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Promoting the System Integration of Renewable Energies: Toward a Decision Support System for Incentivizing Spatially Diversified Deployment

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Abstract: The system integration of intermittent renewable energies (RE) poses an important challenge in the transition toward sustainable energy systems. Their intermittency introduces variability into electricity generation, leading to high ancillary service costs and technical issues impairing grid stability and supply reliability. These issues can be mitigated through spatially diversified capacity deployment, as RE intermittency can be geographically smoothed over sufficiently large regions. Following a design science research approach, we develop a model for the quantification of location-based investment incentives in RE support mechanisms to foster spatially diversified capacity deployment. We evaluate the modeling approach in a simulation study with focus on diversifying wind energy deployment in Mexico under an idealized auction mechanism and demonstrate how location-based investment incentives reduce resource-dependent competition among projects. Our research contributes a nascent design theory that combines the kernel theories for identifying favorable spatial distributions of RE capacity with current policy designs to support capacity expansion management

Key words and phrases: design science, energy policy, green information systems, policy decision support, renewable energy, renewable energy auctions, sustainable energy planning, wind energy.

Motivation

Climate change mitigation through energy transition is one of the most critical challenges to be addressed by individuals, organizations, and societies in the twenty-first century [13, 58]. As information is a prerequisite for making appropriate decisions on sustainability actions [13], information systems (IS) research has the opportunity to make solution-oriented and effective contributions to the mitigation of global warming and issues surrounding the transition toward renewable energies (RE) [13, 36, 52]. The motivation for our research stems from the globally increasing deployment of RE technologies and the need to manage issues resulting from the variability of electricity generation from intermittent RE resources [45, 57].

In recent decades, the deployment of RE technologies has largely relied on financial support mechanisms with low market integration—for example, feed-in priorities, purchase guarantees, and fixed feed-in tariffs—as these technologies were unable to compete with conventional electricity generation [2]. Although these support mechanisms were effective in facilitating the expansion of RE deployment in many countries, they led to significant subsidy costs [20]. To reduce these costs, policymakers currently shift toward market-based support mechanisms [11, 46]. Especially auctions for RE subsidies are increasingly deployed in many countries as they introduce a price discovery element into the establishment of subsidy levels