DEPARTMENT OF ELECTRICAL ENGINEERING
Government College University Faisalabad

Design of On-Grid Photovoltaic System Considering Optimized Sizing of Photovoltaic Modules for Enhancing Output Energy

Muhammad Tamoor
engr.muhammadtamoor@gmail.com
ORCiD: 0000-0003-0981-9904

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Presentation Outlines

- Introduction
- Research Methodology
- Results and Discussion
- Conclusions

Introduction

Research Background

- ☞Photovoltaic systems play a significant role for decreasing global warming and achieving climate change targets like carbon emission and environmental issues .
- ☞ Industrial, commercial and domestic customer are highly benefitted by standalone or grid connected PV system to reduce their peak demand.
- ☞ Energy security challenges have arisen as a result of increased energy demand in developing countries.
- ☞ On-grid Photovoltaic energy generation systems have proven to be the most cost-effective large-scale renewable energy source.

Research Background

- A PV system that is properly designed and sized eliminates extra costs from an oversized system and insufficient power delivery from an undersized system.

- The performance of PV systems is influenced by a multitude of parameters, including the type of photovoltaic modules used, PV modules power rating, the sun irradiance potential, and the geographic location of the system.

- Photovoltaic power systems installed at the optimal inclination angle and row spacing generate maximum energy, avoid unnecessary costs, and make optimal use of the available space.

Aim of Study

The aim of this study to analyze the simulated photovoltaic output of different PV module sizes have identical efficiency in the same fixed area using the Helioscope. With the variation of the PV module size having nearly identical efficiencies, there is a wide variation in power output. This research strongly recommended that optimum PV module size for a certain location should be evaluated using available simulation tools to ensure maximum energy from photovoltaic system.

Research Methodology

Research Methodology

- In order to evaluate the optimal sizing of PV modules and PV energy potential at a proposed location, a number of experiments were carried out in this study.
- There were four different rating of PV modules are analysed for each location in the experiment.
- An azimuth angle of 180° and a tilt angle of 15° were used in all four scenarios.

Research Methodology

- The study was conducted at following locations:
- Location 1: Energy generation by PV system installed at GC University Faisalabad
- Location 2: Energy generation by PV system installed at University of Agriculture Faisalabad

- The surface area of each location is 30,224.5 ft2 for GC University Faisalabad and 54,994.4 ft2 for Agriculture University Faisalabad.

Research Methodology

- In this study, the Meteonorm programme and database were utilised to measure solar energy resources. For PV energy output assessment irradiance data, sunlight hours, temperatures and precipitation are all important parameters to evaluate. Seasonally, the weather change from a cold winter to a warm summer, with a high temperature of 46.0°C

Research Methodology

- The monocrystalline photovoltaic module manufactured by Trina Solar are used in this study and their power rating vary from (340 watt to 540 watt).

- Specification of all Photovoltaic module

Rated Maximum Power	340	380	450	540
V_{MP}	38.200V	40.300V	41.000V	31.200V
V_{OC}	46.200V	48.800V	49.600V	37.500V
I_{MP}	8.900A	9.430A	10.980A	17.330A
I_{SC}	9.500A	9.940A	11.530A	18.410A

Research Methodology

- Ginlong Technologies (Solis-50K) solar inverters were used for each design.

- Specification of PV Inverter.

Parameters	Value
Manufacturer	Ginlong Technologies (Solis-50K)
Maximum Power	50.0 kW
Minimum Power	250.0 W
Maximum Voltage	1,100V
Maximum MPPT Voltage	1,000V
Minimum MPPT Voltage	200V
Minimum Voltage	200V
AC Output	380Y/220V

Results & Discussion

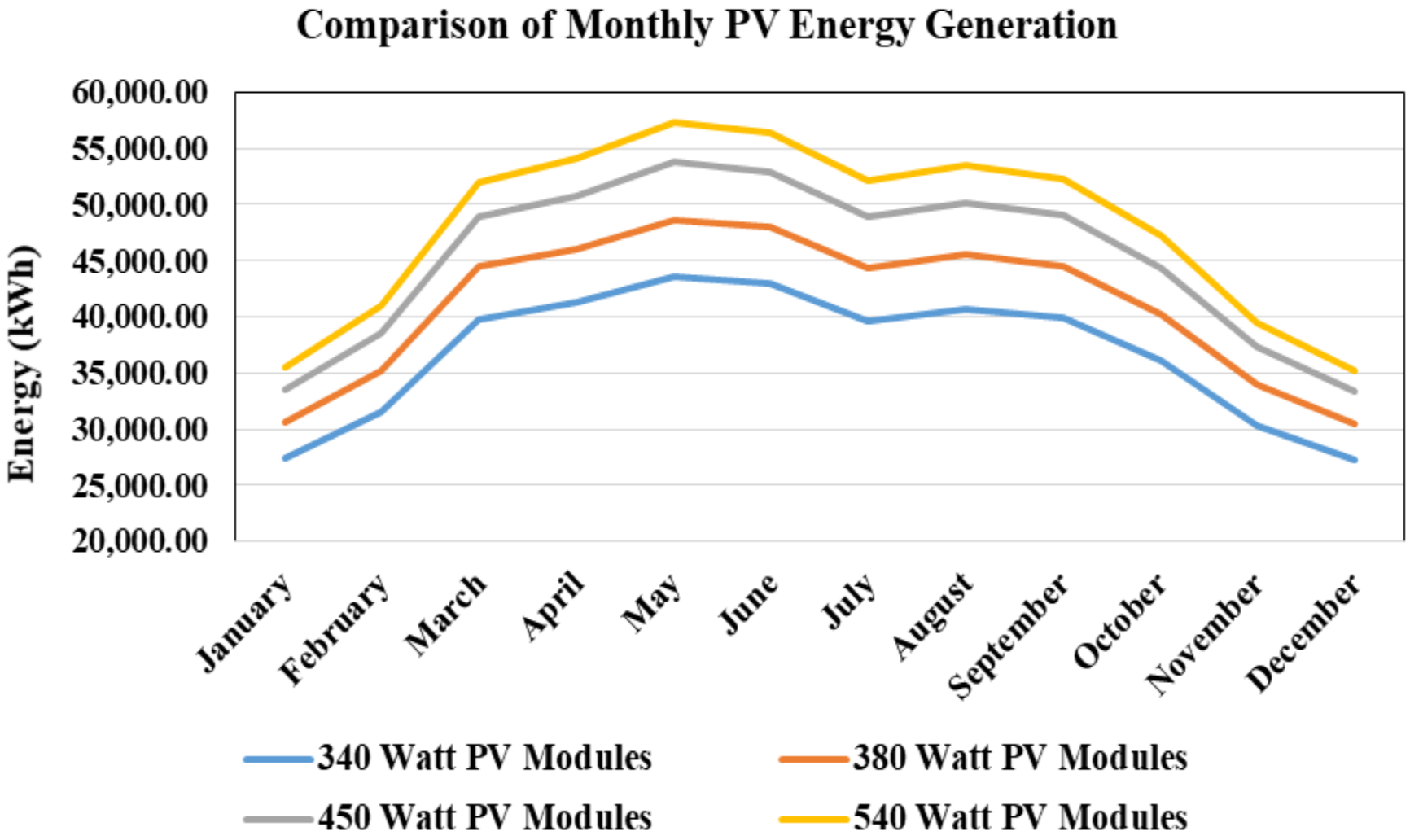
Energy Generation by PV System Installed at GC University Faisalabad

PV Rating	Installed PV Capacity	Annual Energy Generation	Performance Ratio	kWh/kWp
340	294.4 kW	440.4 MWh	81.2%	1495.8
380	329.1 kW	492.0 MWh	81.2%	1495.2
450	360.9 kW	541.7 MWh	81.5%	1500.9
540	383.4 kW	576.7 MWh	81.7%	1504.2

- By comparison, we analyse that the photovoltaic energy generation system installed with 540.0 watt PV modules are more efficient installed at fixed area in GC University Faisalabad.

- For this case, the simulation results show that the annual energy generation of the photovoltaic system is 576.7 MWh, and the performance ratio (PR) of the system is 81.7%.

Comparison of Monthly PV Energy Generation



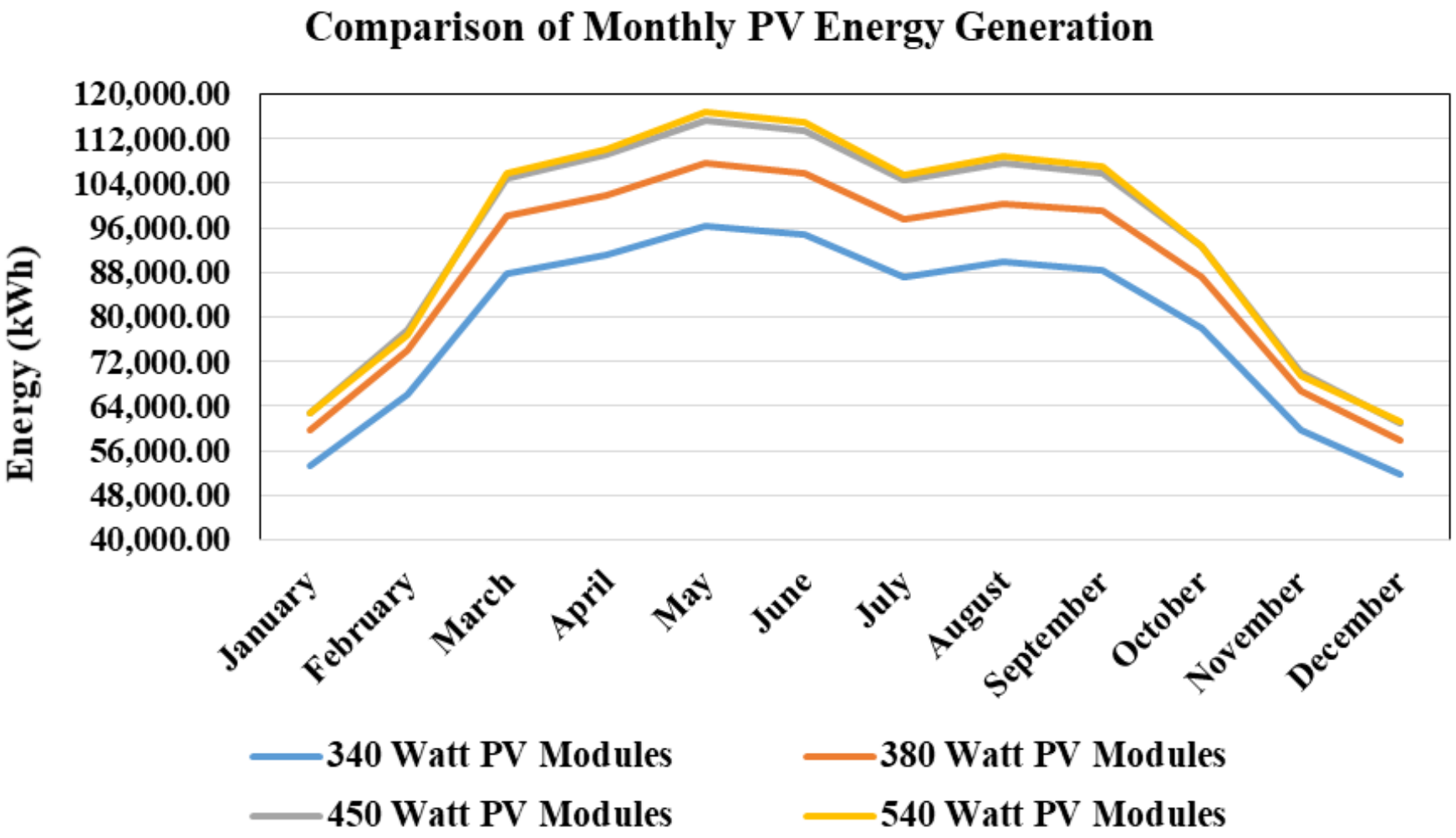
Energy Generation by PV System Installed at University of Agriculture Faisalabad

PV Rating	Installed PV Capacity	Annual Energy Generation	Performanc e Ratio	kWh/kWp
340	658.2 kW	944.5 MWh	78.1%	1434.9
380	735.7 kW	1.056 GWh	78.1%	1435.6
450	782.1 kW	1.125 GWh	78.3%	1438.0
540	789.5 kW	1.131 GWh	78.0%	1433.2

- By comparison, we analyse that the photovoltaic energy generation system installed with with 450.0 watt PV modules are more efficient (having high PR ratio and kWh/kWp) installed at fixed area in University of Agriculture Faisalabad.

- For this case, the simulation results show that the annual energy generation of the photo-voltaic system is 1.125 GWh, and the performance ratio (PR) of the system is 78.3%.

Comparison of Monthly PV Energy Generation



CONCLUSION

- This study intends to emphasize the fact that when designing an On-Grid photovoltaic system, relatively little consideration is given to selecting the appropriate type and size of PV modules.
- In this research, different PV modules of various sizes and power ratings with nearly identical efficiencies were analyzed in two selected locations.
- For GC University Faisalabad, the annual energy generation of the photovoltaic system is 576.7 MWh and for University of Agriculture Faisalabad, the annual energy generation of the photovoltaic system is 1.125 GWh.
- This research strongly recommended that optimum PV module size for a certain location should be evaluated using available simulation tools to ensure maximum energy from photovoltaic system.

Q & A