Energy Storage for Baseload Generation

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Topic: Stakeholder Developments & Industry Trends
Vertical: Analytics | Strategic Pathway: Grow
Project start and finish: FY26

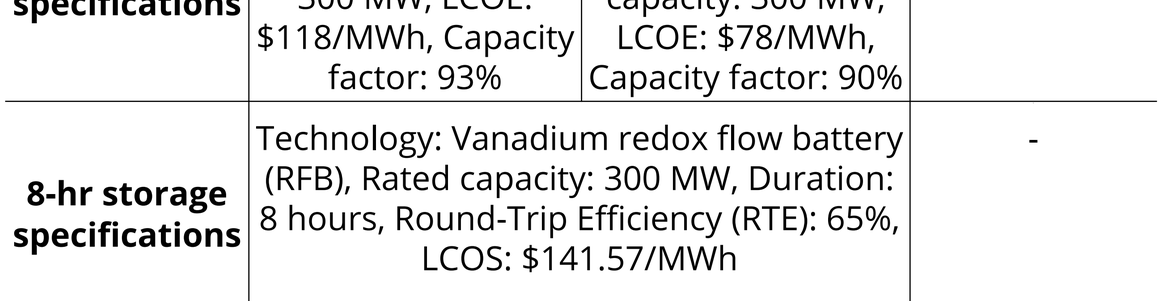
PROBLEM

Historically, energy storage – such as pumped storage hydropower – was deployed to complement baseload generation, enabling continued operation during low-demand periods. Recent breakthroughs in thermal baseload generation and storage technologies create a need to reinvestigate:

- The potential of pairing of thermal generation sources with emerging energy storage technologies
- Operational and economic performance of standalone generation technologies vs hybrid systems paired with emerging storage technologies

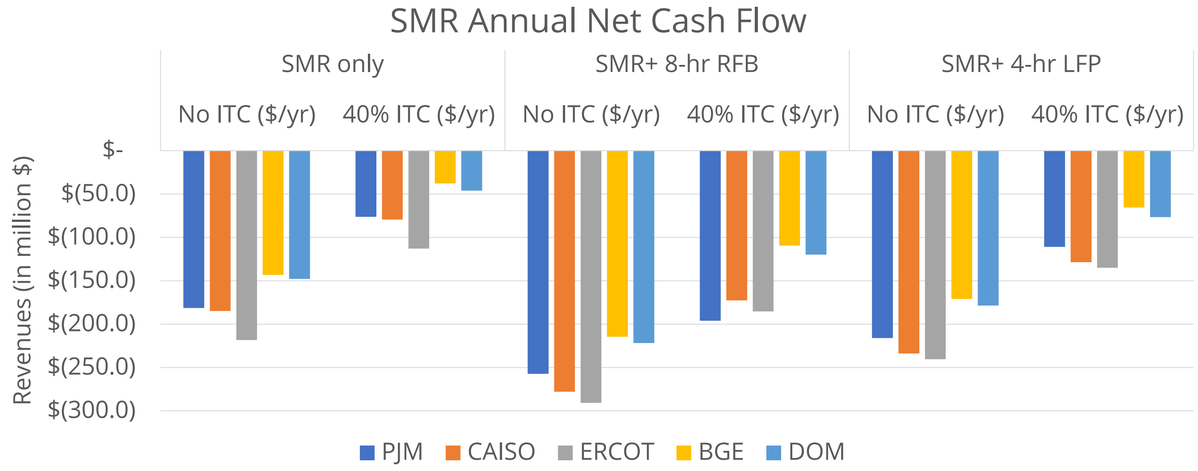
APPROACH

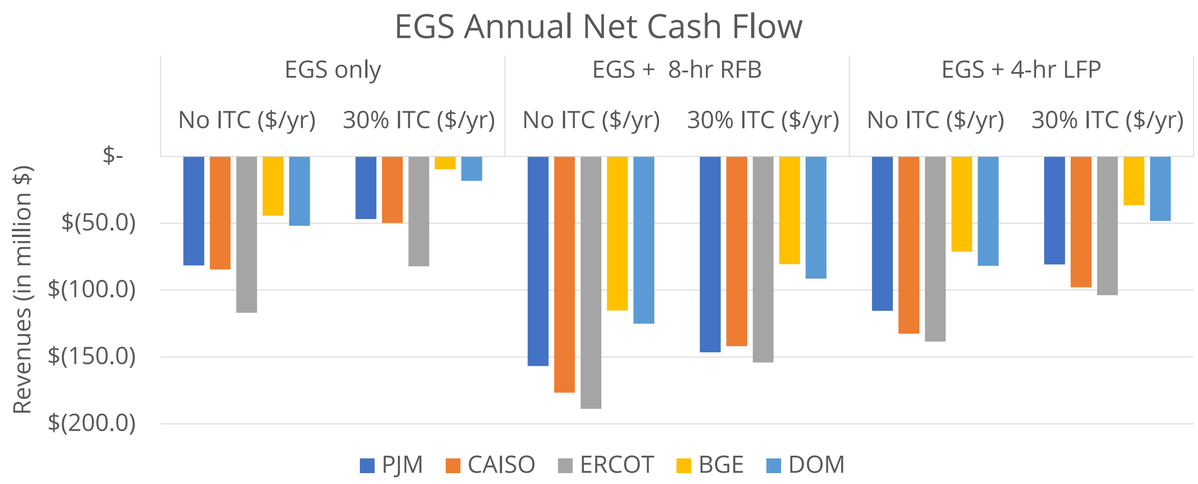
This study evaluates energy storage integration with three thermal baseload generation resources: natural gas power plants, small modular reactors (SMRs), and enhanced geothermal systems (EGS). The diagram summarizes the methodology, and the table contains high level project context:



	SMR	EGS	Natural Gas
Motivation	Safer designs, lower construction times, strong investment signals	Technological advancements, higher capacity factors	Largest electricity generation source
Challenges	No operational SMRs, limited data availability, lower ramp rates	Pre-commercial phase, limited data availability	Frequent start/stops, ramping
Power Plant specifications	Nameplate capacity: 300 MW, LCOE: $118/MWh, Capacity factor: 93%	Nameplate capacity: 300 MW, LCOE: $78/MWh, Capacity factor: 90%	-
8-hr storage specifications	Technology: Vanadium redox flow battery (RFB), Rated capacity: 300 MW, Duration: 8 hours, Round-Trip Efficiency (RTE): 65%, LCOS: $141.57/MWh		-
4-hr storage specifications	Technology: Lithium Iron Phosphate (LFP), Rated capacity: 600 MW, Duration: 4 hours, RTE: 85%, LCOS: $67.71/MWh		-

RESULTS





PJM: PJM Interconnection, CAISO: California Independent System Operator, ERCOT: Electric Reliability Council of Texas, BGE: Baltimore Gas and Electric, DOM: Dominion Energy

Natural gas + storage

- Minimizing plant start/stops, and reducing ramping fluctuations
- Reduction in avg. heat rates and fuel consumption

Natural gas + LDES

- Captures extended peak demand periods
- Avoids longer ramp-ups/downs
- Provides multi-hour firm capacity, enhancing effective load carrying capacity (ELCC)
- Extends grid reliability benefits

CONCLUSIONS & IMPACT

For hybrid SMR and EGS scenarios, electricity markets with frequent and higher daily peaks (e.g. BGE and DOM) produce slightly smaller losses, whereas ERCOT performs worst, primarily due to the absence of firm capacity market revenues.

Overall, while RFB provides additional grid benefits, RFB coupled systems are not yet profitable, mainly due to:

- High levelized costs of selected emerging generation and storage technologies
- Limited use cases that may not fully capture storage value

For current assumptions, lithium-ion has better overall economic performance due to lower costs and higher round-trip efficiency, but relatively longer duration emerging energy storage technologies can meet longer periods of peak demand more effectively.

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