Impacts of Battery Storage on the Electric Sector Mix

Battery storage can help (but not solve) the misalignment between wind and solar profiles and load shapes.

This analysis shows how:

- Battery deployment may be extensive but changes the backup for renewables (especially gas-fired generation) more than total wind and solar penetration
- Energy storage can lower system costs and curtailments of wind and solar in some grids, especially if trends in cost declines for lithium-ion batteries continue
- Some regions and scenarios may have extensive battery storage but limited wind and solar deployment (and vice versa)
- Impacts of batteries and other energy storage technologies can vary by region, assumptions about the future, and company-specific considerations

This EPRI brief investigates the potential impacts of low-cost battery storage on electric sector investment and generation changes, using the U.S. Regional Economy, Greenhouse Gas, and Energy (**US-REGEN**) model.

Model results suggest that there is a **positive but weak correlation between energy storage and wind and solar deployment**. Points on Figure 1 represent the 15 model regions under a range of scenarios described on the next page. Battery storage can provide value even with lower wind and solar shares by shifting generation from lower- to higher-priced hours, being available when demand is high, deferring transmission builds, and/or providing ancillary services. Conversely, there are conditions with high renewable shares where the services batteries provide can be met more cheaply by other resources.

Low-cost battery storage may help to mitigate the impact of decreasing economic returns (also called "value deflation") for wind and solar as their deployment increases but likely will not eliminate it.* Like renewables, **energy storage exhibits decreasing returns** as market values saturate at higher penetration levels.

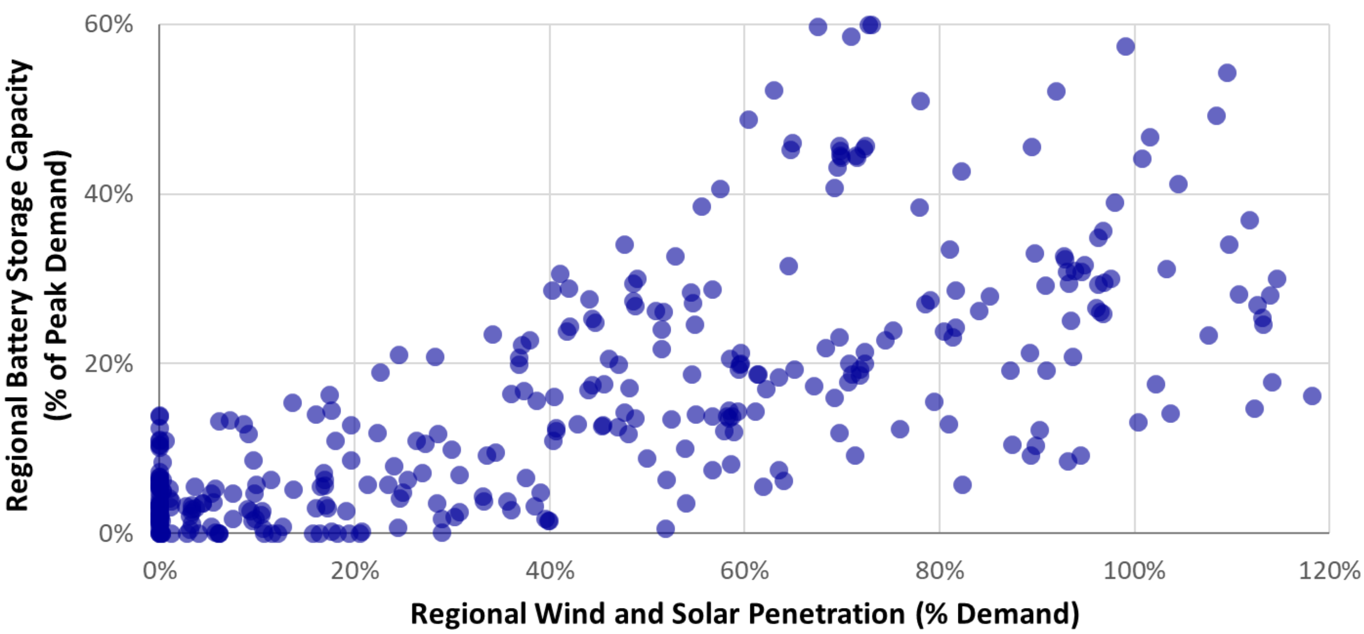
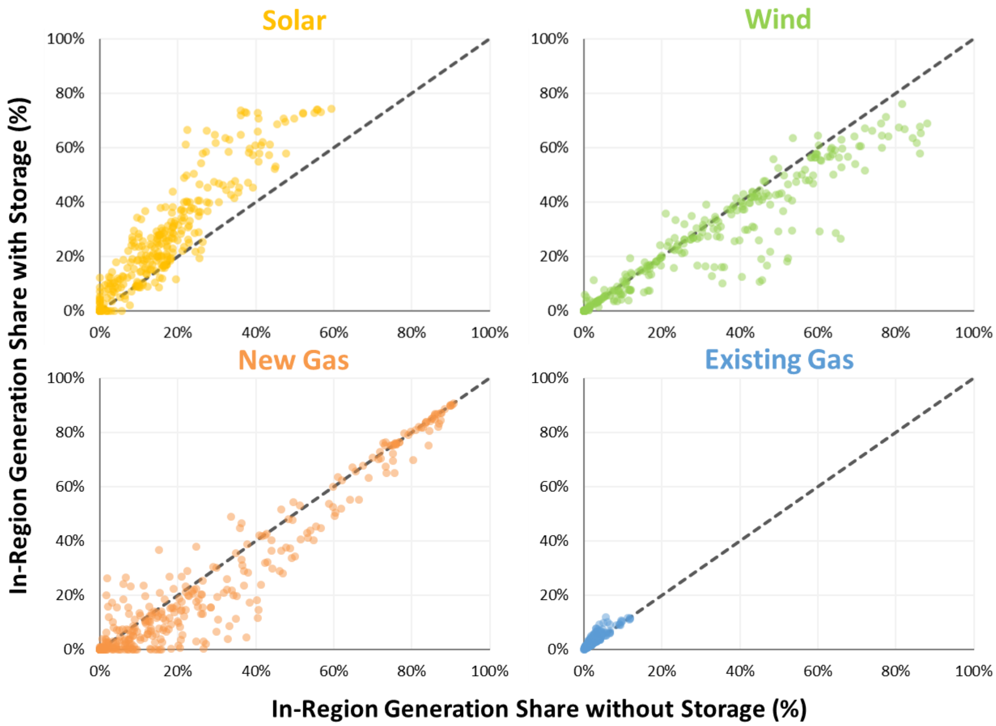


Figure 1: Regional energy storage capacity (as fraction of regional peak load) across penetration levels of wind and solar (fraction of in-region demand). Points represent individual model regions, and values are shown across policy scenarios, gas prices, and wind and solar costs. Scenarios are described on the next page.



- Points on Figure 2 illustrate the impact of battery storage on different generation options
- Individual points represent regional results across different scenario assumptions
- For each panel, points above the dotted line indicate that the technology's share increases with battery storage for a specific region and scenario (and vice versa)
- For instance, solar deployment generally increases with energy storage, especially under conditions where solar would be high even without storage (e.g., low-cost solar, CO_2 cap, high gas prices)

Figure 2: Generation shares for four technologies with energy storage (vertical axes) and without storage (horizontal axes). Points on individual panels represent different regional results across policy, gas price, and wind/solar cost scenarios.

US-REGEN selects battery storage investment and duration based on a cost structure with a $50/kW power capacity cost, $100/kWh energy capacity cost, 91% efficiency, and 20-year lifetime. Scenarios include:

- Investment costs of new wind and solar: Four scenarios span from flat costs (at current levels) to a 90% reduction in 2050
- Natural gas prices: $4, 6, and 8 per MMBtu
- CO_2 policy: No policy and a 95% national cap in 2050 (relative to 2005)

The model solves for the least-cost mix for each combination of outcomes. The model also includes energy storage technologies like pumped hydro, compressed air, thermal storage, and hydrogen.

Figure 2 illustrates the impact of battery storage on individual technologies like solar, wind, new gas, and existing gas. Displaced generation and capacity **depend on policy and market assumptions** and require detailed modeling to evaluate. For instance, solar generation impacts depend on the level of deployment in the equivalent scenario without storage, as increases are mostly likely when solar deployment is high. Storage tends to have a neutral or negative impact on wind, new gas-fired generation, or transmission. **Battery storage impacts the relative competitiveness of solar versus wind**, as scenarios with solar increases are often accompanied by wind decreases. Note that batteries often lower (but do not eliminate) curtailment, as the value of reducing curtailments may not exceed the cost of installing low-utilization equipment.

The results suggest that energy storage is not necessary to achieve high wind and solar shares, and that energy storage by itself does not enable high renewable penetration. There are many facilitating resources for renewable integration, and the effectiveness of these options should be evaluated under a range of future assumptions.

Contact Information

For more information, contact John Bistline (jbistline@epri.com) or David Young (dyoung@epri.com). Model documentation and related research can be found at http://eea.epri.com.

* EPRI (2015), "Decreasing Returns to Renewable Energy," EPRI Product #3002003946

February 2019

Electric Power Research Institute
3420 Hillview Avenue, Palo Alto, California 94304-1338 • PO Box 10412, Palo Alto, California 94303-0813 USA
800.313.3774 • 650.855.2121 • askepri@epri.com • www.epri.com