iJRASET
International Journal For Research in
Applied Science and Engineering Technology

INTERNATIONAL JOURNAL FOR RESEARCH
IN APPLIED SCIENCE & ENGINEERING TECHNOLOGY

Volume: 13 Issue: V Month of publication: May 2025

DOI: https://doi.org/10.22214/ijraset.2025.70128

www.ijraset.com

Call: 08813907089 | E-mail ID: ijraset@gmail.com

International Journal for Research in Applied Science & Engineering Technology (IJRASET)
ISSN: 2321-9653; IC Value: 45.98; SJ Impact Factor: 7.538
Volume 13 Issue V May 2025- Available at www.ijraset.com

100KW Solar Power Generation at SPCOE&T: A Performance Analysis

Jagtap Sayali[1], Holkar Shivaji[2], Shinde Tejal[3], Borawake Pratiksha[4], Prof: Gadhave.G.G[5]
[1, 2, 3, 4]*Final Year student,* [5]*Head of Electrical Department at Sharad Chandra Pawar College of Engineering and Technology*

Abstract: This study presents a comprehensive analysis of a 100kW grid-connected solar photovoltaic (PV) rooftop power generation station installed at Sharadchandra Pawar College of Engineering and Technology, Someshwarnagar, Baramati. The analysis focuses on evaluating the performance of the system, including energy yield, performance ratio, capacity utilization factor (CUF), and the impact of environmental factors such as solar irradiance and ambient temperature. The study investigates the system's efficiency in converting solar energy into electrical energy, assesses its reliability, and quantifies its contribution to reducing the college's reliance on grid electricity. The economic viability of the installation is also considered, examining the payback period and the long-term financial benefits. The findings provide valuable insights into the real-world performance of rooftop solar PV systems in the specific climatic conditions of Baramati, contributing to the understanding of solar energy potential in educational institutions. The results highlight the system's effectiveness in promoting sustainable energy practices and reducing carbon footprint.

Index Terms: Solar Photovoltaic (PV), Rooftop Solar Power, Grid-Connected System, Performance Analysis, Energy Yield, Performance Ratio, Capacity Utilization Factor (CUF), Economic Viability, Solar Irradiance, Ambient Temperature, Sustainable Energy, Baramati.

I. INTRODUCTION

The escalating global demand for energy, coupled with growing concerns regarding environmental degradation and climate change, has catalyzed a paradigm shift towards sustainable and renewable energy sources. Solar photovoltaic (PV) technology, harnessing the abundant and freely available solar irradiance, has emerged as a promising solution to mitigate the reliance on fossil fuels and reduce greenhouse gas emissions. India, with its significant solar potential and ambitious renewable energy targets, has witnessed a rapid expansion of solar PV installations, particularly in the rooftop segment. Educational institutions, acting as both energy consumers and centers for knowledge dissemination, play a crucial role in promoting the adoption of solar energy. By installing rooftop solar PV systems, these institutions can not only reduce their operational costs and carbon footprint but also provide a practical demonstration of sustainable energy practices to students and the wider community

Sharadchandra Pawar College of Engineering and Technology (SPCOET), located in Someshwarnagar,Baramati, Maharashtra, has taken a proactive step towards embracing renewable energy by installing a 100kW grid-connected solar rooftop power generation station. This initiative aligns with the college's commitment to sustainability and its dedication to fostering an environmentally conscious learning environment. Baramati, situated in the semi-arid region of Maharashtra, experiences significant solar irradiation throughout the year, making it an ideal location for solar PV installations. Understanding the performance and economic viability of this particular system is essential to evaluate its effectiveness and to provide valuable insights for future solar energy projects in the region.

This study aims to conduct a comprehensive analysis of the 100kW solar rooftop power generation station at SPCOET. The analysis will focus on evaluating the system's performance metrics, including energy yield, performance ratio, and capacity utilization factor (CUF), and assessing the impact of environmental factors such as solar irradiance and ambient temperature on the system's output. Furthermore, the study will examine the economic viability of the installation by analyzing the payback period and the long-term financial benefits. The findings of this research will contribute to a deeper understanding of the real-world performance of rooftop solar PV systems in the specific climatic conditions of Baramati and provide valuable data for optimizing system design and operation.

The transition to renewable energy is not merely a technological shift but also a socio-economic imperative. Educational institutions, like SPCOET, are uniquely positioned to lead this transition by integrating renewable energy technologies into their infrastructure and curriculum. The installation of a 100kW solar rooftop system at SPCOET serves as a tangible example of how educational institutions can contribute to sustainable development goals.

By analyzing the performance of this system, we can gain insights into the practical challenges and opportunities associated with rooftop solar PV installations in educational settings.

The performance of a solar PV system is influenced by various factors, including the quality of the components, the system design, the installation practices, and the prevailing environmental conditions.

Solar irradiance, ambient temperature, and shading are critical factors that affect the energy yield of a PV system. Understanding the relationship between these factors and the system's output is essential for optimizing its performance. Furthermore, the performance ratio (PR) and capacity utilization factor (CUF) are crucial metrics that provide insights into the overall efficiency and reliability of the system. The PR indicates the ratio of the actual energy output to the theoretical energy output, while the CUF represents the ratio of the actual energy generated to the maximum possible energy generation.

The economic viability of a solar PV system is another critical aspect that needs to be considered. The initial investment cost, the operational and maintenance costs,the payback period and the long-term financial benefits of the system. In the context of educational institutions, the economic analysis should also consider the social and environmental benefits, such as reduced carbon emissions and enhanced sustainability awareness.

This study will adopt a systematic approach to analyze the 100kW solar rooftop power generation station at SPCOET. The analysis will involve collecting and analyzing data on solar irradiance, ambient temperature, energy output, and other relevant parameters. The data will be used to calculate the performance metrics and to assess the impact of environmental factors on the system's output. The economic analysis will be conducted using appropriate financial models and assumptions.

The significance of this study lies in its potential to provide valuable insights into the performance and economic viability of rooftop solar PV systems in the specific context of educational institutions in a semi-arid region like Baramati. The findings of this research will contribute to the growing body of knowledge on solar energy and provide practical guidance for the design, installation, and operation of similar systems. Furthermore, this study will serve as a case study for other educational institutions considering the adoption of solar energy.

The research will contribute to the following aspects:

Performance Evaluation: Detailed analysis of the system's energy yield, performance ratio, and capacity utilization factor.

Environmental Impact Assessment: Evaluation of the impact of solar irradiance and ambient temperature on the system's output.

Economic Viability Analysis: Assessment of the payback period and long-term financial benefits of the installation.

Contribution to Sustainability: Evaluation of the system's contribution to reducing the college's reliance on grid electricity and reducing carbon emissions.

Knowledge Dissemination: Providing valuable insights and recommendations for the design and operation of similar solar PV systems in educational institutions.

Promoting Renewable Energy: Encouraging the adoption of renewable energy technologies in educational institutions and the wider community.

The study will utilize a combination of quantitative and qualitative methods to achieve its objectives. Data will be collected from the system's monitoring system, meteorological data sources, and financial records. The data will be analyzed using statistical tools and financial models. The findings of the study will be presented in a clear and concise manner, highlighting the key insights and recommendations. This research will ultimately contribute to the advancement of solar energy adoption in educational institutions and promote a sustainable energy future preservation.

II. SELECTED LOCATION AND SITE SURVEY

A. Study Area Location

Specifically, the address is:

Gate No. 53, Waghalwadi, Post Someshwar Nagar, Taluka Baramati, District Pune, Pincode: 412306.

Key location details to remember:

Baramati: This is a city in the Pune district of Maharashtra, known for its agricultural and industrial activity.

Someshwarnagar: This is the specific locality where the college is situated.Pune District: This is the administrative district in which the college is located.

Figure1.SatelliteimagerythroughGoogleMap

Table .Geographical Location

Geographical Site	Someshwarnagar	Time Zone	UT+5.5
Latitude	18.11_N	Longitude	74.28_E

B. Site Survey Analysis for solar irradiance and climate data

1) Solar Irradiance:

This is the amount of solar radiation received per unit area. It's typically measured in kWh/m²/day or kWh/m²/month.
This is the most critical factor for determining the potential energy output of a solar PV system.

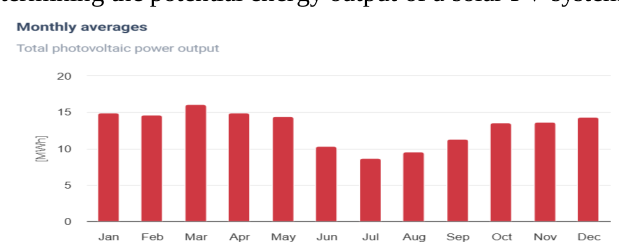


Figure2.monthly pv output

2) Ambient Temperature

High temperatures can reduce the efficiency of solar panels. Therefore, understanding the temperature profile of the location is essential.Temperature data should include average monthly temperatures, as well as extreme high and low temperatures.

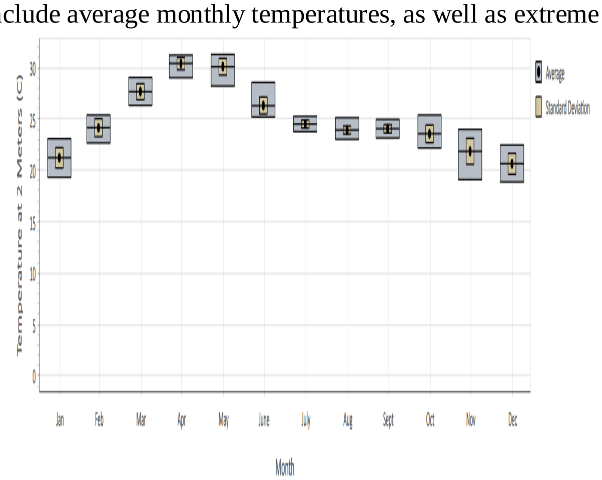


Fig 3:average temperature from nasa power

3) Rainfall and Humidity:

Rainfall can affect the cleaning frequency of solar panels. High humidity can contribute to corrosion and other issues.

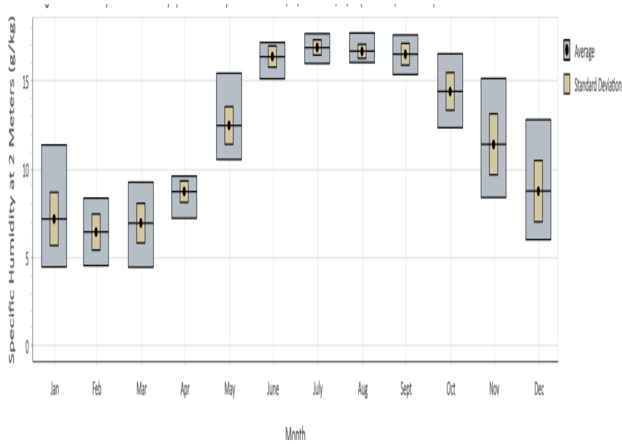


Fig 4:average Humidity from nasa power

4) Wind Speed:

Wind speed is important for structural design considerations, as solar panels and mounting systems must withstand wind loads.

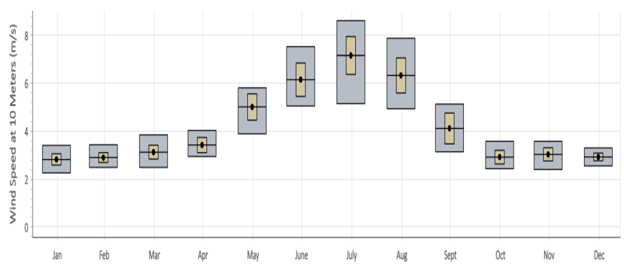


Fig 5:average wind from nasa power

III. DESCRIPTIONOF COMPONENTAND MOUNTING STRUCTURE

A. Component used :

1) Pv panel :

Solar panels are devices that convert sunlight into usable electricity through the photovoltaic effect. Composed of interconnected solar cells, typically made from silicon, these panels absorb photons from sunlight, which then liberate electrons, creating an electrical current. This direct current (DC) electricity is then transformed into alternating current (AC) by an inverter, making it compatible with standard electrical grids and household appliances. Solar panels are increasingly utilized in residential, commercial, and utility-scale applications, offering a clean, renewable energy source that reduces reliance on fossil fuels and diminishes greenhouse gas emissions. While initial installation costs can be a factor, advancements in technology and increasing efficiency are making solar energy a more accessible and economically viable option for power generation worldwide.

Fig 6:Solar Module 545wt (waaree)

Panel Specification:(WAAREE)

Length* Width*Thickness (L*W*T)	2272mm(L)*1133mm(W)*35mm(T)
Weight	27.5 kgs
Solar Cells per Module	144 cells
Solar cell type & size	Mono PERC,91*182 mm
Front Glass	3.2 mm
Encapsulate	PID Free& UV Resistant
Junction box	IP68/Weatherproof PPO
Cable& Connectors (protection degree)	IP68 rated/MC4 compatible
Cable crosssection&length	4mm&500mm
Frame	Anodized Aluminium Alloy

Table 2:Mechanical Characteristics

2) Inverter **:**

The Growatt 80kW inverter is a powerful and efficient solution designed for large-scale commercial and industrial solar installations.As a three-phase string inverter, it's engineered to maximize energy yield by converting the DC output from solar panels into grid-compatible AC electricity.Featuring multiple MPPT (Maximum Power Point Tracking) inputs, it optimizes power generation even in complex shading conditions. [2] Growatt inverters are known for their robust build quality, advanced monitoring capabilities, and user-friendly interface, allowing for remote system management and performance analysis. [3] This 80kW model typically includes integrated safety features like DC and AC surge protection, ensuring reliable and safe operation. [4] With its high efficiency and grid support functionalities, the Growatt 80kW inverter plays a crucial role in enabling businesses and organizations to harness solar energy effectively and reduce their carbon footprint

.

Fig 7:Growatt 80kw inverter

Inverter Specification:(GROWATT):

Model name	MAX 80KTL3Lv
Max. PV voltage	1100d.c.V
Pv voltage range	200-1000d.c.V
Nominal input voltage	600v
PV ise	32 d.c
Max input voltage	26d.c
Max .output power	8000 w
Nominal output voltage	88800VA
Max. output current	3Win
Nominal output frequency	50/60HZ
Power factor	0.8lead-0.8lag
Safety level	Class I
Ingress protection	IP65
Operation ambient temperature	-25c- +60c

Table 3:Inverter Characteristics

3) Dc distribution box:

The DC distribution box (DCDB) is an essential component in a solar photovoltaic (PV) system, acting as a crucial safety and connection point on the direct current (DC) side. Its primary role is to consolidate and protect the DC electricity generated by the solar panel arrays before it reaches the inverter. Inside the DCDB, components like fuses or DC circuit breakers protect against overcurrents and short circuits, safeguarding the solar panels and wiring. Surge protection devices (SPDs) are often included to shield against voltage surges, especially from lightning strikes. Disconnect switches allow for safe isolation of the DC circuits during maintenance or in emergency situations. The DCDB also facilitates the organized connection of multiple solar panel strings, streamlining wiring and improving overall system reliability. By effectively managing and protecting the DC electricity flow, the DC distribution box ensures the safe and efficient operation of the solar PV system, minimizing risks and maximizing energy output.

Fig 8:DCDB

International Journal for Research in Applied Science & Engineering Technology (IJRASET)
ISSN: 2321-9653; IC Value: 45.98; SJ Impact Factor: 7.538
Volume 13 Issue V May 2025- Available at www.ijraset.com

4) Ac distribution box:

The AC distribution box (ACDB) serves as a critical safety and management hub within a grid-tied solar photovoltaic system, bridging the gap between the inverter's AC output and the building's electrical grid. Its primary function is to protect the AC side of the system from electrical faults, employing circuit breakers to safeguard against overcurrents and short circuits, and surge protection devices to mitigate voltage spikes. This box also provides a centralized point for distributing the AC power, ensuring a safe and organized connection to the existing electrical infrastructure. Equipped with disconnect switches, the ACDB allows for the isolation of AC circuits during maintenance or emergencies, enhancing overall system safety. By effectively managing and protecting the flow of AC electricity, the AC distribution box ensures the reliable and secure integration of solar power into the building's electrical network.

Fig 9:ACDB

5) Net meter:

A net meter is a vital component in grid-tied solar photovoltaic (PV) systems, enabling bidirectional measurement of electricity flow between a consumer's property and the utility grid. This device accurately tracks both the electricity consumed from the grid and the surplus electricity generated by the solar panels that is fed back into the grid. By recording these flows, the net meter allows for accurate billing and credit calculations. When a solar system produces more electricity than the consumer uses, the excess is sent to the grid, and the meter runs backward, effectively crediting the consumer's account. Conversely, when the consumer uses more electricity than the solar system generates, the meter records the consumptionfrom the grid. This system allows consumers to offset their electricity bills by the amount of solar energy they contribute to the grid, promoting the adoption of renewable energy and providing economic benefits to solar system owners.

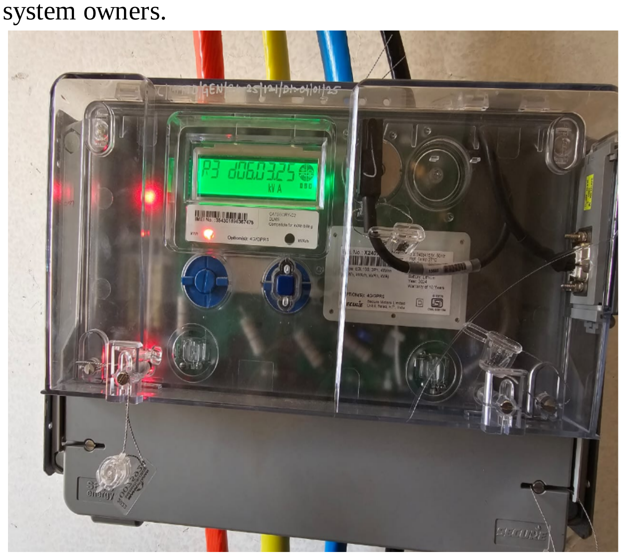


Fig 10:Net Meter

International Journal for Research in Applied Science & Engineering Technology (IJRASET)
ISSN: 2321-9653; IC Value: 45.98; SJ Impact Factor: 7.538
Volume 13 Issue V May 2025- Available at www.ijraset.com

B. Mounting structure:

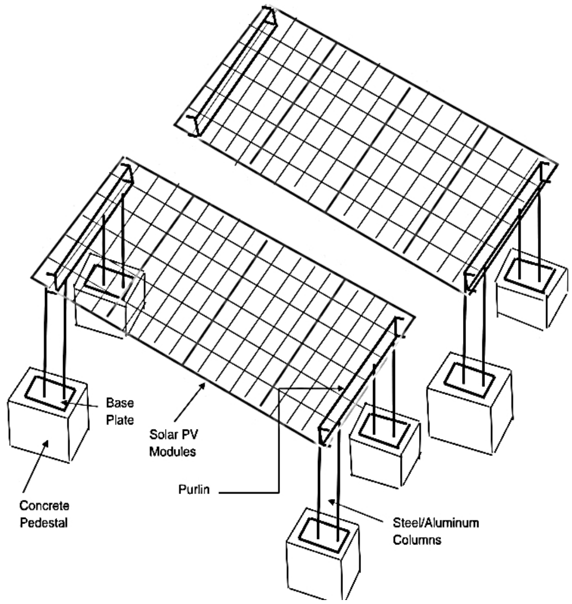


Fig 11: Panel Orientation

Diagram Components:
Solar PV Modules: The rectangular panels at the top, representing the solar panels themselves.
Purlin: Horizontal beams supporting the solar panels.
Steel/Aluminum Columns: Vertical supports holding up the purlins and panels.
base Plate: A flat plate at the bottom of the columns, providing a stable base.
Concrete Pedestal: A concrete foundation on which the base plate rests, anchoring the entire structure.

IV. SINGLE LINE DIAGRAM AND DESIGN

A. Single line diagram :

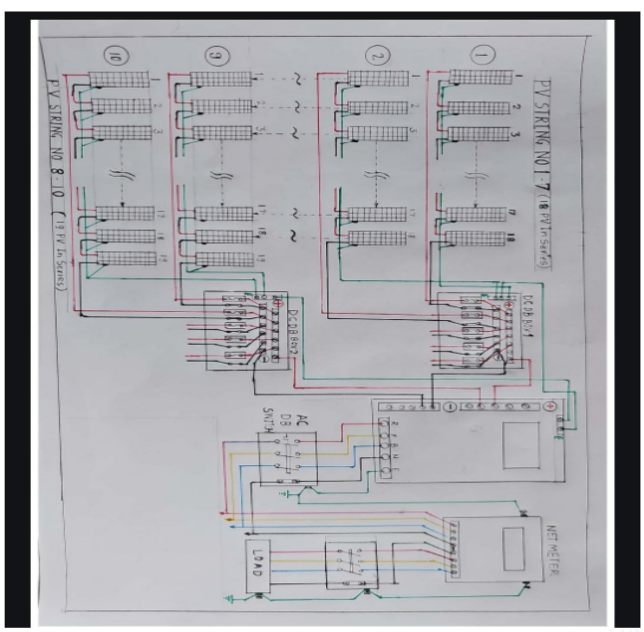


Fig 12:SLD for power generation system

B. Design considerations:

Total number of modules	190
Open circuit voltage of inverter	1000
Panel voltage(voc)	864
Number of panels connected in series	18
Panel working voltage	41.5v
Series panel working voltage	750 v
Total power output of each inverter	55000 w/55kw
Weight of single solar panel	27.5 kg
Weigth of single iron rod	20kg
Weight of single concrete	2.5kg
Total weight of complete panel	35-40kg
Length of panel	2272mm/227.2cm
Width of panel	1133mm/113.3cm
Thickness	35mm/3.5cm
Area of concrete	74100
Total area of concrete	390*190*90 mm

Table 4: design considerations

V. PERFORMANCE ANYLYSIS AND CHARACTERISTICS

PV module

Manufacturer	Generic
Model	WSMD-545
(Original PVsyst database)	
Unit Nom. Power	545 Wp
Number of PV modules	190 units
Nominal (STC)	104 kWp
Modules	10 string x 19 In series
At operating cond. (50°C)	
Pmpp	94.7 kWp
U mpp	714 V
I mpp	133 A

Total PV power

Nominal (STC)	104 kWp
Total	190 modules
Module area	489 m²

Fig 13:pv characteristics

Inverter

Manufacturer	Generic
Model	Growatt-80000KTL3-MV
(Original PVsyst database)	
Unit Nom. Power	80.0 kWac
Number of inverters	6 * MPPT 17% 1 unit
Total power	80.0 kWac
Operating voltage	200-1000 V
Pnom ratio (DC:AC)	1.29
No power sharing between MPPTs	

Total inverter power

Total power	80 kWac
Number of inverters	1 unit
Pnom ratio	1.29

Fig 14:nverter characteristics

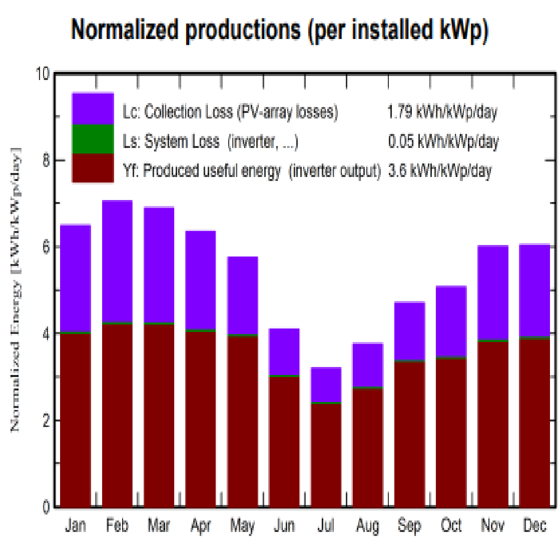


Fig 12:Normalized production per month

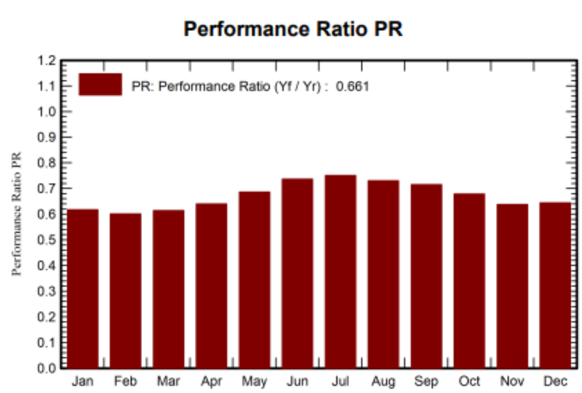


Fig 13: performance ratio

International Journal for Research in Applied Science & Engineering Technology (IJRASET)
ISSN: 2321-9653; IC Value: 45.98; SJ Impact Factor: 7.538
Volume 13 Issue V May 2025- Available at www.ijraset.com

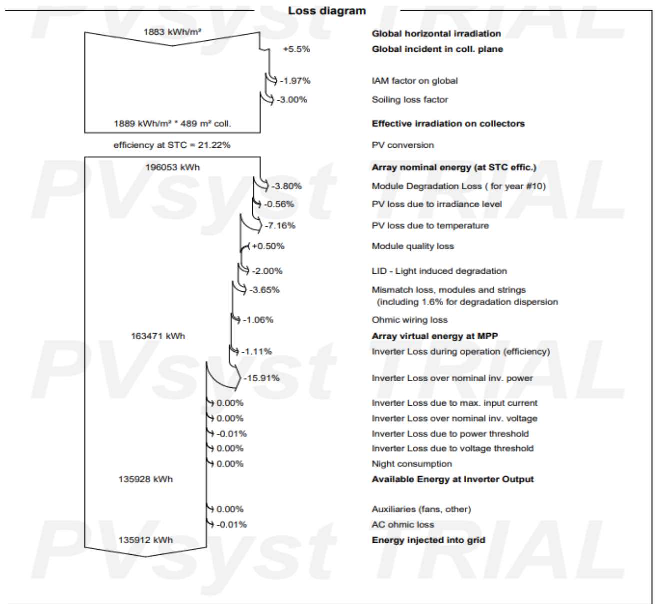


Fig 14: Losses Diagram

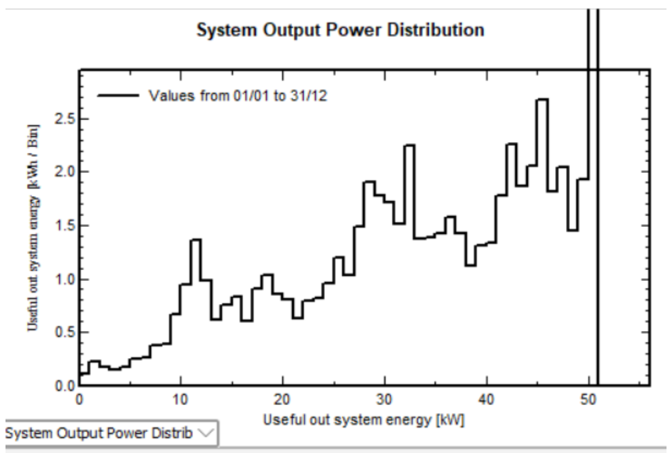


Fig 15: system output power

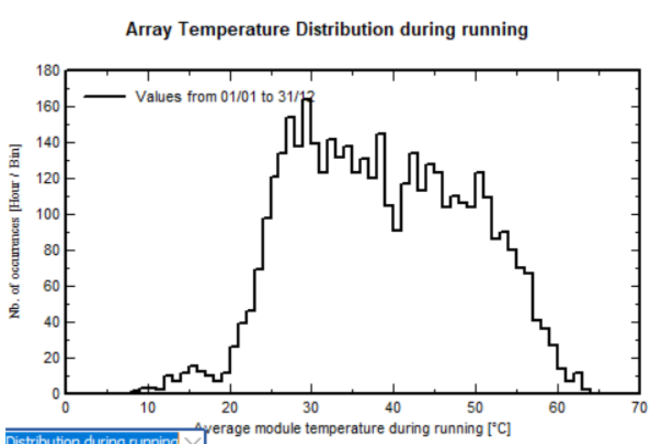


Fig 16: array temperature during running

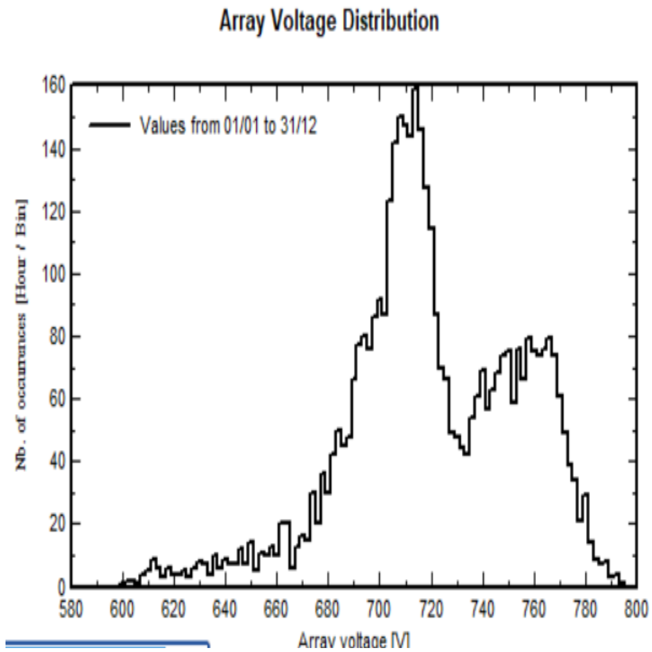


Fig 17: array voltage during running

Balances and main results

	GlobHor kWh/m²	DiffHor kWh/m²	T_Amb °C	GlobInc kWh/m²	GlobEff kWh/m²	EArray kWh	E_Grid kWh	PR ratio
January	153.6	44.65	20.27	201.3	192.8	13057	12880	0.618
February	163.3	45.82	22.97	197.3	188.9	12449	12284	0.601
March	200.1	63.85	26.72	213.6	203.5	13764	13575	0.614
April	200.9	74.65	29.54	190.4	180.7	12809	12622	0.640
May	206.2	87.88	30.07	178.4	168.3	12866	12679	0.687
June	146.5	81.98	26.52	123.1	115.5	9550	9397	0.737
July	114.9	75.89	25.09	99.2	93.2	7851	7709	0.750
August	127.5	81.60	24.28	116.6	110.1	8976	8828	0.731
September	142.0	86.47	24.55	141.3	133.9	10605	10458	0.715
October	143.4	72.53	25.13	157.4	149.7	11218	11063	0.679
November	143.3	52.24	22.57	180.5	172.7	12083	11917	0.638
December	141.3	49.64	20.49	187.4	179.5	12673	12500	0.644
Year	1882.9	817.19	24.86	1986.5	1888.8	137901	135912	0.661

PVsyst TRIAL

Fig 18: balance and main result

International Journal for Research in Applied Science & Engineering Technology (IJRASET)
ISSN: 2321-9653; IC Value: 45.98; SJ Impact Factor: 7.538
Volume 13 Issue V May 2025- Available at www.ijraset.com

VI. CONCLUSION

A Sustainable Investment in Education and Energy Independence

The implementation of a 100kW solar rooftop power generation station at Sharadchandra Pawar College of Engineering represents a significant stride towards sustainable energy practices and a reduced carbon footprint within the educational sector. Based on the PVsyst analysis, the project demonstrates a potential annual energy production of 135,951 kWh, translating to a specific production of 1313 kWh/kWp/year and a performance ratio (PR) of 86.0%. These figures underscore the viability and efficiency of the system, indicating a substantial contribution to the college's energy needs.

The high specific production suggests that the system is optimally designed for the location's solar irradiation profile. The 86.0% performance ratio, while not reaching 100%, is commendable and reflects the inherent losses associated with real-world PV systems. These losses, as detailed in the PVsyst report, include factors such as module temperature effects, soiling, incident angle modifier (IAM) losses, light-induced degradation (LID), and other system-specific losses.

The analysis of these losses is crucial for understanding the system's overall efficiency. Module temperature losses, accounting for 3.80%, highlight the importance of effective ventilation and module selection to mitigate temperature-related performance degradation. Soiling losses, at 3.00%, emphasize the need for regular cleaning and maintenance, particularly in environments with high dust or particulate matter. IAM losses, at 2.00%, are intrinsic to the angle of incidence of sunlight on the modules and can be minimized through optimal tilt and orientation. LID losses, at 1.00%, are typically observed in the initial stages of module operation and stabilize over time. The remaining system losses, at 3.65%, likely encompass factors such as wiring losses, inverter inefficiencies, and shading effects.

The 100kW solar installation translates to a considerable reduction in the college's reliance on grid-supplied electricity, which often originates from fossil fuel-based power plants. This shift to solar energy aligns with the global imperative to transition towards cleaner and more sustainable energy sources. By generating its own electricity, the college not only reduces its carbon footprint but also mitigates the environmental impact associated with traditional power generation.

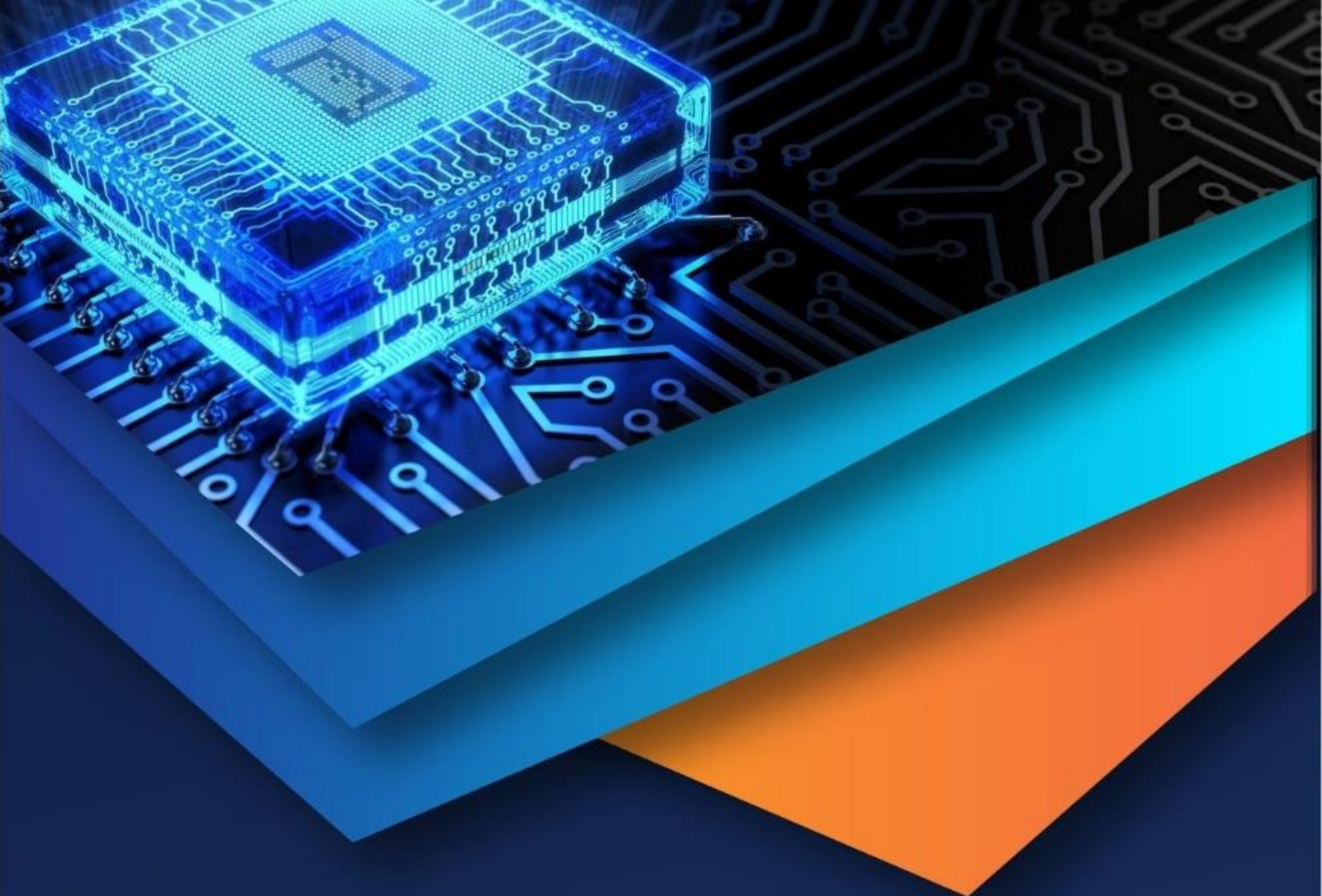
Moreover, the solar installation offers significant economic advantages. The reduced electricity bills translate to substantial cost savings over the system's lifespan, freeing up financial resources that can be reinvested in educational infrastructure, research, and student development. The long-term economic benefits of solar energy are particularly pronounced in regions with abundant solar irradiation, such as the location of Sharadchandra Pawar College of Engineering.

The project also serves as an invaluable educational tool for students. It provides a real-world, hands-on learning experience in renewable energy technologies, fostering a deeper understanding of solar PV systems and their applications. Students from various disciplines, including engineering, environmental science, and management, can benefit from studying the system's design, operation, and performance. This experiential learning can enhance their technical skills and prepare them for careers in the rapidly growing renewable energy sector.

Furthermore, the implementation of the solar rooftop system enhances the college's reputation as an environmentally responsible institution. It demonstrates a commitment to sustainability and sets an example for other educational institutions and the broader community. This can attract environmentally conscious students, faculty, and partners, strengthening the college's standing as a leader in sustainable practices.

The PVsyst report, while comprehensive, is based on simulated data and assumptions. The actual performance of the system may vary depending on factors such as weather conditions, panel degradation, and grid fluctuations. Therefore, continuous monitoring and performance evaluation are crucial to validate the simulation results and identify areas for improvement.

In conclusion, the installation of the 100kW solar rooftop power generation station at Sharadchandra Pawar College of Engineering is a testament to the college's commitment to sustainability and innovation. It not only provides a reliable source of clean energy but also serves as an educational tool and a symbol of environmental stewardship. The project's success underscores the importance of investing in renewable energy technologies to create a more sustainable and resilient future. By embracing solar energy, the college is not only reducing its environmental impact but also empowering its students and contributing to a greener and more prosperous society. The college's initiative is a beacon of hope and a practical demonstration of how educational institutions can lead the way in adopting sustainable energy practices. The project's long-term benefits, both economic and environmental, are undeniable, making it a wise and forward-thinking investment. As the world continues to grapple with the challenges of climate change and energy security, such initiatives are crucial in driving the transition towards a sustainable energy future. The Sharadchandra Pawar College of Engineering's endeavor stands as a significant milestone in this journey, illustrating the power of renewable energy in transforming educational institutions into models of sustainability and progress.



10.22214/IJRASET

INDEX COPERNICUS
45.98

IMPACT FACTOR:
7.129

TOGETHER WE REACH THE GOAL
IMPACT FACTOR:
7.429

INTERNATIONAL JOURNAL FOR RESEARCH

IN APPLIED SCIENCE & ENGINEERING TECHNOLOGY

Call : 08813907089 (24*7 Support on Whatsapp)