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# Operational Strategies for Scalable Electrolyzer Deployment

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**Abstract**
As global energy systems transition toward decarbonization, electrolytically produced hydrogen is emerging as a key energy vector for industrial decarbonization, long-duration energy storage, and fuel optionality for a resilient energy system. This project explores the role of low-temperature electrolyzers—specifically Alkaline Water Electrolyzers (AWE) and Proton Exchange Membrane (PEM) systems—in producing hydrogen from variable renewable electricity (VRE) under flexible operational conditions.

Leveraging dynamic modeling of electrolyzer stacks, the study looks at different solar and wind electricity profiles across 5 different locations in the United States (US). Using these values as inputs to the model, the study evaluates how electrolyzer performance varies with renewable electricity profiles, sizing strategies, and operational modes. It identifies critical trade-offs between hydrogen output, system efficiency, and grid integration, offering insights into how technology choice and operational planning can influence project reliability.

Key findings show that for the technology assumptions of the in the model, AWE systems typically yield higher hydrogen volumes under stable conditions, while PEM technologies offer superior responsiveness in high-ramping environments—making them well-suited for integration with intermittent renewables. The analysis also reveals that optimal sizing of electrolyzers relative to renewable assets is essential to minimize curtailment and maximize utilization.

For industrial stakeholders, this work provides a strategic framework to guide investment decisions in hydrogen technologies, and infrastructure. It highlights the importance of aligning technology capabilities with site-specific renewable profiles and operational goals. Future phases will expand the modeling to include degradation, storage integration, and cost optimization—supporting more robust planning for scalable, low-carbon hydrogen deployment.