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Statistical Analysis of Tamil Nadu's Contributions to Sustainable and Green Energy: A Model for Renewable Energy Transition

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Abstract: *Tamil Nadu has established itself as a leader in India's renewable energy sector, contributing significantly to the nation's sustainable and green energy goals. This study employs statistical tools such as correlation and regression analysis to evaluate Tamil Nadu's renewable energy initiatives and their socio-economic and environmental impacts. Using data from government reports, energy production records, and environmental surveys, the research examines the relationship between renewable energy capacity (solar, wind, and biomass), economic growth, and carbon emission reductions. The findings reveal a strong positive correlation ($r > 0.8$) between the increase in renewable energy capacity and GDP growth, indicating that green energy investments drive economic development. Regression analysis demonstrates that a 1% increase in renewable energy adoption leads to a 0.5% reduction in carbon emissions, highlighting the environmental benefits of Tamil Nadu's initiatives. The state's achievements, such as contributing over 30% of India's wind energy capacity and establishing large-scale solar parks, are analyzed as case studies. Additionally, the study explores the role of policies like the Tamil Nadu Solar Energy Policy 2019 and the promotion of wind-solar hybrid projects in accelerating the energy transition. Despite these successes, challenges such as grid instability, land acquisition issues, and financing gaps are identified through statistical trends. The study concludes that Tamil Nadu's renewable energy model offers valuable insights for other states and countries aiming to achieve sustainable development goals (SDGs). By combining statistical analysis with policy evaluation, this research provides actionable recommendations for scaling up green energy initiatives and underscores Tamil Nadu's pivotal role in India's low-carbon future.*

Keywords: Sustainable energy, green energy, Tamil Nadu, renewable energy, solar power, wind energy, biomass energy, correlation analysis, regression analysis, carbon emissions, economic growth, energy transition, SDGs

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