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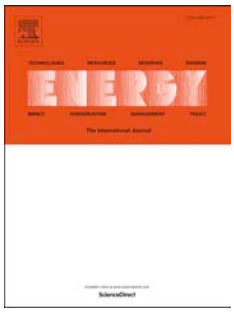

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Spatio-Temporal Optimization of a Future Energy System for Power-to-Hydrogen Applications in Germany

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Abstract

Achieving greenhouse gas reduction targets requires an increased share of renewable energy sources in todays energy systems. The spatial and temporal mismatch between electricity supply and consumers demand arising from fluctuating renewable electricity generation can be overcome by energy transport and storage. Here, one option is the Power-to-Gas concept. With this, hydrogen is produced by water electrolysis and can then be flexibly distributed and stored throughout the energy system. In this study, an optimization model is proposed that represents such an energy system as multiple interconnected nodes and which considers the systems time-dependent characteristics in terms of the integration of typical days and their chronological order. This methodology is applied to determine the cost-optimal design and operation of future energy systems for Power-to-Gas scenarios in Germany. In these scenarios, hydrogen is supplied to mobility and industry. Onshore wind turbines and hydrogen pipelines and underground storage facilities are considered for generation, transmission and storage. For all scenarios, a hydrogen cost below the current hydrogen retail price of 9.5 Euro/kg at German fueling stations is obtained. Additionally, the value of hydrogen storage in salt caverns is investigated by prohibiting their construction during optimization, which results in a cost increase of 1.5 Euro/kg.

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