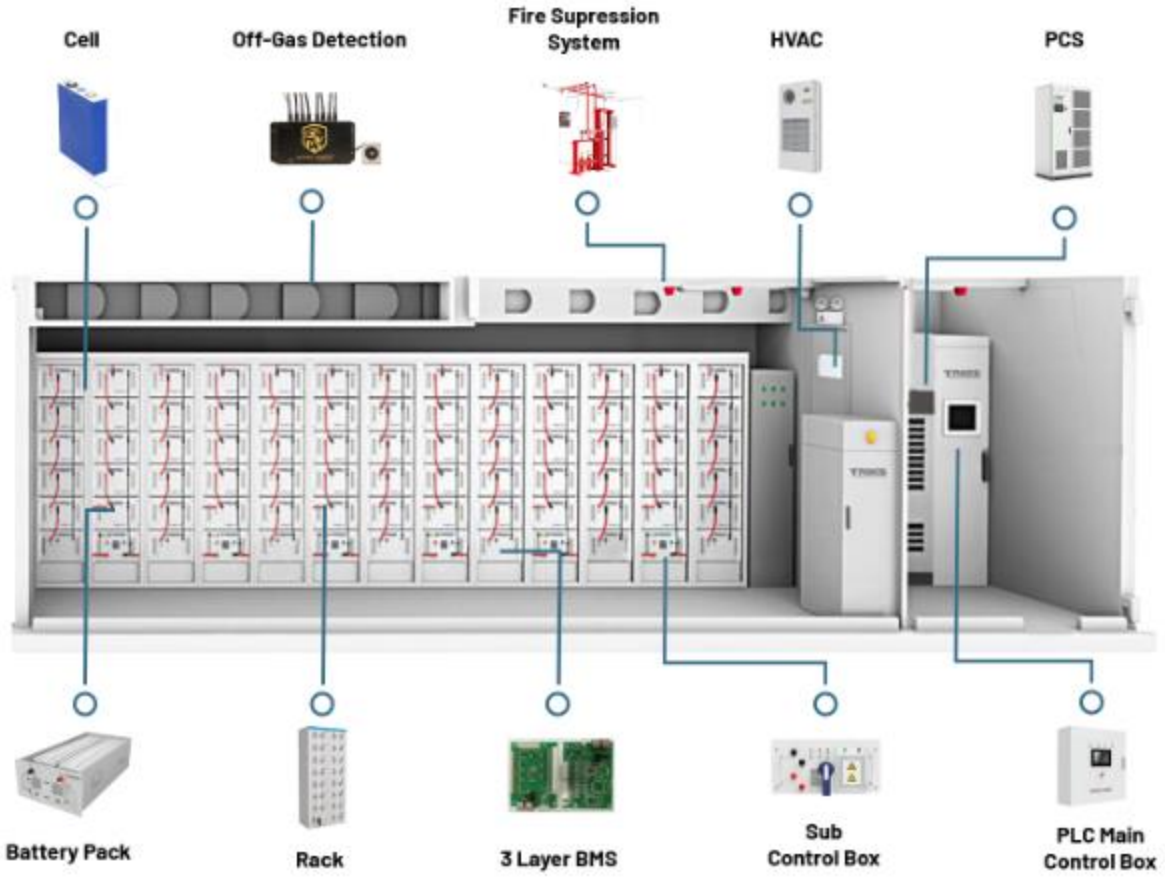
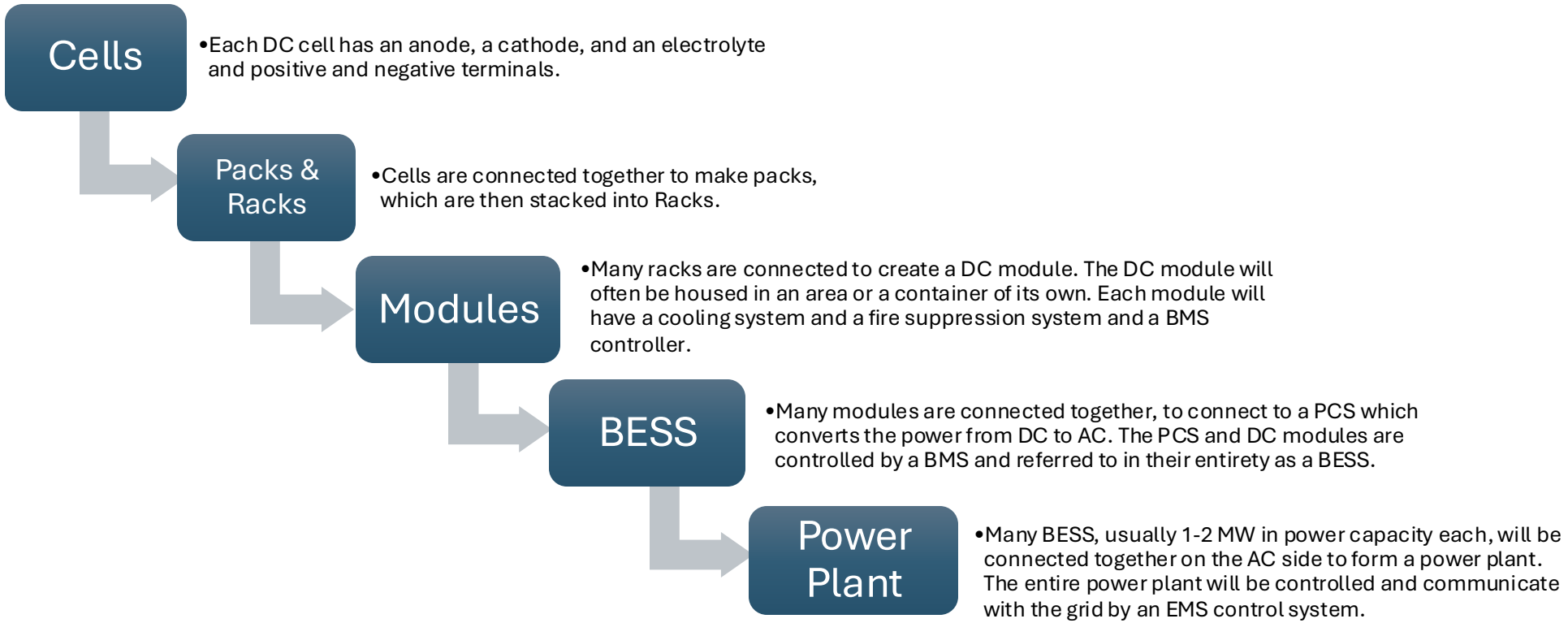
BESS 101

BESS: Parts of a Whole



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

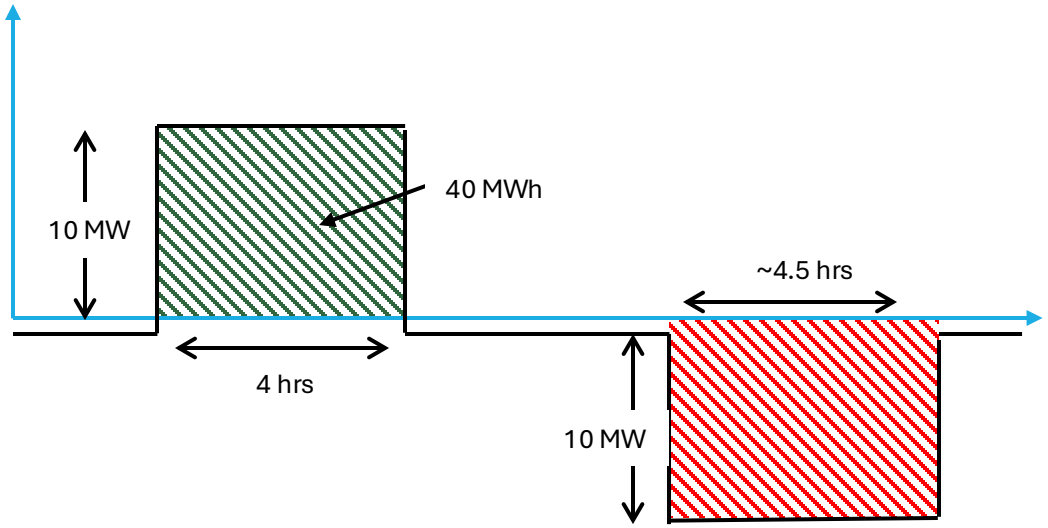
BESS: Parts of a Whole



BESS Specifications

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

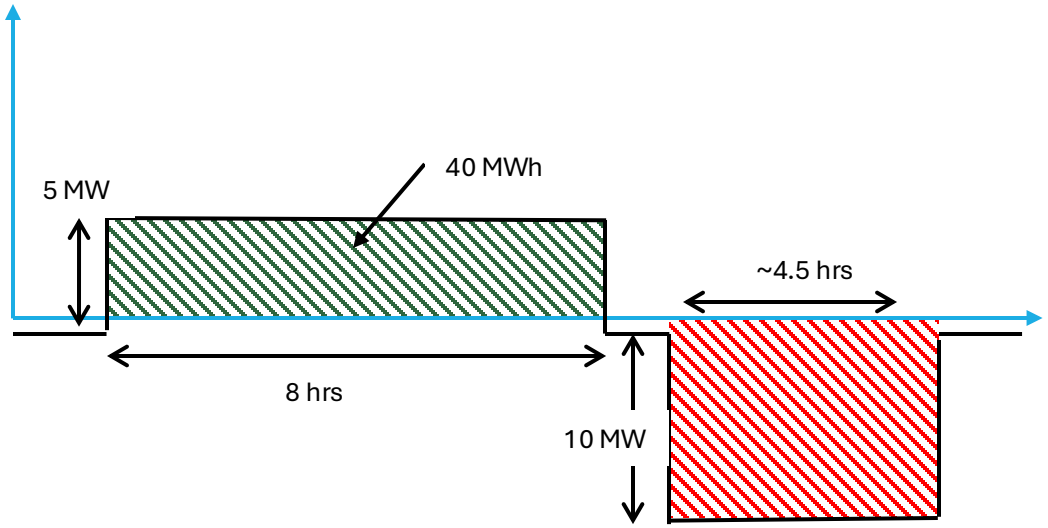
Power * Duration = Energy



BESS Specifications

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

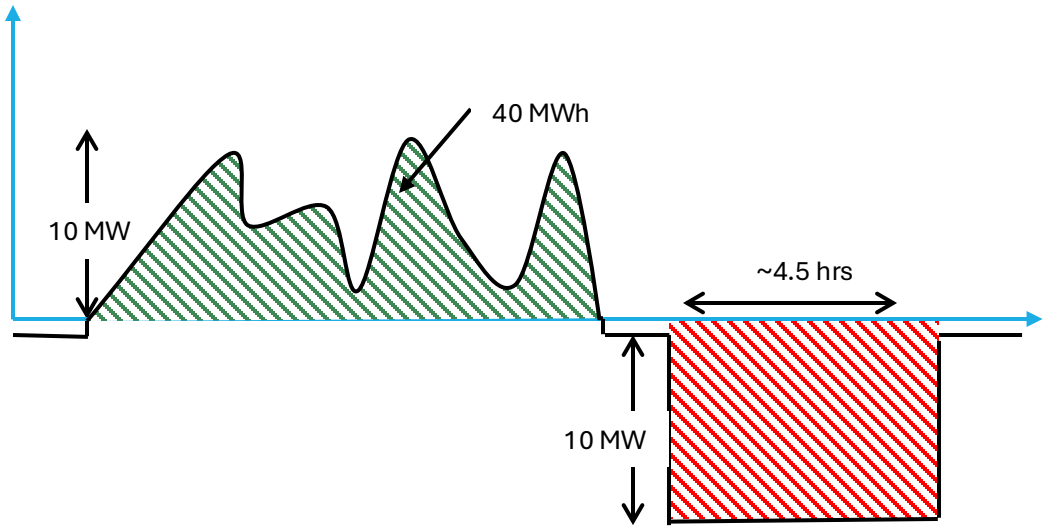
Power * Duration = Energy



BESS Specifications

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

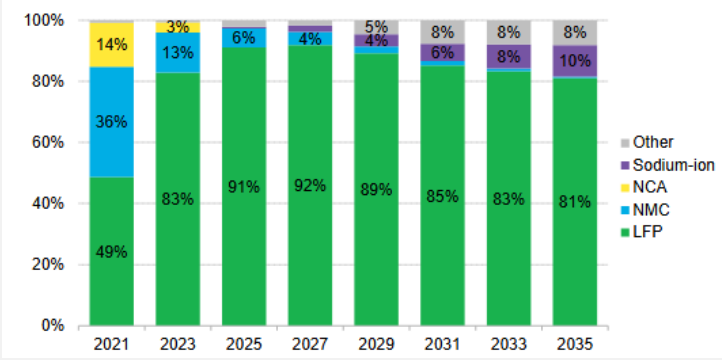
Power * Duration = Energy



Battery Energy Storage Technologies, by deployment

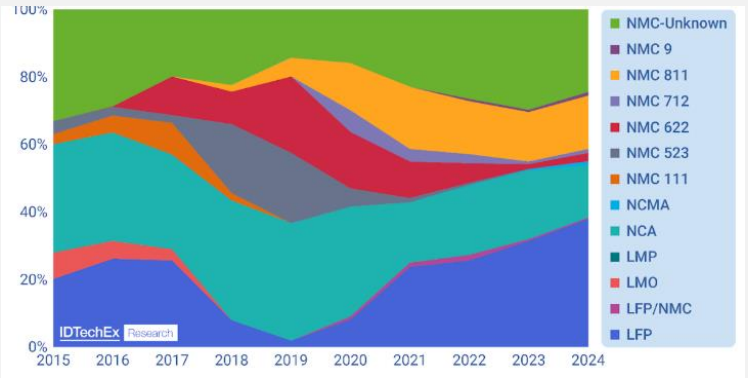
- Lithium Iron Phosphate (LFP):
  - Dominant Tech for 2024 BESS deployments (~90%)
  - Also ~30% of EV batteries
  - Considered safer and better cycle life.
  - 46% Less expensive in 2024
- Lithium Nickel Magnesium NMC
  - Still the choice for long range EVs due to higher energy density.
  - 72% of global EV batteries in 2023
  - In 2023 in the US 93% of EVs use NMC, 92% are high nickel NMC.
- Sodium-Ion
  - Forecasted to have lower costs once manufactured at scale.
  - 3 Gigafactories in China announced
  - 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 1 H 2025

Global Li-Ion Battery Chemistry Market Share, 2015-2024



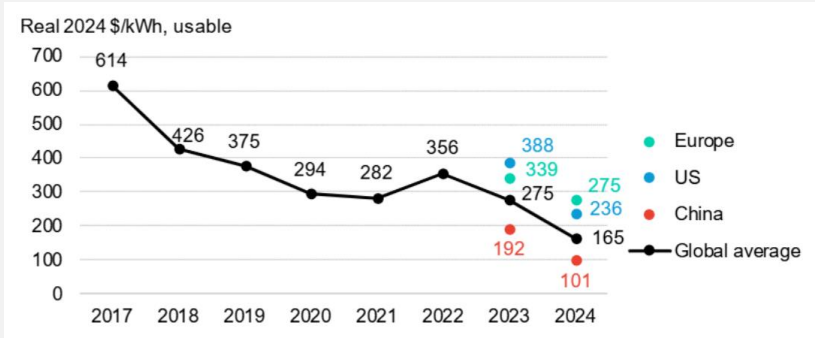
Source: Takahashi, Mika. IDTechEx. Iron and Phosphate to Unlock the Mass-Market EV at Last. Jan 16 2025

Cost of BESS

Despite Tariffs, Prices are competitive for BESS

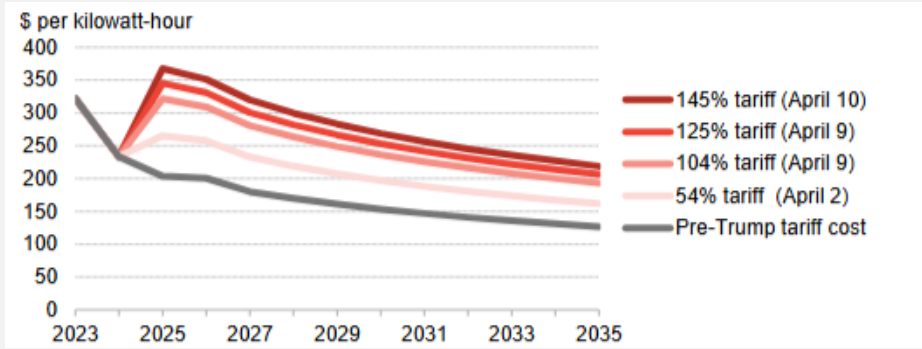
- Turnkey BESS prices fell 39% in 2024 to $236/kWh (US)
  - Translates to $944/kW, well below $1,600 benchmark for natural gas
- At the April 2025 tariff rate,104% on Li-Ion battery racks from China, the turnkey price would be $322/kWh, similar to 2023 prices
- Besides cost, BESS has:
  - A relatively low community impact: no pipeline construction, low land use requirements
  - A relatively short schedule 2-3 yrs versus 3-5 yrs for a new gas plant
- BESS may therefore be selected in a utility “all source RFP” over gas. These RFP’s are meant to keep rates as low as possible.

Turnkey BESS Prices



Source: Bloomberg New Energy Finance, Energy Storage System Cost Survey 2024

Turnkey BESS Price including Tariffs, 4-hr System



Note: Applies 104% tariff to battery rack and inverters from China, and 25% to transformers from Canada and Mexico. Includes Section 301 tariffs (7.5% to 25%, as applicable) and general import tariffs.

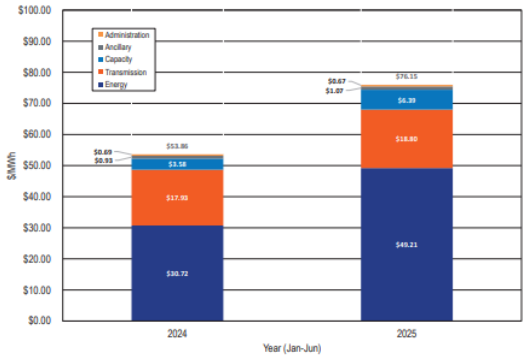
Source: Bloomberg New Energy Finance, Energy Storage Market Outlook 1 H 2025

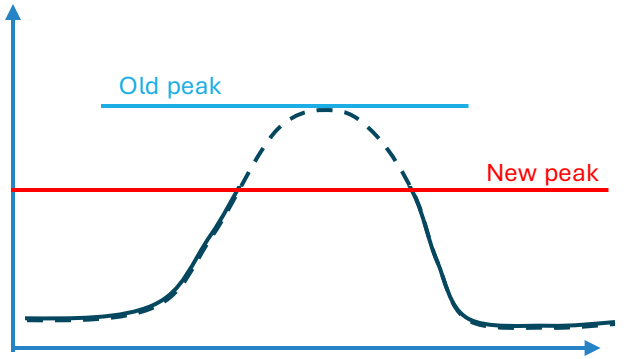
Applications for BESS

- In Front of the Meter
  - Capacity
  - Energy Arbitrage
  - Frequency Regulation or other (AS)
  - Transmission Deferral
  - Solar Firming
  - Volt/Var management

- Behind the Meter
  - Peak Demand Shaving
  - Energy Arbitrage (rare)
  - Backup Power
  - Solar Firming
  - Power Quality Correction

Total Cost of Energy in PJM shows rising Energy and capacity costs impacting rates





Recent BESS Development in Indiana

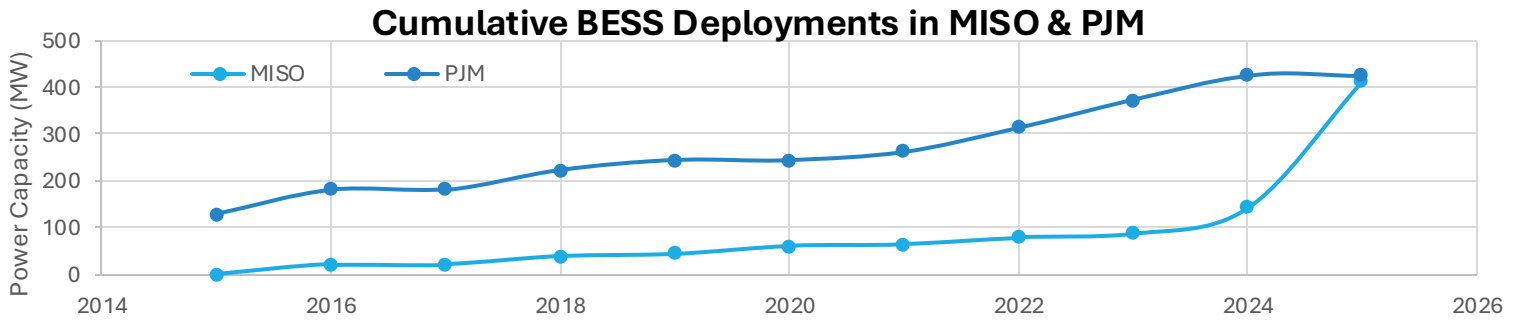
- Completed Projects (EIA data)
  - 337 MW Online in Indiana (all in MISO)
    - 82% of all MISO capacity
- Planned Projects:
  - Indiana Queue in MISO:
    - ~12 GW
    - ~1 GW through DP1
  - Indiana Queue in PJM:
    - ~5 GW

NextEra & NIPSCO Projects

76% came online in 2025

BESS in Indiana (as of March 2025, EIA)

Entity Name	Plant Name	County	Sector	MW	Online Mo.	MWh
AES Indiana	Harding Street	Marion	Utility	20.0	6/16	20
Southern Indiana Gas & Elec Co	Volkman Road Solar Array Hybrid	Vander-burgh	Utility	1.0	1/19	4.6
Duke Energy Indiana, LLC	Camp Atterbury Microgrid Hybrid	Clark	Utility	5.0	11/19	5
Duke Energy Indiana, LLC	Nabb Battery Energy Storage System	Johnson	Utility	5.0	12/20	5
Duke Energy Indiana, LLC	Crane Battery Energy Storage System	Martin	Utility	5.0	12/20	5
Cavalry Energy Center LLC	Cavalry Solar Hybrid	White	Utility	45.0	5/24	180
Dunns Bridge II Solar and Storage Generation LLC	Dunns Bridge II Solar	Starke	IPP Non-CHP	56.3	1/25	225
AES Indiana	Pike County Energy Storage	Pike	Utility	200	3/25	877



Appendix

BESS Acronyms, names and categories

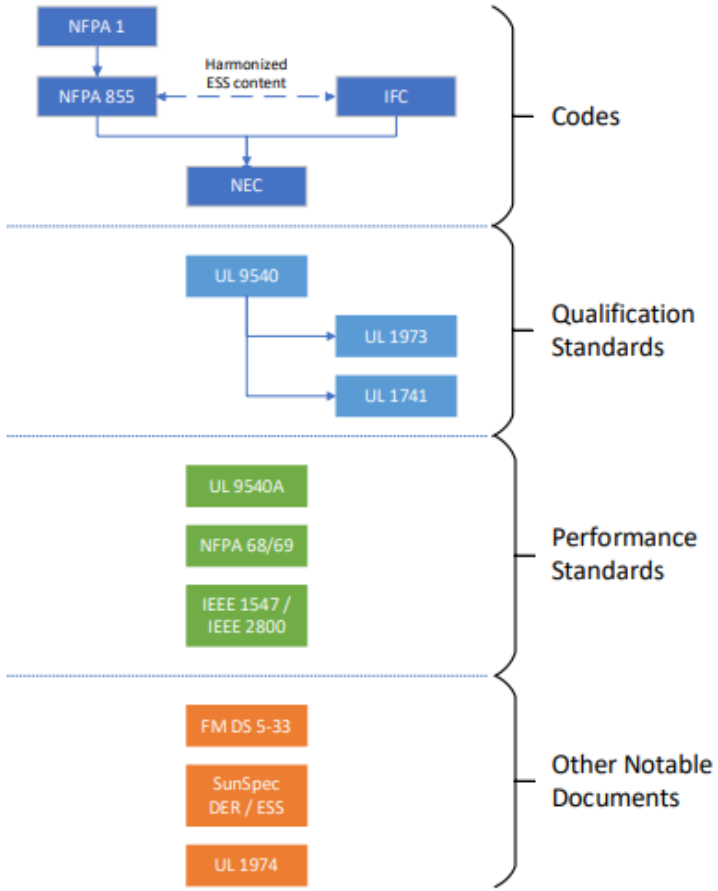
- BESS
  - Battery Energy storage systems, common term of art. Pretty Specific to Battery systems and usually includes all the controllers and PCS to make a functioning AC system. May be used interchangeably with a BESS Power Plant, e.g. many BESS connected together on the AC side make a bigger BESS.
- BES
  - Battery Energy Storage, refers to the technology type, but not the systems
- ESS
  - Energy storage systems. While this term is more general and could include other storage systems like flywheels, pumped hydro and pumped air, NFPA 855 uses it and that is focused on BESS
- ESR
  - PJM and MISO both use Electric storage resources to refer to BESS. Roughly a synonym.
- Limited Duration Resources
  - This term is used by ISO's (And sometimes utilities) to refer to resources that can't produce indefinitely. These used to include BESS, but now BESS are typically separated out into their own category and these are just DR resources.
- Energy Limited Resources
  - A term used by CAISO that is an umbrella that includes DR and BESS

Other Resources with Guidance for Local AHJs

- IOED BESS overview in Indiana
  - Information gathering focused
- EPRI
  - Storage best practices, focused on Utility audiences
- ACES Energy Storage Best Practices Guide
  - Developer focused
- BNEF 2025 1H Energy Storage Outlook
  - Important background only
- EPRI BESS roadmap
  - Nationally Focused
- NYSERDA local stakeholder engagement efforts
  - NY Focused, dated
- Clean Tech America
  - An industry group with various educational info, paid for by BESS industry players

National Codes & Adoption in Indiana

- Indiana Adopted NFPA 855 in 2023 (Pressel)
  - Applies to Utility Scale, > 1 MWh excluding fully BTM systems
  - Chapter 22, Article 14 Sec 4-10
  - Adopted 2023, amended 2024
  - Note: NFPA 855 heavily reference UL 9540 and 9540a
  - Indiana Dept of Homeland Security Implements NFPA 855
- Indiana uses NEC-2008
- Local zoning and permitting processes can block BESS



American Clean Energy. 2023. US Codes and standards for BESS

Tax Benefits and SB1 Impacts

- County-level Tax Benefits
  - BESS increase the county property tax base.
  - Revenue from property tax can be invested into community development projects.
  - Job additions (primarily during construction) and increased local income tax base

- SB 1 Property Tax Reform
  - **Business Personal Property Exemption Expanded:**
    - Exemption threshold increases from $80,000 to $1 million in 2025 and $2 million in 2026, exempting many assets from taxation.
    - The exemption applies if the total acquisition cost of a taxpayer's business personal property in a county is less than $2 million.
  - **Valuation Floor Removed:**
    - The 30% floor no longer applies to personal property placed in service after January 1, 2025.
  - **Homestead Deduction Reforms**:
    - Over the next five years, the standard homestead deduction will be phased out, increasing reliance on the supplemental deduction.
  - **New Cap on Levy Growth:**
    - Starting in 2026, political subdivisions must adopt rate/levy increases via ordinance and public hearing, even when assessed value (AV) grows.

Note: *Business Personal Property and Real Property defined in 50 IAC 4.2-4-10*

- SB-1-Final-plus-Executive-Summary-04-17-25.pdf (AIM)
- Indiana SB1 Overhauls Property Tax Rules — DMA

Is 4 hours enough to meet the capacity needs?
Introduce concepts

- Storage (and all dispatchable capacity must help meet the net load curve. The net load curve with PV has sharper peaks than the load curve, and is easier to meet with shorter duration storage.

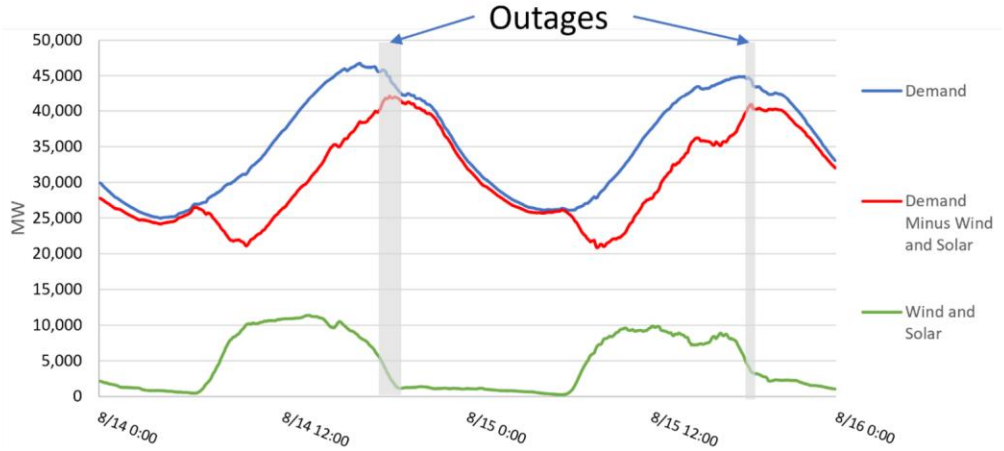
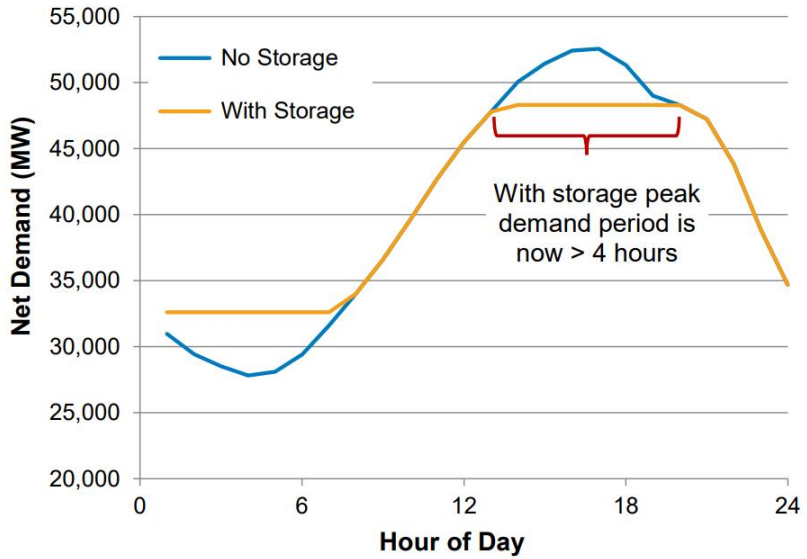


Figure 8. The California 2020 resource adequacy event resulted in rolling blackouts for as long as 2.5 hours (gray bars). 4-hour storage with sufficient power capacity would have been sufficient to avoid this event, with the ability to recharge overnight during off-peak periods.

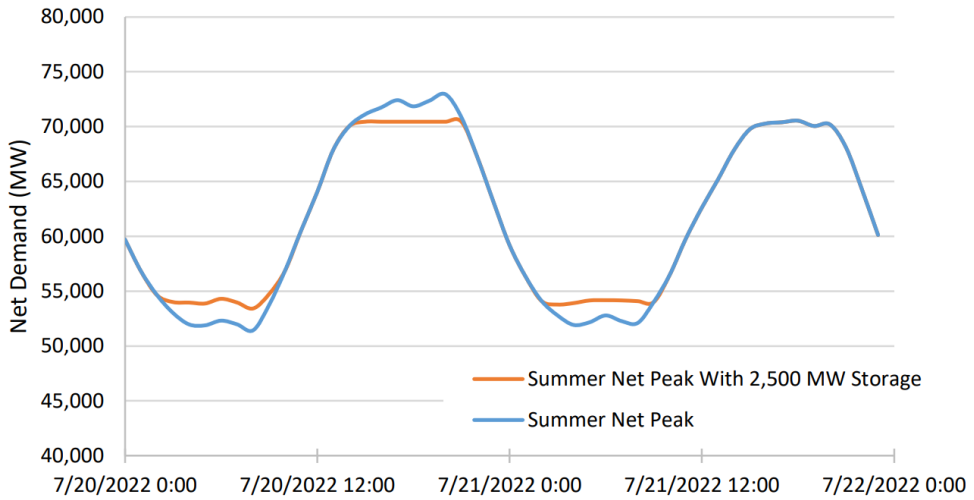
- As more storage comes online, the remaining peak becomes longer duration. Put another way, the more storage is part of the capacity mix, the longer a duration it needs to provide (duration is the ratio of area to height in these curves)



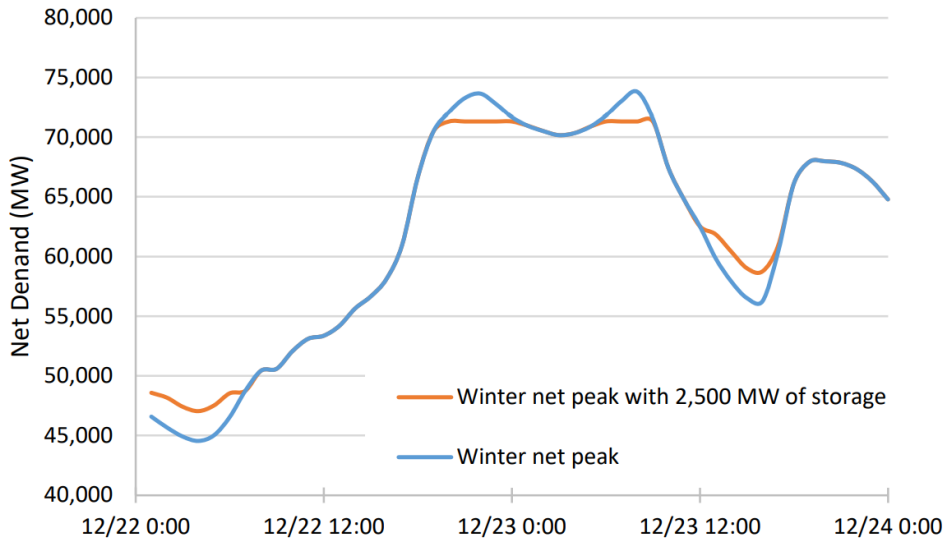
Denholm, Paul et. Al. NREL. Moving beyond 4-hour Li-Ion Batteries. Sept 2023

Is 4 hours enough to meet the capacity needs?
Introduce concepts

- ERCOT Summer simulating additional 2,500 MW of 4 hours storage



- ERCOT Summer simulating additional 2,500 MW of 4 hours storage



Denholm, Paul et. Al. NREL. Moving beyond 4-hour Li-Ion Batteries. Sept 2023

MISO resource accreditation
RRA predicts future grid scenarios

- Average net load shows notionally what is happening, but doesn't align perfectly with the LOL hours, which will happen on specific days.

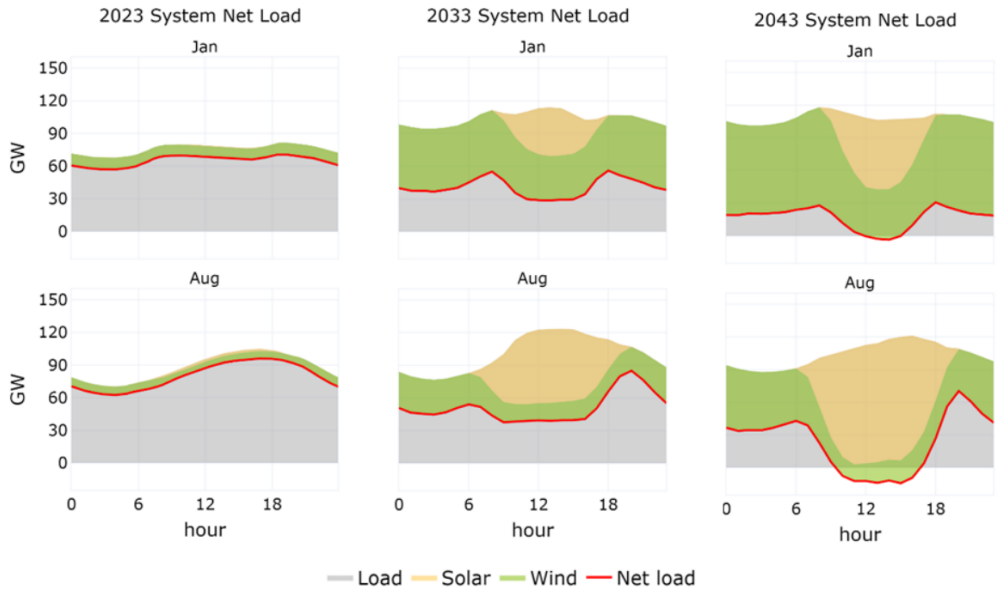


Figure 7: Projected changes in system net load profile from 2023 to 2043

- Storage accreditation can be tied to shifts in length of peaks and timing of peaks.
- By 2043 the winter morning hours are the riskiest LOL hours.

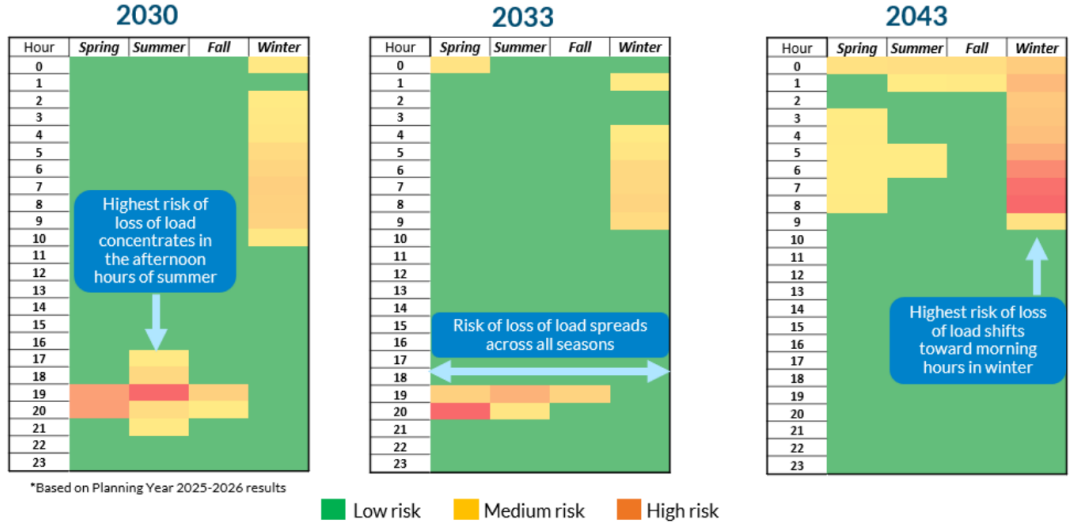


Figure 6: Projected shift in risk of loss of load between 2030 to 2043

MISO Inc. MISO 2024 Regional Resource Assessment. January 2025.

Latest Storage analysis did include the value of 8 hour storage

- MISO modelled 4 hour storage and 8 hour storage for the 2030-2031 year in an Long duration storage (LDS) scenario with 25% of the storage as 8-hour storage.
- In the LDS scenario 8-hour storage does have a slight accreditation increase compared to the 4-hour storage.
- Given prices move mostly as $/kWh, and only slightly as a function of kW, it is unlikely the slight bump in accreditation will drive investment.

Storage receives higher accreditation with the "blended" and "even loss" approaches, although cases did not include EFORd

- Results for all three approaches are very similar

	PY2030-31			PY2030-31 LDS scenario					
	Storage (4h)			Storage (4h)			Storage (8h)		
	Early	Blended	Even loss	Early	Blended	Even loss	Early	Blended	Even loss
Summer	87%	87%	91%	89%	90%	92%	100%	99%	100%
Fall	99%	99%	99%	100%	100%	100%	100%	100%	100%
Winter	92%	92%	93%	95%	95%	96%	97%	97%	100%
Spring	100%	100%	99%	100%	100%	100%	100%	100%	100%

12

***Note*: Storage was simulated without EFORd, which would reduce availability and accreditation.** Accreditation is also sensitive to the amount of storage deployed, and the rest of the resource mix

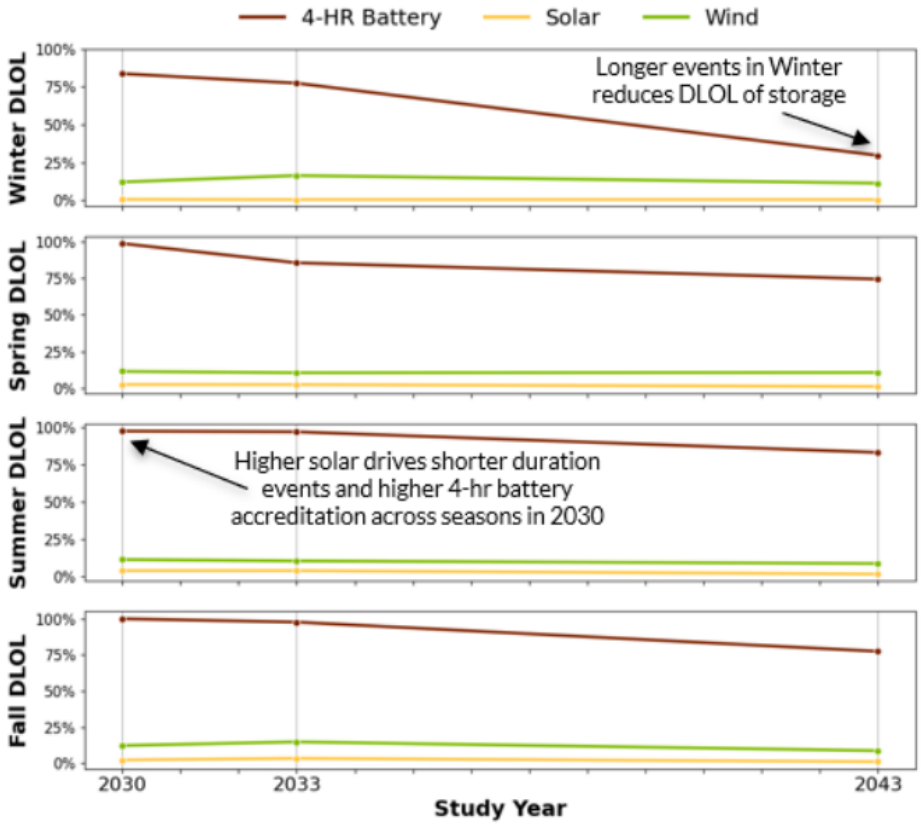
MISO RASC. LOLE Modeling Enhancements Storage modeling. April 9 2025.

MISO resource accreditation
RRA predicts future grid scenarios

- Storage accreditation will increase to 99% by 2030, but will sta again in years 2030-2043

		Initial LOLE Assessment – DLOL %					Final LOLE Assessment – DLOL %				
Resource Class	LOLE Study Year	ICAP (GW)	Spring	Summer	Fall	Winter	ICAP (GW)	Spring	Summer	Fall	Winter
Wind	2030	90	11	11	11	11	82	11	12	12	12
	2033	99	10	10	13	15	91	10	11	15	16
	2043	185	11	8	9	11	181	11	9	9	11
Solar	2030	64	3	5	3	1	74	2	4	2	1
	2033	75	3	5	4	0	85	2	4	3	0
	2043	134	1	2	1	0	140	1	2	1	0
4-hour Battery	2030	15	97	96	100	79	15	99	97	100	84
	2033	23	81	96	95	77	23	86	97	98	77
	2043	53	75	82	77	31	53	75	83	77	30

Table 1. Final resource expansion input DLOL % from initial LOLE resource adequacy assessment as a function of installed capacity (Left). Final and calibrated DLOL % from final LOLE resource adequacy assessment as a function of installed capacity (Right).

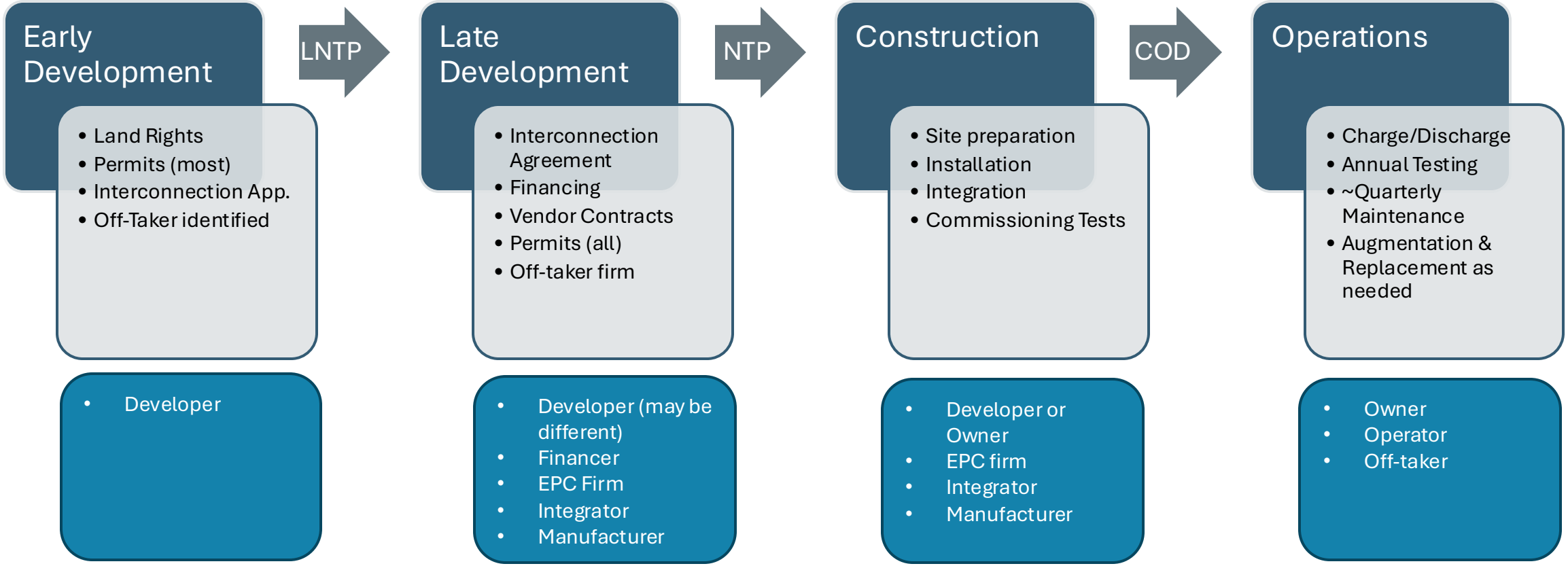


MISO Inc. MISO 2024 Regional Resource Assessment. January 2025.

BESS Project Development

Why are BESS built and how will the project change hands throughout the development process

BESS development timeline



BESS Operations

Operations and Maintenance Players

- **Owner**
  - Owner is financially liable for the activities of the BESS and the costs it incurs and the revenues it earns
- **Operator**
  - Makes day-to-day decisions around charging and discharging the BESS
  - Registers with the market
  - Ensures it meets all obligations as required, e.g. as a capacity asset
- **Off-taker**
  - BESS may directly sell capacity and/or storage as a service to one or more offtakers
- **O&M contract**
  - Original Integrator may maintain an O&M contract
  - Obligated to maintain and test per their own written procedures, but often also tied in to performance guarantees with the
  - May have roles such as: Emergency Contact, NFPA 855 implementation, and continuous monitoring

Example 1: IPP owned with LT capacity contract

- IPP: Owner & Operator
  - Owns the asset and operates it in the grid in accordance with the rules that assure it is earning at least the contracted capacity accreditation.
  - Likely performs other grid services to earn money, such as energy arbitrage or frequency regulation
- Utility: Off-taker
  - Long Term Capacity Contract
- O&M contract: Original Integrator
  - Some IPP's maintain their own equipment (or are integrators) and yet most will leave many maintenance, monitoring and other tasks to the original integrator
  - The integrator may be further tied to the project by a performance guarantee and a sharing of liabilities in the event of BESS failure.

Example 2: Utility Owned

- Utility: Owner & Operator
  - Owns the asset and operates it in the grid to maximize benefits to ratepayers
  - Likely is counting it as a capacity asset, and complying with the rules of that market too.
  - May have secondary use cases that support the distribution system such as volt/var support, distribution system upgrade deferral
  - May be able to provide backup power for a customer or control center.
  - May be able to use it as a transmission upgrade deferral asset (likely instead of RA)
- Off-taker: None, BESS is used to self-serve load and capacity obligations
- O&M contract: Original Integrator
  - Some utilities maintain their own equipment and yet most will leave many maintenance, monitoring and other tasks to the original integrator
  - The integrator may be further tied to the project by a performance guarantee and a sharing of liabilities in the event of BESS failure.

Example 3: Behind the Meter

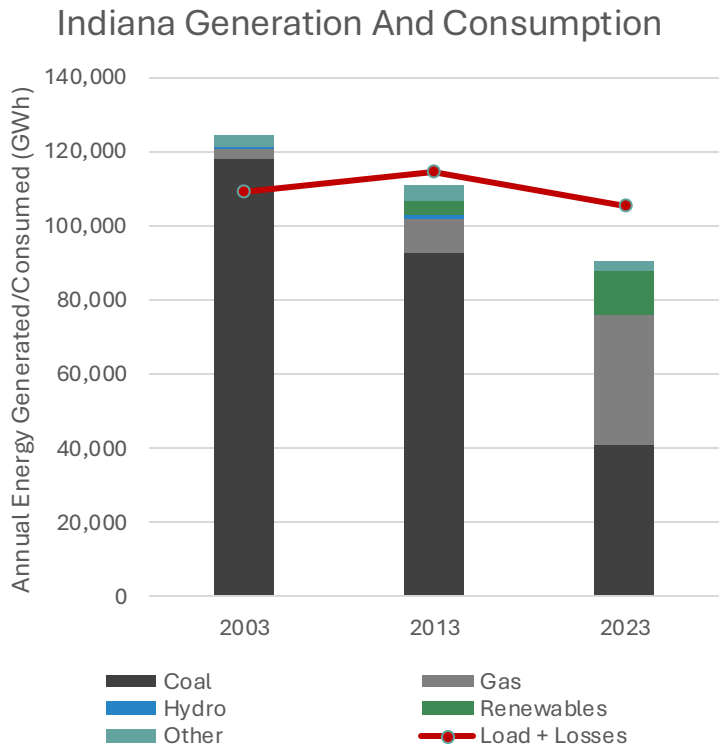
- C&I company: Owner & Operator
  - Owns the asset and operates it to perform functions such as peak shaving, backup power, power quality correction etc. EMS likely performs said functions automatically.
- Off-taker: None, BESS is used to self-serve load and capacity obligations
- O&M contract: Original Integrator
  - Likely managed by original integrator
  - The integrator may be further tied to the project by a bill-savings guarantee

Community Benefits

Community Benefits

BESS provide firm capacity to help meet system peaks

- AEP expects its peak demand to double by 2030, to 8 GW.
- Indiana already imports about 14% of the energy it needs
- BESS can provide capacity to meet system peaks and, depending on the owner and off-taker that capacity can allow for:
  - Saying “yes” to new development
  - Serving existing load during peaks
  - Smoothing out the contributions from renewable resources
- New capacity enables the utility to accept new loads. New loads often represent new economic development opportunities.
- For microgrids or other behind-the-meter installations, BESS may enable them to build or expand despite utility limitations.

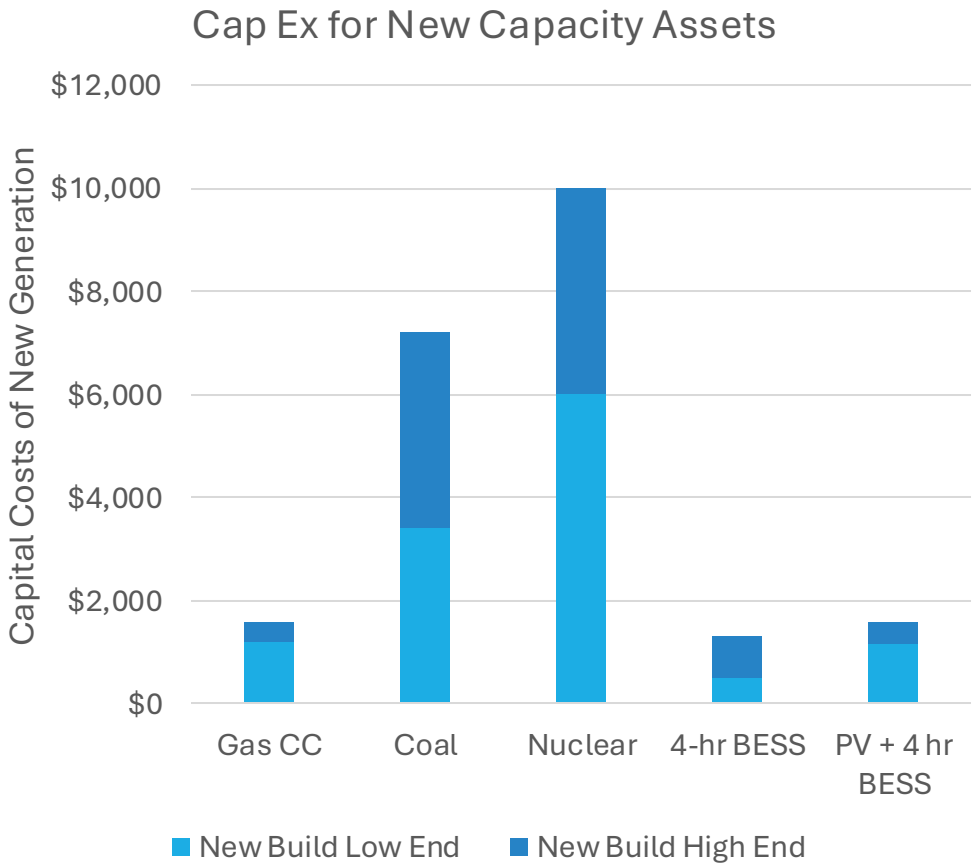


Source; EIA data browser: Generation and Consumption, assumes 5% losses on utility consumption.

https://www.utilitydive.com/news/indiana-michigan-power-aep-amazon-google-microsoft-data-center-interconnect/733850/,

BESS is the lowest cost for of firm capacity

- Utilities have an obligation to serve load using the least cost method available to them
- BESS can provide capacity resource (not a pure generation source), that is less expensive than new gas combined cycle
- Solar + BESS, with the BESS power rating being half of the PV power rating, the costs are nearly exactly on par with new combined cycle gas
- The detailed analysis of what the utility needs and when they need it, in terms of capacity and generation will vary by utility and from year to year (see Integrated Resource Plan)
- Allowing the utility to select BESS will open up the option for them to pick it **when** it results in a lower cost to provide service.
  - Lower cost of service will lead to lower rates.
  - The IURC will reject a CPCN if BESS is not a prudent investment.



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

Tax Benefits

Disclaimer: I am not a tax advisor, or tax attorney

- IOED BESS Report
  - “On-site BESS equipment would be considered a business personal property ….”
- The value of the storage system will depend, mostly on the energy capacity of the system.
  - New, all-in system cost (U.S. Average): $236/kWh
  - Example: 40 MWh system would be initially valued around $9.4 million
- Business personal property taxes are under debate. Current law, passed as SEA 1 in April 2025 would exempt first $2 million and then have the remaining value depreciate in 5 years down to $0. That may change as a result of ongoing debates.
- Besides taxes, sometimes developers negotiate specific economic development agreements to ensure the local jurisdiction receives benefits from their project.

Economic Impact: two press releases in Indiana

- Dunns Bridge Energy Center
  - 435 MW PV, 75 MW (4 hours) BESS
  - Up to 300 Jobs during construction
  - ~$59 million in county tax rev. (estimate)

Source: NextEra https://www.nexteraenergyresources.com/dunns-bridge-energy-center/project-overview.html

- AES: Two projects in Pike County
  - 250 MW PV, 180 MWh (sic) BESS
  - $1.1 Billion total, including a fuel conversion project in addition to the PV and BESS proj.
  - 300 Jobs during construction
    - 2 ongoing jobs specific to BESS maintenance
  - $40 million in “taxes and benefits” to Pike Co.

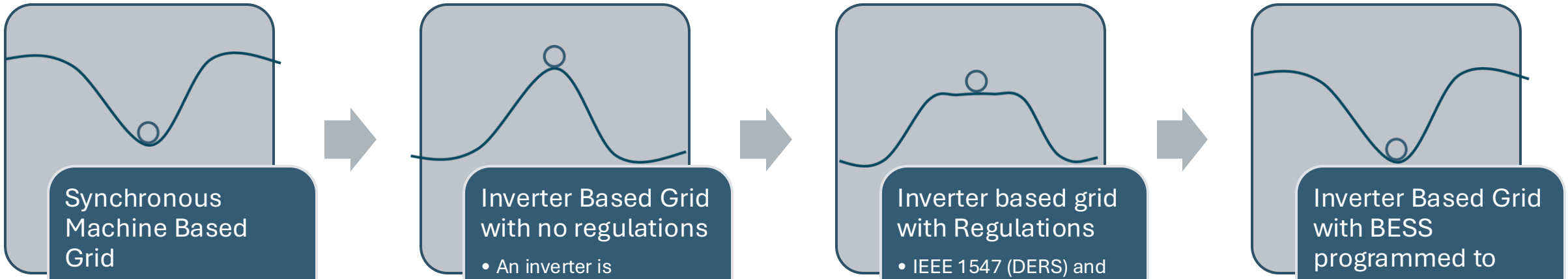
Source: AES https://www.aesindiana.com/press-release/aes-indiana-accelerates-future-energy-11-billion-investments-pike-county

Local Grid Benefits

- BESS can support distribution grids if employed by the utility owner/operator to do so
  - Provide voltage support for long or over-loaded feeders
  - Defer substation upgrades or distribution system upgrades by modulating real and/or reactive power needs
- BESS can support the transmission system
  - If this is purchased by a utility or transmission owner for that specific purpose, it can be used to assure that the transmission capacity is sufficient to meet the load
- BESS can support electrical system stability (next slide)

Local Grid Benefits

We are here



Synchronous Machine Based Grid

- Natural Voltage Stability
- Inertia of moving generators stabilize the grid in short timescales

Inverter Based Grid with no regulations

- An inverter is programmed to be grid following
- Inverters go offline when voltage dips
- Outages in TX and CA

Inverter based grid with Regulations

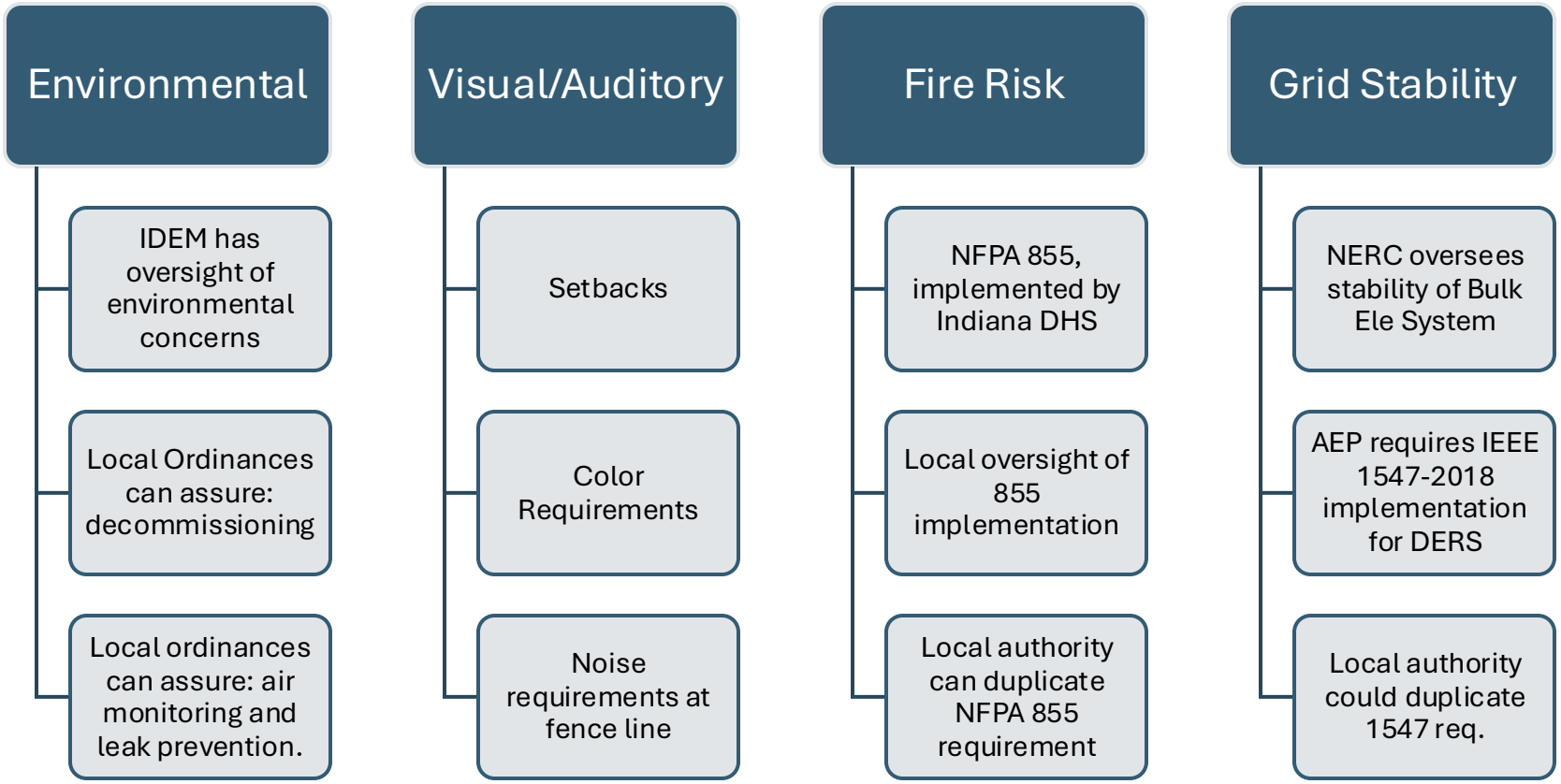
- IEEE 1547 (DERS) and IEEE 2800 define standards
- FERC order 901
- Inverters must operate over wide voltage ranges

Inverter Based Grid with BESS programmed to stabilize

- BESS can discharge toaddress low voltage events
- 2026-2027 Timeframe

Risks and Risk Managment

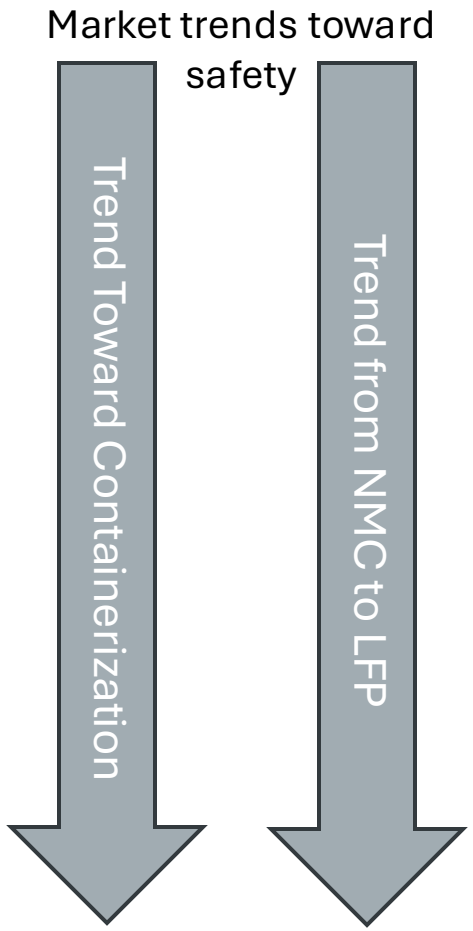
BESS risks and ways to address through local ordinances



BESS Safety Timeline

Indiana adopts NFPA 855

2018	• IFC Codes Include BESS for first time
2019	• McMicken, Surprise AZ Fire
2020	• NFPA 855 Released
2023	• NFPA 855 updated (including learnings from Surprise AZ)
2024	• Gateway project Fire, CA (NEC Energy, 2018 design, 2020 online, no IFC regulations enforced)
2024	• Moss Landing Fire, CA (Vistra, 2018 design, 2020 online, no IFC regulations enforced)



Canary Media. Recent BESS Fi theres

Conclusion

Key Takeaways

- With appropriate regulation and safety considerations, BESS can benefit local communities, assist in grid stabilization, and ensure firm capacity.