navi Mumbai, Maharashtra, India (Autonomous) has

installed 452 solar panels and employed a grid connected PV system in March 2019. The system exports the excess electrical power generated by solar panels to the electricity board (MSEB) and the exported units are compensated in the actual consumed units. This compensation is reflected in the monthly bill which reduced significantly for some months.



Graph 2: Analysis of Billing Amount with and without solar panel

The Graph 2 above compares the electrical bills generated every month before and after installation of the grid connected PV system in March 2019. The red line indicates the month wise billing amounts from March-2019 to February-2020 i.e. after the installation of grid connected PV system. The blue line indicates the month wise billing amounts from March-2018 to Feb-2019 i.e. before the installation of grid connected PV system. As indicated by the graph, the electricity bills reduced significantly after the installation of a grid connected PV system. The graph also shows some variations in the period from November to February due to rise in temperature in these days and continuous lectures & practicals & other events during this period. There is a significant decline of about Rs. 270,532/- on an average in the electricity bill amount in the period from March to May which is remarkable. During the period from June to October, not much of a difference was observed. In the year 2018, the total electricity bill was found to be Rs. 3,885,691/- which is more than the electricity bill as observed from March-2019 to February 2020 after installation of grid connected PV system to be Rs. 3,186,578/-. The total bill amount saved in this period was Rs. 699,113/-.



Graph 3: Comparison of Amount Saved

In a similar way, when the electricity bills for 2020 & 2021 were compared, it was observed that Rs. 1,726,069/- were saved from March-2020 to Feb-2021 and Rs. 2,219,391/- were saved from March 2021 to February 2022. This monthly savings in electricity bill is remarkable which agrees with the research paper by M. M. Chakravarthy, where savings of Rs. 2.5 lac per month in electricity bill was observed by a 200 KW power Solar roof top plant which was installed at Vasavi College of engineering, Ibrahimbagh, Hyderabad .[15]

Conclusion:

It is observed that after installation of the grid connected PV system, electrical units consumed has been reduced

which is reflected in the MSEB bill. A significant reduction in the monthly bill was observed since March 2019 i.e. after installation of the grid connected PV system. On an average, the monthly bill was reduced by Rs. 58259.41/-. Since March 2019, C K Thakur A.C.S College has been able to save Rs.4, 644,543/- on electricity bills. Till March 2022, after comparing the cost of purchase, installation & maintenance i.e. Rs.6, 000,000/- with the amount saved every year, it can be approximated that the invested amount can be recovered in 4 to 5 years. This means, within the next one and half years, the total cost will be recovered.

Suggestions:

The solar panels should be regularly cleaned to remove any dust accumulated on the solar panels. This increases the efficiency of the Solar Panels thereby generating more electricity. If any home or any industry is installing solar panels then it is advised to use the grid connected PV system as it is more advantageous than just a solar panel alone. Such a connection allows the users to take advantage of solar energy during sunny days and electricity from the grid during night time, rainy or cloudy days.

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