

A Window DEA Analysis of Renewable Energy Innovation Efficiency in Top Green-Living Countries

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Abstract:

This study evaluates the renewable energy innovation efficiency of the world's top ten "green living" countries, as identified by a collaborative ranking from the Wharton School, BAV Consulting, and U.S. News & World Report. While these countries are recognized for environmental performance, health, and innovation, this research examines how efficiently they convert key inputs into economic and energy outputs. Using panel data from 2017 to 2020, Cumulative Renewable Energy Patents, Renewable Energy Capacity, and Energy Consumption are treated as inputs, while Total Energy Production and GDP are considered outputs. A Pearson correlation test is first conducted to verify the isotonic relationships among variables. Subsequently, the Data Envelopment Analysis (DEA) Window Model is applied to measure dynamic efficiency across time. Results indicate a clear ranking led by European countries, with Switzerland, Norway, and the Netherlands achieving the highest efficiency scores, while some advanced economies such as Japan and Germany rank comparatively lower. These findings suggest that a high level of technological development does not necessarily guarantee efficiency in renewable energy innovation, and that effective resource allocation plays a critical role. The study offers a structured framework for assessing national performance in sustainable energy and provides practical insights for policy development.

Keywords:

Data Envelopment Analysis, DEA Window Model, Renewable Energy Innovation, Efficiency Analysis, Sustainability.