

# A Comprehensive Analysis on Carbon Dioxide Emission Reductions in Germany's Wind Turbine Manufacturing Ecosystem through Innovation Policies

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## Abstract

The urgent need to combat climate change and resource depletion has highlighted the global transition towards renewable energy sources. However, the impact of innovation policies on the wind turbine manufacturing ecosystem and their effectiveness in reducing CO<sub>2</sub> emissions remain understudied. This paper provides a comprehensive analysis of Germany's wind turbine manufacturing ecosystem and investigates the effects of innovation policies on CO<sub>2</sub> emissions through a system dynamics approach.

While previous research has examined specific aspects of renewable energy and innovation policies, there is a lack of comprehensive analysis at the macro-meso level using microeconomic data in the wind turbine manufacturing sector. Drawing on existing literature on renewable energy, innovation policies, and system dynamics, we have developed a wind turbine manufacturing ecosystem model that captures the complex interactions and allows for simulation of different policy options. Through experiments with various policy tools and behavioral scenarios, our study explores the holistic behavior of the wind turbine innovation system in Germany, focusing on understanding the system dynamics rather than making future predictions.

By gathering and analyzing data from multiple sources, our findings highlight the intricate balance between innovation, cooperation, patents, and GDP growth ratios in reducing CO<sub>2</sub> emissions & intensity. We emphasize the importance of not only setting lower GDP growth targets but also implementing complementary policies to promote technology development and create a thriving market for wind energy turbines. Our study contributes to the understanding of how innovation policies impact the wind energy sector and offers insights into optimizing these policies to foster innovation while reducing CO<sub>2</sub> emissions.

**Keywords:** climate change, CO<sub>2</sub> emissions, wind energy, innovation policies, wind turbine manufacturing