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Optimized Tilted Solar Radiation in Equator Region: Case Study of Seven Climatic Zones in Tanzania

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Optimized Tilted Solar Radiation in Equator Region: Case Study of Seven Climatic Zones in Tanzania

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Abstract

This study delves into the ongoing discourse surrounding the optimal tilt angles for solar panels to maximize solar PV power generation. Focused on seven equatorial regions in Tanzania; Dodoma, Dar es Salaam, Kilimanjaro, Kigoma, Iringa, Mtwara, and Mwanza. Multiple mathematical models are employed to ascertain the most efficient panel tilts. Leveraging solar radiation data spanning from 2000 to 2017, we developed an algorithm specifically tailored for computing suitable tilt angles in the southern hemisphere. Our investigation reveals compelling insights into the variation of optimal panel tilts throughout the year. Notably, the monthly optimal tilt angles fluctuate significantly across the regions. June emerges as the month with the highest recorded monthly optimal tilt angle, ranging from 45 degrees in Mtwara to 31 degrees in Kilimanjaro. Conversely, December showcases the lowest tilt angles, spanning from -30 degrees in Mwanza to -26 degrees in both Kigoma and Iringa. Quarterly angles exhibit peaks during the second quarter of the year, reaching 39 degrees in Mtwara and 27 degrees in Kilimanjaro, while experiencing declines in the fourth quarter, plunging to levels between -19 and -24 degrees. Additionally, our study calculates annual optimal tilt angles, revealing a range from 2 degrees in Kilimanjaro to 11 degrees in Mtwara. Crucially, the deployment of monthly optimally tilted solar PV panels demonstrates a noteworthy enhancement, yielding a 6-11% gain in solar radiation compared to horizontally mounted panels. Our study advocates for the adoption of dynamic tilt adjustment strategies of periodic angle alterations to maximize solar PV power generation.

Keywords: Optimal tilt angles, solar radiation, solar panels, equator region