

BESS 101



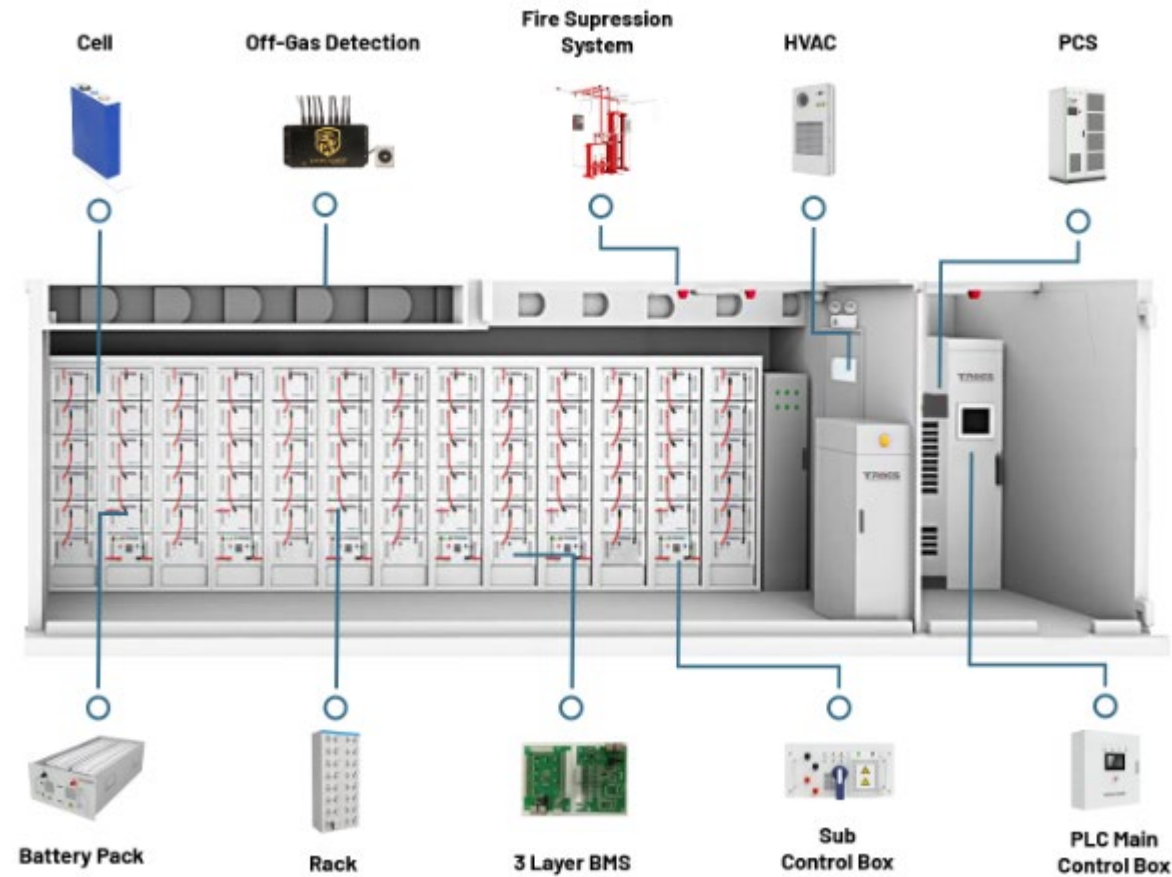
Becca Gillespie

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BESS parts of a whole

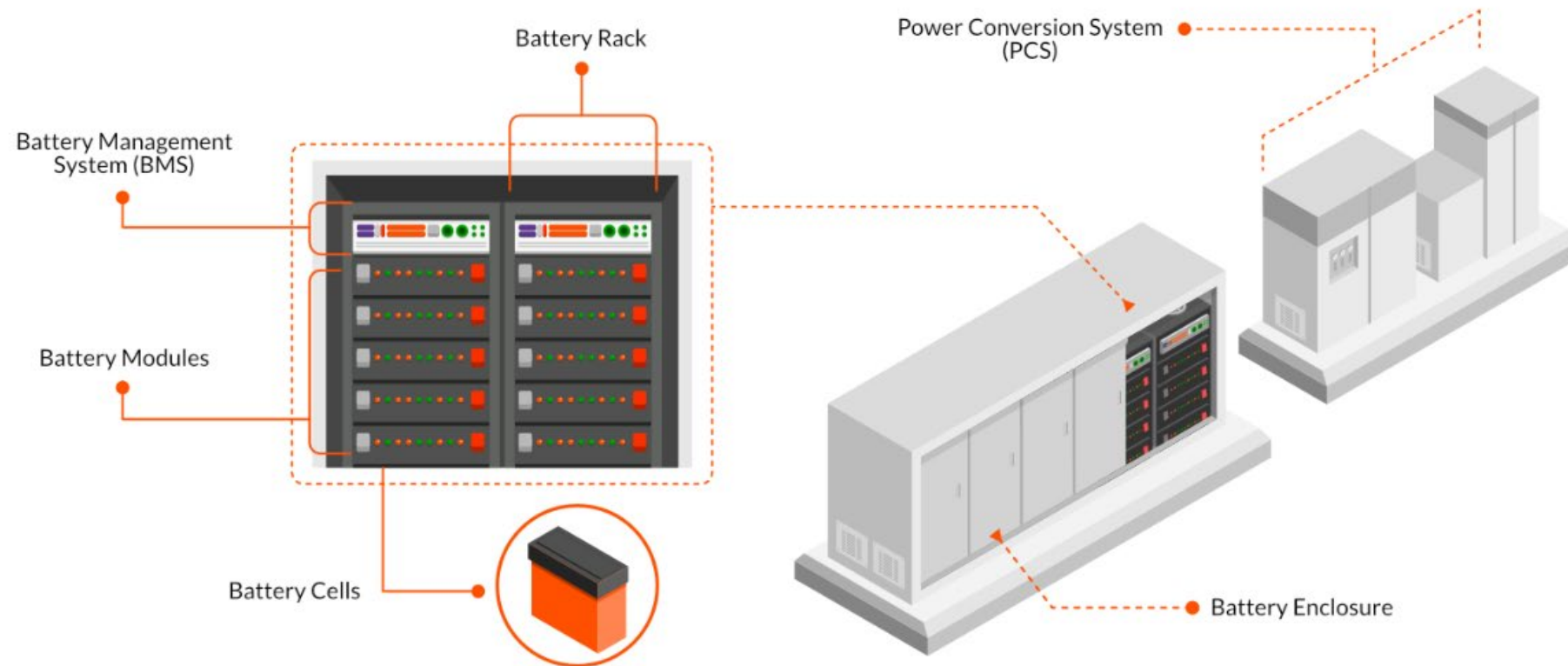


BESS: Parts of a Whole



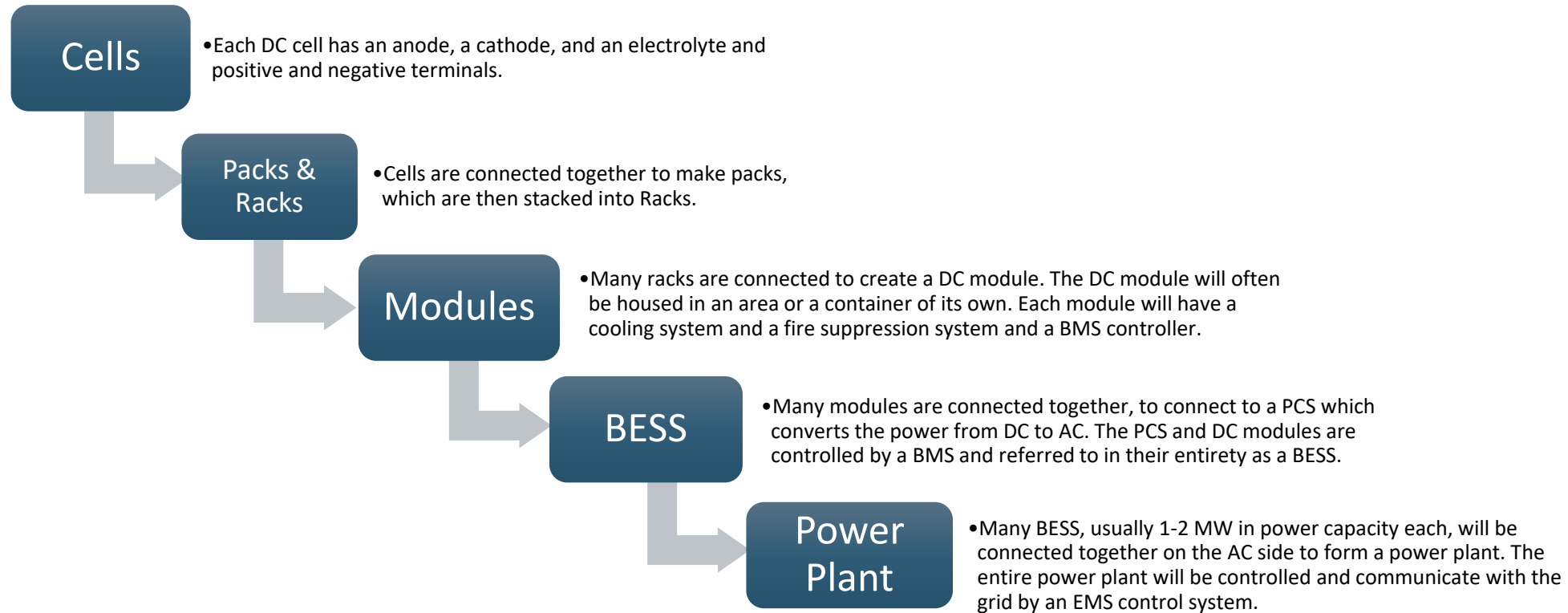
Source: TROES Corp. What is a BESS. <https://troescorp.com/what-is-battery-energy-storage//>

BESS: Parts of a Whole 2

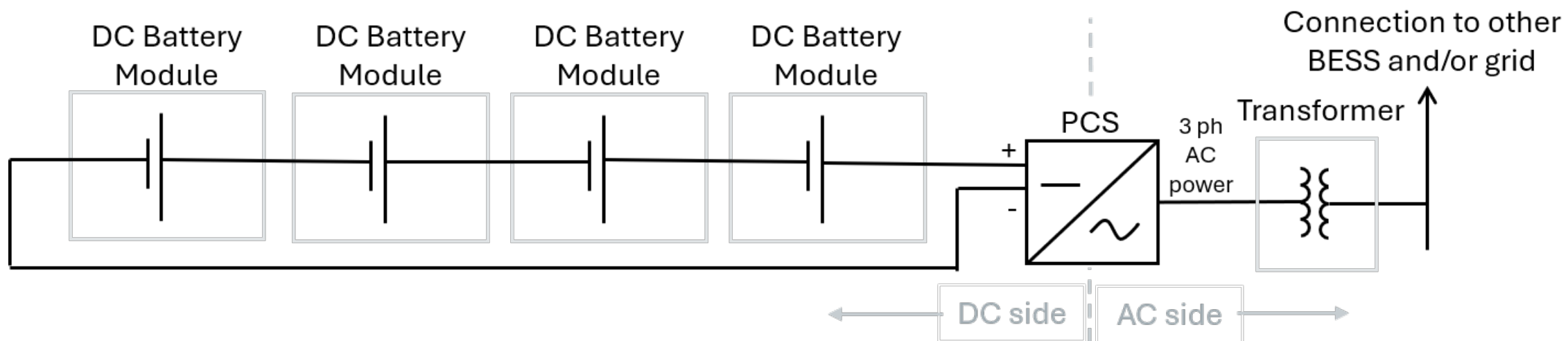


Source: Lightbridge. BESS 101. <https://lightsourcebp.com/us/energy-solutions/energy-storage-systems/bess-101/>

BESS: Parts of a Whole, buildup

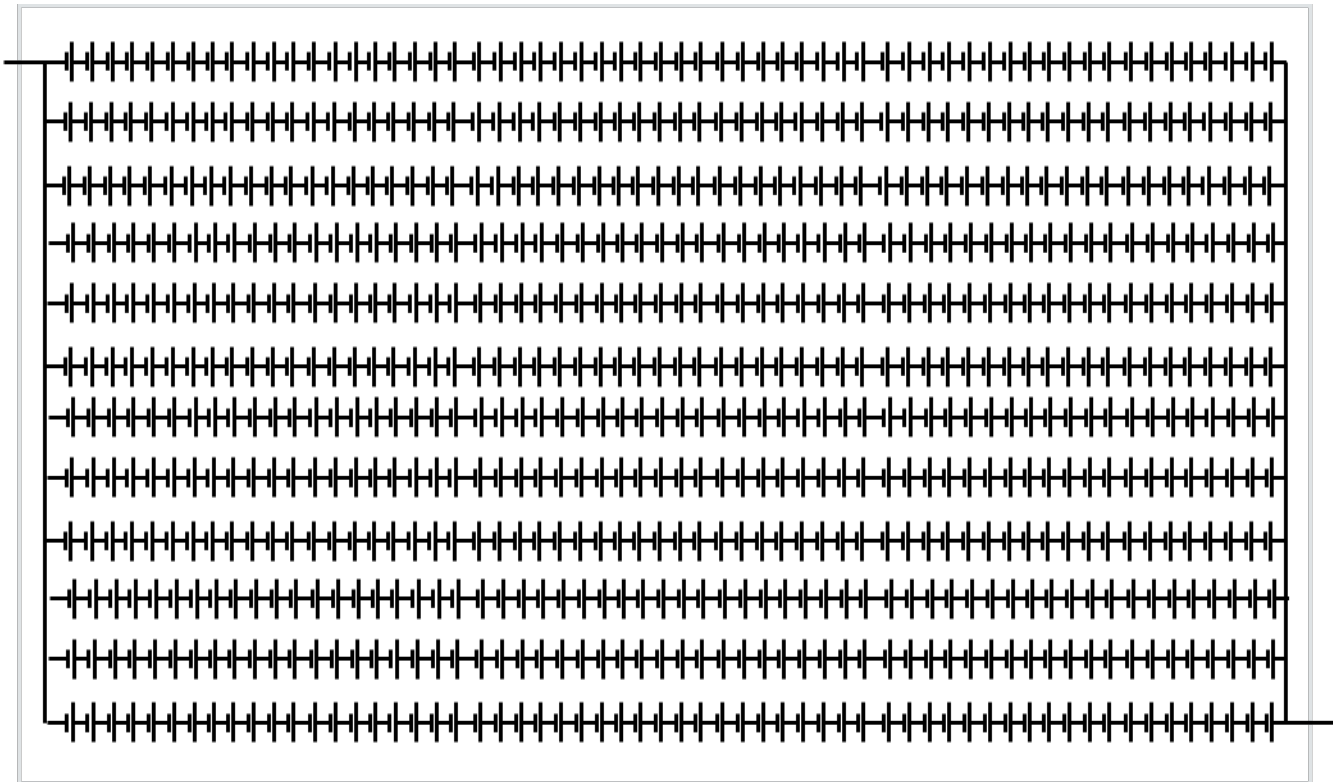


Example Electrical Connection: Modules to BESS



Example Electrical Connection: Cells to Module

DC Battery Module



A typical LFP prismatic cell:

- Voltage 3.2 V Nominal [2.5-3.65V]
- 314 Ah (1 kWh)

Example: CATL DC module:

- 1,331 V [1040-1500 V]
 - About 415 cells in series
- 5.64 MWh
 - About 5,640 cells in total
- About 13-14 DC Strings

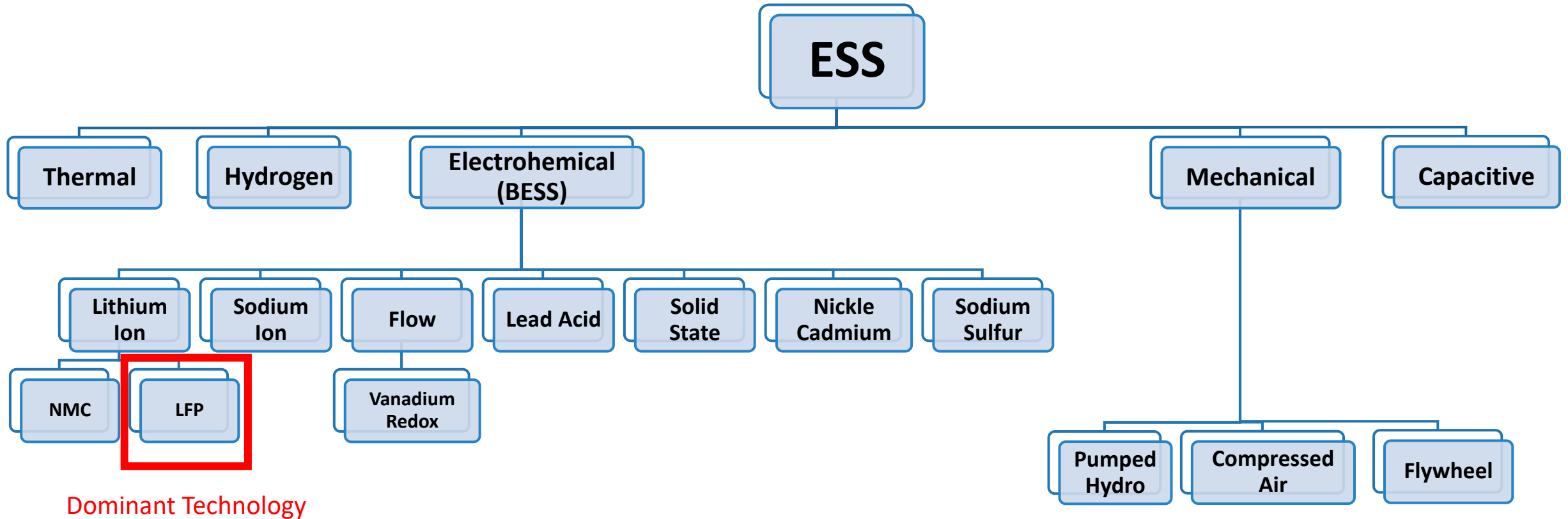
BESS Specifications





- Type and Chemistry
- Core, Functional Specifications:
 - Power (MW)
 - Energy (MWh)
 - Duration (hr)
- Integrator, manufacturer
- Other Technical Specifications
 - Auxiliary Power
 - Round Trip Efficiency
 - Module Size
- Land use requirements
- Standards: UL, ANSI, ASHRAE, IEEE

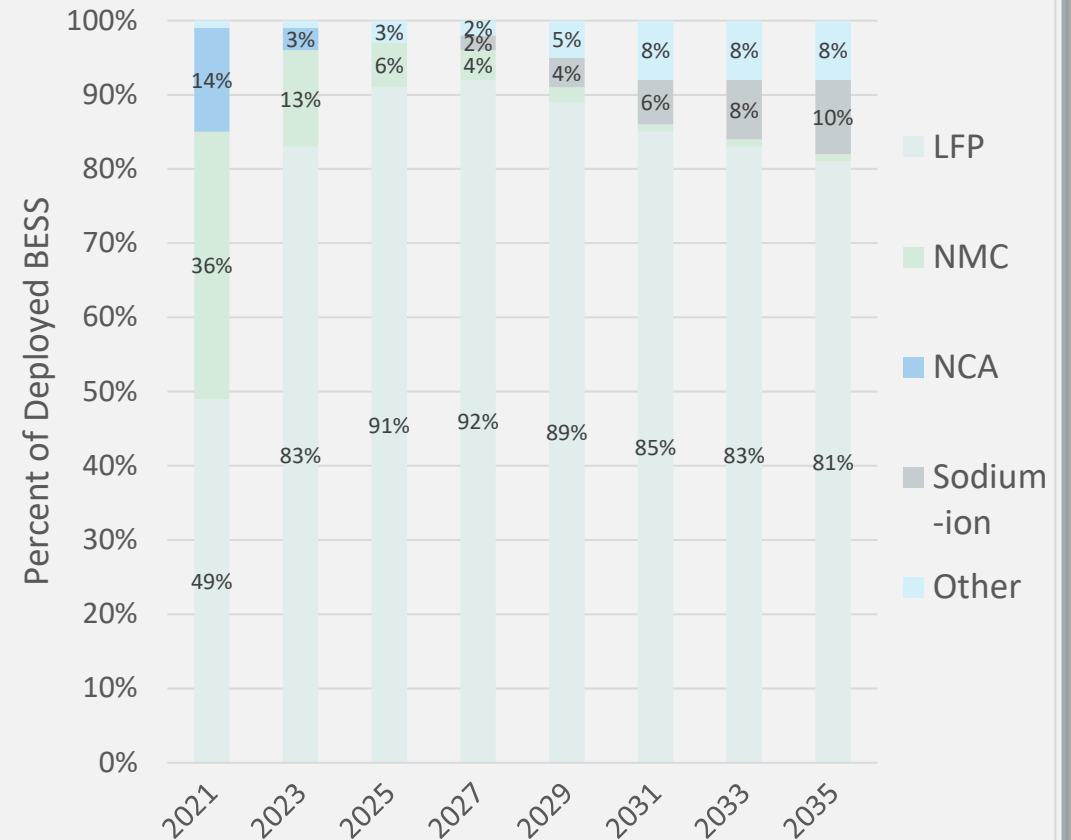
BESS Specification: Type/Chemistry



BESS Technologies, by deployment

- **Lithium Iron Phosphate (LFP):**
 - Dominant Tech for 2024 BESS deployments (~90%)
 - Also ~30% of EV batteries
 - Considered safer and has better cycle life.
 - 46% Less expensive than NMC in 2024
- **Lithium Nickel Manganese Cobalt (NMC):**
 - Best choice for long range EVs due to higher energy density.
 - 72% of global EV batteries in 2023 were NMC
 - In 2023 in the US 93% of EVs use NMC, 92% are high nickel NMC.
- **Sodium-Ion**
 - Negligible market share in 2024, expected to grow in future years.
 - Forecasted to have lower costs once manufactured at scale.
 - 3 Gigafactories in China announced in 2024-2025
 - U.S. Gigafactory announced Aug 2024 in SC (Natron)
- **Other, LDES**
 - Growth predicted in out years is not broken down by technology.

Stationary Storage Technology, 2021-2035

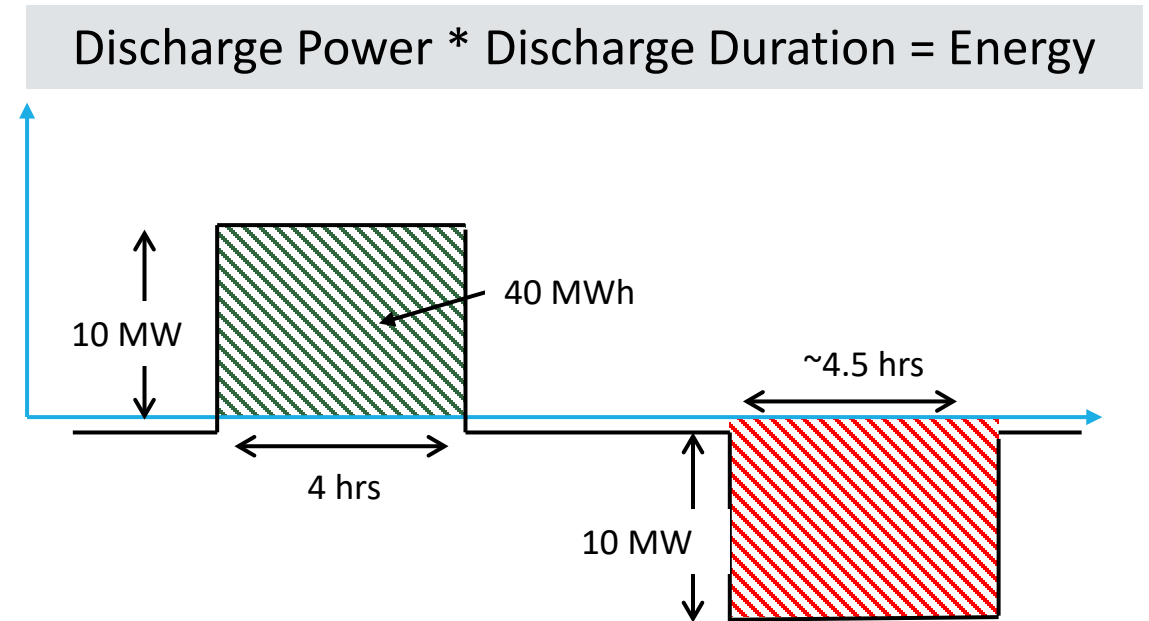


Source: Bloomberg New Energy Finance, Energy Storage Market Outlook 2H 2025

BESS Specifications: Functional Specifications

- Core, Functional Specifications:

- Power (MW)
- Energy (MWh)
- Duration (hr)

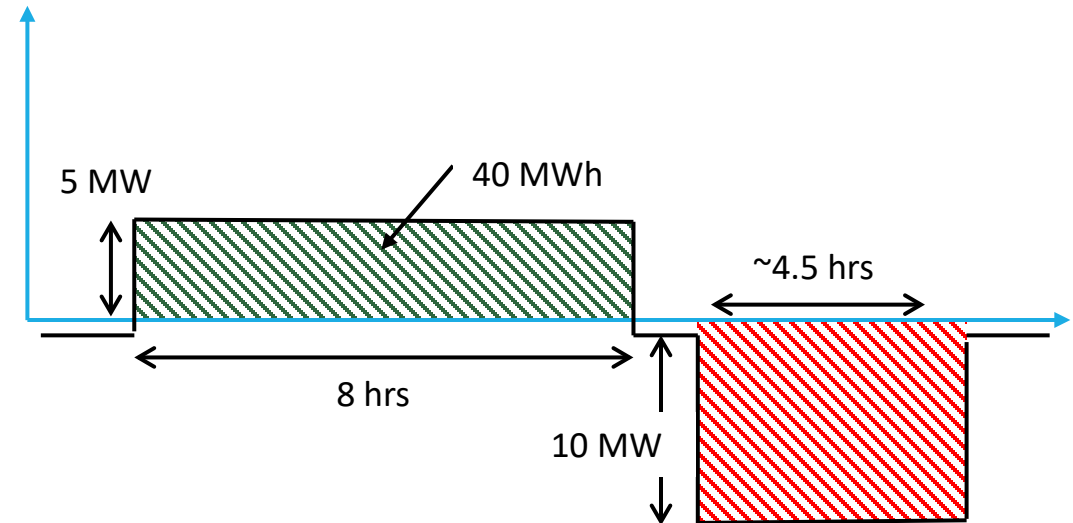


BESS Specifications: Functional Specifications 2

- Core, Functional Specifications:

- Power (MW)
- Energy (MWh)
- Duration (hr)

Discharge Power * Discharge Duration = Energy



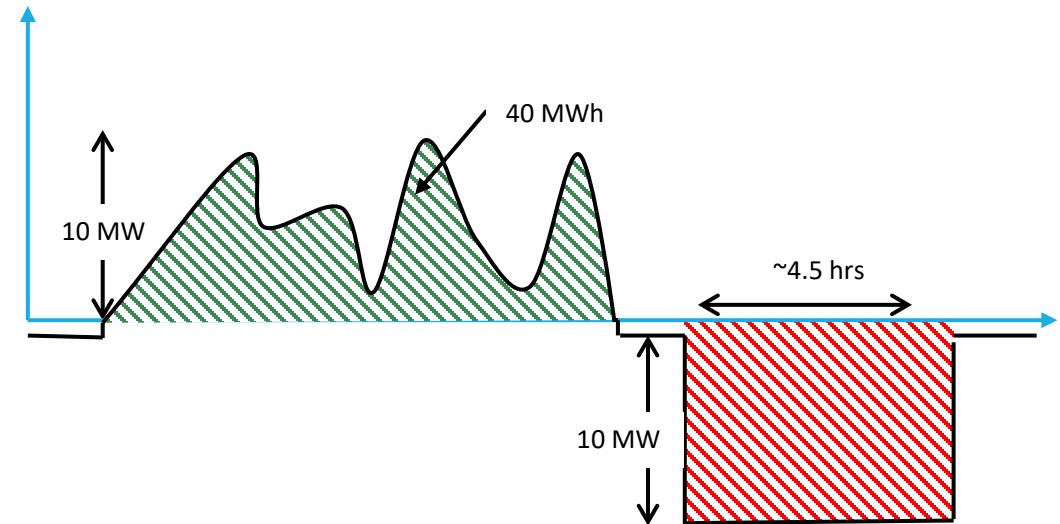
It its capable of 10 MW, people will still call this battery a “4-hour” system

BESS Specifications: Functional Specifications 3

- Core, Functional Specifications:

- Power (MW)
- Energy (MWh)
- Duration (hr)

Discharge Power * Discharge Duration = Energy



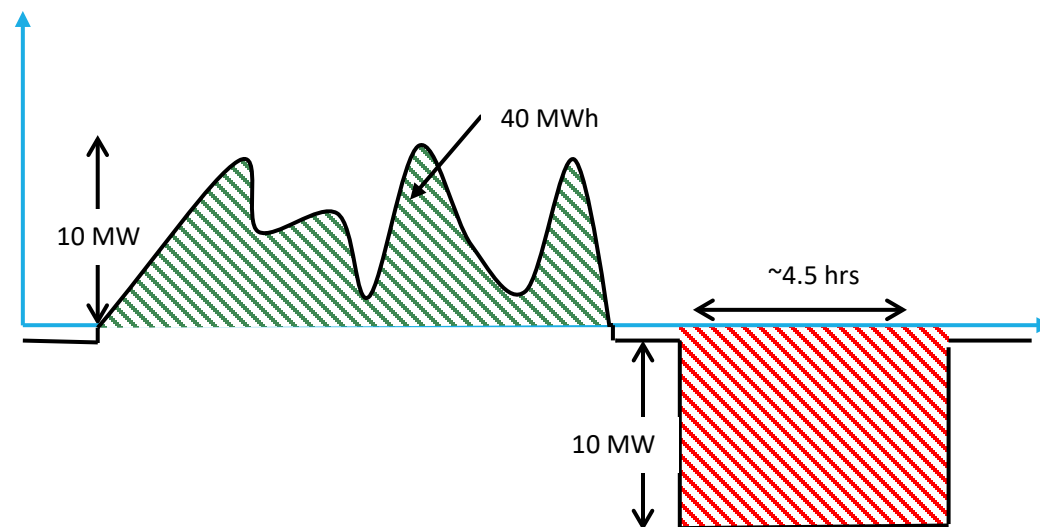
BESS Specifications: Functional Specifications 4

- Core, Functional Specifications:

- Power (MW)
- Energy (MWh)
- Duration (hr)

Discharge Power * Discharge Duration = Energy

Land use, hazard size, cost are mostly driven by Energy (MWh)



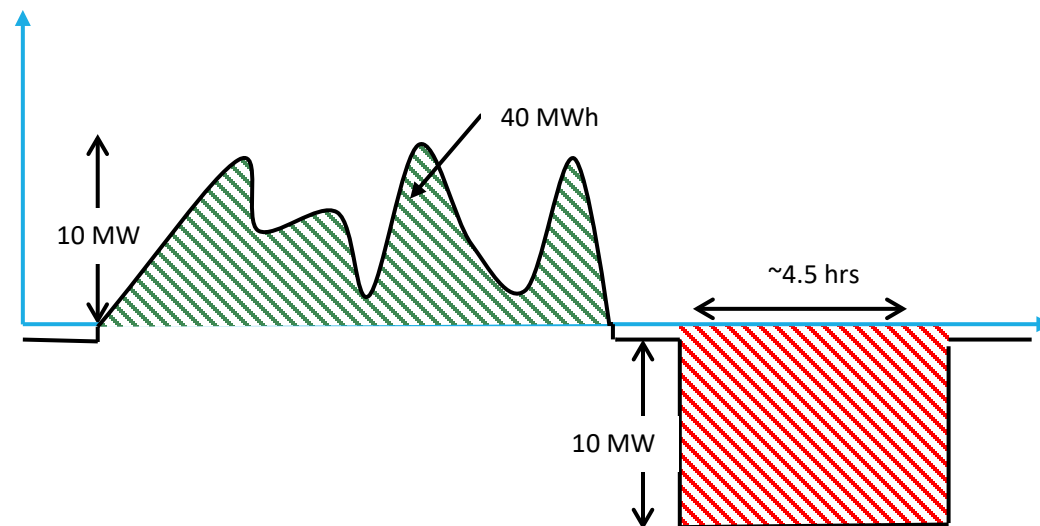
BESS Specifications: Functional Specifications 5

- Core, Functional Specifications:

- Power (MW)
- Energy (MWh)
- Duration (hr)

Discharge Power * Discharge Duration = Energy

Other power plants are measured in MW. Size of transformer, PCS, interconnection and capacity value measured in MW



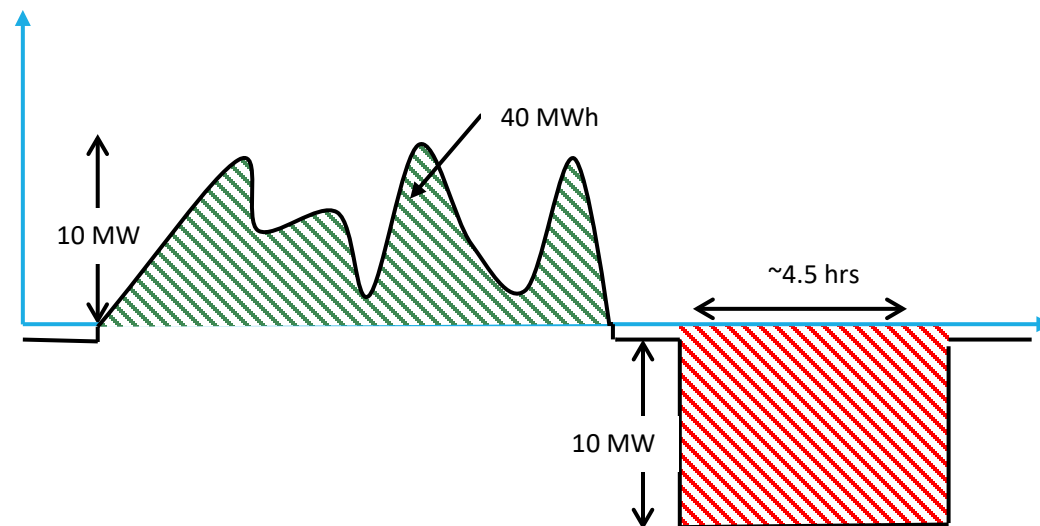
BESS Specifications: Functional Specifications 6

- Core, Functional Specifications:

- Power (MW)
- Energy (MWh)
- Duration (hr)

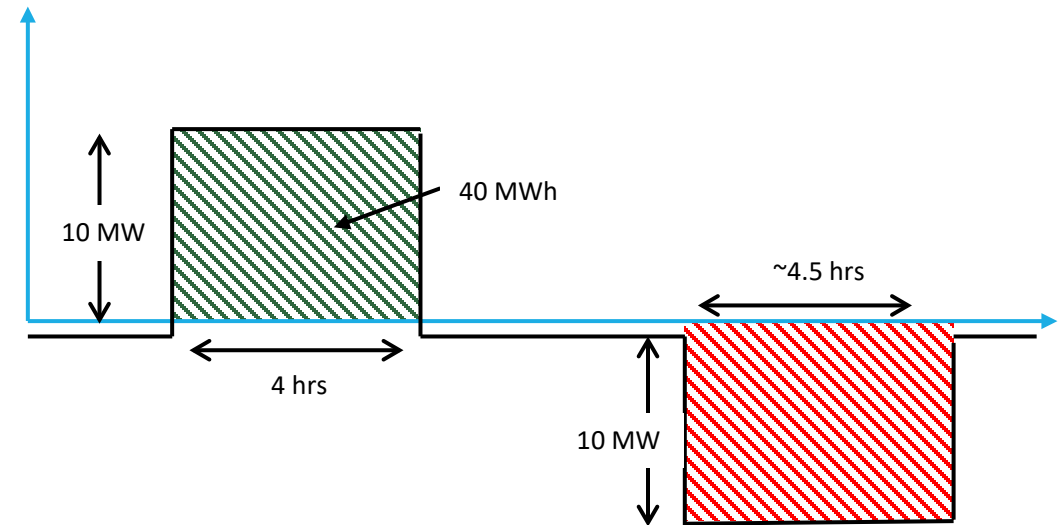
Discharge Power * Discharge Duration = Energy

The word “capacity” is vague:
MISO, Utility or FERC – It probably means power
BESS Manufacturer – It probably means energy
?? – Could mean duration for end users

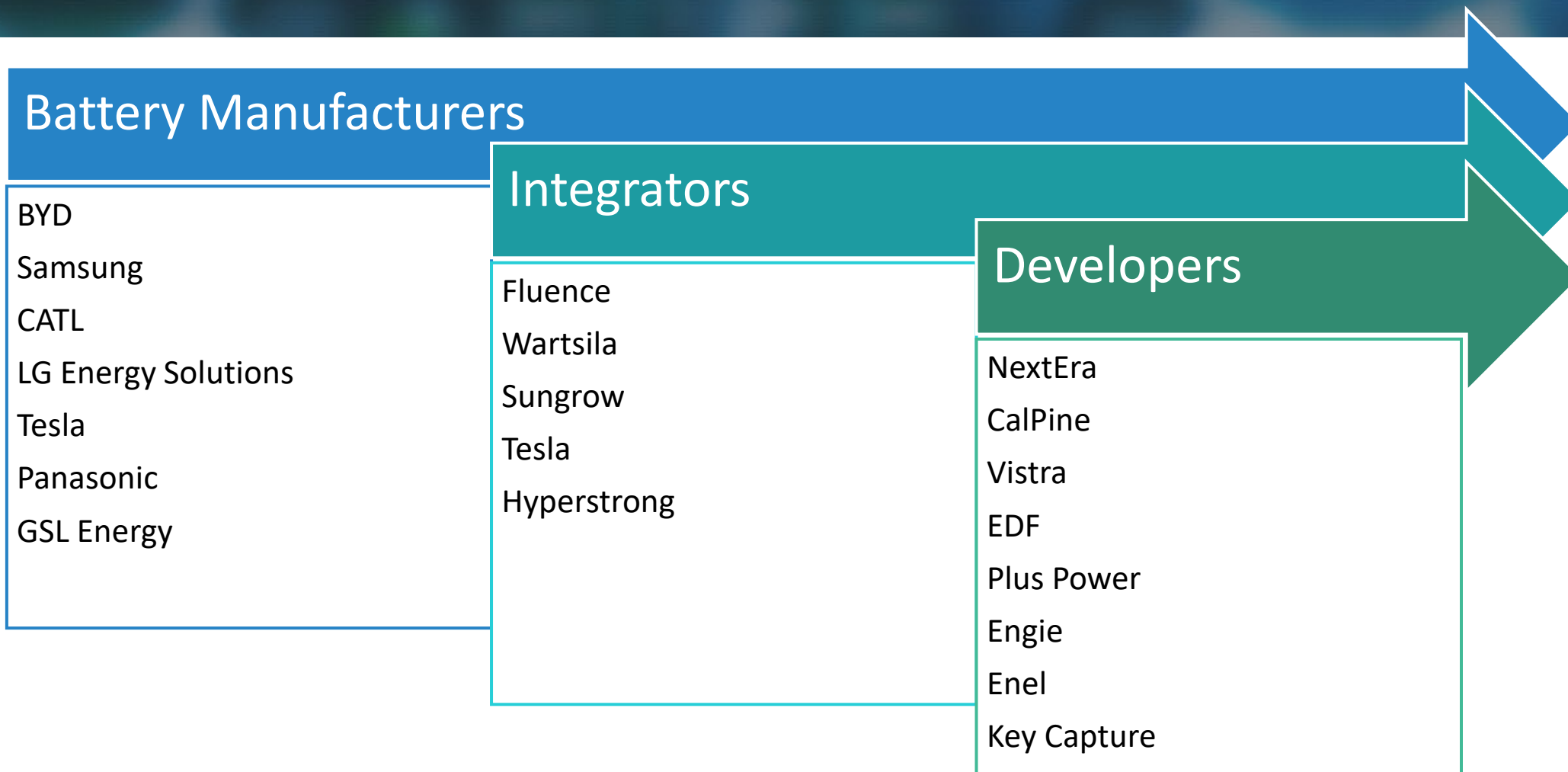


BESS Specifications: More to learn before writing an RFP

- Power and Energy Specifications
 - DC power and DC Energy
 - AC Power and AC Energy
 - AC net aux
- Energy Specifications
 - Useable range
- Round Trip Efficiency
 - DC, AC and including aux versions
- Degradation/Augmentation
 - Calendar Life
 - Cycle Life



BESS Specification: Integrator and Manufacturer



Integrators: <https://www.spglobal.com/energy/en/research-analytics/the-five-largest-battery-energy-storage-system-bess-integrator> Developers: <https://cleanview.co/content/top-battery-developers>

BESS Specification: Standards Compliance

BESS Component	National Codes
Interconnection	IEEE 1547, IEEE 2800
Installation Overall	NFPA 70, NFPA 855 , IFC, UL 9540, IEEE C2
Fire/Gas Detection	IFC, NFPA 72, NFPA 855
Fire Explosion Detection	IFC, NFPA 13, NFPA 15, NFPA 68, NFPA 69, NFPA 855
Battery Rack	UL 9540A
Power Conversion System	UL 1741
Cell battery	UL 1642, UL 1973, UL 9540A
Communications, BMS	UL 1741, UL 9540, CSA/ANSI C22.2 No. 340, IEEE 2686, IEEE 2688

Indiana Office of Energy Development. Battery Planning: Siting and Other Considerations. <https://www.in.gov/oed/files/BESS-Handout-Siting-website.pdf>

BESS Specification: NFPA 855 compliance

- **Hazard Analysis**
Evaluate thermal runaway, fire propagation, explosion potential, and toxic gas release before installation.
- **Fire Protection Systems**
Require smoke/fire detection, automatic suppression, ventilation, and measures to limit cascading battery failures.
- **Separation Distances**
Maintain minimum spacing between ESS units, buildings, exits, and property lines to reduce fire spread risk.
- **System Listing & Fire Testing**
ESS equipment must be evaluated using standards such as UL 9540 and UL 9540A to validate overall system safety, fire behavior, and thermal runaway performance.
- **Emergency Response Features**
Include emergency shutdowns, warning signage, responder access pathways, and documented emergency procedures.
- **Monitoring & Controls**
Use Battery Management Systems (BMS), fault detection, alarms, and continuous monitoring to identify unsafe conditions early.
- **Key Resource: EPRI Energy Storage Integration Council (ESIC)**
Storage Safety, First Responder Engagement, Decommissioning and Recycling, Commissioning Guide, Test Manual

NFPA 855.

BESS Specification: Land Use Requirements

- No need for water access, gas pipeline access or highway access
- Siting priority is typically
 - Community Acceptance/Permitting
 - Interconnection Cost
- Land use is 0.03-0.1 acres per MW
 - Heavily influenced by setback requirements
 - Lower than other Power plants
- Other Considerations:
 - Fencing, appearance, setbacks
 - Space for BESS Augmentation
 - Grid infrastructure, or interconnection ROW

20 MW/45.6MWh LFP BESS in Erie County, NY (2023)



Image Credit: Key Capture Energy

Fenced area with BESS: ½ acre
Entire Site: 10 acres

Mills, S. & Krol, M. (2024). Planning & Zoning for Battery Energy Storage Systems. University of Michigan, Graham Sustainability Institute <https://graham.umich.edu/media/files/BESS-guide.pdf>

Energy Market Signals



Broad energy market trends are driving BESS adoption

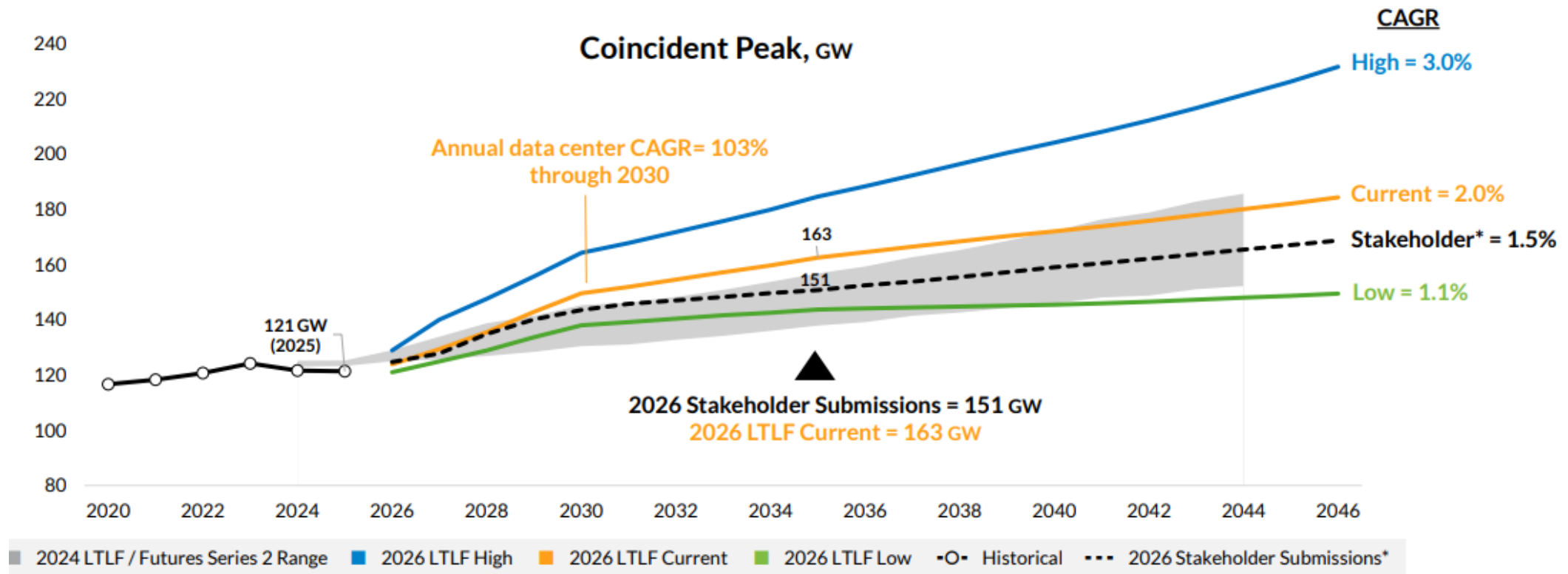
Indiana is part of MISO, a wholesale electricity market

- Long term: Capacity market
 - Ability to “be there” for the grid
 - Most utilities bring their own capacity in MISO (or use long term bilateral contracts to secure their capacity), and don’t trade on the market
- Medium Term: Day-ahead Market
 - Buy and sell energy and ancillary services.
- Short Term: Real-time market
 - Same products at day-ahead market
 - Accounts for real-time events
- Build, plan, and manage the transmission System.

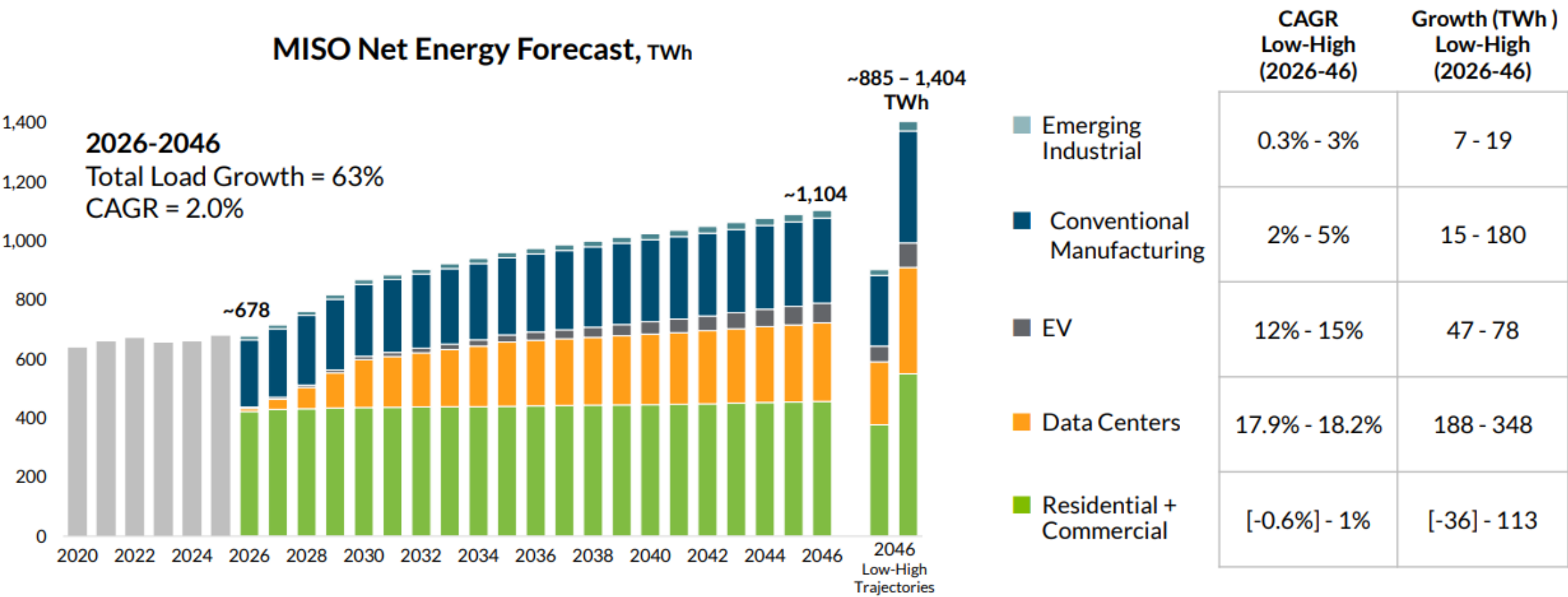


Demand for Electricity is Rising

MISO’s 2026 long term load forecast aligned with the 2024 “high” forecast.



Demand for Electricity is driven by data centers

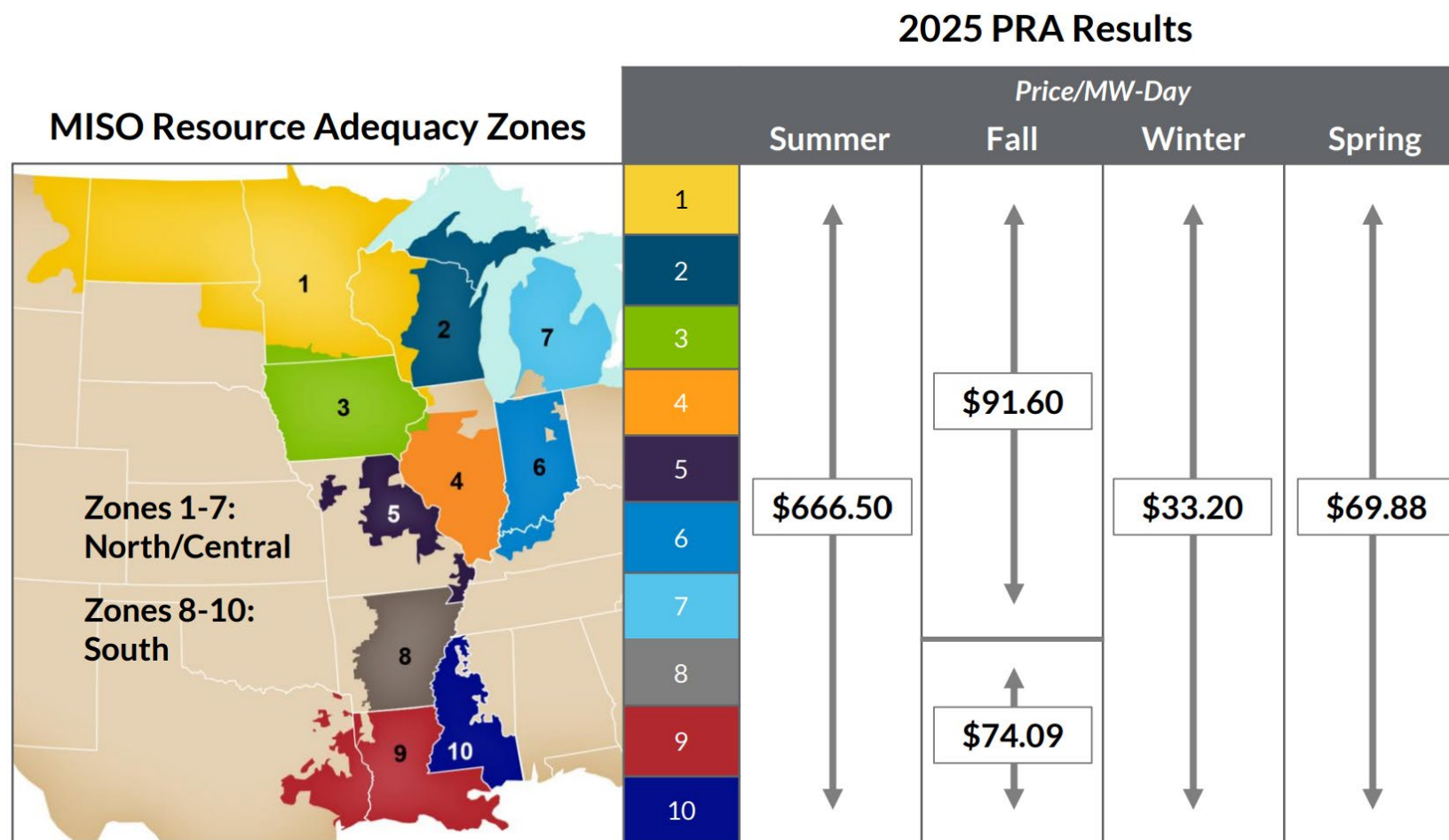


Generation mix is shifting toward intermittent renewables

MISO Projected Energy Mix by Resource Type (TWh)



Capacity prices, in particular, are increasing



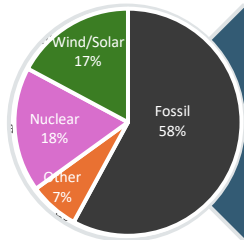
BESS Value Proposition



Value of BESS to Indiana's Grid



Demand for electricity is up, while legacy power plants are retiring.



Intermittent renewables are a large and growing part of the generation mix.



BESS is a low-cost, quick-to-deploy capacity asset, competitive with gas

1: 1.6% CAGR Growth Rate is expected growth rate system wide in MISO according to MISO long term Load Forecast. December 2024

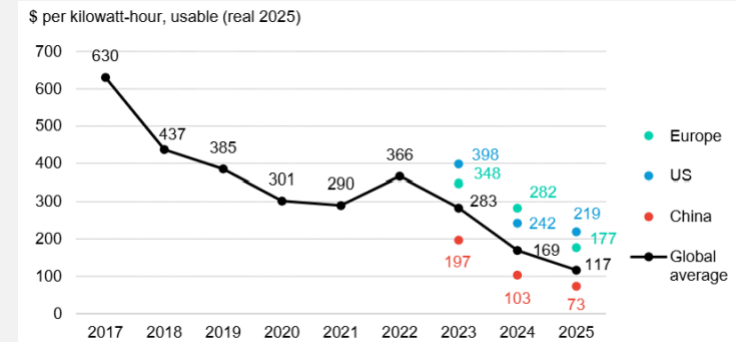
2: Shown in generation mix nationwide in 2025 according to EIA generator reporting, with wind and solar (intermittent renewables) up from 0% a decade ago.

Cost of BESS

Despite Tariffs, Prices are competitive for BESS

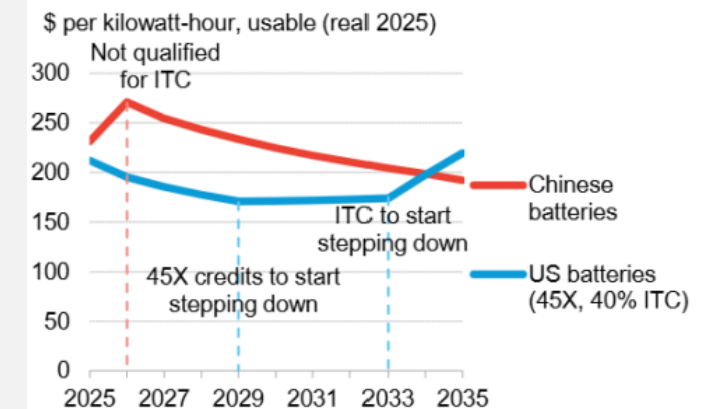
- Turnkey BESS prices fell 9% in 2025 to \$219/kWh (US) even after tariffs.
 - \$219/kWh translates to \$876/kW for a 4-hour system, well below \$1,600/kW benchmark for natural gas combustion turbine.
- OBBBA retained investment tax credits (ITC) for BESS through 2033
 - Worth 30-50% total cost of development.
- Besides cost, BESS has other competitive factors:
 - A relatively low community impact: no pipeline construction, low land use requirements
 - A relatively short schedule: 2-3 yrs to develop and construct versus 3-5 yrs for a new gas plant
- BESS may therefore be selected in a utility IRP or “all-source RFP” over gas.

Turnkey BESS Prices, Historical



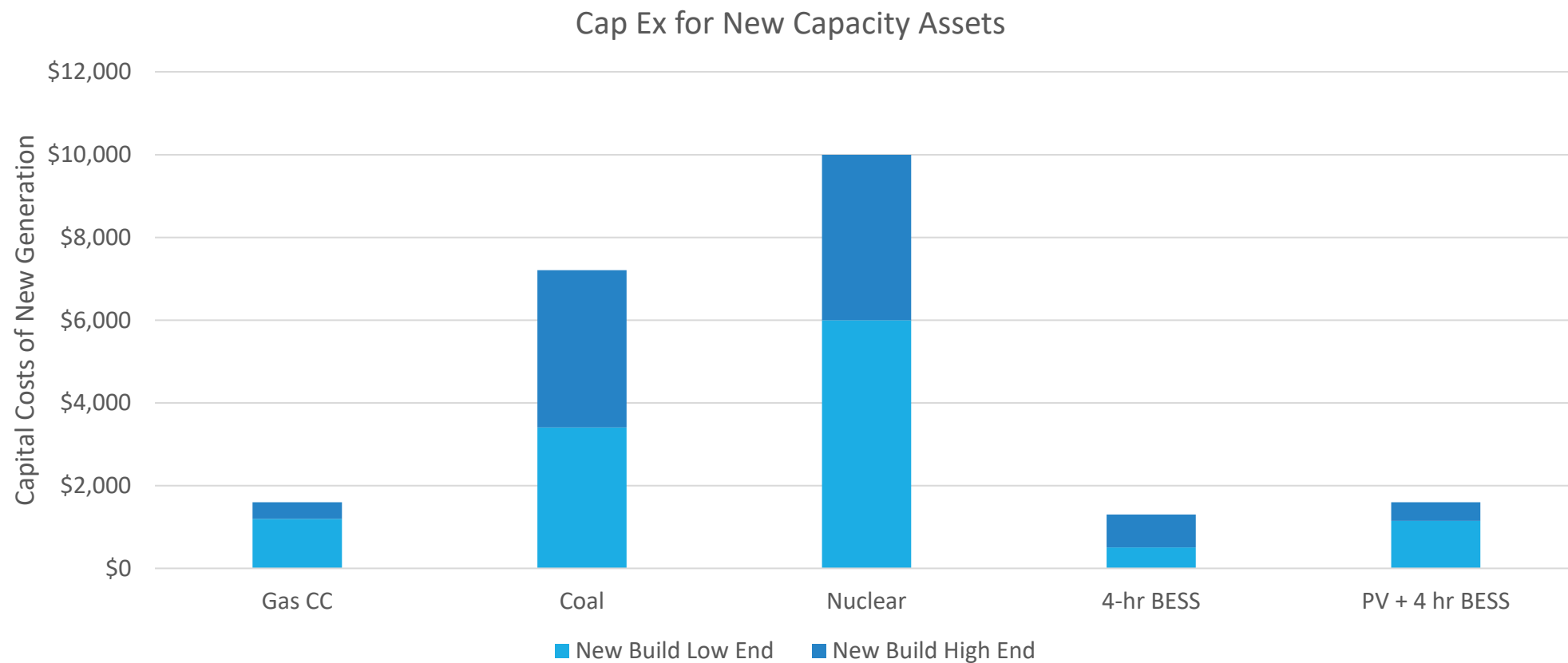
Source: Bloomberg New Energy Finance, Energy Storage System Cost Survey 2025

Turnkey BESS Prices 4-hr, Outlook



Source: Bloomberg New Energy Finance, Energy Storage System Cost Survey 2025

BESS is the lowest cost for of firm capacity



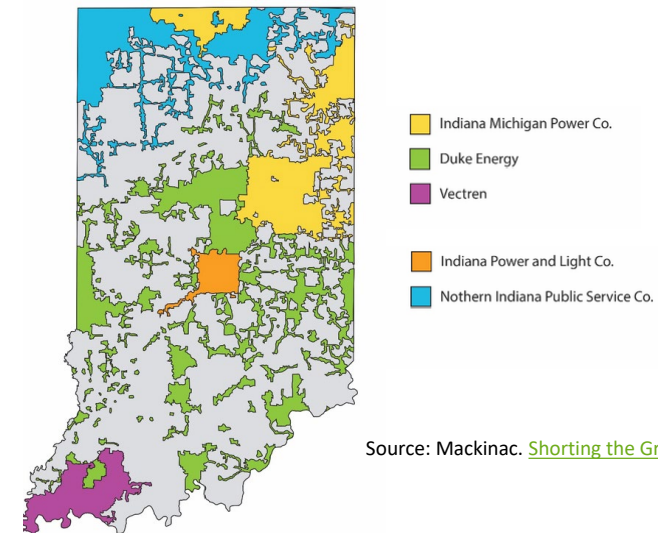
Lazard LCOE+ Assumptions were used to build up CapEx for Gas, Coal and BESS and Nuclear is based on DOE LPO study

Value of BESS: Key Applications

- In Front of the Meter Value
 - Utility Internal Calculations
 - Wholesale Market Participation
 - Bilateral Contracts – Long and short term



Indiana IOU's



Source: Mackinac, [Shorting the Great Lakes Electric Grid](#)

Value of BESS

BESS has a variety of applications: two key ones are capacity and arbitrage

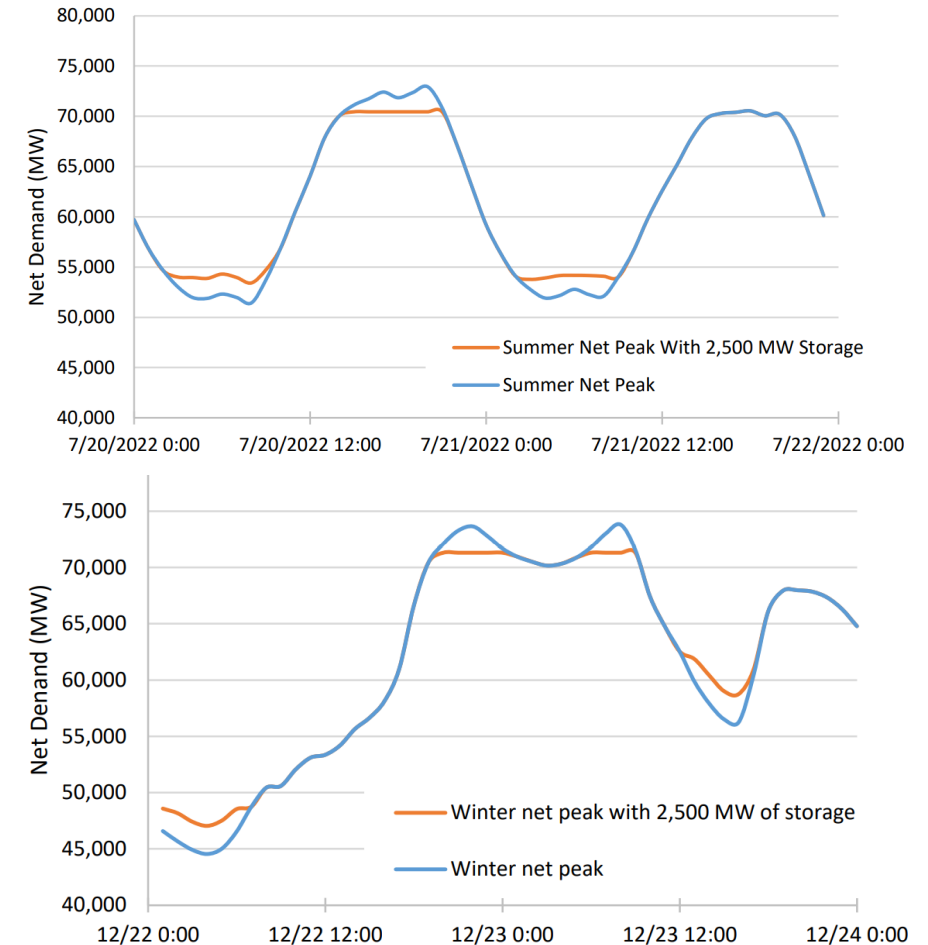
- Capacity

- Value associated with reliability, promising to show up when needed
- Measured in \$/kW-day, \$/kW-year, etc
- Growing load peaks and power plant retirements are tightening this market
- Today, 4 hours is still “enough” to meet peaks

- Energy Arbitrage

- Buying Energy during overproduction, or other low-cost hours
- Discharging energy during high-cost hours
- Possibly finally becoming valuable

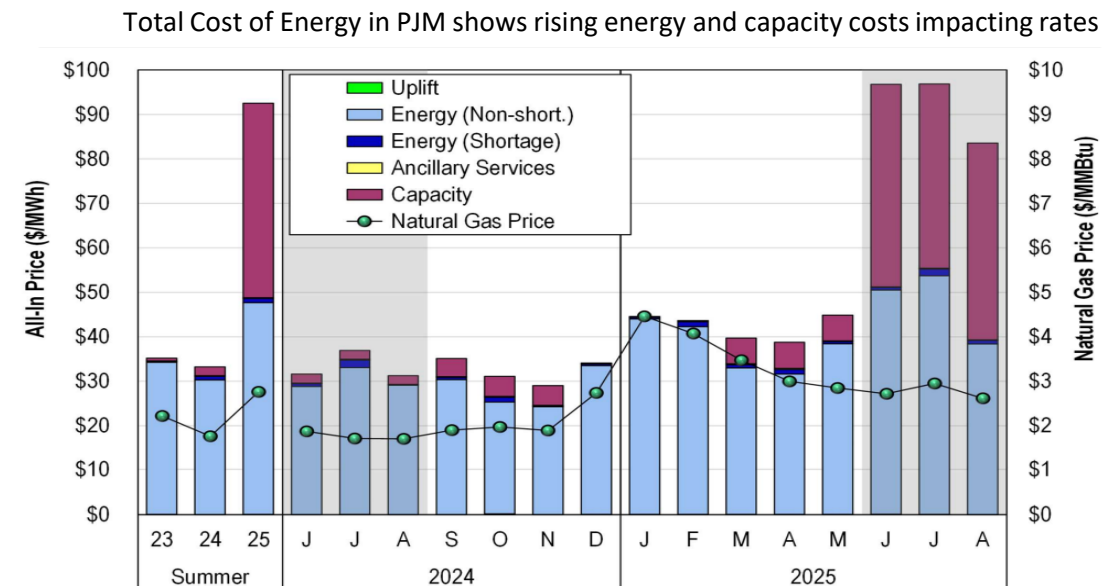
Effect of 2,500 MW of BESS in ERCOT



Value of BESS: Key Applications Capacity

- In Front of the Meter: Capacity
 - Value associated with reliability, promising to show up when needed
 - Measured in \$/kW-day, \$/kW-year, etc
 - Growing load peaks and power plant retirements are tightening this market
 - Today, 4 hours is still “enough” to meet peaks

MISO all-in-price Summer 2023-2025



MISO IMM Quarterly Report Summer 2025, Sept 16 2025, Potomac Economics

Value of BESS: Key Applications Arbitrage

- In Front of the Meter: Energy Arbitrage
 - Buying Energy during overproduction, or other low cost hours
 - Discharging energy during high-cost hours
 - Possibly finally becoming valuable

Indiana Hub 4-hour real-time spreads averaged **\$444/MW-day**, up 104% year over year

Average tolling battery spread at Indiana Hub by duration, February 2026 (\$/MW-day)

TB Spread	DA (\$/MW-day)	DA YoY	RT (\$/MW-day)	RT YoY
1-hour	\$60	+23%	\$180	+59%
2-hour	\$107	+29%	\$316	+98%
4-hour	\$179	+32%	\$444	+104%

Source: MISO, Modo Energy

MODOENERGY

Source: <https://modoenergy.com/research/en/miso-february-2026-monthly-benchmark>