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Economic Analysis of Thermal Energy Storage Integration in Small Modular Reactors Balance of Plant

The increasing penetration of renewable energy sources in the electric grid intensifies more than ever the demand for adjustable power outputs. Nuclear plants often find load-following, though feasible, undesirable especially due to the associated thermo-mechanical stresses placed on reactor components. To help absorb the load variability and improve the overall plant economics we can integrate molten salt thermal energy storage (TES) into a Small Modular Reactor (SMR) balance-of-plant (BOP). This study assesses the economic viability of this approach through a discounted cash flow analysis. In particular, we are considering lead-cooled SMRs with an electrical capacity of about 100 MWe, 3 different TES tank sizes, and 6 BOP configurations for loading and unloading the molten salt at different rates. By storing excess thermal energy during low-demand periods and releasing it during peaks, it is possible to effectively meet fluctuating energy needs and improve overall revenues. We provide net present values and internal rates of return for the proposed systems by considering factors such as capital costs, operating expenses, revenue streams, and discount rates. The results show which configurations could be economically profitable, underlying the need to have such preliminary analysis to drive the design of nuclear systems adopting TES.

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