BESS – A Critical Grid Resource

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BESS Integrates Across the Grid – A Critical resource for reliability and resilience

Image created with AI support

Key Current Trends in Power Grid & Role of BESS

Trend	BESS Involvement	How BESS Contributes
Grid-scale + distributed storage growth	Direct	This trend is essentially the deployment of BESS (value stacking across services)
Inverter-based grid (IBR) operations	High	Fast voltage/frequency controls, ride-through, stability support via inverter controls
Grid-forming inverters (early deployments)	Very high	BESS is the most common near-term grid-forming resource; supports weak grids/islands
Electrification & Growth (HVAC, data centers, etc.)	Medium	Peak shaving and local capacity relief; does not replace need for new generation/transmission
Extreme weather + resilience investments	High	Microgrids/backup, resilience hubs, black start support; duration-limited for multi-day outages unless paired with LDES
ADMS adoption	Medium	Enables dispatch of utility/aggregated BESS for volt/VAR, congestion, peak reduction (needs telemetry/controls)
Distributed resource coordination (e.g., FERC 2222)	Very high	Batteries are highly dispatchable and fast; strong fit for aggregation and performance-based programs
Flexible demand / DR modernization	Medium	Complements DR by providing firm controllable response; DR can exist without BESS
Transmission expansion pressure + interconnection reform	Medium	Local congestion relief and some upgrade deferral; does not eliminate need for new transmission
Grid-enhancing technologies (GETs)	Low–Medium	BESS can relieve congestion but is not a GET in the narrow definition; complementary
Digital substations / IEC 61850	Low	BESS may connect at substations and benefit, but not a primary driver
Synchrophasors (PMUs) / wide-area monitoring	Low	PMUs can inform controls; BESS not central to PMU rollout
Cybersecurity focus	Medium	Adds OT/IT endpoints that must be secured
Rising power quality concerns	Medium–High	Inverter-based support for voltage regulation, flicker mitigation, sags/swells support
Protection system modernization	Medium	Inverter fault behavior drives protection updates; some BESS can provide grid-forming and fault current contribution depending on design
Market design evolution (fast ancillary services)	High	BESS is ideal for fast frequency and other ancillary services

Key Future Trends in Power Grid & Role of BESS

Trend	BESS Involvement	How BESS Contributes
Higher electrification + load growth	Medium–High	Peak management and deferral at constrained nodes
Firm long-duration resource scale-up	Mixed	Li-ion strong for daily (4–8h); LDES batteries (flow/metal-air, etc.)
Grid-forming becomes mainstream	Very high	BESS likely cornerstone for grid-forming, black start, and IBR-dominant stability
Hybrid plants / co-located resources	Very high	Improves interconnection utilization, shapes output, increases dispatchability/deliverability
Actively managed distribution (DERMS everywhere)	High	Dispatchable flexibility for feeder constraints, hosting capacity, volt/VAR, local reliability
Distribution flexibility / transactive energy markets	High	Batteries fit locational kW products (fast, measurable, controllable)
Advanced forecasting + AI operations	Medium	Better scheduling/dispatch and degradation-aware optimization
Self-healing grids (automation, switching)	Low–Medium	Can keep islands/critical sections energized during reconfiguration
Probabilistic, risk-based planning	Medium	BESS capacity value depends on duration/net load; degradation/availability
GETs scale broadly	Low–Medium	Like today: can relieve congestion but not substitute for sustained transfer capability
HVDC growth (multi-terminal/offshore)	Low	BESS may support terminals/offshore integration, but HVDC growth is not driven by BESS
Interoperability standards deepen	Medium	Important for safe integration/aggregation of BESS fleets (DERMS)
Digital twins at grid scale	Medium	BESS states/constraints are important to model
Condition-based asset management	Medium	BESS heavily uses cell/thermal/State of health monitoring
Undergrounding / covered conductor for wildfire	Low	BESS doesn’t reduce ignition risk directly (future BESS will have reduced fire risk) and help to provide resilience
Protection & stability in low-fault-current grids	High	Grid-forming BESS can improve stability; protection adapts to inverter characteristics
Power electronics everywhere (FACTS, smart transformers)	Medium	BESS is part of broader power-electronics ecosystem; coordinated control increasingly common
Cyber-physical resilience as a design requirement	Medium	BESS improves operational resilience (backup/islanding) and needs to be secure-by-design
Customer-centric reliability / resilience-as-a-service	High	Behind-the-meter BESS, community storage, and microgrids are core enablers
Rate design + regulation evolution	High	Dynamic prices raise value and BESS is an effective resource for energy modulation

Energy Storage for Rural Resilience (FY 24 – FY 26)

APPA
- City of Lompoc's Electric Division - CA
- Kansas Power Pool Energy - KS
- Southern Minnesota Municipal Power Agency - MN
- Town of Stowe Electric Department - VT
- Delaware Municipal Electric Corporation - DE

NRECA
- Georgia Transmission Corporation - GA
- Tipmont Rural Electric Membership Corporation - IN
- Wayne - White Counties Electric Cooperative - IL
- Cuivre River Electric Cooperative - MO
- Powder River Energy Corporation - WY

Other Efforts
- Grant PUD - WA
- Farmers' Conservation Alliance (FCA) – OR (supports multiple irrigation districts across CONUS)
- BESS Test Systems and Model development
- Evaluation of Data Centers and BESS Role including affordability aspects

"On behalf of the American Public Power Association and our members, I would like to extend our heartfelt gratitude for your exceptional work on energy storage. The utilities have found immense value in the partnership with the lab, particularly appreciating the lab's ability to meet each of them where they are on their energy storage journey. This personalized approach has been incredibly important and beneficial." - SVP Grid Security, Technical & Operations, APPA

- Provided technical assistance to multiple rural utilities on techno-economic analysis to enable increased deployment of BESS in the rural regions.
- The use cases of BESS were very diverse. The report is in final stage and provides the detailed methodology enabling other rural utilities to apply the methods to their systems and use cases.

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Thank you

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