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Flexibility limits in Small modular reactors for enhanced load following

VRE sources like solar and wind have high intermittency and with large shares of them, thermal generators would need to match the net load curve rather than the demand curve or need to perform VRE-following. The French experience [2] and existing literature, including works by Jenkins et al. [3] and Ponciroli et al. [4], primarily focus on load-following in large reactors, in scenarios with low VRE penetration, revealing a gap in the context of VRE-following, especially for SMRs. Current operational constraints limit NPPs'by allowing a shift from 100% to 50% and back to 100% of rated power once in 24 hours [1]. However, nuclear reactors inherently possess a substantial reactivity reserve, enabling them to closely load-follow for a significant portion of their irradiation cycle.

We perform reactor physics numerics for enhanced VRE-following from beginning-of-life (BOL) to end-of-life (EOL) for PWR-SMRs, considering burnup, enrichment, ramp limits, declining reactivity, Xenon poisoning-induced deadtimes, and minimum power levels. We use the insights in a modified Unit Commitment model with a large amount of renewable energy. The objective is to establish a granular constrained operational space within which a nuclear reactor, specifically a GW-class AP1000, and the newly unveiled AP300 SMR, can perform VRE-following.

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