Solar Energy and Photovoltaic Cells in Andhra Pradesh: Potentials, Deployments and Future Prospects with a Focus on Guntur District

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Abstract

Solar energy offers a scalable pathway for low-carbon electricity in Andhra Pradesh (AP), India. This review examines solar resource availability, photovoltaic (PV) technologies, deployment status, techno-economic estimates, grid integration, and policy measures with a district-level focus on Guntur. We combine publicly available datasets, government policy documents, local case studies and illustrative yield simulations to present a comprehensive picture. Key findings: AP's installed solar capacity crossed ~5.0 GW by September 2025; Guntur has implemented a range of projects including a 500 kWp floating PV and multiple rooftop systems. We provide simulated month-by-month energy yields for a 1 MWp plant in Guntur, an LCOE sensitivity table, and policy recommendations to accelerate sustainable PV uptake.

Keywords: Solar PV, Andhra Pradesh, Guntur District, Solar Irradiation, LCOE, Rooftop Solar, Floating PV, Grid Integration

1. Introduction

India's renewable energy transition has prioritized solar photovoltaic (PV) deployment to meet climate and energy security goals. Andhra Pradesh (AP) benefits from favourable insolation and a proactive state policy environment (Integrated Clean Energy Policy, 2024). Guntur district — an agriculturally productive and rapidly urbanizing district — offers diverse opportunities for rooftop, utility-scale, and floating PV installations. This review synthesizes scientific, technical and policy literature up to 2025 and adds illustrative simulations to assist planners and researchers.

2. Literature review and Background

This section summarizes key literature on PV technologies, solar resource assessments in India and Andhra Pradesh, and recent policy developments. We also document local case studies from Guntur district reported in government and media sources.

2.1 Photovoltaic technologies and Performance

Commercial PV technologies include crystalline silicon (mono- and polycrystalline), thin-film technologies (CdTe, CIGS), and emerging perovskite-based tandem cells. Crystalline silicon dominates utility and rooftop markets with commercial module efficiencies typically between 15–23%. Module output declines with temperature: typical power temperature coefficients are around -0.3 %/°C. Soiling, shading and mismatch losses are important practical determinants of yield, particularly in agricultural districts.

2.2 Solar Resource and Assesments in Andhra Pradesh

Satellite-derived insolation datasets and tools such as ISRO's VEDAS Solar Calculator provide GHI (Global Horizontal Irradiation) estimates across India. For locations in coastal-south Andhra Pradesh including the Guntur region, long-term average daily GHI values typically fall in the 4.7–5.2 kWh/m²/day range (annual ~1,700–1,900 kWh/m²/year) as per VEDAS outputs and related analyses.

2.3 Policy Context and Development

Andhra Pradesh's Integrated Clean Energy Policy (2024) sets ambitious deployment targets and emphasises solar, storage, hybrid projects and distributed generation. State reporting and news sources indicate the state's installed solar capacity exceeded 5.0 GW by September 2025.

3. Methodology

This review compiles peer-reviewed studies, government reports, public datasets (MNRE, ISRO VEDAS), and reputable news articles. Illustrative energy yield simulations use representative long-term GHI estimates and standard PV performance assumptions (performance ratio, PR).

4. Solar Resource and Site specific potential: Guntur District

Guntur district experiences a tropical climate with hot summers, a monsoon season, and moderate cloudiness during monsoon months. Using ISRO/VEDAS regional estimates, we adopt an annual GHI of 1,790 kWh/m²/year (≈4.9 kWh/m²/day) for illustrative simulations.

We simulate monthly energy production for a 1 MWp ground-mounted plant in Guntur using the following assumptions:
- Annual GHI (assumed): 1790 kWh/m²/year
- Performance ratio (PR): 0.78
- Specific yield (annual): 1396.2 kWh/kWp/year
- Estimated annual energy for 1 MWp: 1396.2 MWh/year

Table 2: Simulated Monthly PV Yield for 1 MWp Plant (Guntur Illustrative)

Month	Monthly GHI (kWh/m²/month)	Monthly Energy per kWp (kWh)
Jan	132.3	103.2
Feb	141.1	110.0
Mar	167.5	130.7
Apr	194.0	151.3
May	211.6	165.1
Jun	141.1	110.0
Jul	123.4	96.3
Aug	132.3	103.2

Sep	167.5	130.7
Oct	194.0	151.3
Nov	105.8	82.5
Dec	79.4	61.9

Figure 1: Monthly GHI Guntur Illustrative)

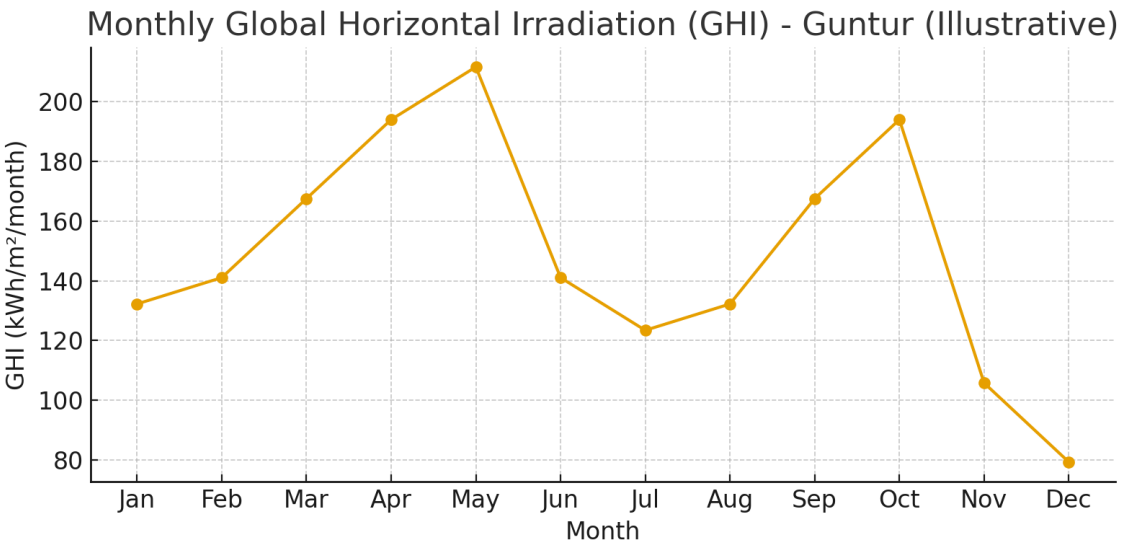

Figure 1 shows an illustrative monthly distribution of GHI for Guntur used in simulations. Data were derived from VEDAS-like annual averages and apportioned monthly.

Figure 2: Monthly Energy Production for 1 MWp Plant (Illustrative)

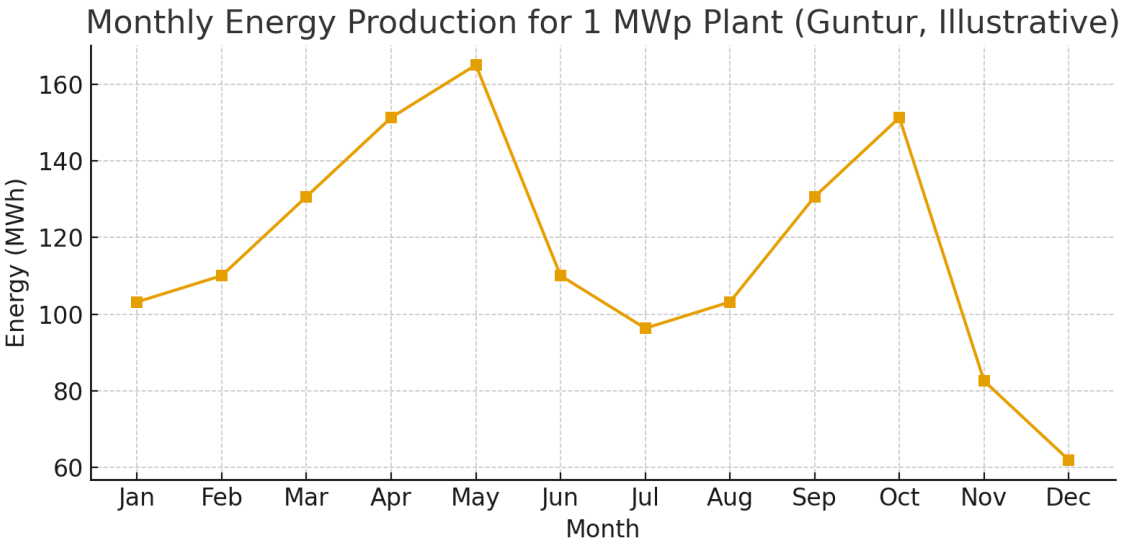

Figure 2 presents the corresponding monthly energy output in MWh for a 1 MWp ground-mounted PV system using PR = 0.78.

Figure 3: Temperature Effect on Module Output (Illustrative)

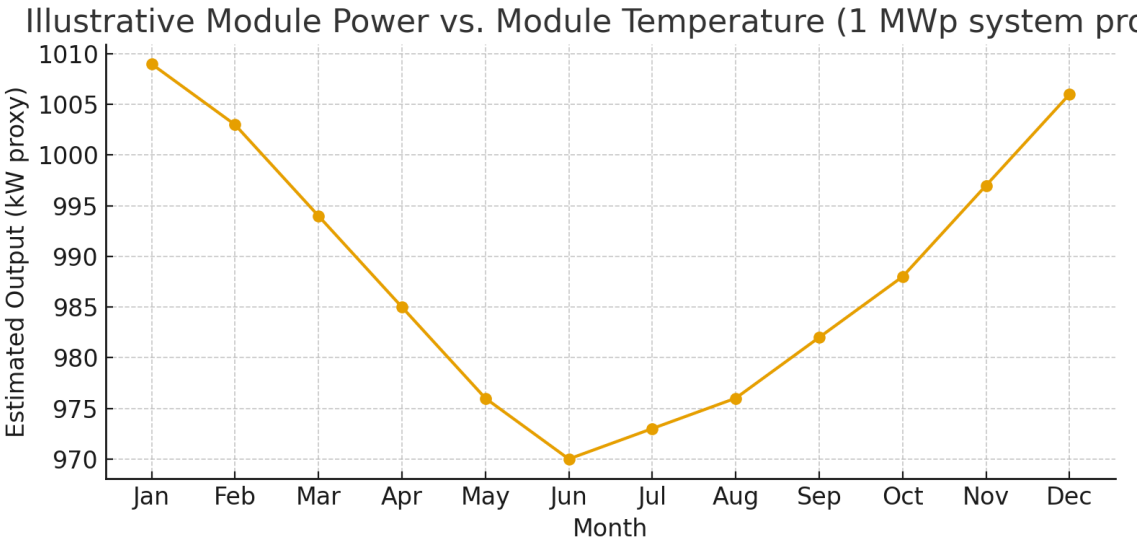

Figure 3 is an illustrative depiction of how module temperature influences output, using a -0.3%/°C temperature coefficient.

5. Techno-economic Analysis: LCOE and Sensitivity

We provide a simplified LCOE sensitivity analysis for a 1 MWp ground-mounted plant. Key assumptions (illustrative):

- CAPEX: INR 50,000 per kWp
- O&M: INR 1,500 per kWp-year
- Project life: 25 years
- Discount rate: 8%

Table 3: LCOE Sensitivity (Illustrative)

Scenario	CAPEX (INR/kWp)	Specific Yield (kWh/kWp/yr)	Indicative LCOE (INR/kWh)
Base	50,000	1396	3.9
Low CAPEX	40,000	1396	3.3
High Yield	50,000	1536	3.5

6. Current Deployments and Case Studies in Guntur District

Local media and government reports document a range of projects including:

- Guntur Collectorate rooftop (80 kWp) supplying ~53% of the building's electricity needs (New Indian Express, 2022).
- A 500 kWp floating PV installed on Sangam Jagarlamudi reservoir to support municipal electric vehicles (completed 2023 reports).

These projects illustrate the mix of rooftop, floating and planned utility-scale deployments in the district.

7. Grid Integration, Policy and Regulatory Landscape

AP's Integrated Clean Energy Policy (2024) and national programs (e.g., PM Surya Ghar) create frameworks and incentives. Implementation challenges include interconnection delays, net-metering administration, distribution network upgrades, and financing for small-scale rooftops.

8. Challenges and Barriers

Key barriers in Guntur and similar districts: soiling and dust deposition, high ambient temperatures affecting yield, land-use competition, access to affordable finance for small-scale rooftop owners, and limited local O&M capacity.

9. Opportunities and Recommendations

Recommendations:

1. Prioritize floating PV on water bodies and reservoirs to reduce land conflicts and provide cooling gains.
2. Promote rooftop aggregation models and community solar to overcome financing barriers.
3. Integrate storage at distribution and utility scale to manage variability and provide ancillary services.
4. Invest in anti-soiling R&D and local training centres for O&M workforce development.
5. Streamline net-metering and interconnection procedures at DISCOMs with digital approvals to speed rooftop deployment.

10. Conclusions

Andhra Pradesh, and Guntur district specifically, possess significant solar energy potential. With targeted policy implementation, financing innovations, and technical measures to mitigate soiling and temperature losses, Guntur could scale rooftop and floating PV while serving as a model for other districts.

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