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Assessment of feasible strategies for seasonal underground hydrogen storage in a saline aquifer

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Renewable energies are unsteady, which results in temporary mismatches between demand and supply. The conversion of surplus energy to hydrogen and its storage in geological formations is one option to balance this energy gap. This study evaluates the feasibility of seasonal storage of hydrogen produced from wind power in Castilla-León region (northern Spain). A 3D multiphase numerical model is used to test different extraction well configurations during three annual injection-production cycles in a saline aquifer. Results demonstrate that underground hydrogen storage in saline aquifers can be operated with reasonable recovery ratios. A maximum hydrogen recovery ratio of 78%, which represents a global energy efficiency of 30%, has been estimated. Hydrogen upconing emerges as the major risk on saline aquifer storage. However, shallow extraction wells can minimize its effects. Steeply dipping geological structures are key for an efficient hydrogen storage.