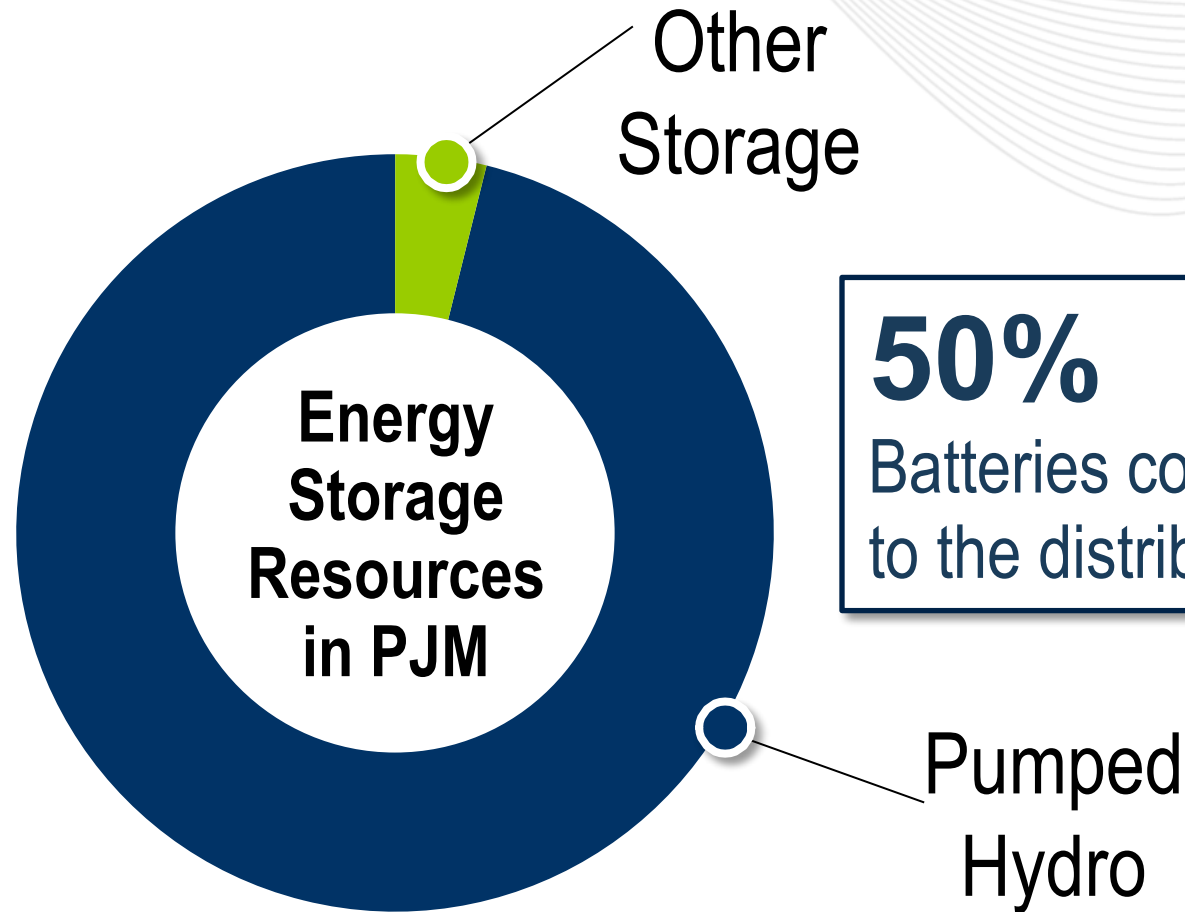




Energy Storage Resources: Opportunities in PJM Wholesale Markets

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Other storage is about ~300 MW of mostly batteries

50% Batteries connected to the distribution system

50% Connected to the Bulk Electric System

Pumped hydro currently participates in capacity, energy, regulation and reserves

Data taken from Generation Queue and EIA 860

Energy
Storage
Model



Effective
Load
Carrying
Capability



Battery
Hybrid
Resources

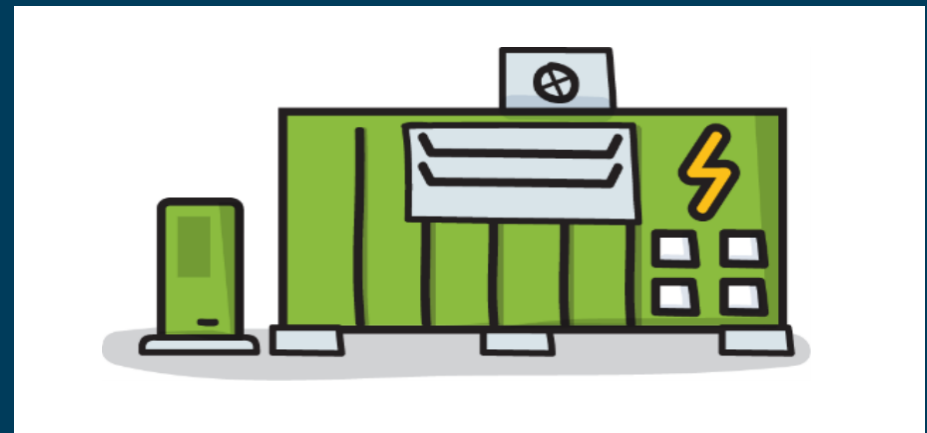
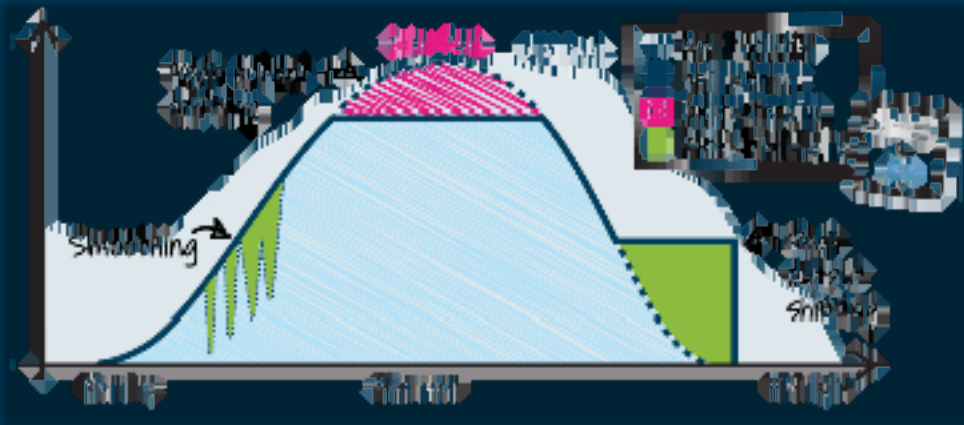


Regulation



~260 GW Total (nameplate)

Over 90% solar, wind, battery, hybrid



~40 GW
Hybrid resources



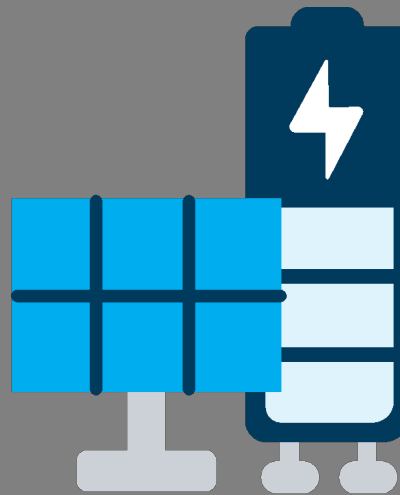
~54 GW
Stand-alone storage



Resource Adequacy (RASTF)



Regulation Re-design (RMDSTF)



DER Aggregation Model (Order 2222 – DISRS)



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Grid of the Future: PJM's Regional Planning Perspective

PJM Planning Division
May 10, 2022

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Energy Transition in PJM: Emerging Characteristics of a Decarbonizing Grid

May 17, 2022

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Energy Transition in PJM: Resource Retirements, Replacements & Risks

Feb 24, 2022



Focus Area No. 5

Energy Storage (4-hours) Enhances Operational Flexibility, but Seasonal Capacity and Energy Constraints Require Transmission Expansion, Long-Term Storage, and other Emerging Technology.

4-Hour Storage
6 GW Stand Alone
31 GW Solar Hybrid



Long-Term/Seasonal Storage



Emerging Technology



Regional Transmission Expansion

Short-Term
Operational
Flexibility

Long-Term
Operational
Flexibility

Essential
Reliability
Services

Capacity &
Seasonal Energy
Constraints

KEY INDICATORS

- Storage provides up to 80% synch-reserves and 30% of ramping requirements
- Congestion increased by 60%
- Renewable curtailment 16%