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Environmental & Financial Benefits of 360 kW Photo Voltaic Solar System (On-Grid) in University of Wah

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Abstract. In the 21st century, the utilization and application of renewable energy resources are the need of the hour. Currently, in Pakistan, the cost of electricity per unit is very high and it has a huge effect on financial matters. In this study, we have analyzed the 360 kW Photovoltaic (PV) Solar system (On-Grid) installed at the University of Wah, its effects on the financial aspects, and environment change before and after its installation and operation. There are many types of renewable energy resources but not all of them are environmentally friendly. The University of Wah opted for the PV Solar system because it is environmentally friendly with no carbon emissions and requires very less maintenance. In this paper, we have also discussed, how this system benefits the local community and benefits the environment. All the facts and statistics about the 360 kW PV Solar System (On-Grid) are shared in detail.

Keyword:
Photovoltaic solar panels, Electricity Demand, Renewable energy, Environmentally friendly, Climate change

1. Introduction

In many countries, the potential for clean, carbon-free energy generation from solar PV sources overshadows their current electricity demand. Around 20% of the world's population lives in 70 nations with favorable solar PV conditions. Countries with high capacity tend to have low seasonality in solar PV output, implying that the resource is relatively steady between different months of the year [1]. The University of Wah is located 30 km to the northwest of Islamabad-Rawalpindi. The coordinates of the University are

33°44'30.0"N Latitude and 72°47'26.4"E Longitude. So, according to these details' Allah Almighty has blessed Pakistan with substantial sunshine hours for the whole year. The output of the PV Solar panels varies during the day and when the seasons change. In the summer season, sunshine hours are around 14 to 16 hours. But, in the winter season, sunshine hours are around 9 to 10 hours. The total energy produced by the PV solar panels during the whole day decreases significantly in the winter season, but the electricity demand decreases significantly as well. So, the overall electricity generation via 360 kW PV Solar (Net Metered On-Grid) system fulfilled the total electricity University load demand and excessive electricity is dispatched to the main grid free of cost

2. Background

In 2015, the total energy demand of the University of Wah was 200 kW and the unit price of the electricity at that time was Rs 25 (Incl. Tax). It was predicted that with the construction of two new academic blocks, the campus population and electricity load demand would increase, resulting in a drastic increase in electricity bills and the increase in the unit price of the electricity in the country. On these bases, the University of Wah decided to install renewable energy to meet the energy demand of the University. There are many types of renewable energy resources like PV Solar energy, Wind energy, Hydro energy, Tidal energy, Geothermal energy, Biomass energy but not all of them are environment friendly [2]. Electricity generation from a nuclear power plant is not considered a renewable energy resource, but it is zero-carbon, which means it emits little or no CO_2, much like renewable energy sources. Nuclear energy provides a steady source, which means it is not weather dependent, but the cost of the nuclear power plant to generate electricity is very expensive and it is also very difficult to implement it on a small scale [2]. PV Solar energy systems are considered environmentally friendly, and they require very less maintenance.

2.1. PV Solar Panels

There are mainly three types of solar panels Mono-crystalline, Poly-crystalline, and Amorphous silicon solar modules. Poly-crystalline has higher power output efficiency compared to mono-crystalline and is amorphous in a high level of average solar radiation per day. While in low average solar radiation per day the power output for poly-crystalline is at a low level compared to another PV solar module. The power output of mono-crystalline drops as the module temperature reaches a high value. Amorphous solar panels in low intensity solar radiation produce more power output than poly-crystalline and mono-crystalline PV modules. However, in the high intensity of solar radiation, the energy output for amorphous materials is low as compared to poly-crystalline and mono-crystalline [3]. A detailed comparison between all types of Solar panels is mentioned in Figure.1.

Table.1 Comparison between PV Solar Panel Types [4]

Sr. No.	Comparing Solar Panel Types			
1	Solar Panel Type	 Monocrystalline	 Polycrystalline	 Amorphous
2	Glass Color	Black	Blue	Brown, Grey, Black
3	Composition	Single-Crystal Silicon	Multi-Crystal Silicon	Thin Layer Silicon
4	Size	Small (most space efficient)	Larger (less space efficient)	Largest (least space efficient)
5	Price	Premium	Value	Economy
6	Efficiency	15-20%	13-16%	6-9%

2.2. Net Metering

Net metering is a billing method that rewards owners of solar energy systems for the electricity they provide to the grid. For example, if a residential consumer has a PV Solar system on their roof, it may generate more power than the consumer consumes throughout the day. If the house is net-metered, the electricity meter will run backward to offer a credit against the amount of power spent at night or during other times when the house electricity consumption exceeds the system's output. Customers are only charged for their "net" energy use. On average, only 20-40% of a solar energy system's production is exported to the grid, and this exported solar electricity feeds loads of neighboring consumers [5].

3. System Details

The University of Wah decided to install the 360 kW PV Solar system (On-Grid) and the type of Solar panels used by the University for the PV Solar system is Poly-crystalline, due to its suitability to the climate conditions and reasonable price range. All the PV Solar Panels are placed at the rooftops of the University buildings and the optimal solar angle at which all these panels are placed is 30^0.

The total cost of the 360 kW PV Solar system is about Rs 37 Millions including the purchase cost of the solar panels and installation cost of the overall system.

3.1. UW Total Energy Consumption in 2020

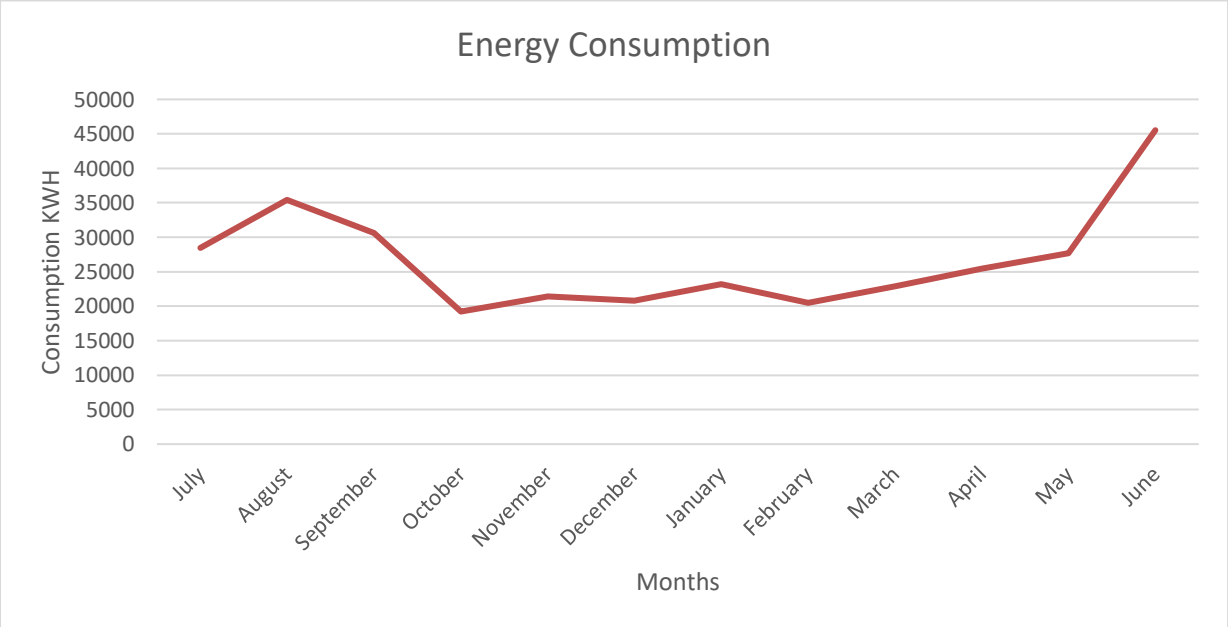

Figure 3. Energy Consumption (kW) in 2020

- The Total electricity usage of University of Wah in 2020 is 327,058 kWh

3.2. UW Total Energy Production in 2020

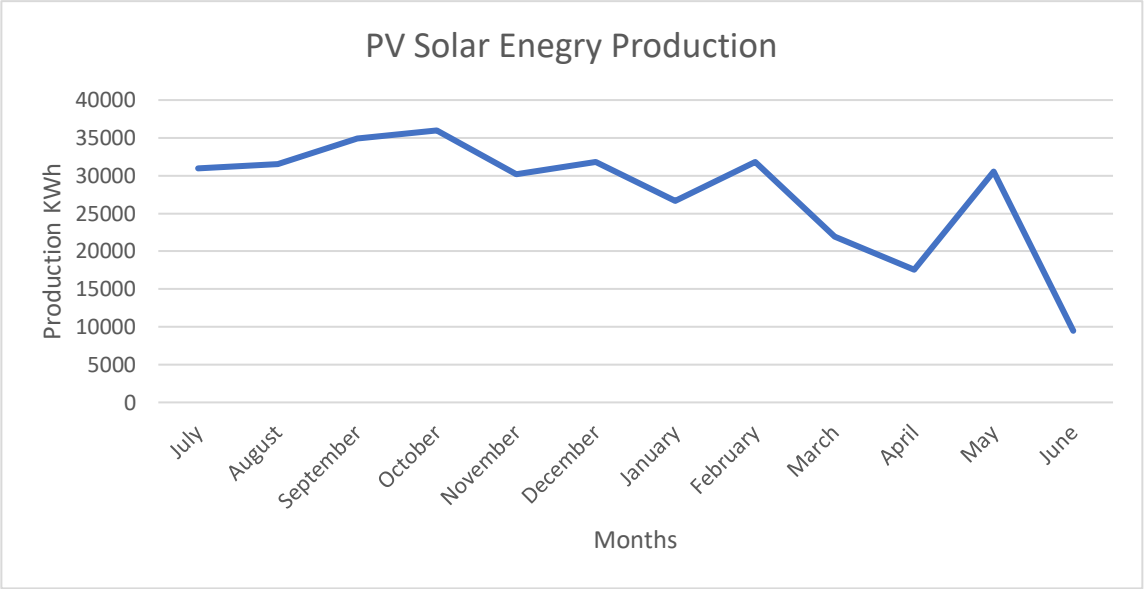

Figure 4. Renewable Energy Production (kWh) in 2020

- Total Energy produced by these units are 363270 kWh.

3.3. Comparison of Energy Produced & Consumed

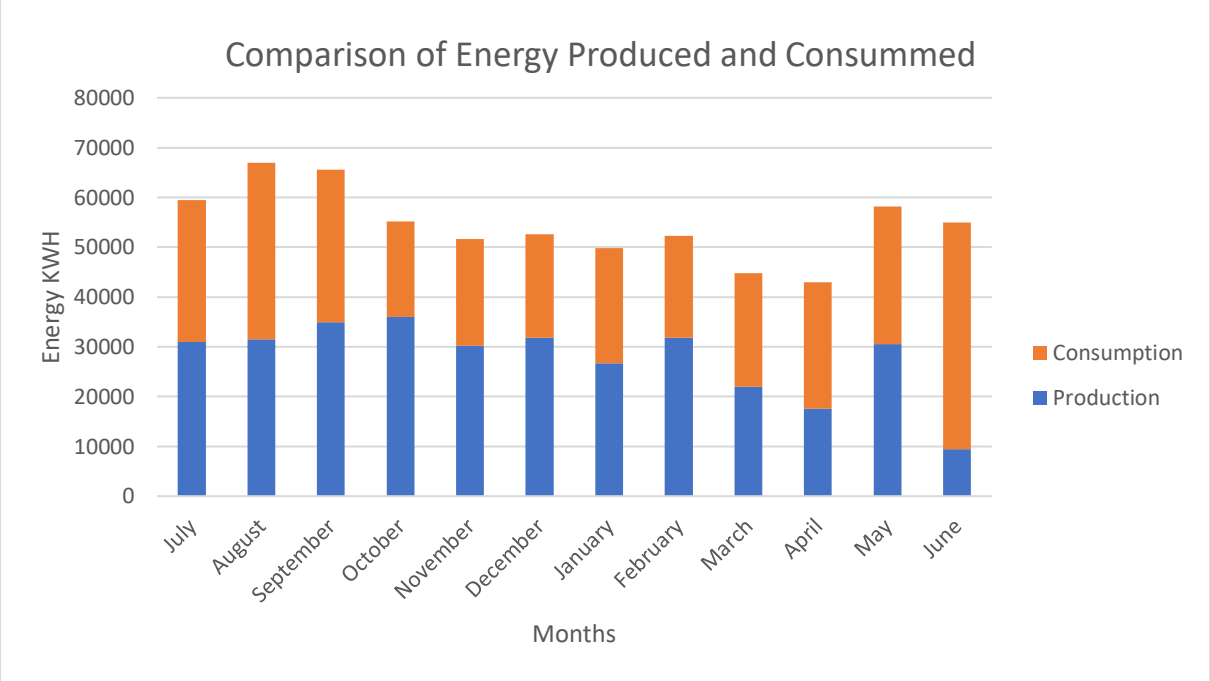

Figure 5. Comparison of Energy Produced & Consumed – Year 2020

- Total PV Solar Energy Produced = 363270 kWh
- Total Energy Consumed = 327058 kWh
- Ratio of PV Solar energy produced to energy consumed = 1.11

As mentioned above, the university energy consumption is less than that of energy produced by the PV Solar renewable energy resource most of the year, the excess of the electricity is dispatched into the main grid free of cost to help the local community and welfare purpose.

4. Analysis of Electricity Bills in terms of Financial Aspects

Table.2 Analysis of Electricity Bills

Year	Peak Power Demand	Unit Price of Electricity	Electricity Bills Paid
2015	**200 kW**	**Rs. 25 (incl Tax)**	**Rs. 5,982,757 /- USD 59,000 /-**
2020	**250 kW**	**Rs. 45 (incl Tax)**	**(Estimated) Rs. 12,500,000 /- USD 78,000 /-**

5. Results

As given in Table. 2 it is mentioned that the University of Wah has paid the electricity bills around 59,000 USD in 2015 when the Pead Power demand was 200 kW. It was predicted in 2015, the load demand and university population would increase substantially. The current Peak Power Demand is around 250 kW and if we estimate the year 2020 electricity bills for the complete year it will be around 78,000 USD due to high unit price of electricity. So, the decision to opt for PV Solar Renewable energy resource was quite beneficial both in terms of financially and environmentally.

6. Conclusion

The total cost of the 360 kW PV Solar system was Rs. 37 millions. As mentioned above in the calculations section, it has been observed that approx. 70% of the total cost of the 360 kW PV Solar System is being paid back. In the near future around 2023, it is estimated that the overall cost of this system will be paid back. It also indicates that this system supports the University in financial terms by saving Millions of Rupees per year in terms of electricity bills. Another benefit of this system is that the University of Wah is utilizing PV Solar renewable environmentally friendly energy with (Zero Carbon Emissions) that supports our motto “Green Energy University”. As mentioned above, the University PV system is generating more electricity than its demand, so the excess of the electricity is dispatched to the main grid free of cost for community support purposes.

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