

Performance of Solar Tracking Systems in Different Climatic Zones of India

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Abstract

This paper presents a comparative performance analysis of a 3 kW horizontal single-axis solar tracking system across five representative climatic zones in India: Mumbai (tropical wet), Hyderabad (tropical wet & dry), Jaisalmer (arid), Delhi (humid subtropical), and Shimla (mountain). Using PVsyst simulations, key performance metrics including annual energy yield, specific production, and performance ratio (PR) were evaluated. Results indicate that climatic conditions strongly influence system output, with Jaisalmer achieving the highest energy yield and Shimla recording the best PR. The findings provide valuable guidance for optimizing solar tracking deployment in diverse Indian climates.

Keywords

Solar tracking, PVsyst, Climatic zones, Performance ratio, Photovoltaics, India

I. Introduction

India's solar energy sector is rapidly expanding, supported by diverse climatic conditions that influence photovoltaic (PV) system performance [1]. Solar tracking systems improve energy capture by following the sun's trajectory, but their effectiveness varies regionally. This study evaluates a standardized 3 kW tracking system in five cities, each representing a different climate type, to understand how weather patterns affect performance metrics [2].

II. Methodology

PVsyst simulation software was used to model a 3 kW horizontal single-axis tracking system across five Indian cities with distinct climatic zones. Input parameters included solar irradiation data from Meteonorm v8.2 and meteorological data from the India Meteorological Department (IMD). The simulation outputs considered include annual energy yield (kWh/year), specific production (kWh/kWp/year), and performance ratio (PR) [3].

III. Results and Discussion

Climate Type		Global Irradiation (kWh/m ²)	Horiz.	Produced (kWh/year)	Energy	Specific Production (kWh/kWp/year)
Tropical (Mumbai)	Wet	1813.4		5859.9		1641
Tropical Wet & Dry (Hyderabad)		1847.0		5837.9		1635
Arid (Jaisalmer)		1880.2		6242.8		1749
Humid Subtropical (Delhi)		1615.1		5249.0		1470
Mountain (Shimla)		1575.5		5653.6		1584

The results highlight that climatic conditions strongly influence solar tracking performance. Among the studied locations, Jaisalmer's arid climate yields the highest energy output (6242.8 kWh/year), while Shimla, despite its lower irradiation, records the best performance ratio due to stable temperature conditions [4]. Mumbai and Hyderabad present balanced outcomes, making them suitable for stable long-term deployment [5].

IV. Conclusion

The analysis confirms that climatic zone selection plays a critical role in solar tracking performance. Jaisalmer demonstrates the highest energy yield, while Shimla shows the best PR. Mumbai and Hyderabad provide balanced outputs. Future research should integrate economic feasibility, long-term degradation analysis, and maintenance strategies for optimizing solar tracking deployment in diverse Indian climates.

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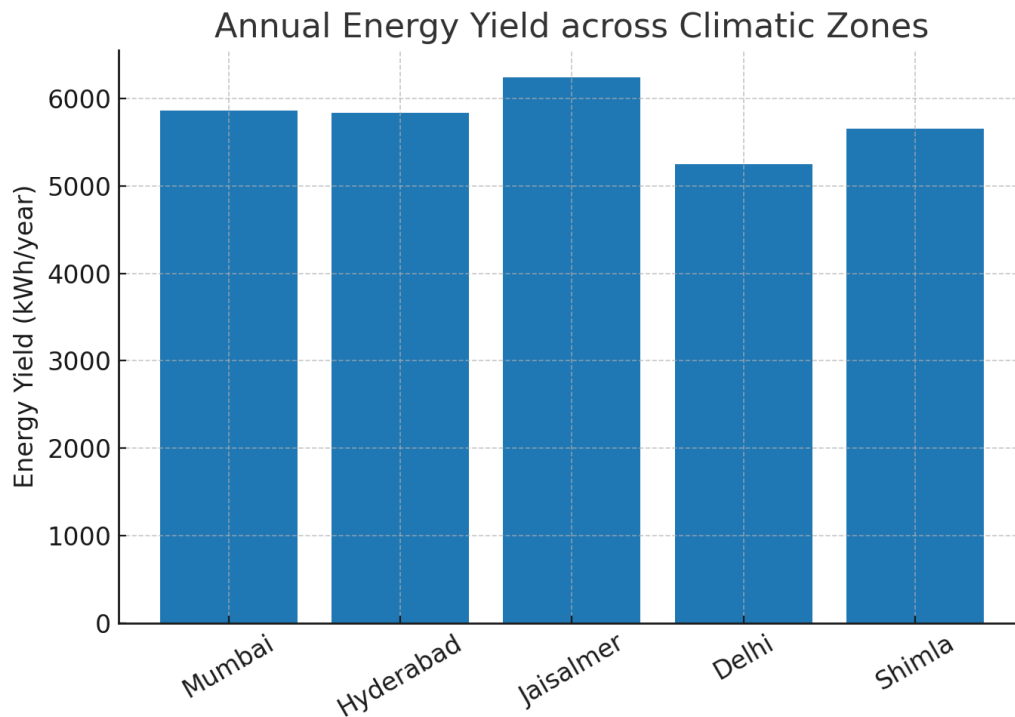
Figures

Fig. 1. Annual Energy Yield across Climatic Zones

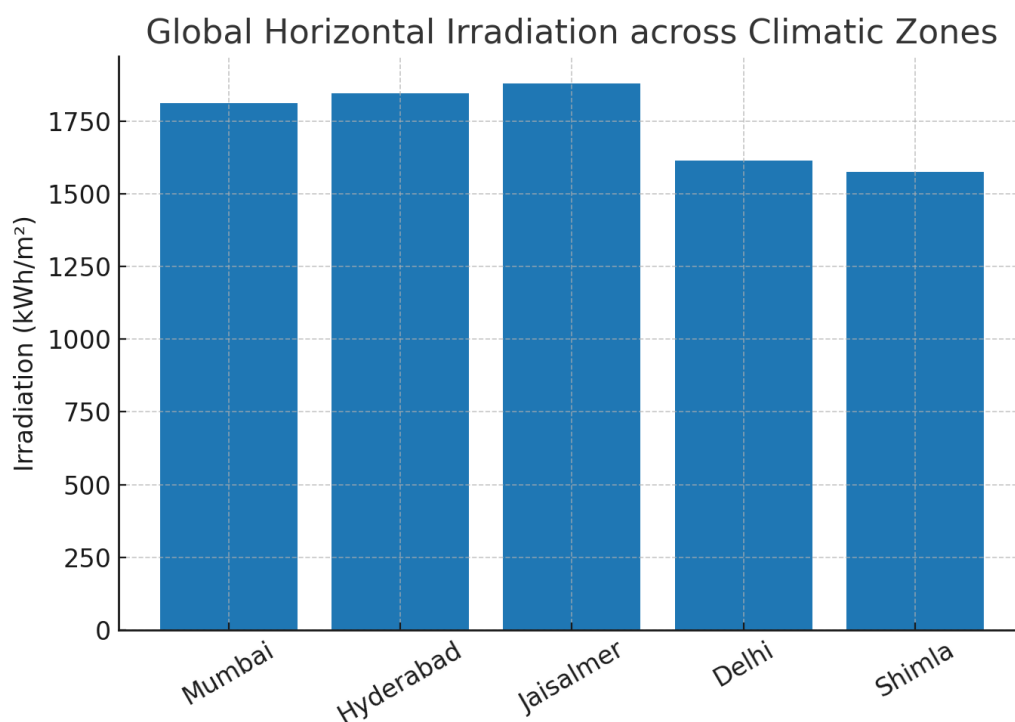


Fig. 2. Global Horizontal Irradiation across Climatic Zones

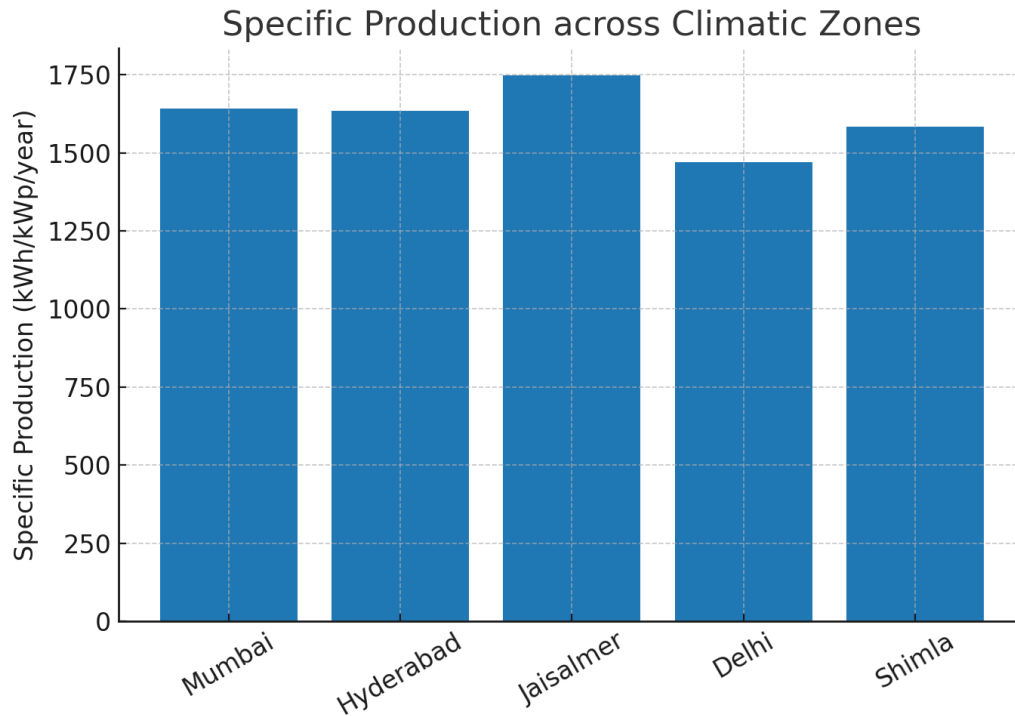


Fig. 3. Specific Production across Climatic Zones

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