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Stability-Driven Approaches for a Sustainable and Safe Energy Transition

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Abstract

The global shift toward sustainable and low-carbon technologies presents major challenges, particularly due to the limited understanding of the dynamic behavior of novel process equipment. Electrified units and next-generation chemical reactors, often at low technological maturity, require careful assessment not only from technical, economic, and environmental perspectives, but also in terms of safety and controllability.

In this context, stability-based methodologies emerge as powerful tools to explore the fundamental behavior of chemical systems and to define safe and reliable operating conditions. By integrating stability analysis into reactor design, optimization, and control, it becomes possible to identify intrinsically safe operating regimes and enhance process resilience—thus enabling a safer and more efficient transition toward sustainable technologies.