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Titel des Beitrags: Small-scale pumped heat electricity storage for decentralised combined heat and power generation: cost optimal design and operation

Abstract: Decentralised rural electrification by means of renewable energy present a challenge to electricity storage devices. Currently used lead-acid batteries have low lifetime and are a threat to human health and environment. Using environmentally friendly and long-lasting materials, a Pumped Heat Energy Storage could offer a valuable alternative to these batteries. In this paper, a Pumped Heat Energy Storage is therefore analysed with respect to its potential as a combined heat and power storage for the autarkic cogeneration of heat and power from renewable energy. The charging and discharging operation are modelled in Matlab for a kW-scale configuration using a two-stage heat pump for charging and pressurized water as the thermal energy storage. During discharge, the stored heat can either be reconverted to electricity using a subcritical organic Rankine cycle or immediately be used in various household applications. Finally, the economic feasibility of the Pumped Heat Energy Storage is compared to that of a lead-acid battery based energy system using cost function optimization for different scenarios. Using off-the-shelf system components, for the investigated conditions, power-to-power round trip efficiencies of 9.32 to 19.85% can already be achieved. Further improvements in turbo machinery design are required to achieve a roundtrip efficiency of 26%, which the optimisation has shown to be sufficient to create an energy system competitive with the current lead-acid based system.
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