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Analyzing and Enhancing the Efficacy of 300 KW GMR Solar Power Plant by comparing the data analysis using PVSYST

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ABSTRACT:

The 300 kWp grid-connected solar photovoltaic (PV) power plant installed at the GMR Vara Lakshmi Foundation Hospital (VCH) in Rajam, Andhra Pradesh, India, is compared in this paper between its simulated and actual operating performance. Using Meteonorm 8.2 weather data, a PVsyst (V8.0.13) simulation report was created for a nearby 300 kWp system at the GMR Vara Lakshmi Foundation Hospital, from which the theoretical performance was obtained. The VCH 300 kW plant's actual operational data was gathered over the course of nine months, from April 2024 to December 2024. An annual Performance Ratio (PR) of 75.65% and an annual Specific Production of 1344 kWh/kWp/year were forecasted by the PVsyst simulation. A 9-month Specific Production of 792.94 kWh/kWp and an average PR of 83.24% for the same period were found in the actual data. As is frequently observed in comparative studies, this disparity, especially the higher real-world PR, points to a possible difference between the actual on-site measurements and the local meteorological data (specifically Plane of Array Irradiance) used in the PVsyst model. The study emphasises the significance of real-time monitoring for precise performance evaluation and optimisation, while validating the use of simulation tools such as PVsyst for preliminary feasibility studies.

Keywords: Grid-connected PV, specific production, PVsyst simulation, performance ratio, and real-time assessment

1. Introduction :

Global demand for renewable energy sources, especially solar power, has increased due to the quick depletion of fossil fuel reserves and rising greenhouse gas emissions. In order to meet the increasing demand for electricity while reducing its negative effects on the environment, solar energy provides an endless, sustainable, and clean solution. Technology breakthroughs and a sharp decline in installation costs have led to a massive increase in the use of solar photovoltaic (PV) systems. To guarantee these systems' dependability and financial viability, effective operation and performance assessment are still essential. Precise evaluation of solar plant performance yields information on energy production, system losses, and efficiency metrics that are crucial for optimisation. The technical behaviour of PV systems under various operational and meteorological conditions is frequently assessed using simulation tools like PVsyst. These tools are essential for forecasting performance ratios, estimating power generation, and verifying design efficiency for large-scale solar installations, such as a 300 kW grid-connected plant.

A complete simulation tool for photovoltaic system design, analysis, and optimisation is the PVsyst software. It makes detailed modelling possible according to component characteristics, site location, weather inputs, and system configuration. PVsyst estimates actual energy outputs under field conditions by combining shading analysis, temperature effects, loss diagrams, and inverter performance. Because of this, it is essential for assessing solar power systems that are both standalone and connected to the grid. Researchers can compare simulated outputs with actual operational data, spot inconsistencies, and suggest optimisation techniques by using PVsyst to analyse a 300 kW solar power plant. Through real-time comparisons, a number of studies have confirmed PVsyst's accuracy and dependability, highlighting its significance in both academic research and the development of real-world solar projects.

2. Literature Review

This term paper uses PVsyst software to analyse the performance of a 300 kW grid-connected solar power plant. By comparing the PVsyst simulation results with the actual field performance of the 300 kWp VCH solar power plant in Rajam, the main goal is to evaluate the plant's energy generation capacity, efficiency, and performance ratio through simulation. Any discrepancies and their potential causes will be identified. This work focusses on verifying a predictive model against empirical data, adhering to the format of previous comparative studies. These studies provide methodological and analytical underpinnings for comprehending how simulation-based optimisation improves solar system productivity (Fiqri et al., 2025) [1], Toure et al., 2024) [2], and Mishra et al., 2024) [3], Senegal, Mbow et al., 2025) [4], Yildirim & Duzkaya, 2025) [5]. These references are compiled and thoroughly examined in the sections that follow.

In order to maximise the efficiency of energy production, Fiqri et al. [1] used 3D PVsyst simulations to analyse a 3 kW solar power plant at Politeknik Negeri Pontianak (Polnep), Indonesia. The study focused on how tilt, azimuth, and solar panel placement affect power generation. The authors showed that moving solar panels could increase overall energy output by about 2% by combining simulation results with real inverter data from the Sunny Boy SMA system. This study demonstrated PVsysts' ability to reproduce realistic performance in a range of environmental factors, including temperature, shading, and irradiance. It created a framework for evaluating the productivity of solar systems and spotting possible layout and configuration enhancements.

The methodology used in [1] combined software-based modelling with field measurements in a quantitative manner. Location-specific parameters, such as solar radiation data from Indonesia's Meteorology, Climatology, and Geophysical Agency (BMKG), were used to develop PVsyst simulations. The study included thorough computations of array area, inverter efficiency, and temperature and system component losses. By contrasting simulated outputs with actual inverter data, these findings were confirmed. The reliability of PVsysts in forecasting PV performance was validated by the agreement between measured and simulated results. The significance of precise climate data for efficient system optimisation and efficiency estimation was also underlined in the study.

Moreover, PVsyst-based optimisation techniques can greatly improve photovoltaic system performance, according to Fiqri et al. [1]. By demonstrating how simulation insights result in real-world performance improvements, the study's methodology acts as a benchmark for large-scale PV projects. In order to improve the accuracy of system design, PVsyst's integration of 3D modelling allowed for the precise visualisation of array configurations and shading effects. Because they show that small-scale simulation principles can be successfully applied to large installations for predicting real operational outcomes, reducing performance gaps, and maximising energy yield, these findings are directly relevant to the 300 kW system that is the subject of this paper's analysis.

At Alioune Diop University in Senegal, Toure et al. [2] used PVsyst software to conduct a thorough performance analysis of a 67.2 kWp grid-connected Si-poly photovoltaic system. In order to supply institutional loads, the study sought to evaluate the systems' technical dependability, energy contribution, and viability. Performance ratio, annual yield, and energy injected into the grid were among the parameters that were simulated using PVsyst 7.4. According to the findings, the system had an annual performance ratio of 81.5%, producing roughly 111.28 MWh of DC energy annually and supplying 108.98 MWh to the grid. The accuracy of PVsyst in assessing medium-scale solar systems was confirmed by these results, which showed a high degree of consistency between simulated and real data.

The authors emphasised that Senegal's solar resource availability varies seasonally, making precise simulation necessary for performance forecasting. They underlined that PVsyst allows for accurate energy yield estimation by taking into account variations in temperature, irradiation, and component efficiency. The study also verified that simulation results are typically within 510% of real-world data by comparing PVsyst predictions with findings from earlier research on 100 kWp, 300 kWp, and 2 MWp systems. As a result, the study validated PVsyst as a trustworthy design and validation tool for grid-connected systems in a variety of climates. The impact of tilt angle, shading, and system orientation on the efficiency of energy production was also covered.

Additionally, Toure et al. [2] showed how simulation-based analysis helps engineers and policymakers scale solar deployment by connecting their findings to national renewable energy goals. Their approach is in line with worldwide developments in solar research, where PVsyst is used to carry out technical feasibility studies prior to the construction of plants. The 67.2 kWp case, which closely matched the 300 kW capacity examined in this paper, confirmed PVsyst's appropriateness for medium-scale systems. A useful resource for comprehending grid-integration efficiency, inverter utilisation, and operational losses—all crucial components in maximising the performance of large-scale solar power plants—is their methodical analysis of performance ratios and loss diagrams.

Using the PVsyst simulation tool, Mishra et al. [3] conducted a thorough performance analysis of a 5 MWp grid-connected solar photovoltaic system in Port Blair, India. Their study contrasted real field data gathered over a one-year operational period with simulated results. With a simulated performance ratio of 80.42% that closely matched the measured value of 81.02%, the study found a strong correlation between the simulated and real outputs. The reliability of PVsysts as a forecasting tool for extensive PV installations was confirmed by this strong agreement. Climate variations have a significant impact on photovoltaic efficiency, according to the study, which also looked at how environmental factors like temperature, humidity, and solar radiation affect energy generation.

To assess the systems module, inverter, and overall efficiency, Mishra et al. [3] used real-time data acquisition systems coupled with PVsyst modelling. While module and system efficiencies averaged 11.27%, they discovered that inverter efficiency surpassed 98%. In compliance with IEC 61724 standards, the study also examined key performance metrics such as array losses, system losses, and capacity utilisation factor (CUF). The analysis showed that PVsyst is appropriate for performance prediction in tropical regions with high meteorological variability because it can accurately model temperature effects, shading losses, and capture losses.

For medium-sized solar plants, like the 300 kW system this paper looks at, the results of [3] have important ramifications. It is clear from comparing large- and medium-sized PV systems that the fundamentals of precise modelling, environmental consideration, and inverter performance analysis are still the same. By offering accurate insights into energy yield and efficiency metrics, the study demonstrated that PVsyst can close the gap between simulation and real-world operation. These insights are essential for establishing performance benchmarks, optimising tilt and orientation, and reducing deviations in performance ratios for a 300 kW solar power plant. As a result, Mishra et al.'s methodology [3] can be used as a guide for long-term performance forecasting and simulation validation.

A very pertinent case study that focusses on the thorough Performance Evaluation of a 500 kWp Solar Photovoltaic Power Plant located in the Lambaye region of Senegal is presented in the first reference paper, written by Badara Mbow et al. [4] in 2025. This study's use of PVsyst software for sizing and performance prediction of a similarly scaled grid-connected system in a high-irradiance tropical climate establishes its immediate relevance to the current 300kW analysis. In order to support Senegal's ambitious Horizon 2050 program, which lays out national energy security and renewable energy goals, the authors specifically set out to build a solar photovoltaic power plant.The project was specifically spurred by the municipality of Lambaye's ongoing electricity load shedding problems, which were exacerbated by the city's rapid population growth and the growing number of women engaged in income-generating activities. The study adds important knowledge about the viability and design factors for commercial PV installations in developing African countries by concentrating on a large-scale power injection system. The Lambaye region was chosen as the study's specific location, and it added uniqueness by examining a range of azimuth and tilt angle options pertinent to that area. Ensuring grid stability and a dependable power supply through a realistically simulated renewable energy project is the main issue addressed. Despite concentrating on a 500 kWp capacity, this thorough investigation sets important standards for the system design decisions and anticipated performance indicators that are entirely relevant to the 300kW design being assessed in this paper. The research is not only a technical study but also a socio-economic one since the conclusions are placed within Senegal's larger national energy strategy. The necessity of thorough and accurate simulation before building utility-scale assets is emphasised in the paper. The ultimate goal of the paper is to simulate the project's performance in real-world scenarios in order to show its high technical viability.

Mbow et al.'s methodology was based solely on the comprehensive simulation features of PVsyst software, version 7.2, which is the exact program used for the current 300kW analysis. Using 1,350 separate monocrystalline panels, each rated at 370 Wp, the authors painstakingly built the virtual 500 kWp system. This resulted in a system architecture that included 45 strings, with 30 panels connected in series for each string. By sizing the system for interconnection using six generic solar inverters, each with a 60 kW power rating, critical component matching was accomplished, guaranteeing the DC-AC conversion and subsequent injection into the national grid. The explicit consideration and optimisation of the azimuth and tilt angles—factors that are essential for optimising solar irradiance capture at the particular site latitude—is one of this paper's main contributions. Further investigation of important performance metrics, including the photovoltaic generator's actual effective energy production, the precise quantity of energy successfully fed into the local grid, the vital Performance Ratio (PR), and the normalised energy production metrics, advanced the analysis. A nominal power ratio of 1.39 (DC:AC), which is essential for inverter sizing and clipping loss management, was determined through careful system modelling. A clear methodological blueprint that directs the execution of the 300kW simulation carried out in the current term paper is provided by the methodical application of PVsyst in this way.

A solid benchmark for the anticipated performance of large-scale PV plants was established by the simulation conducted by Mbow et al., which produced very positive and successful results about the feasibility of the 500 kWp project in the Senegalese context. In particular, the PVsyst simulation predicted that the photovoltaic generator’s output terminals would produce 835.09 MWh of energy annually, highlighting the system’s immense potential to effectively capture solar energy. The system’s operational feasibility and possible influence on local power supply were confirmed by the calculation of the net energy successfully injected into the grid, which was a substantial 820.07 MWh/year after conversion and balance-of-system losses.The Performance Ratio (PR), a widely accepted indicator of overall systemquality, was calculated to be around 82.24% for the current study. This indicates a high level of efficiency with notably lower overall system losses. The quality of the system design and optimisation made possible by the PVsyst environment was emphasised by the authors, who specifically noted that their study’s PR result was obtained in spite of a number of system-level losses. A direct comparison of system quality is made possible by the PR value of 82.24%, which provides an instantaneous, high-quality benchmark for the performance target of the 300kW system examined in this paper.This paper’s thorough arrow loss diagram analysis is especially helpful because it provides a structural model for the 300kW loss budget analysis and explains how the different loss mechanisms affect the final energy yield. In the end, the results validate the general idea that thorough PVsyst modelling is a trustworthy precondition for the effective installation of PV plants.

By conducting a thorough Comparative Analysis of two important solar simulation tools, PVGIS and PVsyst, applied to a 15 MW PV system in Kırıkkale, Turkey, the second core reference, a 2025 article by Beyza Yildirim and Hidir Duzkaya [5], offers an essential methodological context for the current work. Because it directly addresses the crucial problem of simulation accuracy and the variables that lead to differences in energy yield predictions across various software platforms, this study is extremely pertinent to the 300kW analysis. The main issue examined is how reliable preliminary feasibility estimates produced by less complex programs, such as PVGIS, are in comparison to PVsyst’s comprehensive, component-level modelling capability, which forms the basis of this work. Given that Turkey is committed to reaching net-zero emissions by 2053, which is propelling significant investment in solar infrastructure, the country offers a compelling case study for the development of solar power plants. Additionally, the study specifically looked at how adding solar tracking systems could improve energy efficiency while also recognising the difficulties caused by their high upfront costs and ongoing maintenance needs. By showing PVsyst's intrinsic superiority over less granular tools in detailed project planning, this comparative approach aids in validating the selection of PVsyst for the current analysis.Even though the 15 MW system is larger than the 300 kW subject, its sheer size establishes the industrial scale of the methodologies used and firmly places the study within the field of large commercial solar asset performance analysis. The main question being addressed is whether PVsyst’s accuracy in energy forecasting justifies its higher complexity and data requirements.

Using the industry-leading PVsyst software and the European Commission’s PVGIS tool, the authors of the second paper used a direct, two-pronged simulation methodology to model the same fixed-axis 15 MW PV system in the Bahşılı region. The study’s unique contribution is its clear methodological comparison, which highlighted the different ways that simulation parameters and modelling depth affect the final energy yield predictions. The comparison’s technical foundation is based on PVsyst’s exceptional ability to model system components and loss mechanisms in detail, enabling a more realistic representation of PV system performance in the real world. In sharp contrast, the study demonstrated that PVGIS must avoid the detailed, component-specific loss calculations that PVsyst carries out in order to provide its quick estimations, as it mainly depends on generalised satellite-based datasets. Furthermore, by simulating the enhanced yield potential provided by single or dual-axis tracking systems—which was found to increase annual energy production by roughly 24%—the study expanded its analysis beyond fixed-tilt performance. The study carefully looked at how various data sources and modelling philosophies impact important results, and it finally gave a convincing explanation of why, depending on the stage of the project, one tool might be chosen over another. For the current 300kW paper, which supports the use of PVsyst because it can perform extremely detailed, site-specific loss evaluations that are impossible to duplicate with less sophisticated tools, this methodological distinction is crucial. For strong economic feasibility studies, the authors skilfully show that PVsyst's increased complexity is justified.

The Yildirim and Duzkaya comparative analysis's main and most important finding was the significant difference between the two software packages' estimates of the expected annual energy production for the same 15 MW system. In particular, the comprehensive simulation carried out with the PVsyst software calculated an annual yield of 33.179 GWh, which was clearly greater than the PVGIS tool's prediction of 25.392 GWh. This significant discrepancy amounts to a 30% deviation from the anticipated energy output, a margin that has significant financial and contractual ramifications for any developer or investor in a real-world solar project.

The authors concluded that this substantial variation was due to the basic methodological differences between the tools, claiming that the higher, and presumably more accurate, energy forecast was caused by PVsyst's ability to perform more thorough component analysis and careful loss evaluations. The choice of PVsyst as the final simulation tool for the current 300kW performance analysis is strongly supported by this important finding. The study concludes that the modelling approach and simulation tool selection have a significant impact on energy forecasts, which directly informs the current paper's rigorous methodology and central focus. Additionally, the discovery that solar tracking systems considerably boost energy yield—to 41.09 GWh—offers a technical consideration for the 300kW system's upcoming design stages. Therefore, the study confirms that using a high-fidelity tool such as PVsyst is essential to reducing estimation uncertainty and improving project viability.

3. Methodology

The actual performance of the grid-connected 300 kWp Solar Photovoltaic (PV) power plant at the GMR Vara Lakshmi Foundation Hospitals (VCH), Rajam, is compared to the theoretical prediction produced by the PVsyst simulation software using a thorough mixed-method comparative analysis. Three crucial steps make up the methodology: performance metric calculation, empirical data collection, and predictive simulation.

3.1 PVsyst Modeling Predictive Simulation

The expert simulation program PVsyst (V8.0.13) was used to create the theoretical performance benchmark. A simulation report for a nearby 300 kWp system was used to build the model, which faithfully captures the VCH site and design requirements.

- Site and Meteorological Information:

  The GMRIT INSTITUTE in Rajam, India, was identified by the model as the site. Its coordinates were latitude 18.47°N, longitude 83.66°E, and elevation 71 meters above sea level. The Meteonorm 8.2 (2001-2020) Typical Meteorological Year (TMY) database served as the source of the solar resource data.

- Design parameters for the system: The following component specifications were used in the simulation:

  1. PV array: 1275 PV modules of model CS6X-315P MIX (monocrystalline/polycrystalline kWp) arranged in two sub-arrays, with a nominal capacity of 300 kWp.
  2. Two NXV0200 inverters with a nominal output of 400 kWac each.
  3. Orientation: A specific tilt angle of 10° and azimuth angle of 0° were used to model the fixed-tilt system.

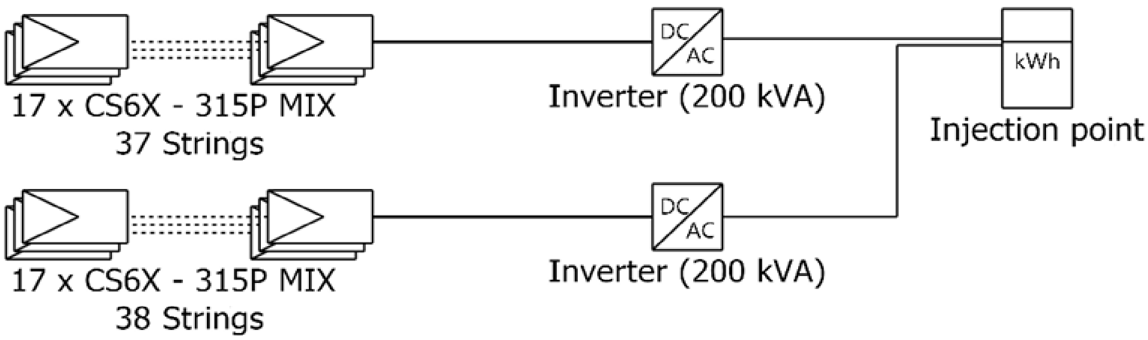

Fig. 1. **Single Line Diagram**

- Benchmark Metrics:

  The Predicted Annual Performance Ratio (PR_Sim = 75.65%) was supplied by the PVsyst engine. The Annual Energy Loss Diagram was used to quantify the specific simulated losses, such as array mismatch, ohmic losses, and thermal losses.

3.2 Gathering Empirical Data through Field Measurements

To determine the empirical performance, real-time operational data was gathered from the actual 300 kWp VCH plant.

- Source and Duration of Data:
  The information, which covered a continuous 9-month operating period from April 2024 to December 2024, was taken from the plant's data logging system.
- Important variables:
  The 300 kWp plant's monthly aggregated values were used:
  1. According to the energy meter, E_Gen,Real (Monthly Energy Generation in kWh) is the total amount of AC energy supplied to the grid.
  2. Total solar radiation incident on the array's plane, as measured by the on-site pyranometer or monitoring system, is expressed as H_A (Monthly Sum Irradiation in kWh/m^2).
- Validation and Filtering of Data:
  An exceptionally low PR of 32.53% was obtained from the May 2024 recorded data. This extreme value was determined to be a non-representative outlier, most likely as a result of an operational issue or extended grid outage. The May 2024 data was not included in the calculation of the overall

representative average Performance Ratio in order to guarantee that the comparative analysis accurately depicts the plant's steady-state performance.

3.3 Comparative Analysis and the Calculation of Performance Metrics

Standard PV performance metrics were computed using the operational data and compared directly to the PVsyst benchmark.

- Calculating Key Performance Indicators (KPIs):
  1. Particular Production (Yf,Real):
     Y_f,Real (kWh/kWp) = Installed Capacity (300 kWp) ÷ Monthly Energy Generated (E_Gen,Real)
  2. Performance Ratio (PRReal):
     The installed capacity-normalized ratio of the system's actual yield to its reference yield.
     PR_Real(%) = (Yf (kW/m^2) / Yr (kWh/m^2))× 100%
- Comparative Analysis:
  The constant PR_Sim of 75.65% was compared to the monthly calculated PR_Real values. In the final assessment, the accuracy of the predictive model and the operational efficiency of the system were assessed by calculating the percentage point difference between the simulated annual PR (PR_Sim) and the representative 8-month average PR (overline PR_8M).

4. Results and Discussions

In the performance analysis, the empirical data gathered from the 300 kWp GMR VCH plant over a nine-month period is compared with the simulated annual energy yield and system efficiency (Performance Ratio) generated by the PVsyst software.

4.1 Simulation Results

The study's theoretical benchmark is established in Table 1, which also provides a summary of the energy loss breakdown and the main annual simulation results.

Table 1. Simulated Results

Indicator	**Value**	**Unit**
Pnom,PV(InstalledCapacity)	300	kWp
Global Horizontal Irradiation (H0)	1802.1	kWh/m2/year
Global Incident in Collector Plane (HA)	1919.2	kWh/m2/year
Predicted Array Energy (EArray) (Gross)	605.9	MWh/ year
Predicted System Production (EGrid, Sim) (Net)	539.84	MWh/ year
Specific Production (Yf, Sim)	1343	kWh/kWp/year
Performance Ratio (PRSim)	75.65	%

4.2 Benefits of Integration

Table 2 shows the 300 kWp plant's monthly operating results based on field measurements and contrasts the PVsyst prediction (PR Sim) with the Real PR (PR Real).

Table 2. Monthly Comparative Performance Analysis (VCH 300 KWP Real Data Vs PVsyst Prediction)

Month	Real Generation (EGen,Real) (kWh)	Sum Irradiation (HA) (kWh/m2)	Specific Production (Yf,Real) (kWh/kWp)	Real PR (PRReal) (%)
Apr-24	33,178	135.01	110.59	81.91
May-24	13,801	141.43	46.00	32.53
Jun-24	30,868	123.36	102.89	83.41
Jul-24	25,398	101.09	84.66	83.75

Aug-24	25,324	101.63	84.41	83.06
Sep-24	27,356	109.78	91.19	83.06
Oct-24	29,404	121.15	98.01	80.90
Nov-24	29,977	124.22	99.92	80.44
Dec-24	22,576	94.95	75.25	79.26
Total (9 Months)	237,882	1057.62	792.92	76.48 (Avg.)
8-Month Avg.	–	–	–	81.97 (Avg.)

In contrast to the PVsyst-predicted PR of 75.65%, the operational data reveals a representative 8-month average PR of 81.97%. This indicates a 6.32 percentage point positive deviation.

1. Discussion of Outliers: The May 2024 PR of 32.53% is a glaring anomaly that is not representative of steady-state performance and indicates significant system outage, most likely brought on by a protracted grid outage or significant planned maintenance.
2. Reality vs. Model: The higher empirical PR indicates that the system losses were probably overestimated by the PVsyst simulation using TMY (Typical Meteorological Year) data. The following are some possible causes of this positive deviation:
   - Irradiance Accuracy: For those particular 8 months, the on-site pyranometer measurements (HA in Table 2) may be higher than the TMY values that PVsyst uses.
   - Thermal Performance: Compared to the PVsyst thermal loss model, the modules' actual operating temperatures and cooling efficiency (caused by mounting and ventilation) may be higher.
   - Inverter Efficiency: It's possible that the NXV0200 inverters ran at peak efficiency points more frequently than the simulation's static loss table indicated.

4.3 Performance Metrics in Visual forms

To visualize and diagnose system performance, the following figures from the PVsyst simulation and the empirical data are crucial.

4.3.1 Monthly Real Performance Ratio Vs simulated Annual PR Comparison

This figure clearly shows the significant deviation and the May outlier when comparing the high operational efficiency of the VCH plant to the PVsyst benchmark.

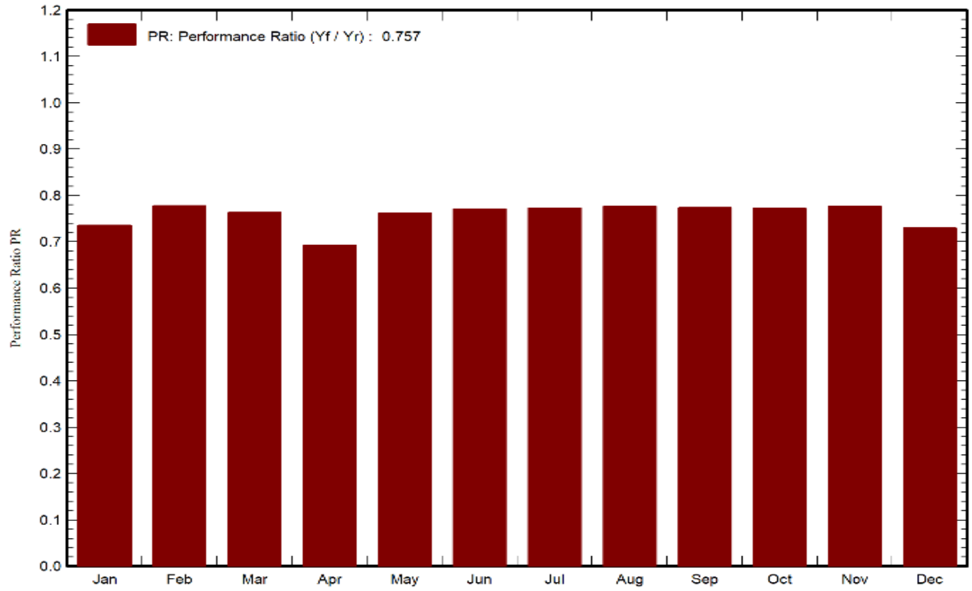

Fig. 2. **Performance Ratio**

4.3.2 Normalised Production (Yield) Graph

In order to identify module-related losses (gap between Yr and Ya) and system/inverter-related losses (gap between Ya and Yf), this graph divides system performance into three separate yields: Reference Yield (Yr), Array Yield (Ya), and Final Yield (Yf).

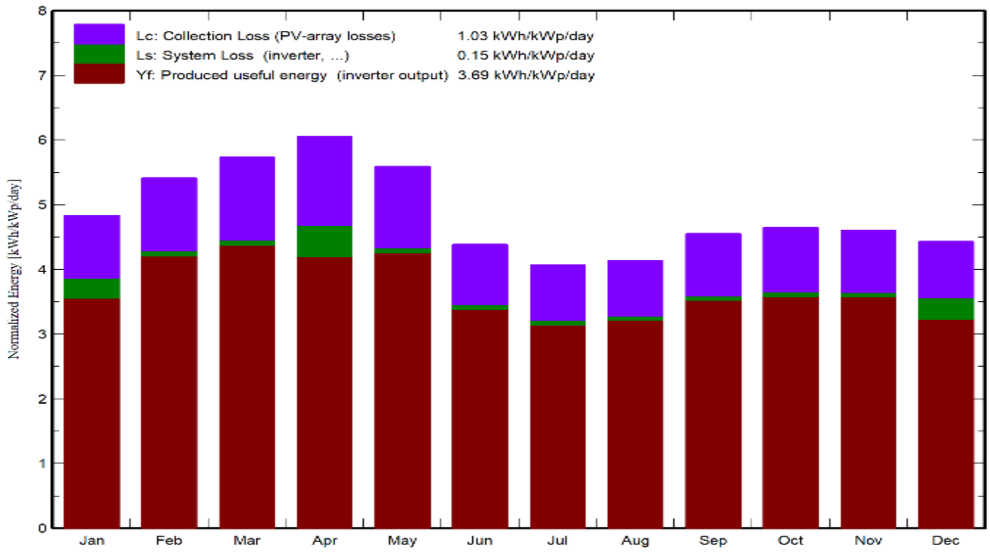

Fig. 3. **Normalized Production**

4.3.3 Irradiation Vs Production Daily Input/Output Graph

In order to visually illustrate the linearity of the system's response, this graph usually plots the daily total energy generated against the corresponding daily global irradiation.

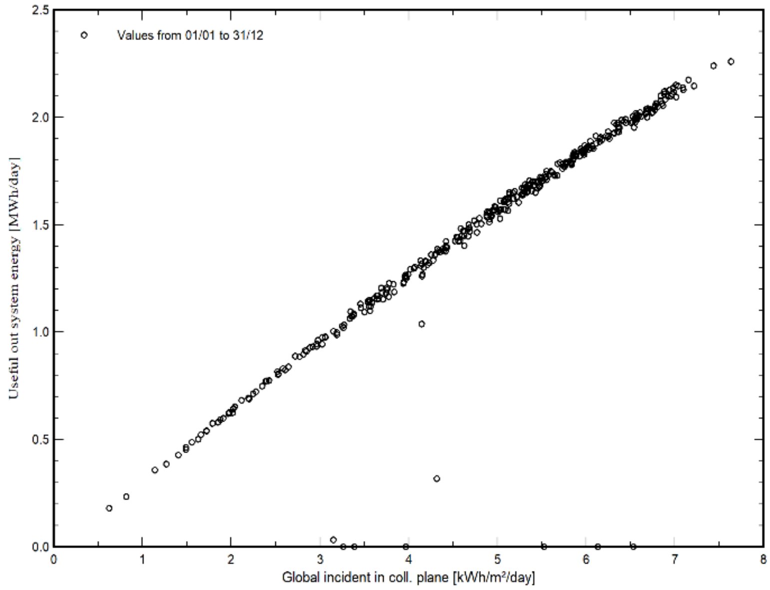

Fig. 4. **Daily input/outpu**

4.3.4 Distribution of System Output Power

This figure illustrates how frequently the inverters run at partial load as opposed to full load by displaying the frequency distribution of the AC output power over the course of a year.

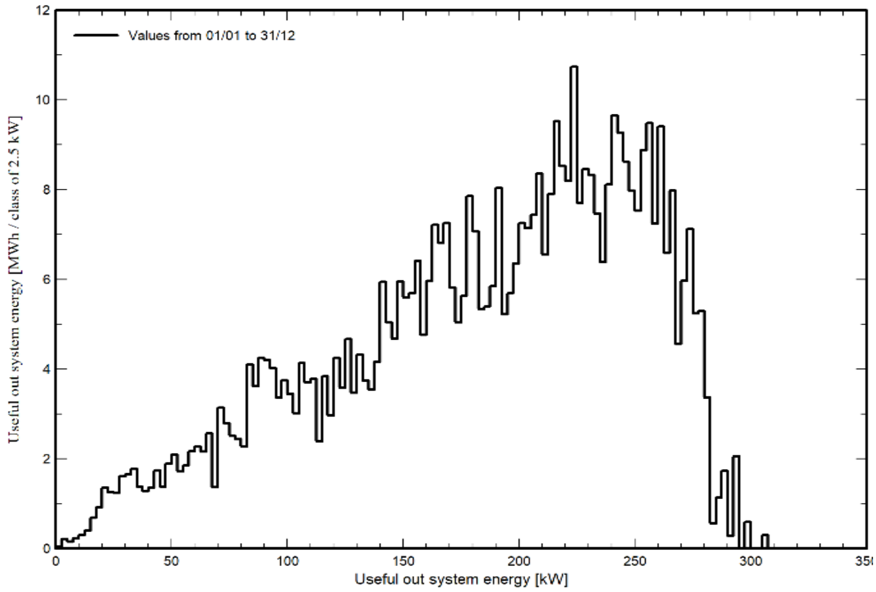

Fig. 5. System Output Power Distribution

4.3.5 PVsyst Annual Energy Loss Diagram

Understanding why PVsyst predicted 75.65% PR requires an understanding of the energy losses in the simulated system, which is broken down in this diagram (Figure 6).

Table 3. Balanced and Main Results

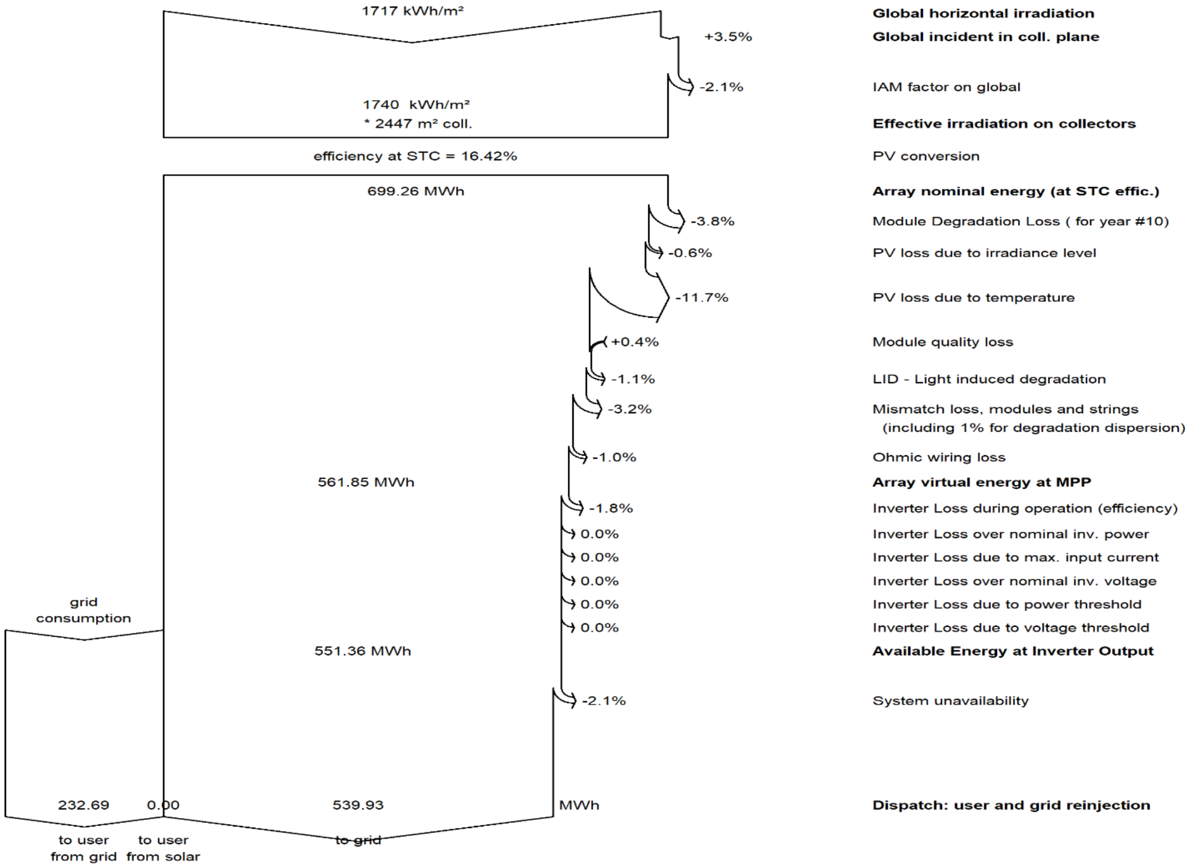

Fig. 6. Loss diagram

Month	GlobHor (kWh/m²)	DiffHor (kWh/m²)	T_Amb (°C)	GlobInc (kWh/m²)	GlobEff (kWh/m²)	EArray (MWh)	E_User (MWh)	E_Solar (MWh)	E_Grid (MWh)	EFrGrid (MWh)
January	134.4	57.9	24.19	149.9	146.9	48.26	19.76	0.000	44.32	19.76
February	140.3	65.6	25.84	151.6	148.9	48.26	17.85	0.000	47.38	17.85
March	170.4	81.7	28.14	177.7	174.5	55.53	19.76	0.000	54.50	19.76
April	180.6	84.9	29.04	183.8	178.3	56.50	19.13	0.000	50.57	19.13
May	177.0	100.5%	30.83	173.4	169.9	53.03	19.76	0.000	50.39	19.76
June	135.5	89.1	29.90	131.6	128.8	41.64	19.13	0.000	43.09	19.13
July	129.7	81.9	29.10	126.2	123.3	40.03	19.76	0.000	39.19	19.76
August	129.5	89.8	28.79	128.6	125.7	40.83	19.76	0.000	40.05	19.76
September	134.1	83.1	28.37	137.4	132.7	42.78	19.76	0.000	44.29	19.76
October	136.9	76.1	27.43	144.1	141.3	43.13	19.76	0.000	42.84	19.76
November	125.4	58.7	26.34	138.4	135.3	43.96	19.13	0.000	43.11	19.13
December	123.2	64.6	24.77	137.4	134.4	44.33	19.76	0.000	40.27	19.76
Year	1717.1	932.0	27.83	1776.8	1740.4	562.36	232.69	0.000	540.42	232.69

Table 3. Balanced and Main Results

5. Conclusion

The effectiveness of the system was confirmed by the comparison of the PVsyst simulation with the actual operational data of the 300 kWp grid-connected solar PV plant at GMR VCH, Rajam. This comparison also gave important information about how accurate the predictive modelling was. A conservative annual Performance Ratio PR_Sim of 75.65% was forecast by the PVsyst simulation. The real-time operational data, on the other hand, showed a noticeably higher average PR of 81.97%, representing eight months of steady-state performance (not including the May outlier). This significant positive deviation of 6.32 percentage points, which is probably the result of better-than-modeled thermal management or more favourable local irradiance, demonstrates that the actual plant is running above the theoretical expectations set by the TMY (Typical Meteorological Year) weather data used in the simulation.

For precise financial and technical evaluations of PV projects, particularly in tropical regions, the study emphasises the need to supplement predictive simulations with thorough empirical validation. When compared to actual performance, PVsyst's use of generalised meteorological data may result in conservative estimates, despite the fact that it offers a strong basis for system design. In order to reduce the modelling errors associated with irradiance and temperature loss assumptions, future studies should concentrate on integrating site-specific, hourly measured meteorological data into the PVsyst simulation. In order to support the best possible design and resource planning for upcoming large-scale solar installations in the area, this will enable the creation of extremely accurate regional models.

REFERENCE:

1. Mbow, B., Toure, C. S., et al., "PERFORMANCE EVALUATION OF A 500 KWP SOLAR PHOTOVOLTAIC POWER PLANT CONNECTED TO GRID USING PVSYST SOFTWARE, IN LAMBAYE AREA, SENEGAL," Int. J. Adv. Res., vol. 13, no. 9, pp. 92-102, 2025.
2. Mishra, P. R., Rathore, S., and Jain, V., "PVSyst enabled real time evaluation of grid connected solar photovoltaic system," Int. j. inf. tecnol., vol. 16, no. 2, pp. 745–752, 2024.
3. Toure, C. S., Sow, P. L. T., and Mbodji, S., "PERFORMANCE EVALUATION OF A 67.2 KWP SI-POLY PHOTOVOLTAIC SYSTEM CONNECTED TO THE GRID USING PVSYST TOOL," Int. J. Adv. Res., vol. 12, no. 7, pp. 954-964, 2024.
4. Fiqri, T. M., Yacoub, R. R., et al., "Analysis of 3 kW Solar Power Plant Production Optimization by Improving Energy Production Efficiency Using 3d Pvsyst Simulation Method," ELKHA: Jurnal Teknik Elektro, vol. 17, no. 1, pp. 15-23, 2025.
5. Yildirim, B., and Duzkaya, H., "Comparative Analysis with PVGIS and PVsyst for Solar Energy Production in Bahşılı Region of Kırıkkale," Gazi Üniversitesi Fen Bilimleri Dergisi Part C Tasarım ve Teknoloji, vol. 13, no. 3, pp. 877-891, 2025.
6. Hanna M. Farghally, Emad A. Sweelem, Mohamed I. Abu El- Sebah, Fathy A. Syam, (2022). "Agricultural Grid Connected Photovoltaic System Design and Simulation in Egypt by using PVSYST Software". vol 21.
7. Ahmed Alnoosani, Mowffaq Oreijah, Mohammed Alhazmi, Yousef Samkari, Hosam Faqeha, (2019). "Design of 100MW Solar PV on-Grid Connected Power Plant Using (PVsyst) in Umm Al-Qura University". Vol. 8, issue 11.

8. Khin Moe Moe, Hla Myo Aung, Hla Aye Thar, and Yee Yee Win (2023). “Analysis of energy production design from grid-connected 40MW large PV power plant”, Teknomekanik, vol.6, no 1, pp.1-11.
9. Muhammad Muneed Khan, Saqib Suleman, Muhammad Shahid Iqbal, Sadiq Ahmad, Muhammad Aamir Shafi, Bernabe Mari Soucase (2024). “Estimation and Sizing of 1 kWp AC Grid-connected Photovoltaic System”. Vol. 02, Issue 02.
10. Brahim Belmahdi, Abdelmajid El Bouardi, (2020). “Solar Potential Assessment using PVsyst Software in the Northern Zone of Morocco.”
11. Prathmesh R. Jagadale, Alpesh B. Choudhari, & Swaroop S. Jadhav, (2021). “Design and Simulation of Grid Connected Solar Si-Poly Photovoltaic Plant using PVsyst for Pune, India Location.” Renewable Energy Research and Applications, Vol3(No1), 41-49.
12. Swati Sharma, Mahipal Bukya, Pancham Kumar, (2023). “PVsyst modeling of 800 kWp capacity grid-tied solar photovoltaic power plant for academic institution.” Visions for Sustainability, 20, 1-14.
13. Mubarak M. Alkahtani, Nor A. M. Kamari, Muhammad A. A. M. Zainuri, & Fathy A. Syam, (2024). “Design of Grid-Connected Solar PV Power Plant in Riyadh Using PVsyst.” Energies, 17(24), 6229.
14. Luis angel iturralde carrera 1, ernesto molina-santana 2, josé m. Álvarez-alvarado 1, josé r. García-martínez 3, and JUVENAL RODRÍGUEZ-RESÉNDIZ 1, (Senior Member, IEEE) “Energy Efficiency Analysis of East-West Oriented Photovoltaic Systems for Buildings: A Technical-Economic-Environmental Approach.” Vol 11, IEEE access.
15. Seyed Azim Hosseini, Seyed Alireza Mansoori Al-Yasin, Mohammad Gheibi And Reza Moezzi, (2025). “Evaluation of solar Energy Performance in Green Buildings Using PVsyst: Focus on Panel Orientation and Efficiency”. Eng2025, 6, 137.