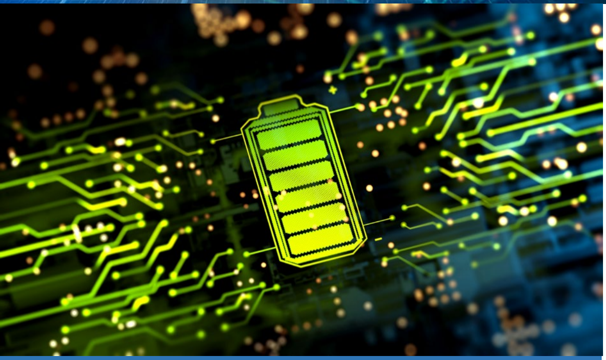

# Assessing Temporal and Spatial Modeling Choices for Energy Storage in Long-Term Resource Planning

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## KEY INSIGHTS

- Existing utility-level planning tools require making tradeoffs in modeling temporal and/or spatial details, to keep simulations tractable.
- Finer temporal granularity—with chronology—drives higher storage deployment; temporal simplifications may overlook peak and off-peak pricing periods crucial for accurately valuing energy storage.
- Myopic models with shorter optimization periods may result in lower storage deployment. These models miss anticipating later carbon targets and thus the need to retire fossil and build more renewables and storage.
- Simultaneously modeling the transmission network can help mitigate future congestion issues by identifying optimal storage locations and deployment timing.

## Research Overview

New research explores potential trade-offs between enhanced spatio-temporal resolution and model complexity with respect to energy storage.

Using a commercial resource planning tool, this study evaluates the effects of temporal and spatial simplifications on capacity expansion model results. Energy storage deployment metrics are analyzed, including installed capacity, technology type, location within the network, and deployment year, within the context of decarbonization.

Simplification methods to reduce the planning model's temporal dimension, optimization period, and representation of the transmission network result in significant variation in storage portfolios. Findings suggest that these simplifications (aimed at reducing lengthy run times in capacity expansion models) may lead to inaccurate evaluations, potentially resulting in either underestimation or overestimation of storage resources and even other generation technologies in planning studies.

## Summary of Findings

- Incorporating energy storage in long-term resource planning tools is complex due to a variety of storage technology types with different operational characteristics. Common temporal and spatial simplifications used in planning tools impact model results, including storage deployment.
- The timing and quantity of simulated storage capacity installations over time are impacted by the tool's temporal resolution and chronology. Deployment starts as early as 2027 in some simulations, and as late as 2035 in others. By the end of the time horizon, cumulative storage capacity varies significantly, reaching a difference of 1.9 GW for the studied test system (Fig. 1).

**Figure 1. Comparison of new storage capacity (MW) across three low-carbon resource portfolios, identified using different temporal resolution modeling strategies**

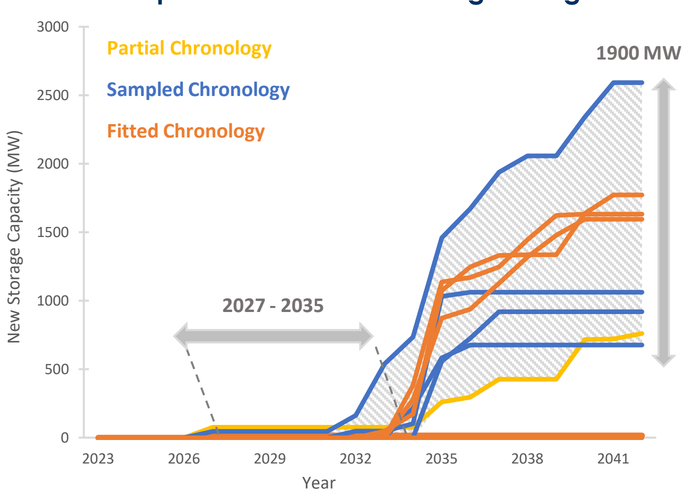
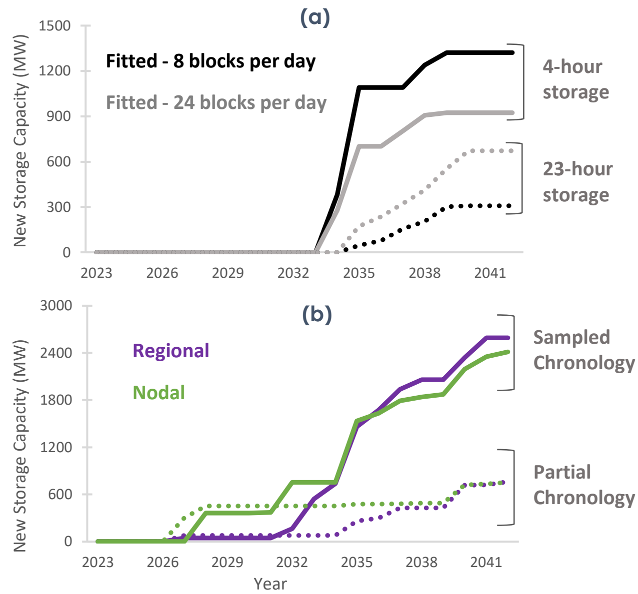



**Figure 2. Comparison of storage deployment by capacity (MW) under different temporal resolutions (a) and between nodal and regional approaches (b)**




- A strategy with higher temporal resolution tends to deploy longer-duration storage, while a lower-resolution strategy favors shorter-duration storage. The reduced number of blocks dampens price variability throughout the day, potentially missing extreme peak and off-peak pricing periods crucial for a more accurate valuation of energy storage (Fig. 2a).
- Modeling the nodal transmission network in simulations provides valuable insights into optimal storage locations and timing. During periods of transmission system congestion, storage deployment increases at affected nodes and during those specific years (Fig. 2b).

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