

Leaders and Followers in Europe's Renewable Electricity Transition: An Agent-Based Model of Diffusion and Imitation

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An agent-based modelling framework is developed to analyse the diffusion of renewable electricity generation across Europe. The study treats countries as agents and models the energy transition as a process of technological diffusion in electricity generation, focusing on the changing shares of combustible fuels, solar, wind, nuclear, hydro, and other sources. Using a balanced panel of 33 European countries from 1990 to 2024, the paper combines diffusion logic with reduced-form panel estimation to distinguish structural determinants of renewable deployment from behavioural dynamics. Country panels capture persistent national differences in geography, natural resources, electricity-system structure, regulation, and economic conditions, while time effects account for common technological and policy shocks. The central contribution is to use deviations from model-predicted solar and wind deployment as evidence of proactivity or imitation. Countries generating more renewable electricity than predicted are interpreted as proactive leaders, while countries below their predicted level are treated as delayed adopters or followers. The patterns found suggest clear cross-national heterogeneity in wind and solar deployment. The study contributes to energy-transition research by linking econometric benchmarking with behavioural rules suitable for agent-based simulation and forecasting.