

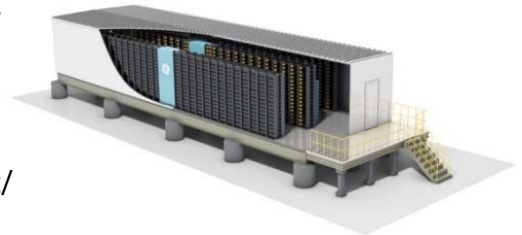
Interpreting Storage Results in Capacity Planning Models

October 2017

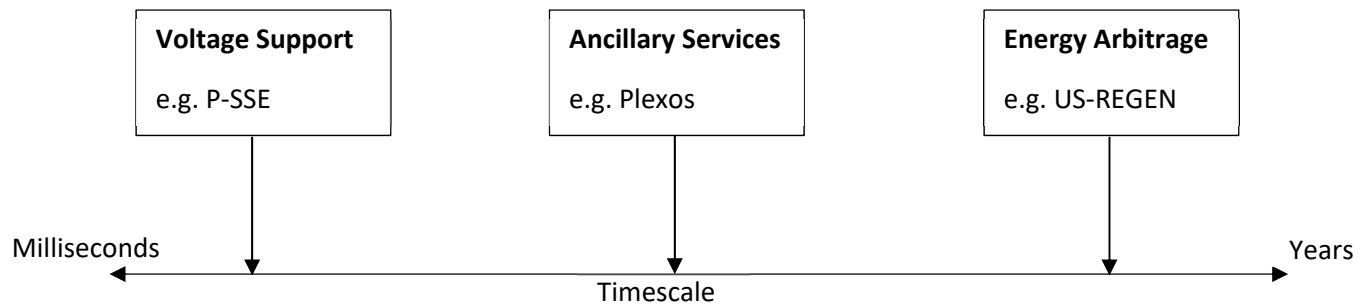
Renewable generation from wind and solar is intermittent, providing electricity at times which do not line up well with demand in the U.S.

Storage technologies can time-shift electricity supply, among other functions, but the payoff for this service, and the potential value of storage investments are not well understood.

Today's modeling tools seek to understand the value of storage, but face challenges in capturing the **chronological detail** to represent storage charging/discharging, the different **potential value streams** for storage, and comparing storage against other technologies in an **uncertain future**.



Different Models Capture Different Value Streams for Storage



No model captures all value streams due to differences in timescale and computational limitations

Modeling Assumptions over an Uncertain Future Influence Outcomes

Prices

Storage revenues depend on future price projections.
How are prices calculated, particularly with high renewable penetration?

Competing Technologies

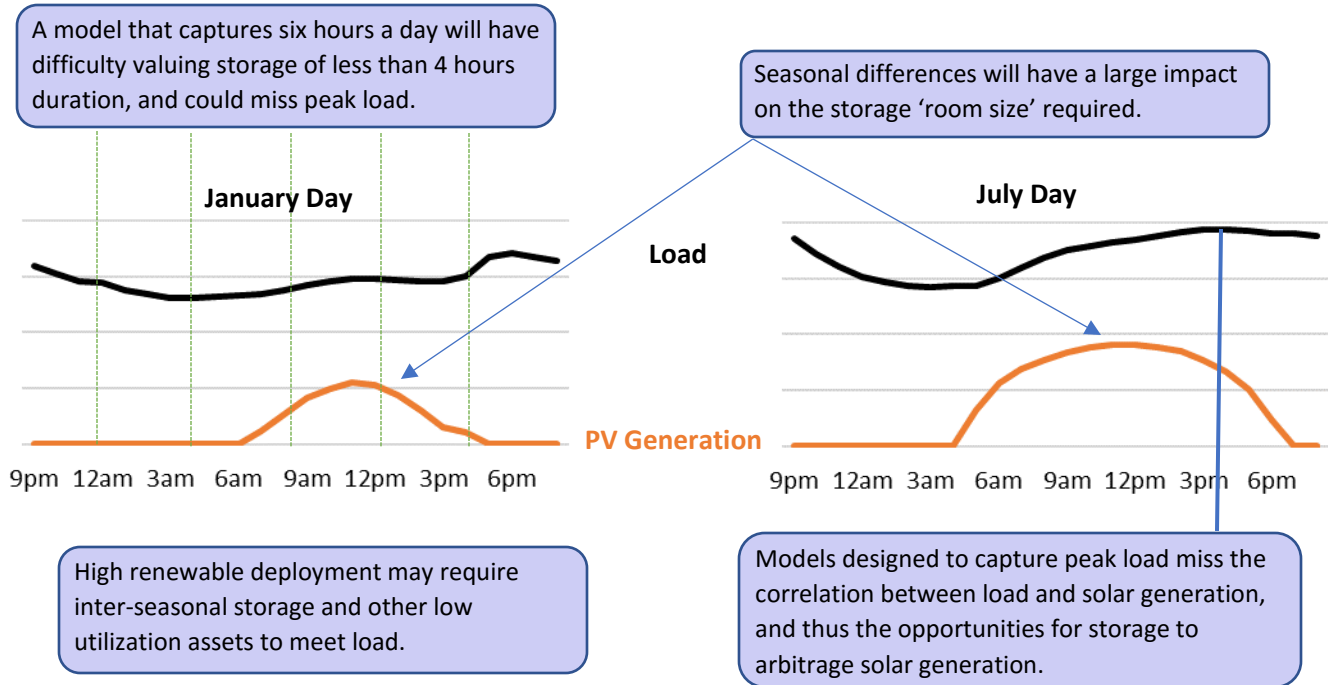
Storage competes with existing technologies for all revenue streams.
How are competing technologies represented and how do their economic costs compare with storage?

Market Demand

Many revenue streams represent small markets with limited demand.
Do revenue estimates account for potential market saturation?

Chronological Resolution Drives Ability to Model Storage Energy and Capacity Value

Regional example based on historic load and solar profiles



Key Questions to Ask When Modeling Storage

Model

- **Endogenous storage?** Is the level of storage capacity a model output (endogenous) or an input (exogenous)?
- **Endogenous electricity prices?** Do market prices change with storage investment and operations? Is "value deflation" captured?
- **Investments in other technologies?** Does the model co-optimize other types of capacity (e.g., gas, wind) alongside storage, or is the capacity mix fixed?

Storage

- **Chronology and dispatch details?** What is the model's temporal resolution (hourly, subhourly)? How detailed are system operations?
- **Storage technologies, costs, and capabilities?** Are these appropriately represented given the model's structure?
- **Revenue streams?** Is arbitrage the only grid application, or are other benefits/functions (e.g., operating reserves) modeled?

Scenarios

- **Policy environment?** What assumptions are made about climate policy, technological mandates, etc.?
- **Reference mix (without storage)?** What would capacity/generation look like without storage?
- **Costs of technological complements and substitutes?** Natural gas? Renewables? Transmission?

For more information, contact John Bistline jbistline@epri.com, or visit <http://eea.epri.com/research.html>