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Simulation of flexible Small Modular Reactor operation with a thermal energy storage system

The surging penetration of variable renewable energy sources into power grids translates into an urgent need for dispatchable generators such as nuclear power plants to effectively balance grid demand. However, nuclear reactors have been traditionally operated as baseload power sources, leveraging the technical and economic advantages of this operational mode. This paper explores the integration of a two-tank thermal energy storage (TES) system with a light-water cooled Small Modular Reactor (SMR) as an alternative to address the flexibility requirements and, at the same time, minimise thermal power variation in the nuclear steam supply system.
In this work, the dynamics of the coupled SMR-TES system are examined across various scenarios by means of dynamic models developed in the object-oriented modelling language Modelica. The aim is to analyse the potential impact of a TES on the operational strategies of a SMR in the context of highly fluctuating load demands. Through this investigation, the study aims at demonstrating that nuclear energy systems can satisfy the evolving grid requirements with minimal perturbations on the nuclear reactor's operation. The results show that the SMR is able to meet variable load demands by exchanging power with the TES, ensuring reliable energy supply.

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