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State of the U.S. Energy Storage Industry: 2023 Year in Review

January 29, 2024

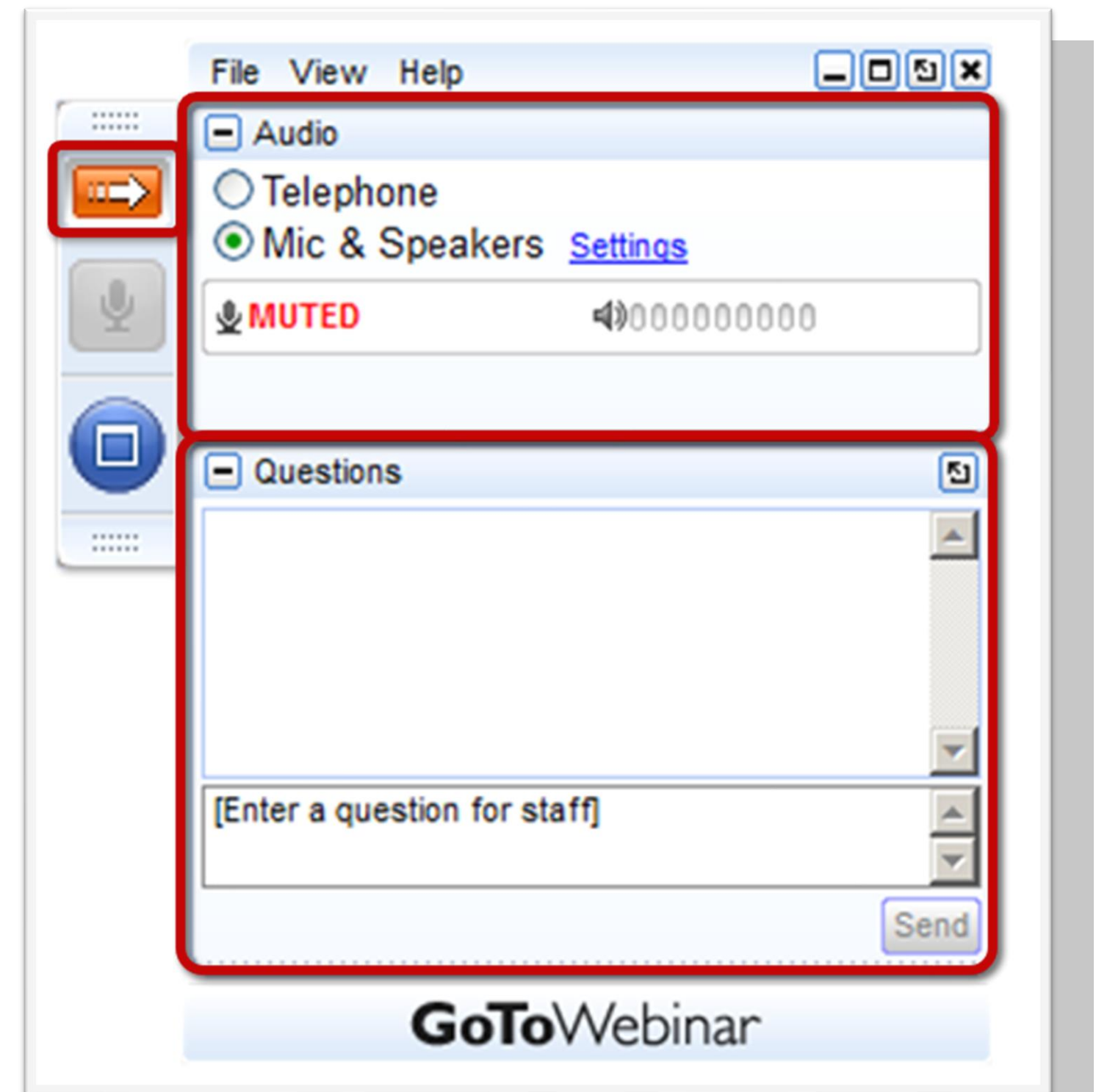
A Presentation of the Energy Storage Technology Advancement Partnership (ESTAP)

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Energy Storage Technology Advancement Partnership (ESTAP)

Conducted under contract with Sandia National Laboratories, with funding from US DOE Office of Electricity.

- Facilitate public/private partnerships to support joint federal/state energy storage demonstration project deployment
- Support state energy storage efforts with technical, policy and program assistance
- Disseminate information to stakeholders through webinars, reports, case studies and conference presentations

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Thank You!



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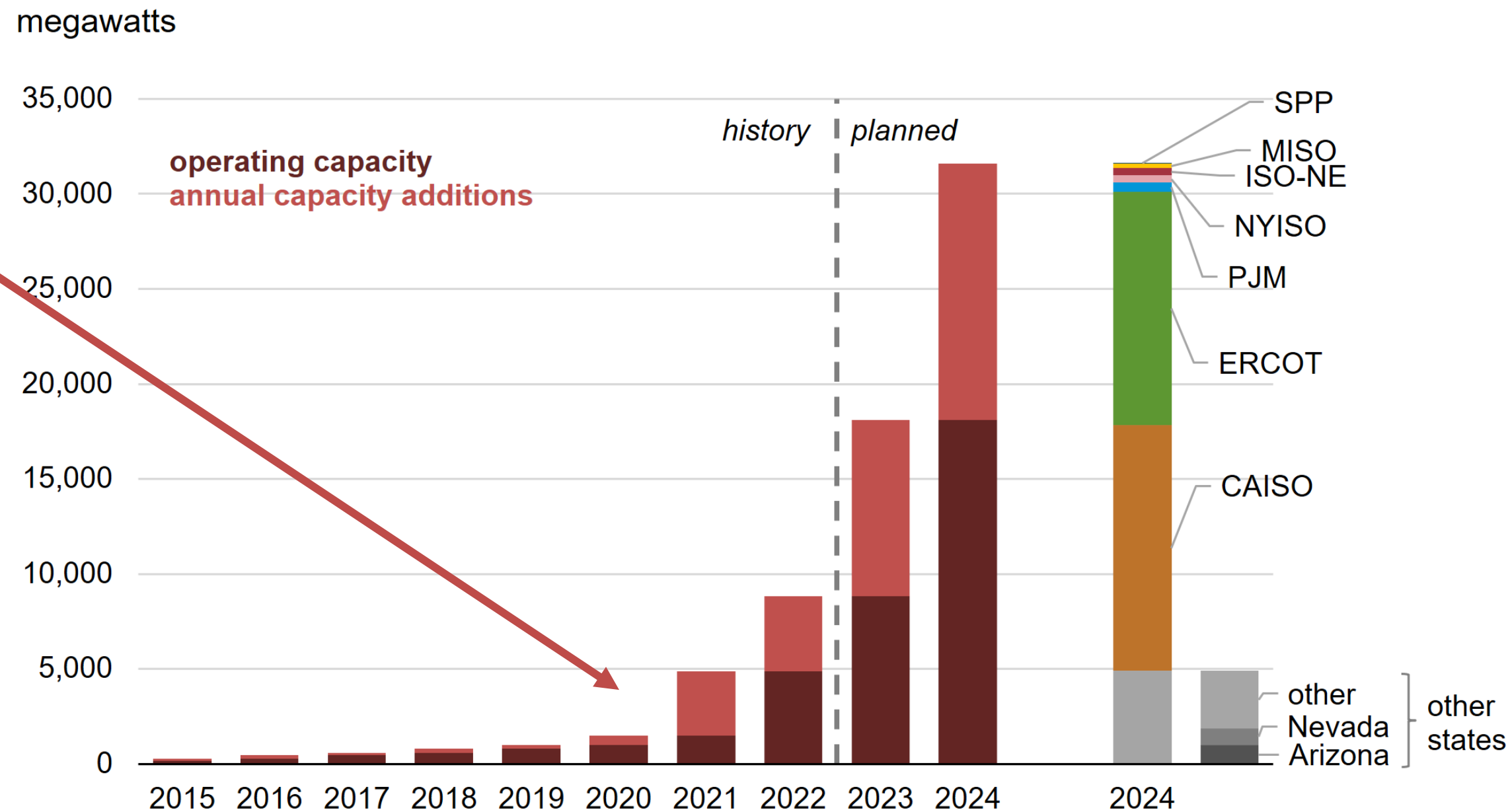


Level-Setting: The State of Storage in the USA

Figure 6. Large-scale battery storage cumulative power capacity (2015–2024)



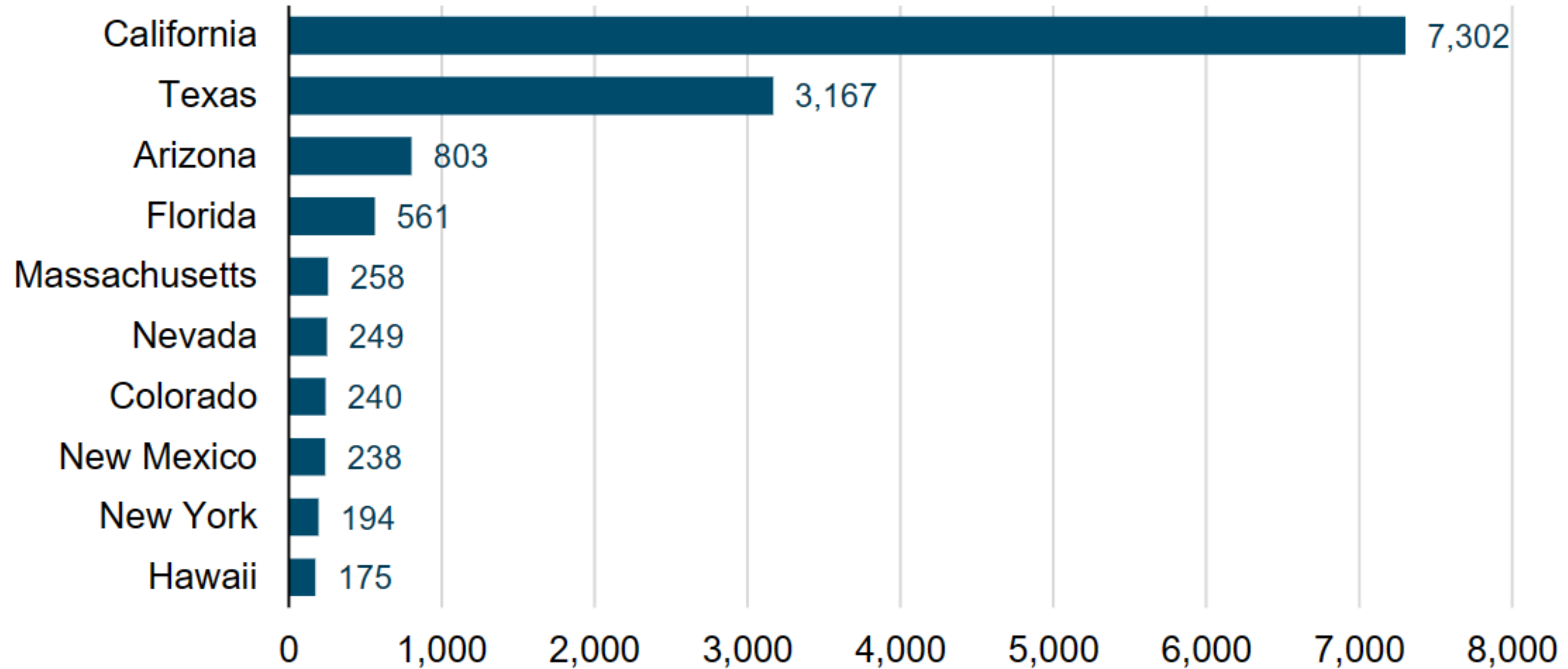
Exponential growth begins



EIA defines “large-scale” storage as 1 MW and above

Data source: U.S. Energy Information Administration, 2022 Form EIA-860 Early Release, Annual Electric Generator Report

Top 10 U.S. states with the most installed battery capacity (as of November 2023) megawatts



Data source: U.S. Energy Information Administration, [Preliminary Monthly Electric Generator Inventory](#), based on Form EIA-860M

Applications served by U.S. utility-scale battery energy storage systems, 2021

Reported application	Number of generators	Percentage of total power capacity
frequency regulation	128	63%
arbitrage	103	58%
ramping/spinning reserve	64	42%
excess solar and wind energy storage	148	30%
voltage or reactive power support	34	23%
load management	62	18%
load following	32	10%
peak shaving	147	10%
co-located renewable firming	38	5%
T&D deferral	14	2%
backup power	33	2%

Data Source: U.S. Energy Information Administration, *Annual Electric Generator Report (Form EIA-860)*, September 2022

Note: T&D is transmission and distribution; percentages sum to more than 100% because many battery installations serve multiple uses.

Power capacity of small-scale energy storage batteries by U.S. electricity end-use sector and directly connected systems, 2021

	Residential	Commercial	Industrial	Directly connected	Total
Total	740 MW	254 MW	79 MW	21 MW	1,094 MW
Net-metered	631 MW	88 MW	62 MW		781 MW
Non net-metered	109 MW	166 MW	17 MW	21 MW	312 MW

Data source: U.S. Energy Information Administration, *Annual Electric Power Industry Report (Form EIA-861)*, October 2022

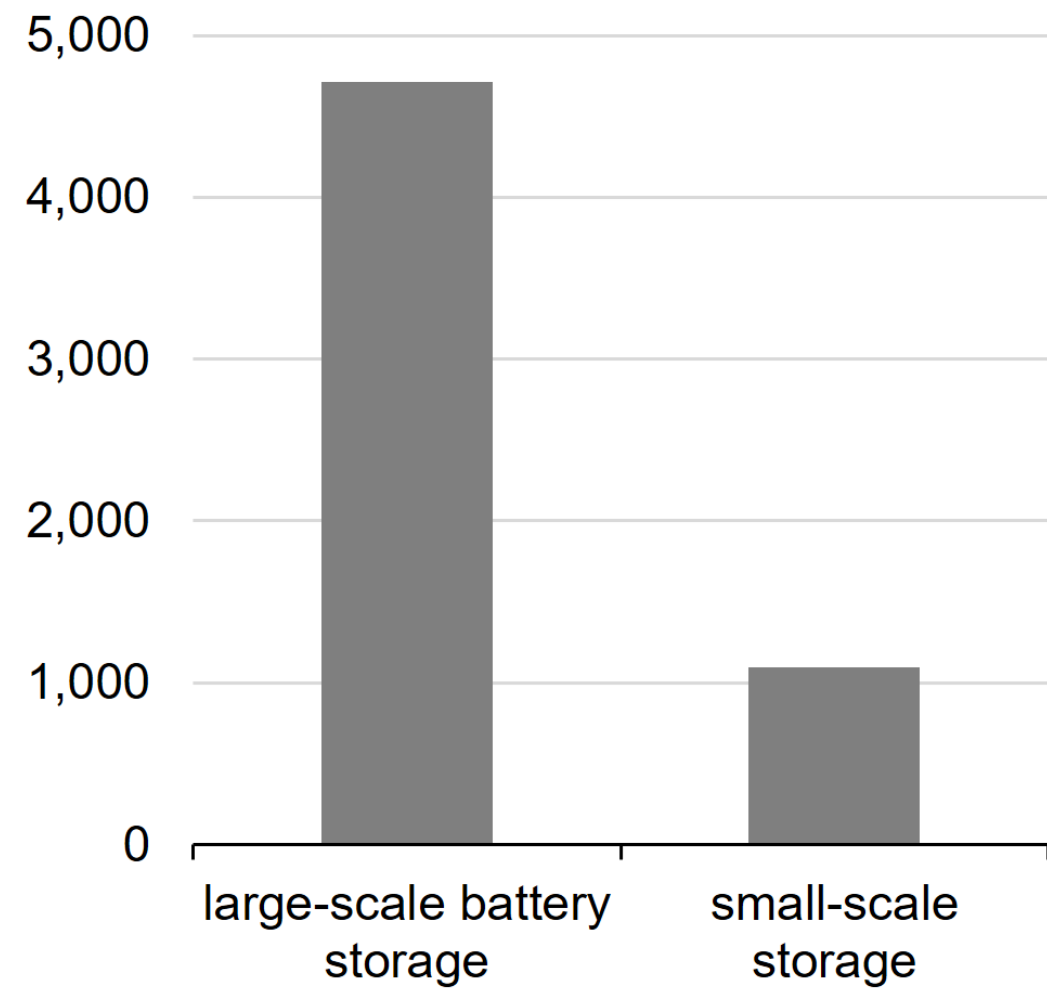
Note: The net-metered capacity is associated with solar photovoltaic systems. Directly connected systems are not located at ultimate utility customers' sites; they are in front of an electric meter and are connected directly to an electricity distribution system. MW = megawatts.

“Small-scale” means <1MW

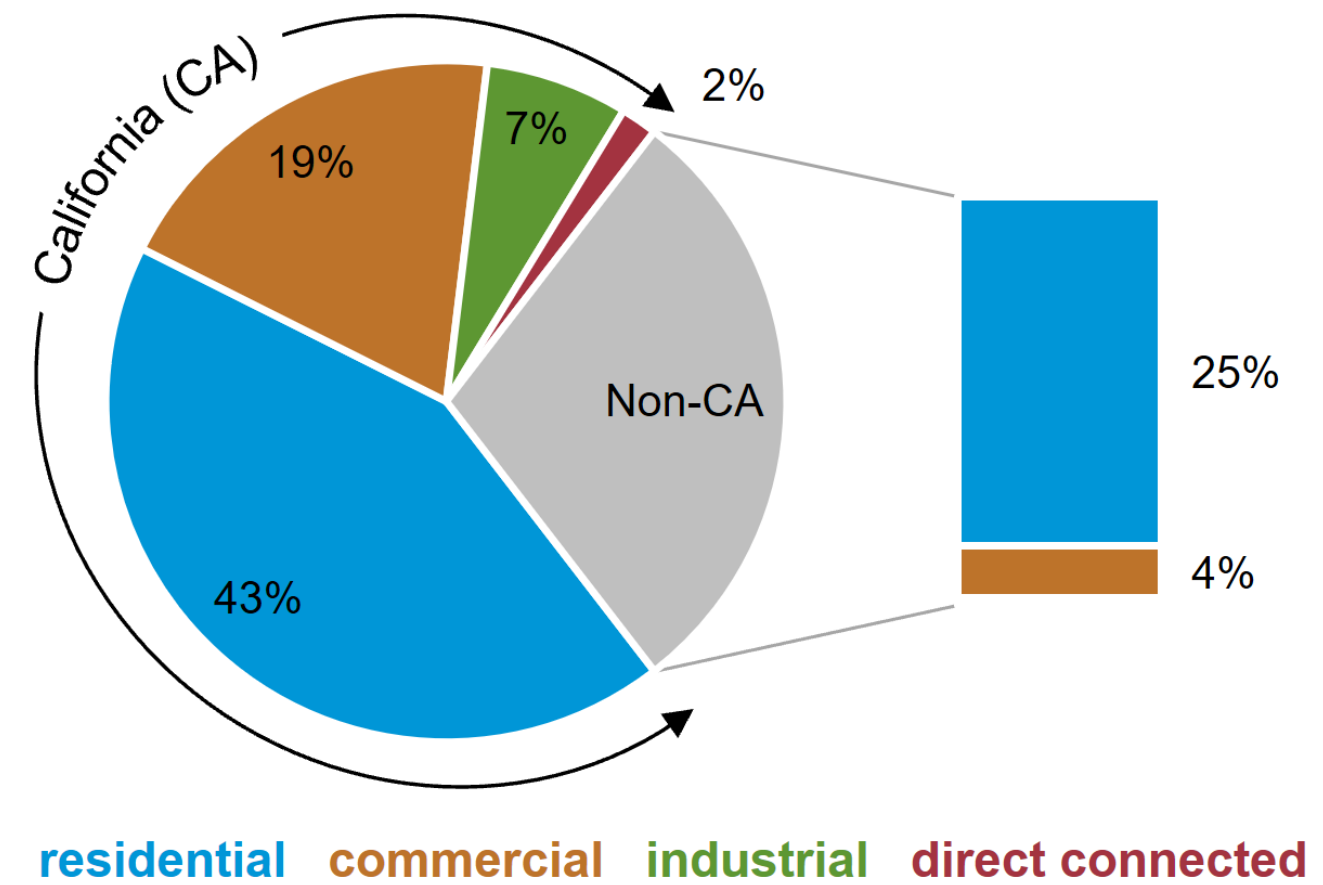


Figure 13. Small-scale energy storage capacity by sector (2021)

power capacity
megawatts (MW)

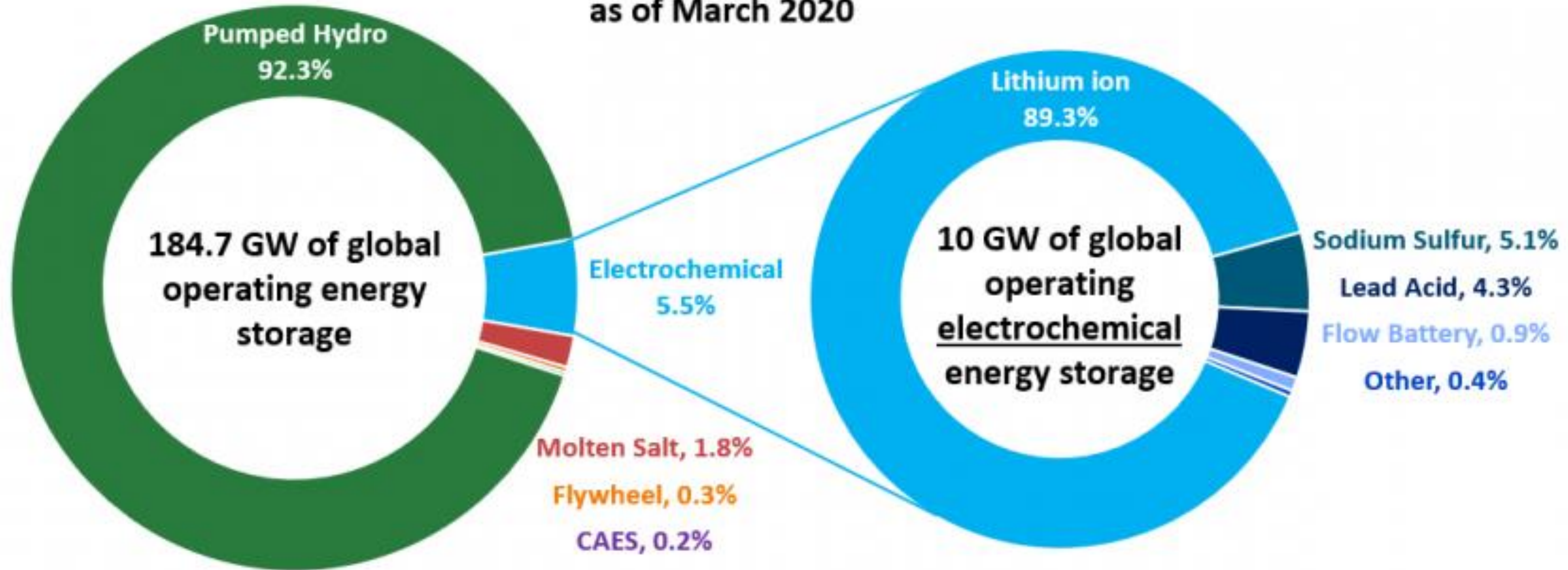


share of total small-scale power capacity (1,094 MW)



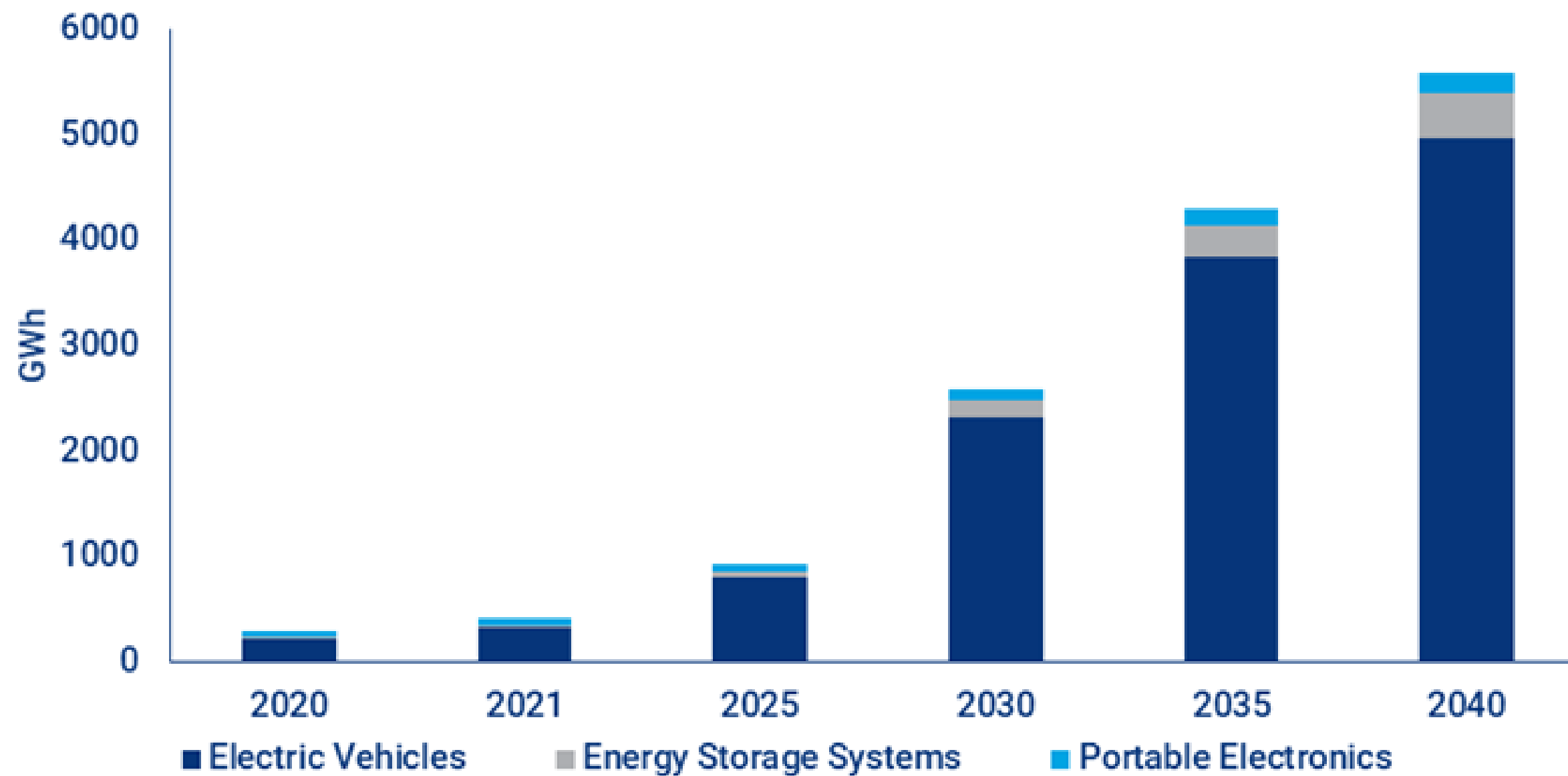
Data source: U.S. Energy Information Administration, 2021 Form EIA-861, Annual Electric Power Industry Report

Global Operational Energy Storage Capacity (MW) as of March 2020



Source: China Energy Storage Alliance Global Energy Storage Market Analysis 2020.2Q Summary

Demand from EVs will account for 89% of global Li-ion battery demand by 2040



Source: Wood Mackenzie



Dr. Imre Gyuk

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Upcoming Webinars

Replacing NYC's Peaker Plants with Clean Alternatives: Progress, Barriers, and Pathways Forward (February 6)

Solar Adopter Income and Demographic Trends: An Update from Berkeley Lab (February 15)

Read more and register at www.cesa.org/webinars

State of the US Energy Storage Industry

Ted Ko, Exec Director, Energy Policy Design Institute

State Policy Progress

- Introduction and Policy Framework
- Ultimate Policy Goals - Perspectives
- Targets
- Revenues
- Costs
- Incentive Programs



Introduction

Energy Policy Design Institute (EPDI)

- Neutral organization dedicated to better, faster development of regulations and programs, using a systems design approach, informed by deep subject matter expertise
- Currently applying approach to Maryland Energy Storage Program Workgroup – design for statewide 3GW storage target

Year in Review – State Policies for Energy Storage

- Not a list of policy events – putting events in policy framework for evaluating progress
- How are a state's laws, regulations and proceedings doing in establishing a long-term sustainable energy storage market?

What does success look like?

What is a state's ultimate goal for energy storage policy?

- From the ratepayer / state government point-of-view: Enabling monetization of all services storage can provide and reducing costs that state can affect (soft costs)
- From the industry point-of-view: revenues exceed costs without incentives / subsidies

	Initial	Early	Growth	Maturity
Targets	NJ, ME, MD	MA	CT, NY	CA
Revenues		CT	NY, CA	
Costs		ME, CT	NY	CA
Incentives	MD, NJ	CT	MA	NY, CA

Targets

- Targets are useful to move agencies into action, but don't advance the market until mechanisms are implemented
- Sample of energy storage targets activity
 - Maryland and Michigan passed energy storage targets
 - Illinois introduced bill for 7.5GW target by 2030
 - Maine introduced legislation to increase existing target
 - New York agencies proposed an increase from 3GW to 6GW and proposed a new roadmap

Revenues Policies

- Major Categories of Revenues: Grid Services, Utility Procurement, Wholesale market
- Sample of Grid Services Programs activity
 - Connected Solutions in Massachusetts rule changes
 - Improving ELRP and DSGS in California
 - Connecticut Energy Storage Program: changes made to grid services rules
- Utility Procurement
 - Non-wires solutions?
- Wholesale Market participation
 - What do states need to do to enable participation based on Orders 841 and 2222
 - ISO/RTO Compliance filings on Order 2222, but minimal state progress on enabling VPPs

Costs Policies

- Interconnection
 - IREC published updated Model Interconnection Procedures
 - Very few states have integrated core concepts such as software controls and flexible interconnection
- Permitting
 - Often at local AHJ level, but possible for state laws to affect permitting requirements/processes
- Wholesale Distribution Tariffs – charging FTM-distribution level storage
 - Maine utilities directed to file new tariffs
- Financing
 - State level green banks
 - State programs/entities access federal BIL and IRA funds intended for financing clean energy or resilience, primarily disadvantaged communities

Incentive Programs

- Incentives intended to bridge the “gap” between revenues and costs
- States use incentives to get market segments going – should be designed to become unnecessary
- Changes and status updates
 - Connecticut ESP made changes to residential incentive
 - New York Market Acceleration Bridge Incentive – proposal to add more funding as part of 6GW roadmap – appears to be stalled
 - New Jersey Storage Incentive Program (SIP) – was also a mix of grid services and incentives. Hoping for new straw proposal soon.
 - California
 - Distributed Electricity Backup Assets (DEBA) – initial RFP issued
 - SGIP funding cut back in most recent state budget

QUESTIONS?

PLEASE SAVE FOR AFTER PRESENTATIONS

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Moving beyond goals and aspirations

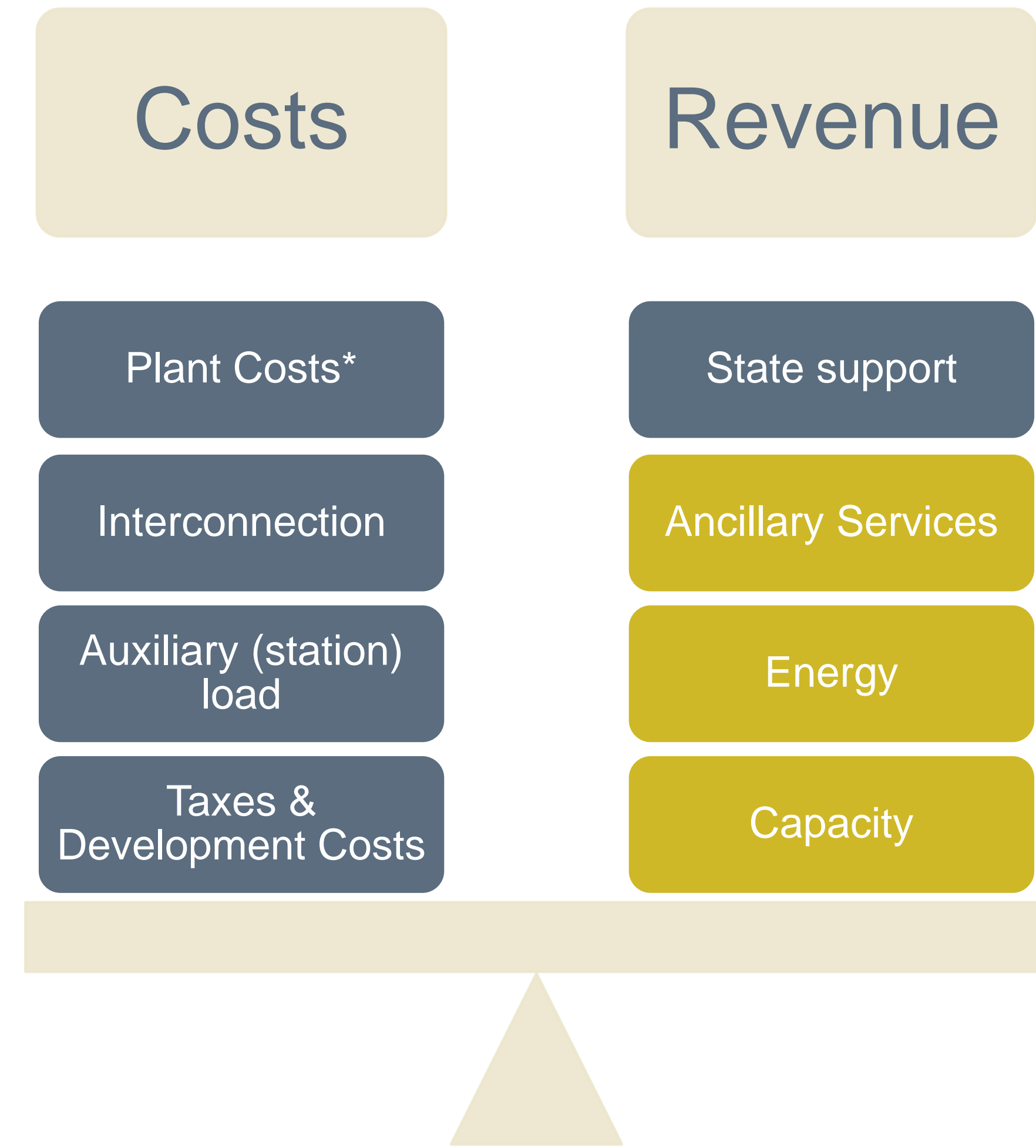
**STATE SUPPORT FOR THIRD-PARTY UTILITY-SCALE
BATTERY STORAGE IN WHOLESALE MARKETS**



State support is needed to support third-party battery energy storage system (BESS) development in wholesale markets

Programs should maximize wholesale market revenue to provide missing money at least cost.

Simple (non-inclusive) Battery Storage Economics



*After Federal ITC



What do long-term contracts for utility battery storage look like?

Market Structure Risk

Future energy price volatility or accredited capacity prices may not support storage revenues.

Performance Risk

ESS fail to earn the revenue that appears in wholesale market prices, or otherwise meet performance obligations.

Tolling Agreements

Fixed monthly payment equal to revenue requirement

Utility schedules charge/discharge and earns market revenue; BESS owner carries performance risk

CA, NY, Vertically Integrated Markets

Resource Adequacy Only

Fixed monthly payment for capacity portion of revenue requirement. Non-capacity revenue is merchant.

BESS owner is exposed to market and performance risk

CA, CT(ish)

Indexed Energy Storage Contracts

Variable monthly payment to fill gap between revenue requirement and available market revenue

BESS owner is protected from market risk; carries performance risk of operating in market to earn available revenue

NY, some in CA

How Index Storage Credits fill the “missing money” gap

- Procuring authority conducts a competitive solicitation for BESS through **long-term contracts**
- Bidders provide a “strike price,” or contract price approximating the revenue requirement of the BESS
- The monthly payment to the BESS equals the strike price *minus* a reference price that approximates the wholesale market revenues available to the BESS
- The payment is reversed (BESS pays or credits ratepayers) if the references prices are *greater* than the strike price.
- Under a “credit” construct (as in NY), the BESS would generate one credit per MWh of installed capacity per day. The credits would be purchased at a variable price using the same formula as the “payment” described above.

Simple Example of Indexed Energy Storage Contract Pricing

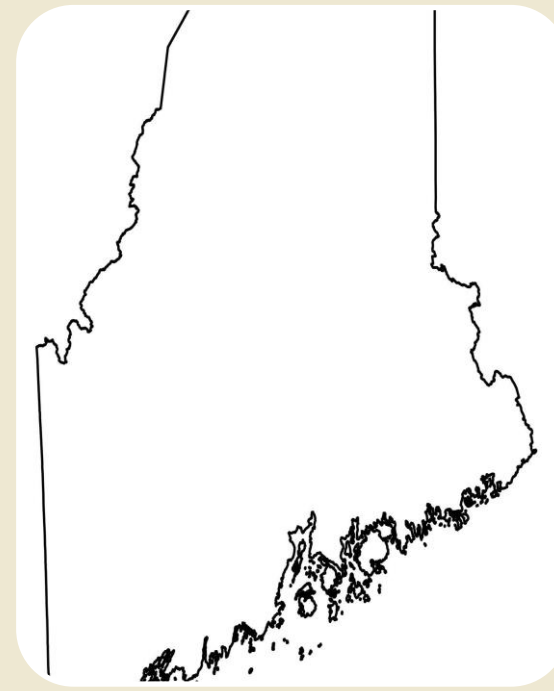


$$\{\text{Payment}\} = \{\text{Strike Price}\} - \{\text{References Prices}\}$$

States in Wholesale Markets are ramping support for utility-scale storage



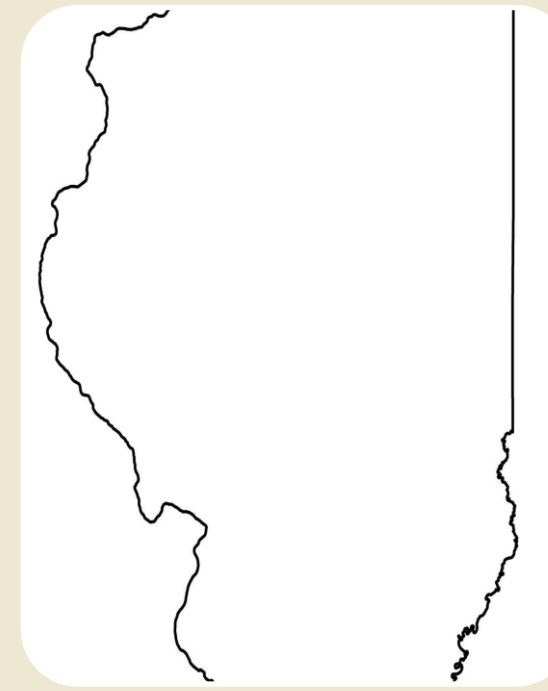
New York
Commission and NYSERDA staff proposed procurement 3,000 MW using Index Storage Credits



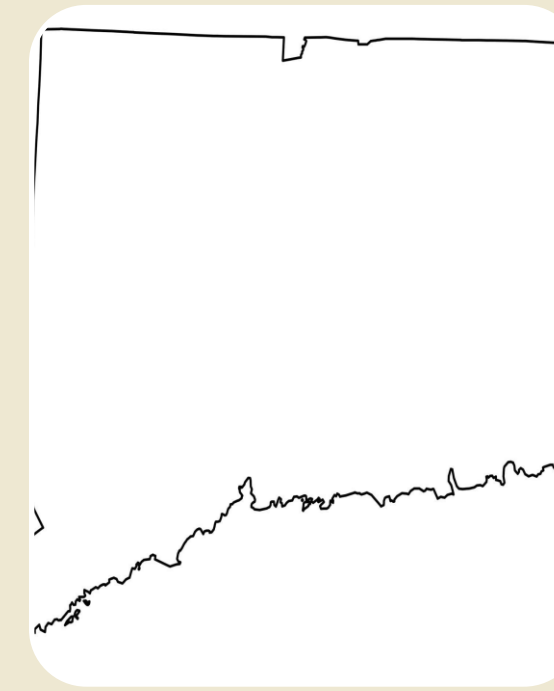
Maine LD 1850 directs energy office and utility commission to consider 200 MW procurement in 2025



Mass. energy office conducts storage study as directed by 2022 Mass. Acts 179 to evaluate potential procurement



Illinois is currently considering SB 1587 to direct procurements for 7500 MW. Illinois Power Agency recently issued draft report evaluating program



Connecticut energy office is preparing draft RFP for up to 450 MW using novel Storage Performance Contract



Maryland SB XX directs utility commission to investigate procurement mechanisms

Fire safety is emerging as top concern

Multiple battery storage fires in New York prompted Governor Hochul to launch Fire Safety Working Group.

- Recommendations expected imminently.

Growing consensus around some best practices for safety guidelines

- NFPA 855, emergency response plans, first responder training

More states are considering rules in legislation





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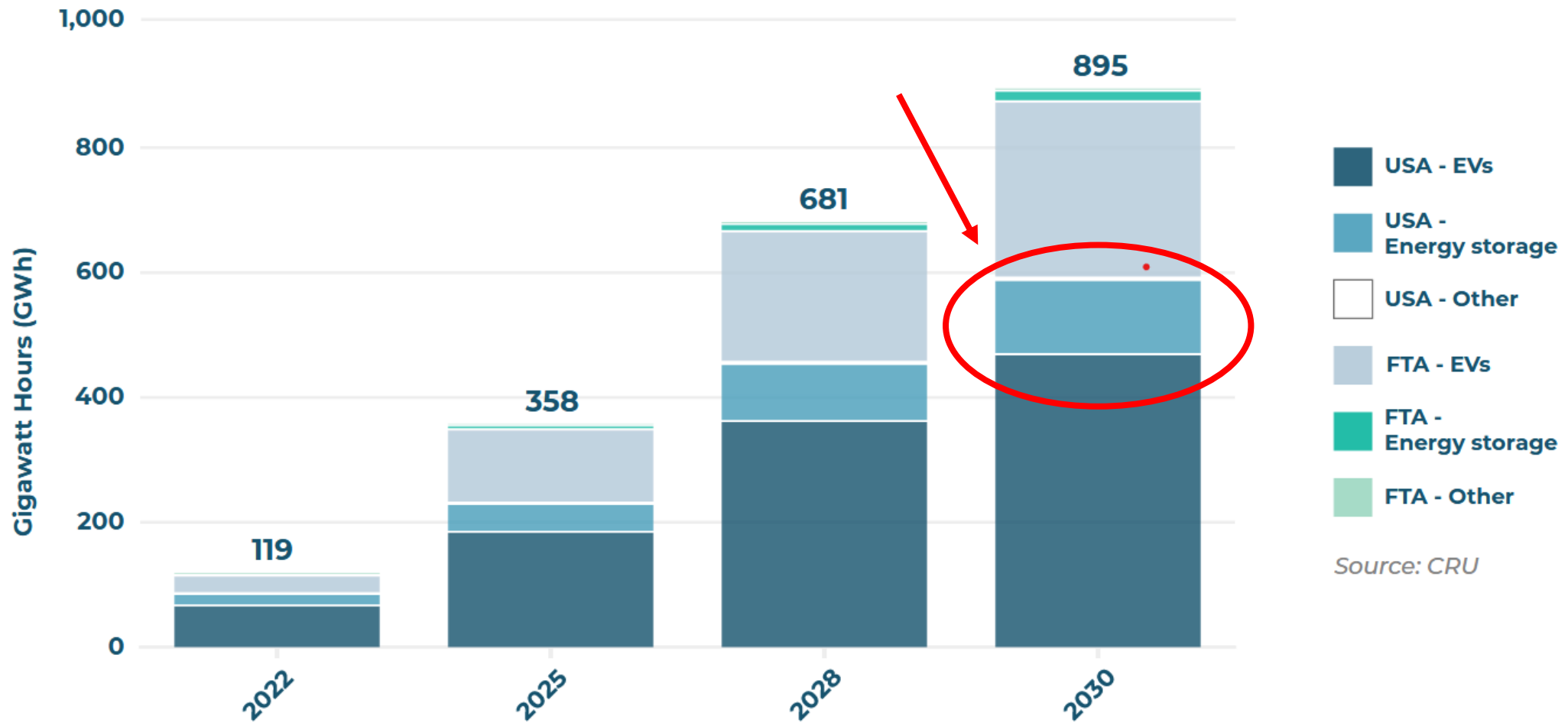
U.S. Energy Storage: 2023

Joan White

Director of Storage and Interconnection Policy

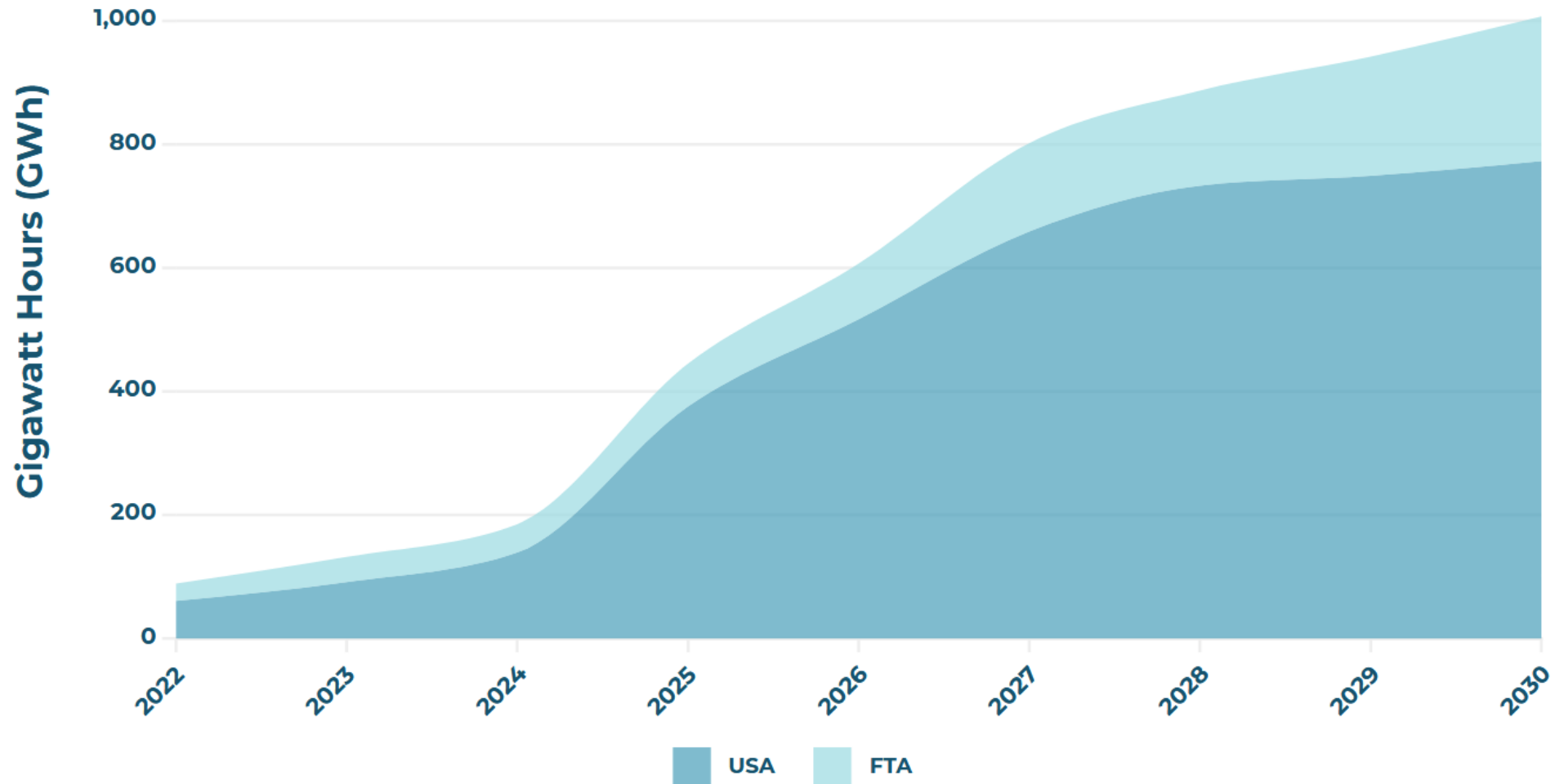
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Figure 2: USA + FTA Battery Demand Forecast by Battery Application, 2022-2030



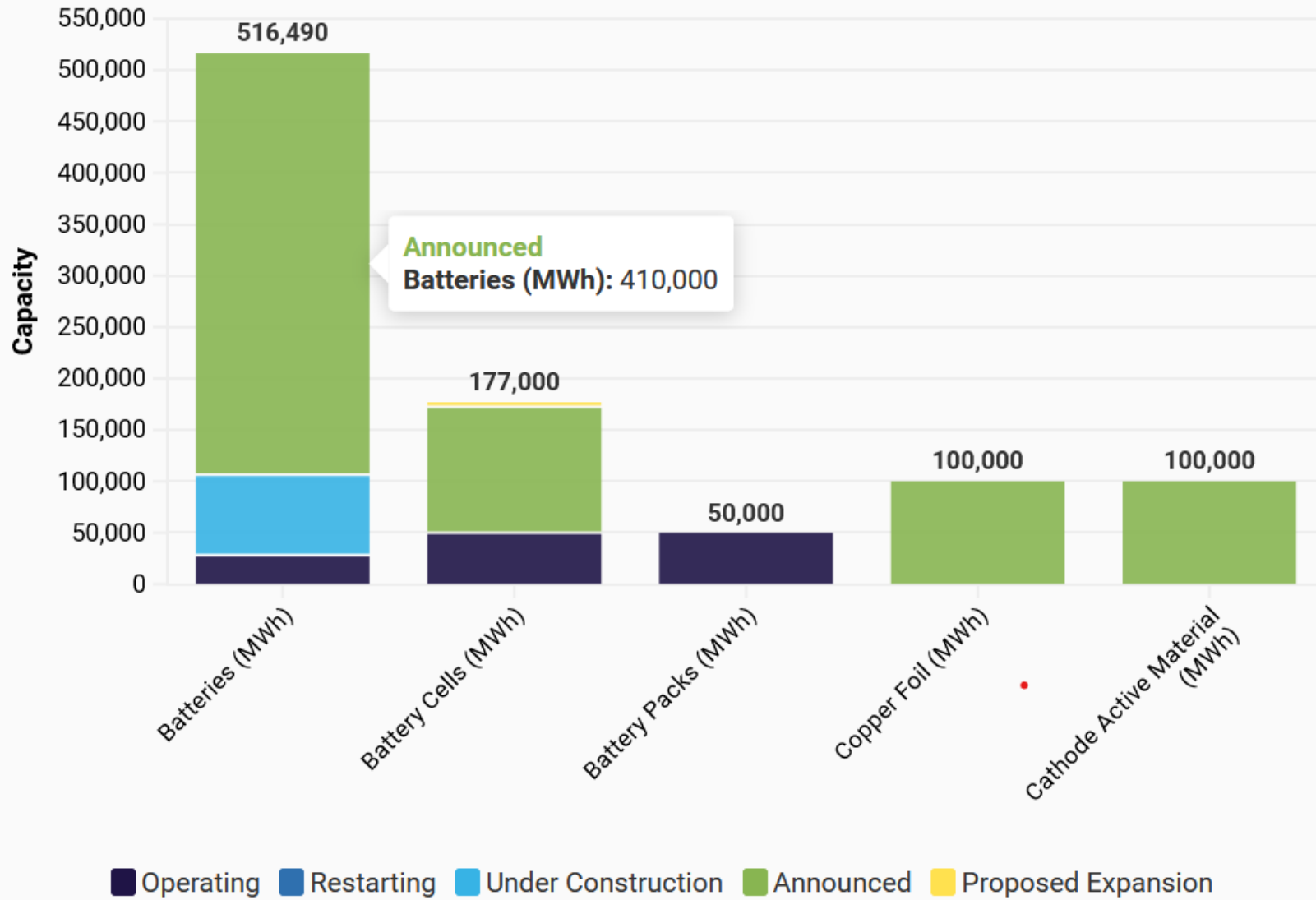
Source: CRU

Figure 3: USA and FTA Countries Gigafactory Capacity Pipeline*



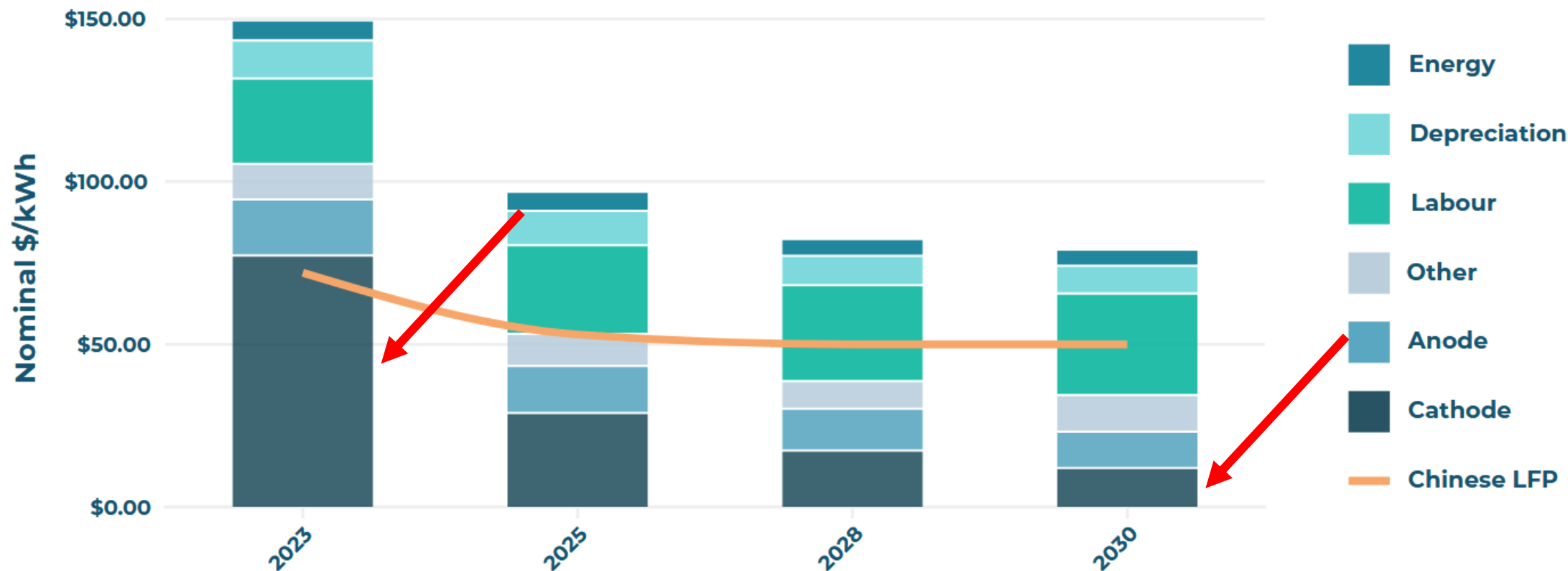
SEIA Energizing American Battery Storage Manufacturing – Nov. 2023
<https://www.seia.org/us-manufacturing-whitepaper-series>

U.S. Storage Supply Chain Capacity by Component & Status



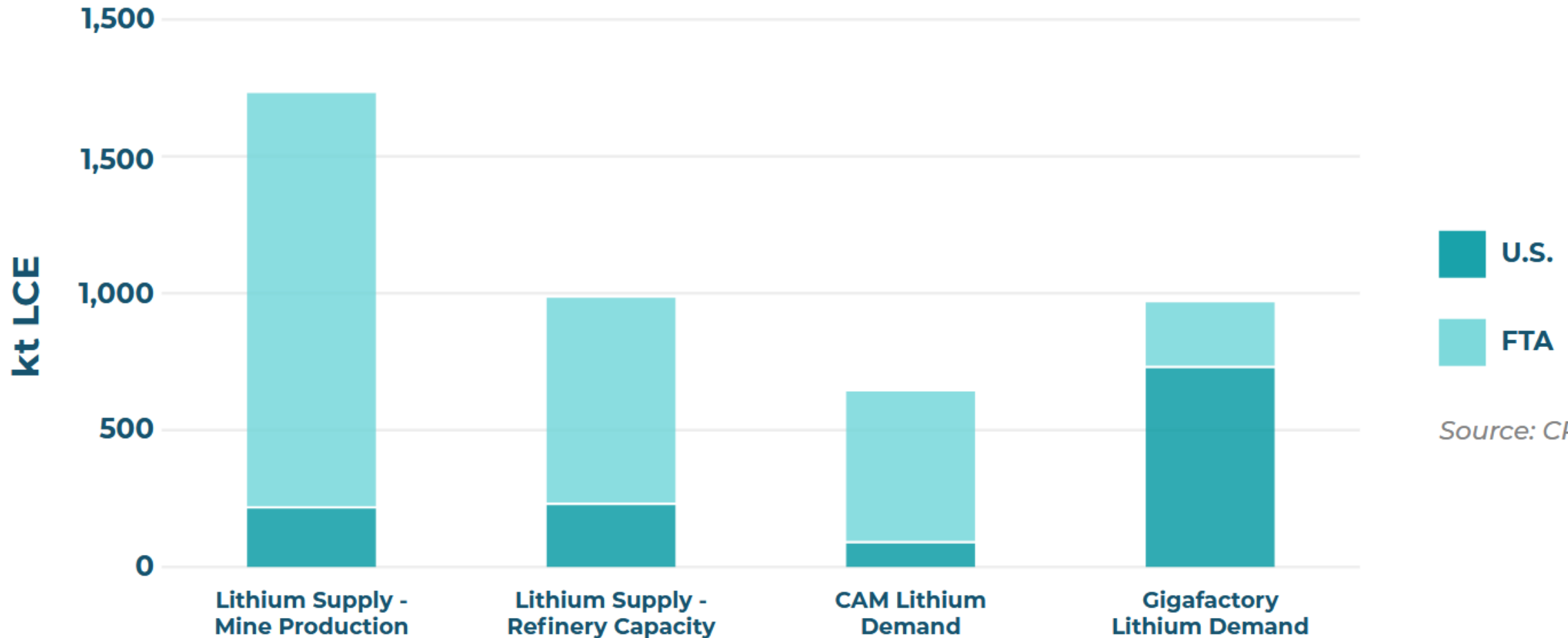
Source: [SEIA Solar & Storage Supply Chain Dashboard](#) • Data includes products for standalone storage applications as well as electric vehicle applications

Figure 4: Manufacturing COGS Forecast for U.S. and Chinese LFP Pouch Cell, 2023-2030



Source: CRU. Battery cost based on 35 Ah pouch cells produced by US and Chinese battery manufacturers at a final output of 10 GWh per year. Produced using CRU's proprietary Battery Cost Model. Material pricing based on Chinese manufacturer prices. "Other" denotes a combination of the electrolyte, separator and casing component costs.

Figure 5: Lithium Supply Chain Balance in U.S. and FTA, 2030



Source: CRU.

Perception of Fire Risk



New York is reeling from its hot battery summer

The state's ambitious clean energy buildout has hit an unexpected setback after three different grid batteries caught fire in the span of two months.

<https://www.canarymedia.com>

DECEMBER 21, 2023 | Albany, NY

**Governor Hochul Announces
Release of Initial Findings From
Inter-Agency Fire Safety Working
Group on Emergency Response**

FERC Order 2222

Region	Participation Models	Max DER Size	Single vs Multi-Node	Initial Review Period (days)	Review Period Modification to Aggregation (days)
CAISO	1	1 MW	Multi	30	14
NYISO	1	20 MW	Single	60	90
PJM	1	5 MW	Single Multi	60	60
ISO-NE	7	5 MW	Multi	60	60
MISO	1	None	Single	30/60	30/60
SPP	N/A	None	Single	60	60

RTO/ISO	Docket No.	Filing Date	Status
NYISO	ER21-2460	7/19/21	Deficiency Letter Issued: 10/1/21 Responded: 11/19/21 FERC Order 6/16/2022
CAISO	ER21-2455	7/19/21	Deficiency Letter Issued: 10/1/21 Responded: 11/1/21 FERC Order 6/16/2022
PJM	ER22-962	2/1/22	Deficiency Letter Issued: 5/15/22 Response Due: 7/7/22
ISO-NE	ER22-983	2/2/22	Deficiency Letter Issued: 5/15/22 Response Due: 6/17/22
MISO	ER22-1640	4/14/22	Comments/Protests submitted 6/6/22
SPP	ER22-1697	4/28/22	Comments/Protests submitted 6/9/22

FERC Order 2023 – Interconnection: A small win for storage

Storage modeling as load

- Mandates that transmission providers model the *withdrawal* of energy from the grid (notably not energy export) according to limits specified by applicant
- Applicants will be required to describe withdrawal limits with applications
- Penalties for non-compliance (can revoke the interconnection agreement) if resources charge during peak times
 - Unclear whether during interconnection or just transmission service
 - Unclear what “peak periods” are
 - Unclear how peak periods could change overtime
 - This could affect the ability to conduct accurate financial modeling
- Storage (and DLR) are NOT included as a transmission alternative

Future issues

- Fire safety
- End of life disposition
 - (safe disposal and recycling)
- Sustainable and just sourcing of raw materials and manufacturing

