Renewable-Storage Hybrids in a Decarbonized Electricity Supply

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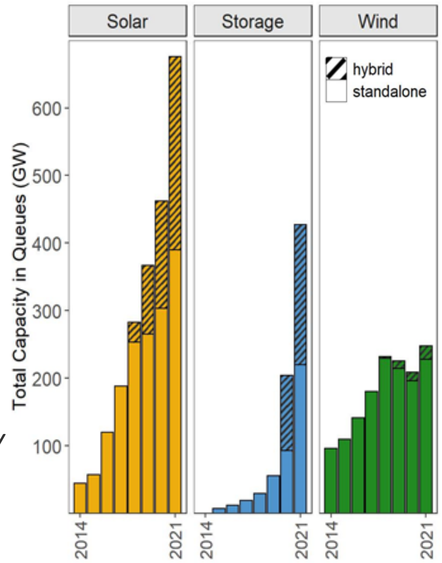
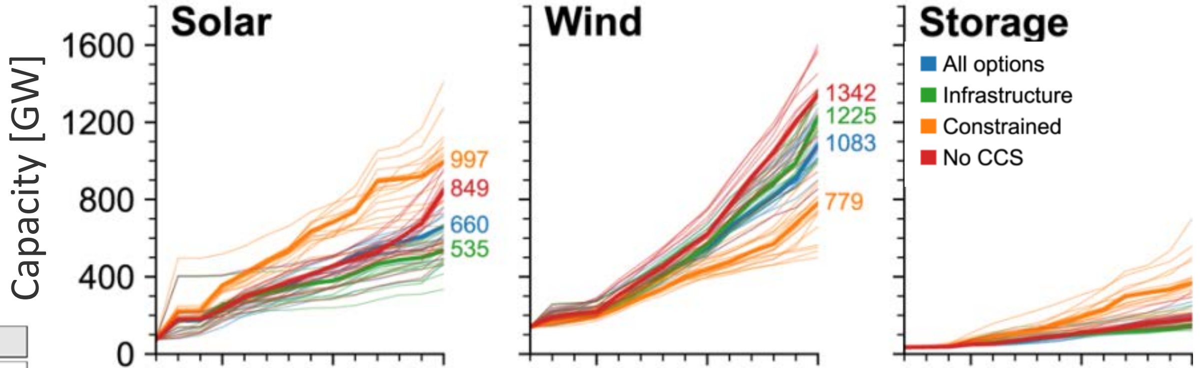
TD60. The Role of Battery Storage in Power System Decarbonization

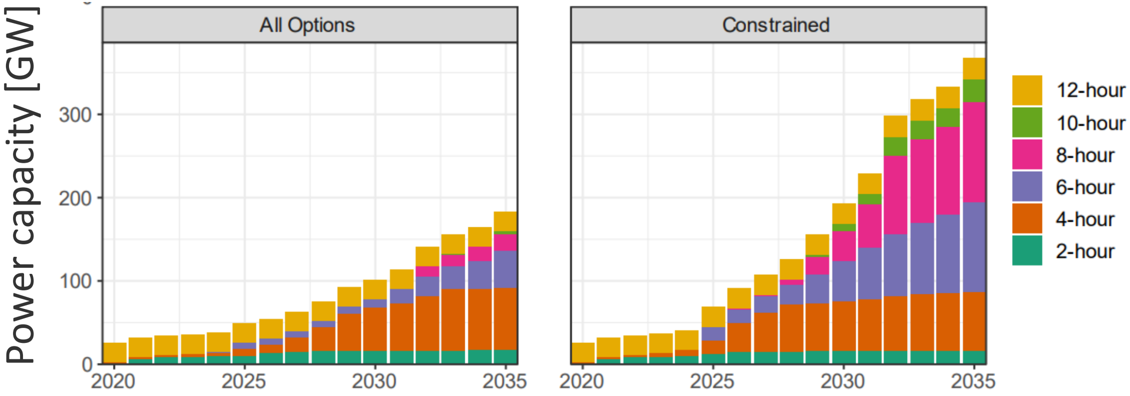
Two Trends in the Evolving Role of Energy Storage

1. Storage will play a prominent role in a decarbonized U.S. electricity supply
2. Hybrids comprise a large – and increasing – share of proposed projects



Rand et al. (2022), https://emp.lbl.gov/sites/default/files/queued_up_2021_04-13-2022.pdf



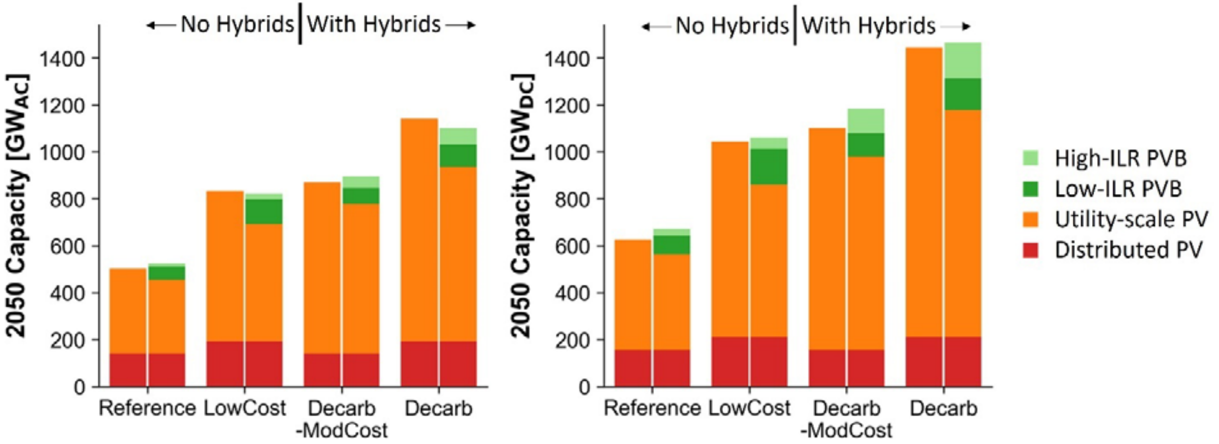


Denholm et al. (2022), https://www.nrel.gov/docs/fy22osti/81

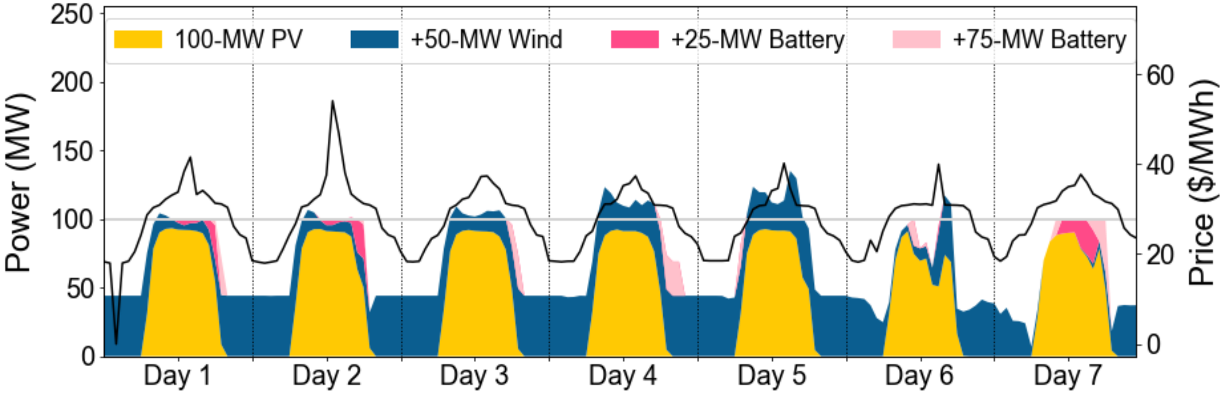
This Presentation: Economics and Impacts of Storage-Based Hybrids

Optimizing storage deployment and operations

Impacts of PV-Battery Hybrids in a Decarbonized U.S. Electricity Supply

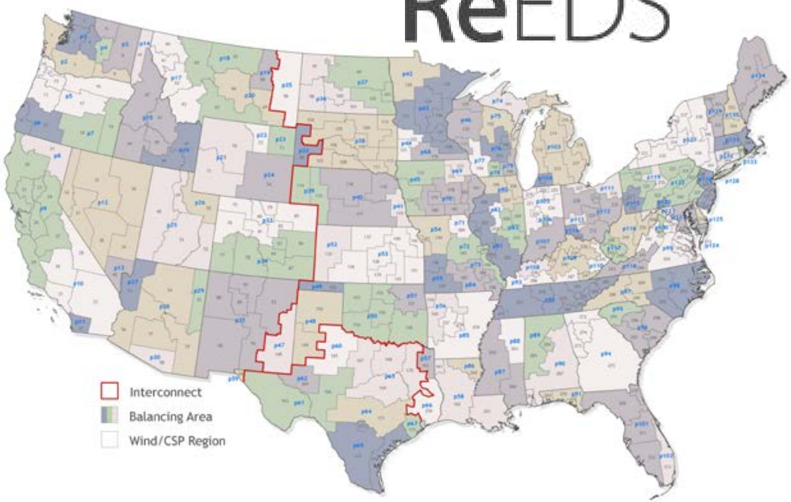


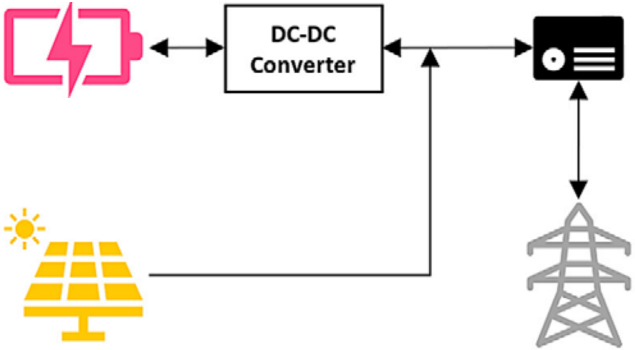
The Value of Storage as a Function of PV-Wind Variability



PV-Battery Representation in a Least-Cost Capacity Expansion Model

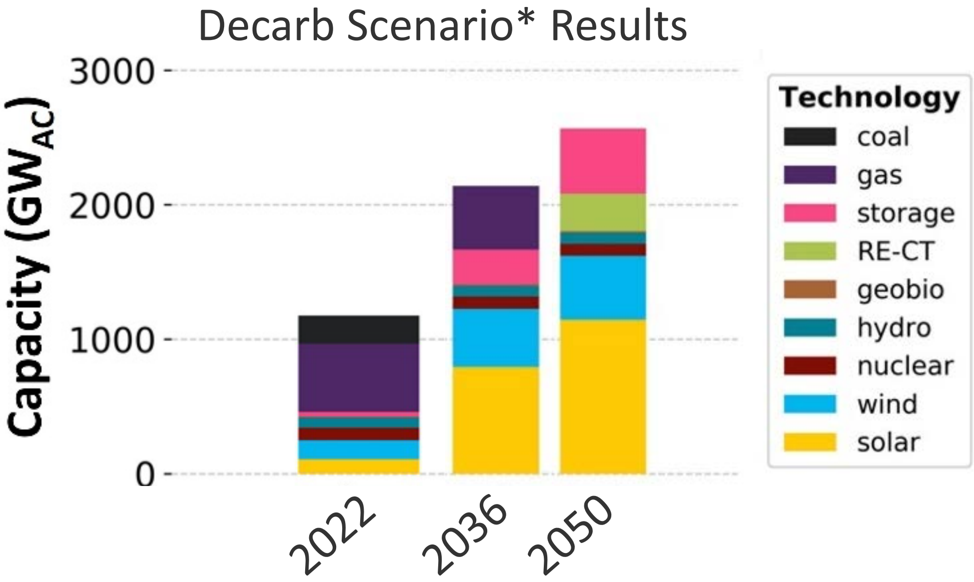
- Use explicit **time series profiles for the ILR-dependent amount of clipped energy** that can be recovered and used by the coupled battery;
- Represent the **shared costs associated with hybridization** (inverter and balance of system), so cost savings are design-dependent
- Assume the battery component in a PV-battery hybrid receives **100% of the ITC value**
- Capture **curtailment-reduction benefits** associated with charging batteries directly from renewable energy

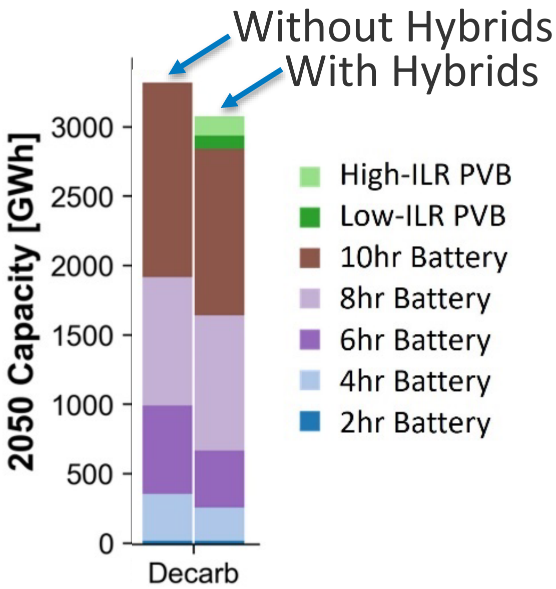




Murphy et al. (2022), https://www.nrel.gov/docs/fy22osti/82046.pdf

The Role of PV-Battery Hybrids in a Decarbonized U.S. Power System





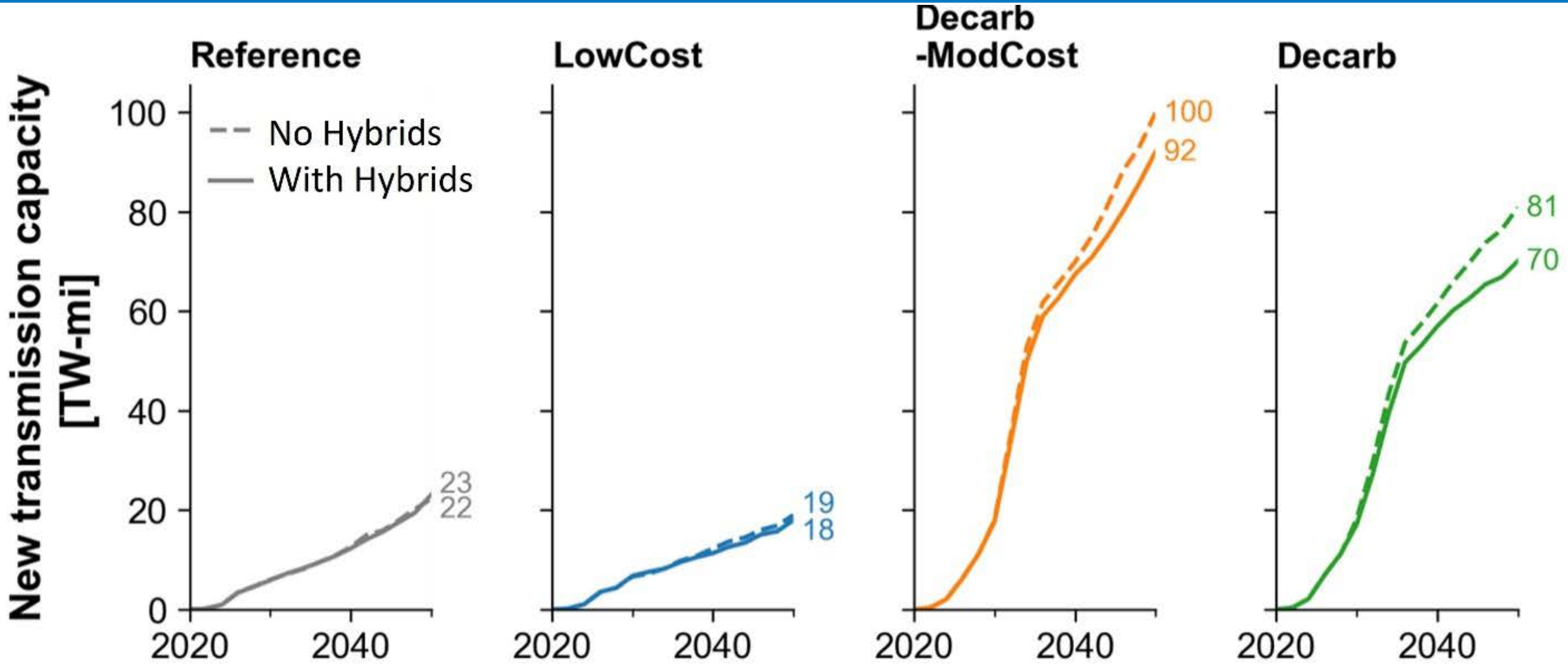
*Scenario definitions include:

- -Low-cost trajectories for PV and battery
- -95% decarbonization by 2035, 100% decarbonization by 2050
- -Business-as-usual electricity demand projections

Murphy et al. (2022), https://www.nrel.gov/docs/fy22osti/82046.pdf

Coupled (4hr) batteries largely displace standalone diurnal (4-6hr) storage

PV-Battery Hybrids Reduce Transmission Buildout and System Costs Associated with Power Sector Decarbonization



0.1% reduction in system costs

0.2% reduction in system costs

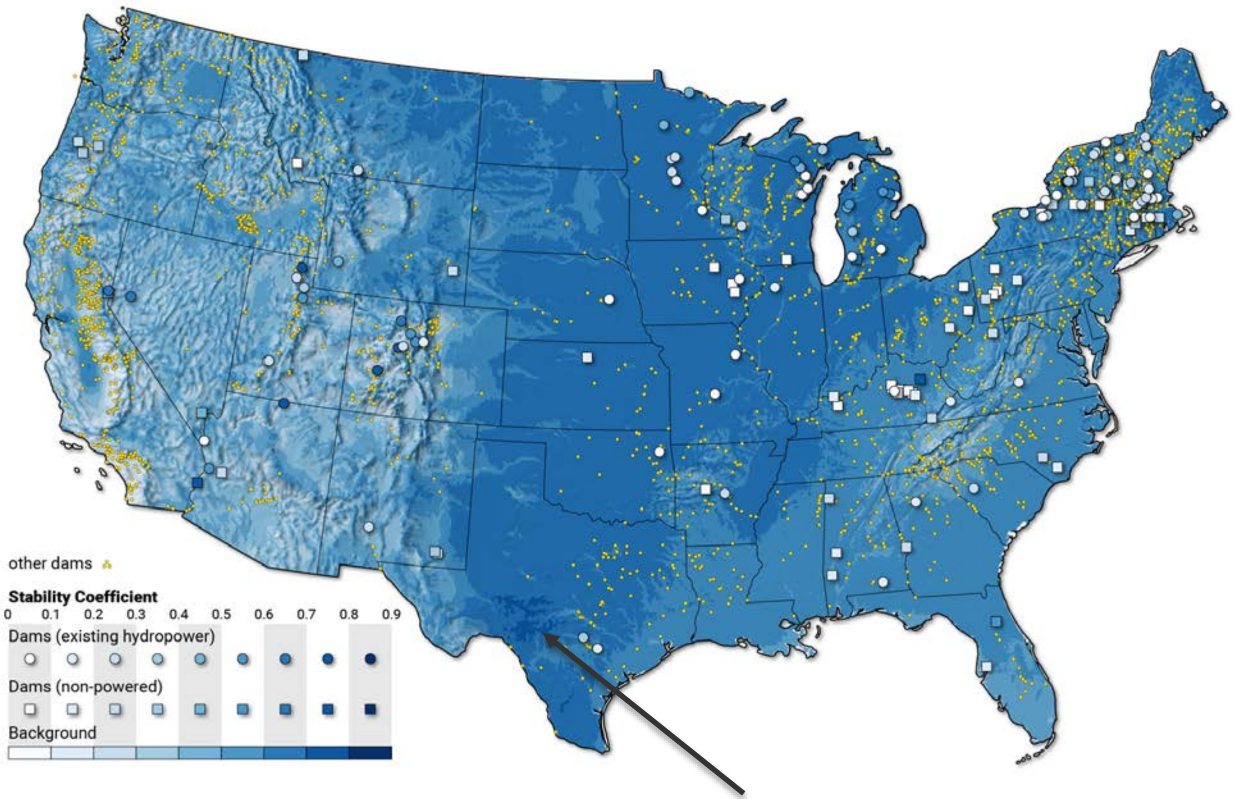
0.2% reduction in system costs

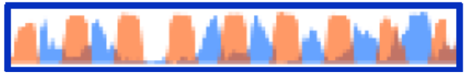
0.7% reduction in system costs

Murphy et al. (2022), https://www.nrel.gov/docs/fy22osti/82046.pdf

FlexPower: Wind-PV-Storage Hybrid Systems

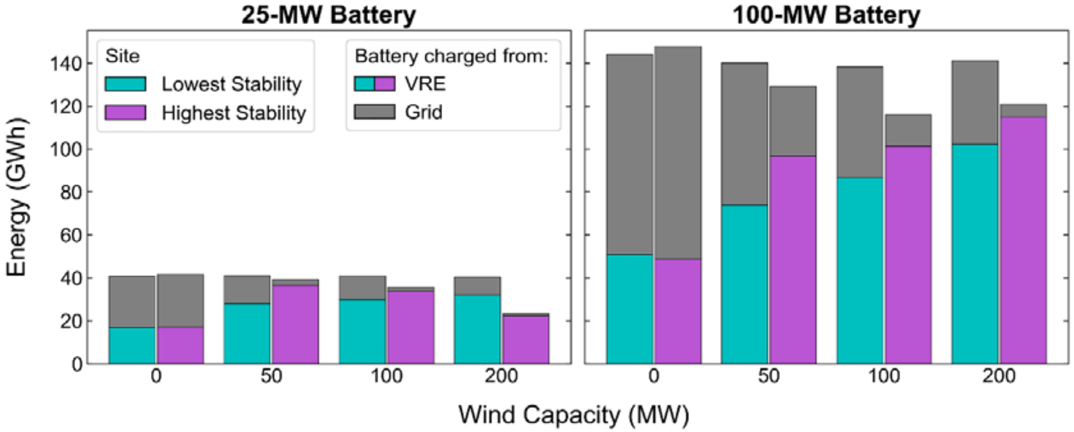
- Optimal storage sizing in a hybrid configuration depends on the variability of coupled generation source(s)
- Hybrid systems comprising **complementary wind-PV systems** can realize many benefits:
  - –Reduced variability
  - –Increased capacity factors
  - –Increased availability (capacity credit) and dispatchability
  - –Increased transmission utilization
  - –Provision of full set of reliability and resilience services



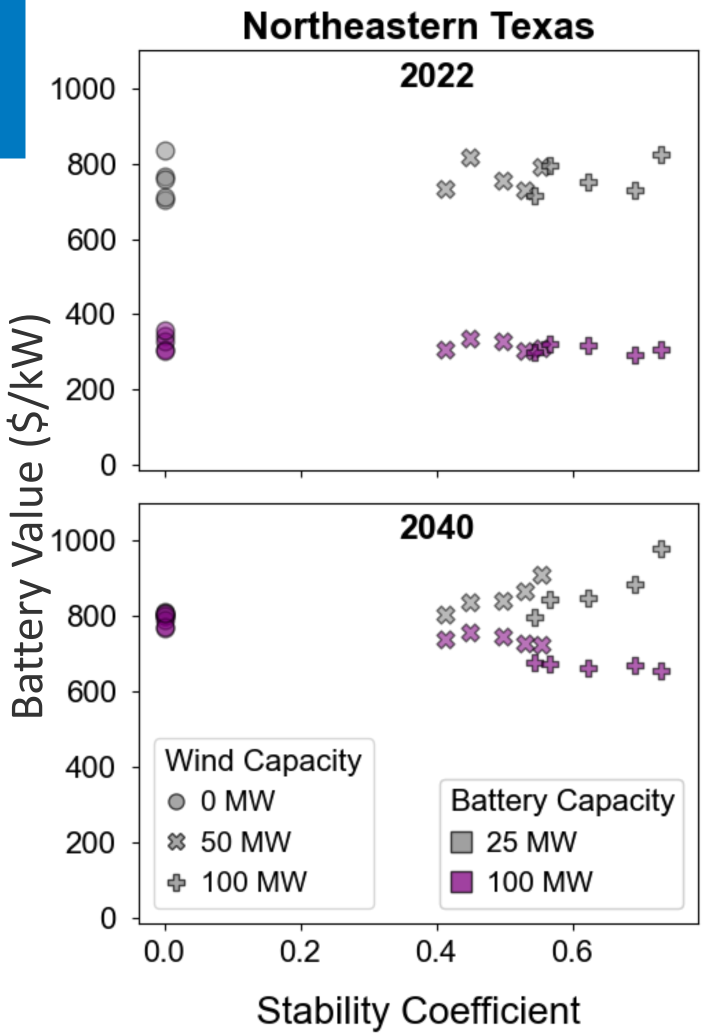


Harrison-Atlas et al., Renewable Energy, accepted

Wind-PV-Storage Hybrids



- In the near term, smaller batteries can provide comparable economic performance as larger batteries when coupled with complementary PV-wind systems
- Storage in a hybrid configuration charges primarily from coupled VRE resources (including clipped energy), and its utilization is reduced overall in regions with high complementarity



Schleifer et al., Frontiers in Energy Research, under review

Key Findings

- In the context of a decarbonized power system, PV-battery hybrids…
  - Influence the future mix of battery technologies
  - Reduce transmission buildout
  - Reduce system costs

- Optimal storage sizing in a hybrid configuration depends on the variability of the coupled generation source and the value of standalone VRE
  - In the near term, smaller batteries can provide comparable economic performance as larger batteries when coupled with complementary PV-wind systems
  - Storage in a hybrid configuration charges primarily from coupled VRE resources, and its utilization is reduced overall in regions with high complementarity
  - As the value of PV and wind approaches zero, larger batteries improve the economic performance of a hybrid power plant

Thank You

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