CleanEnergy States Alliance

State of the U.S. Energy Storage Industry:

2024 in Review and a Look Ahead to 2025

February 5, 2025

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

Webinar Logistics

All attendees are in **“listen only” mode** – your webcam and microphone are disabled.

Submit questions and comments via the Questions panel 

Speaker bios available in the “Materials” section 

Automated **captions** are available 

This webinar is being recorded. We will email you a webinar recording within 48 hours. This webinar will be posted on CESA’s website at **www.cesa.org/webinars**

Celebrating 20 Years of State Leadership

Clean Energy States Alliance

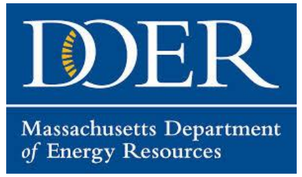
The Clean Energy States Alliance (CESA) is a national, nonprofit coalition of public agencies and organizations working together to advance clean energy.

CESA members—mostly state agencies—include many of the most innovative, successful, and influential public funders of clean energy initiatives in the country.

www.cesa.org

CleanEnergy States Alliance

www.cesa.org



Energy Storage Technology Advancement Partnership (ESTAP)

- 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

www.cesa.org/ESTAP

Webinar Speakers

Todd Olinsky-Paul
Clean Energy States Alliance

Darleen DeRosa
Stem, Inc.

Joan White
Solar Energy Industries Association

Jim Greenberger
NAATBatt International

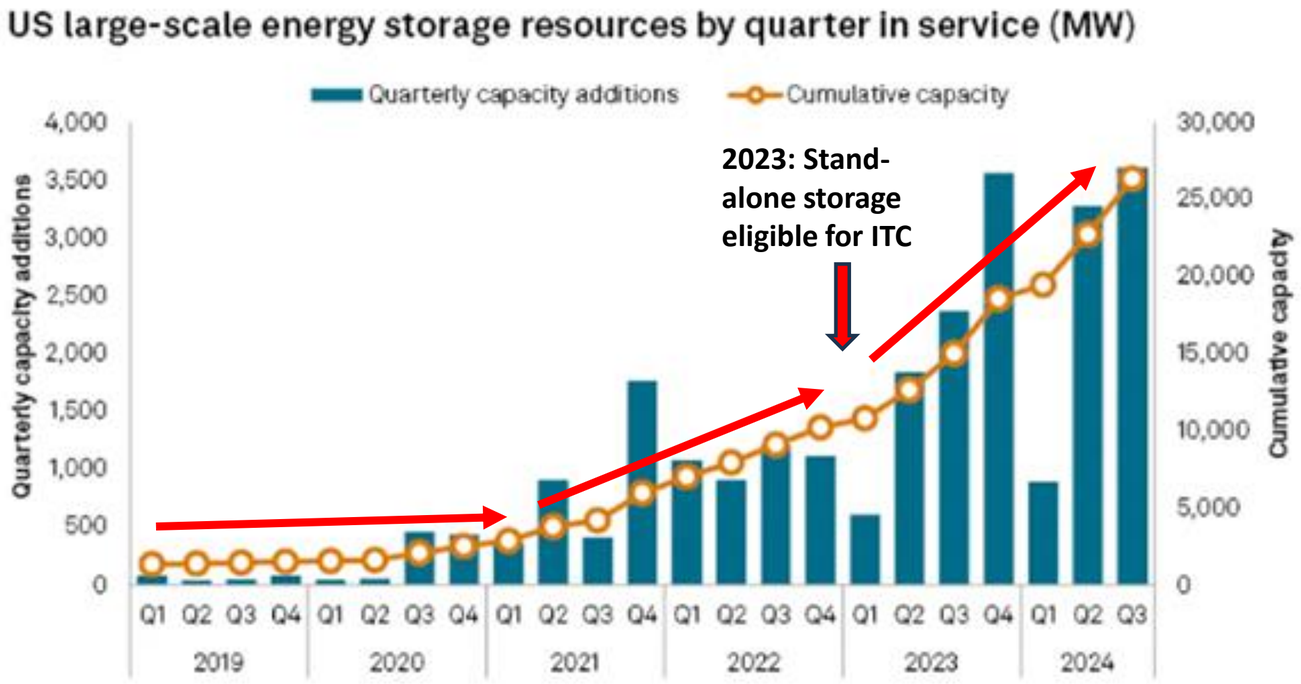
Russ Weed
CleanTech Strategies LLC

Setting the Table

Todd Olinsky-Paul

February 5, 2025

US Energy Storage Growth (deployed, large scale)



Data compiled Nov. 25, 2024.
Analysis includes stand-alone and colocated storage resources. Projects classified as pumped storage are excluded.
Minimum capacity for project units in aggregated list is 200 kW.
Source: S&P Global Market Intelligence.

This chart excludes:

- Pumped hydro
- Distributed/BTM storage

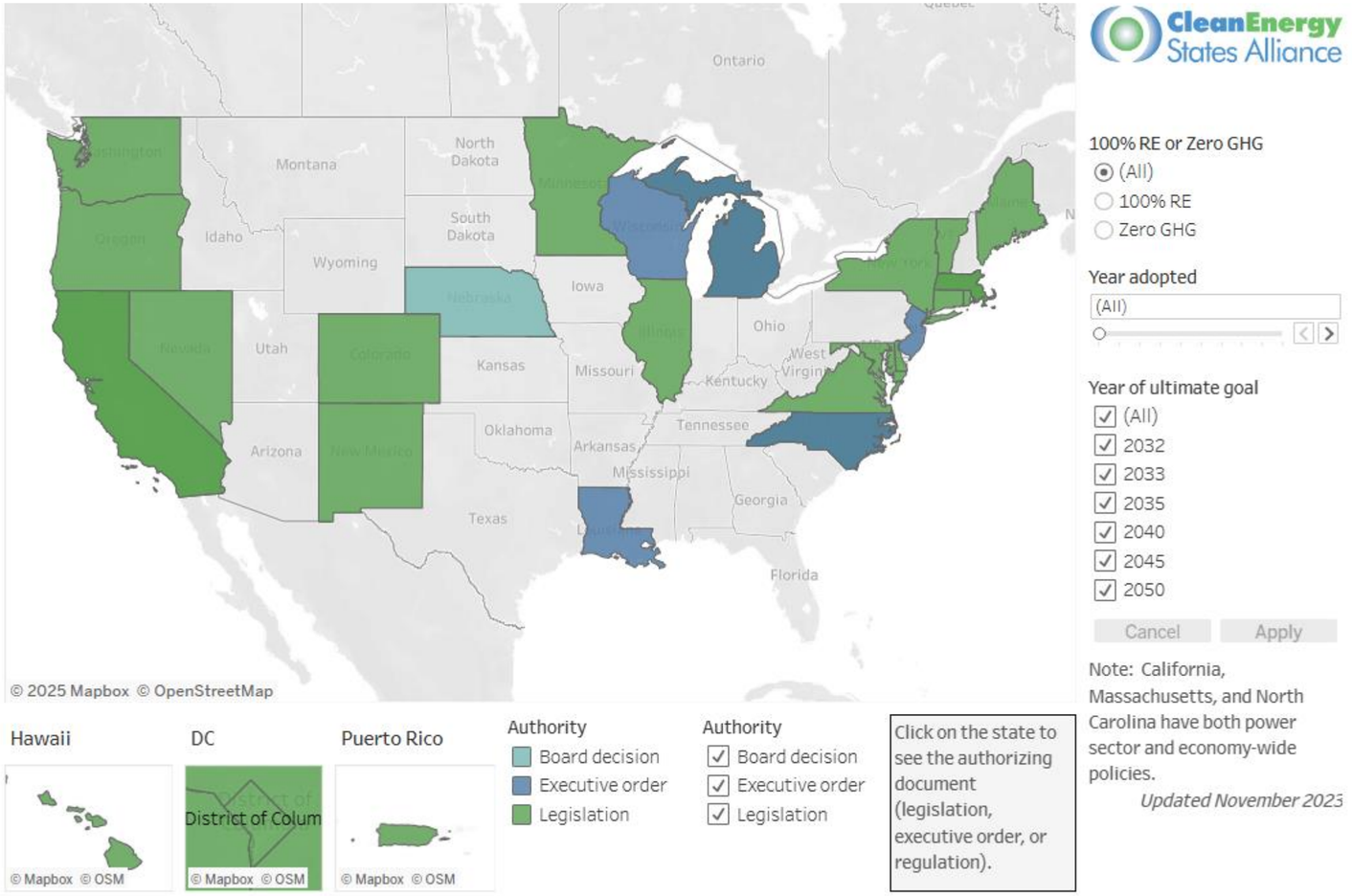
12 States Have Energy Storage Procurement Targets

State	Energy Storage Procurement Targets	Current status	Percent of final target met	Comments	Originating Source	Mandate/Goal/ Target
California	1,825 MW procured by 2020 and installed by 2024. Carve-out of 500 MW for BTM. Additional 2 GW (1 GW of 12-hr storage and 1 GW multi-day) of LDES to be deployed between 2031 and 2037.	10,383 MW total (8,736 MW utility, 571 MW commercial, 1,076 residential) (4999 pending 1,193 MW BTM)	569%	In 2010, the California Legislature authorized the California Public Utilities Commission (CPUC) to consider establishing energy storage targets. The CPUC established their storage procurement targets in 2013, authorized by AB 2514. The procurement targets apply to the state's three largest Investor Owned Utilities. This goal has been achieved. LDES targets were set in August 2024 as part of AB 1373, which sets larger clean energy targets. Statewide energy storage installation data is tracked here.	Legislation and regulation	Mandate
Connecticut	300 MW deployed by 2024, 650 MW by 2027, and 1000 MW by 2030. Carve-out of 580 for BTM	2 MW installed, 206 MW pending	<1% (0.66%)	Connecticut's Senate Bill 952, signed in 2021, mandates three tiers of storage deployment.	Legislation	Goal
Maine	300 MW installed by 2025, and 400 MW installed by 2030	64 MW installed, 267 MW pending	21%	A 2021 law, An Act to Advance Energy Storage in Maine, established energy storage goals and directed steps to advance storage deployment.	Legislation	Goal
Maryland	750 MW deployed by year's end 2027, 1.5 GW through 2030, and 3 GW through 2033	20 MW installed	2.60%	In 2023, Maryland's HB 910 established storage deployment targets.	Legislation	Target
Massachusetts	5,000 MW by 7/31/2030 (3,500 MW of which must be mid-duration and 750 MW LDES)	257 MW installed, 665 MW pending, 30.7 MW BTM	26%	Massachusetts' energy storage target was established in 2018 by An Act to Advance Clean Energy and updated in 2024.	Legislation	Target

This table is available on the CESA website at https://www.cesa.org/resource-library/resource/table-of-state-energy-storage-targets-progress-and-comments/

Michigan	2,500 MW by 2030	16 MW installed, 150 MW pending	<1% (0.64%)	In 2023, Michigan's SB 271 established energy storage mandates as part of a clean energy and climate action package.	Legislation	Mandate
Nevada	100 MW installed by December 31, 2020, and 1000 MW installed by 2030	940 MW installed, 573 MW pending	940%	Nevada's energy storage standard was established by Senate Bill 204 in 2017.	Regulation	Target
New Jersey	600 MW by 2021, and 2000 MW by 2030	90 MW installed	15.00%	2018 legislation established New Jersey's energy storage target.	Legislation	Mandate
New York	1500 MW by 2025, and 6,000 MW by 2030. 35% carve-out for disadvantaged communities and aiming for 20% 8+hr resources.	359.2 MW installed, 571 MW pending	24%	The 2019 Climate Leadership and Community Protection Act set a goal of 1500 MW installed by 2025 and 3000 MW by 2030. In 2022, the state released a roadmap to achieve 6 GW of storage.	Legislation with increase set by governor	Mandate
Oregon	The state's two largest IOUs must each install 5MWh by 2020, up to a maximum of 1% of 2014 peak load.	35 MW installed, 2 MW pending 157 MWh BTM		In 2015, Oregon HB 2193 established a procurement target for the state's two large investor-owned utilities. This goal has not yet been met.	Legislation	Mandate
Rhode Island	90 MW by 2026, 195 MW by 2028 and 600 MW by 2023			June 26, 2024, Rhode Island's Energy Storage Systems Act SB2499 established energy storage procurement targets as part of Rhode Island's journey to a 100% clean energy future.	Legislation	Mandate
Virginia	3100 MW installed by 2035. Carve-out of 10% for BTM	1 MW installed	<1% (.03%)	2020 legislation established procurement targets for the state's two investor-owned utilities (2.7 GW for Dominion, and 400 MW from Appalachian Power Company.) 10% of projects must be deployed behind the meter, and 35% of capacity must be owned by non-utility entities.	Legislation	Mandate

24 States, Plus The District Of Columbia and Puerto Rico, Have 100% Clean Energy Goals



This map, plus more information, is available at https://www.cesa.org/projects/100-clean-energy-collaborative/

Stem is a global leader in AI-enabled software and services that empower its customers to plan, deploy, and operate clean energy assets.

Founded in 2009, now with
600+ employees

Global offices
across United States, Germany, India, and Japan

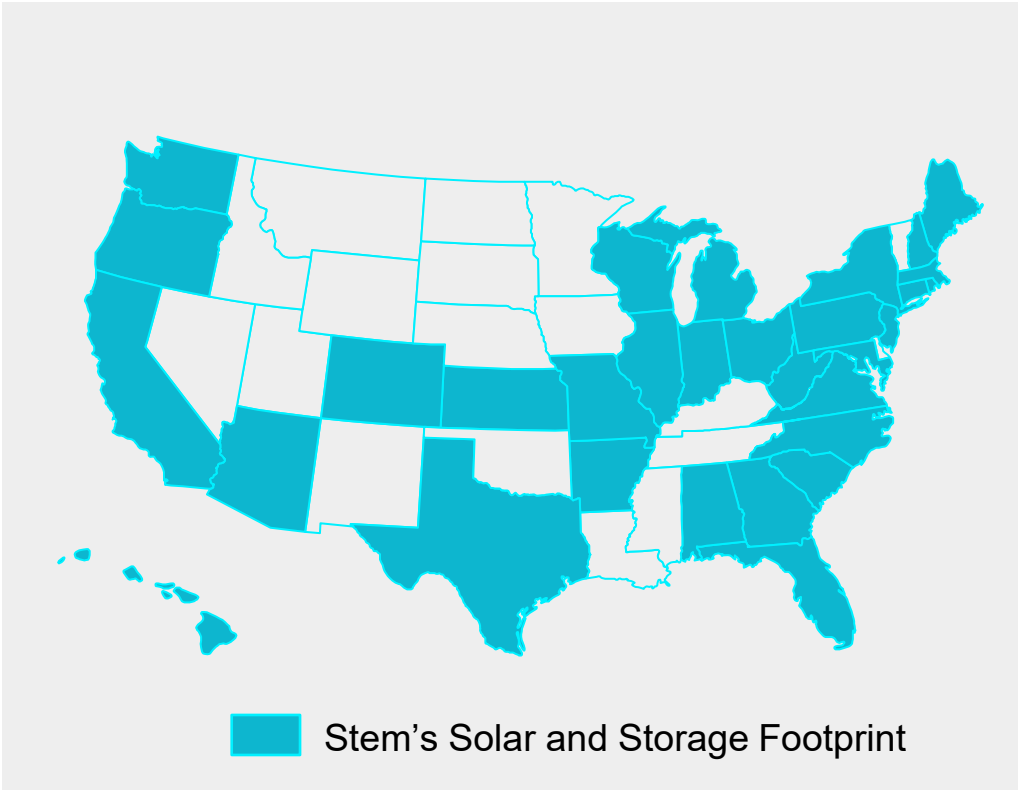
Footprint
50+ countries

25+ GW Solar AUM

6+ GWh Storage AUM
operating or contracted

30+ million runtime hours
of energy data

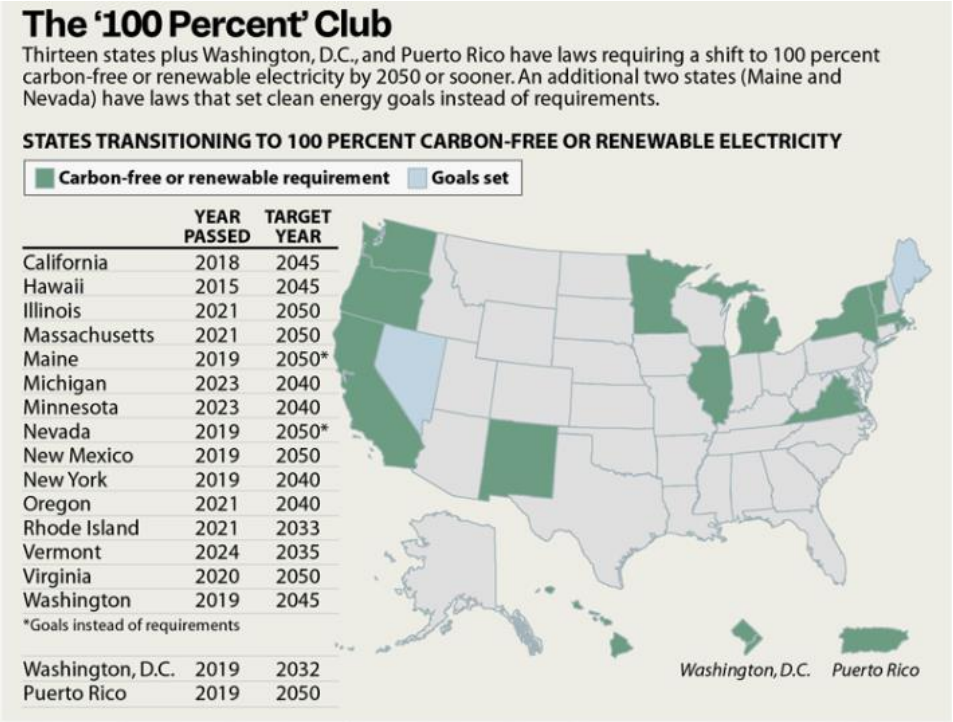
Stem U.S. Customer Footprint



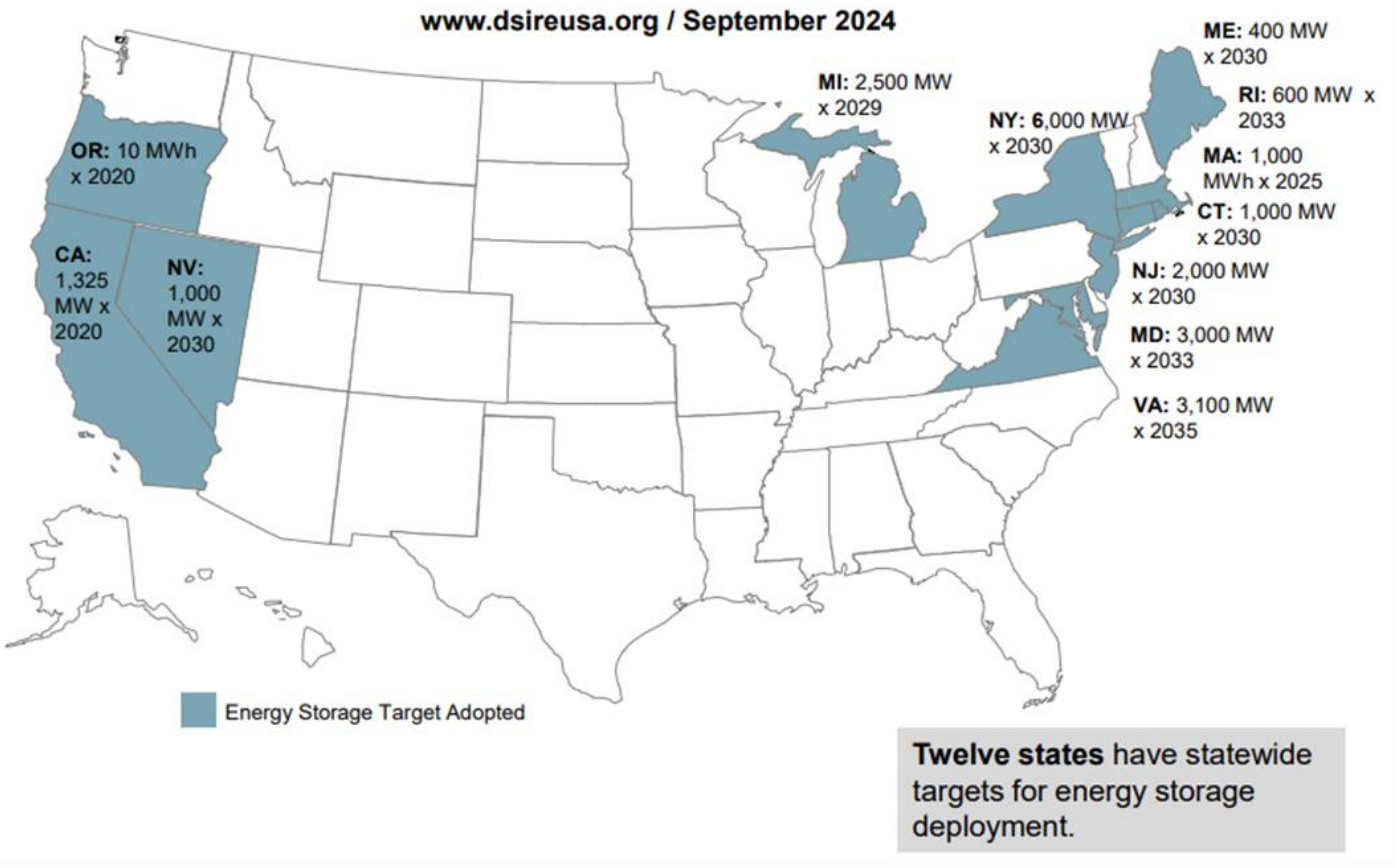
Discussion Purposes Only. Not Intended or Given as Legal, Policy or Tax Advice.

State Targets For Carbon-Free or Renewable Energy

- Twelve states have 100% clean energy mandates
- Timelines ranging from 2033-2050
- These laws *can* lead to storage-specific goals
- In 2024, only one state passed a new mandate (Vermont)
- Texas does not have carbon-free goals and it is a top and growing energy storage market (ERCOT)



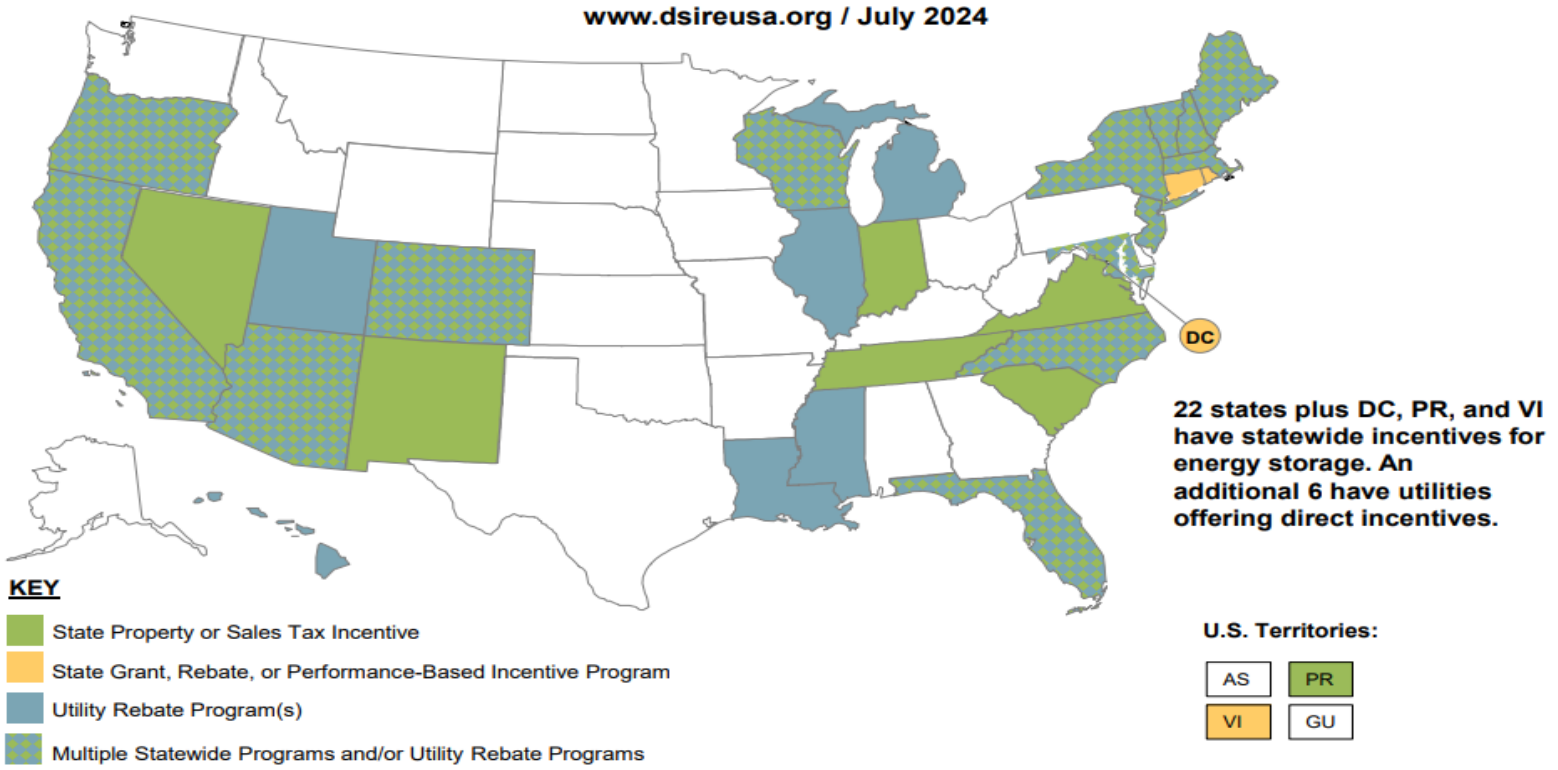
State Energy Storage Targets



In early 2025, Massachusetts increased its energy storage target to 5GW by 2030

Discussion Purposes Only. Not Intended or Given as Legal, Policy or Tax Advice.

State Energy Storage Incentives



State	2024 Storage Policy Highlights & 2025 Look Ahead
NY	6GW by 2030; new retail and bulk incentive plan proceedings moved ahead in 2024. NY PSC must approve implementation plans and timing is TBD, likely 1H 2025. Proposed new fire code language released in September 2024; likely June 2025 time frame for Code Council to codify in state fire code.
NJ	2GW by 2030; incentive proceeding moved ahead in late 2024 after a 2-year delay. Current NJ BPU proposal is to launch distributed program in 2026 and grid supply program in 2025. TBD on timing.
TX	In late 2024, the PUCT voted against implementation of PCM (Performance Credit Mechanism) for ERCOT market redesign. 2025 Texas legislative session is underway; priorities to emerge as policymakers review results and grid performance from 2023 and 2021 (post-Uri) mandates. Anticipate continued focus on grid reliability and affordability and on the relationship between foreign companies and grid infrastructure.
IL	Bill for 8.5GW storage mandate introduced in 2024 did not pass; study to examine how to support 1.5GW of utility-scale storage did pass. New storage legislation for 2025 consideration is likely.
CA	Summer 2024 CAISO dispatchable battery storage played “a major role” as quoted by Elliott Mainzer, CAISO’s CEO & President, in grid reliability. DSGS (Demand Side Grid Services) program first full-season with new guidelines in 2024. Community Solar+Storage plan requiring 4 hours of storage capacity rejected by CPUC. Early 2025 Moss Landing fire under investigation; new legislation on siting has been introduced.
MD **MI**	Regulatory proceedings moved ahead in 2024 on previously-set mandates (3GW by 2033 for Maryland; 2.5GW by 2029 for Michigan.) Anticipate continued proceedings in 2025.
RI **MA**	New energy storage mandates passed in 2024: RI for 600MW by 2033; MA for 5GW by 2030. Anticipate regulatory proceedings to begin in 2025.

State Storage Policy Trends to Watch 2025

- New legislative clean energy and storage mandates less likely
  - IL may be an exception (anticipate new legislation for energy storage to be introduced)
  - State regulatory implementation progress to continue despite evolving federal energy policy environment
- Storage (especially solar+storage) projects continue to increase in size and scale
  - In 2024, Oregon regulators approved Sunstore, a PineGate Renewables project that is the largest solar+storage installation in the U.S. at 9,500 acres, 1200MW of solar and 7,200Mwh of storage. Battery costs continue to decrease and greater ROI given economies of scale.
- Electric Co-Ops build out more energy storage in Western states following programs like New ERA
  - Department of Agriculture New ERA (Empowering Rural America) program provided $9.7B to rural electric cooperatives for storage and clean energy deployment. Of this, approximately $9B has been awarded. AZ, CA, CO, MT, NV, NM, WY have New ERA projects.
- Fire safety is prioritized and addressed in storage regulatory proceedings; local siting considerations take an increasingly prominent role with local governments increasing attention and oversight
  - MD included a Safety Working Group embedded in its storage proceeding

U.S. Energy Storage: 2024

Joan White

Director of Storage and Interconnection Policy

Market data

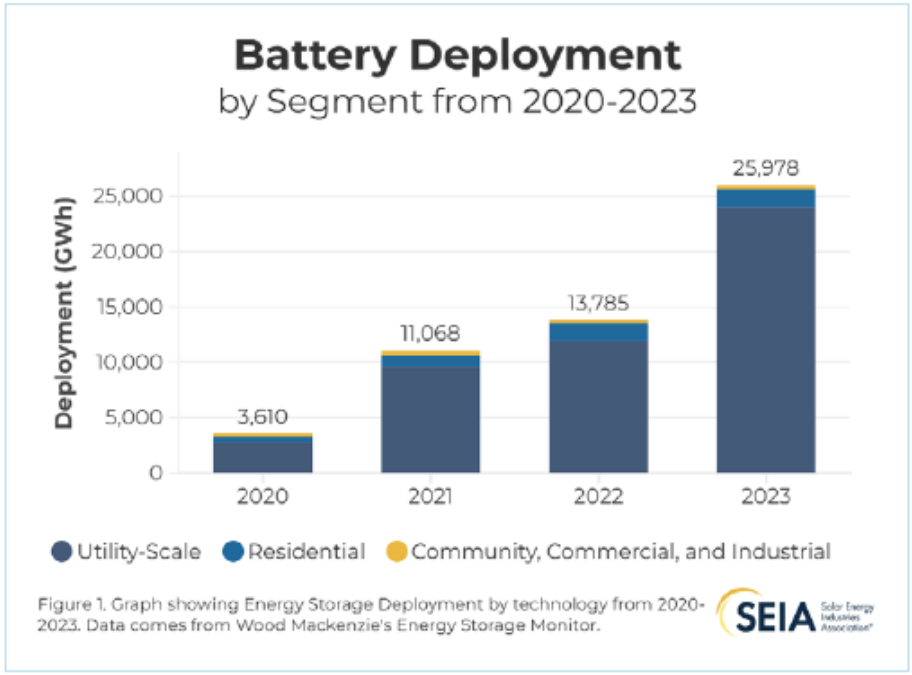


Figure 1. Graph showing Energy Storage Deployment by technology from 2020-2023. Data comes from Wood Mackenzie's Energy Storage Monitor.

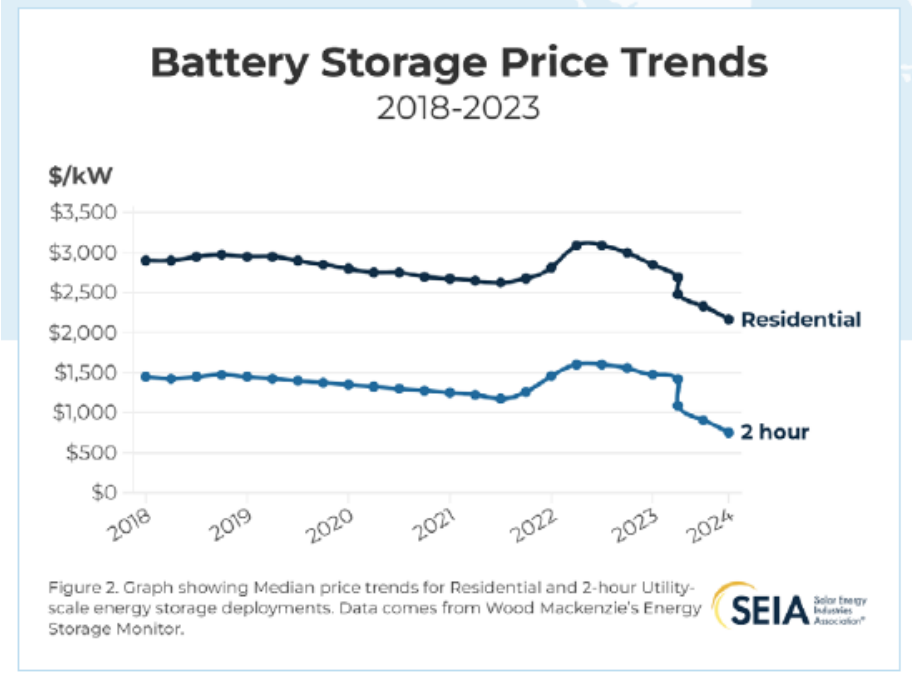


Figure 2. Graph showing Median price trends for Residential and 2-hour Utility-scale energy storage deployments. Data comes from Wood Mackenzie's Energy Storage Monitor.

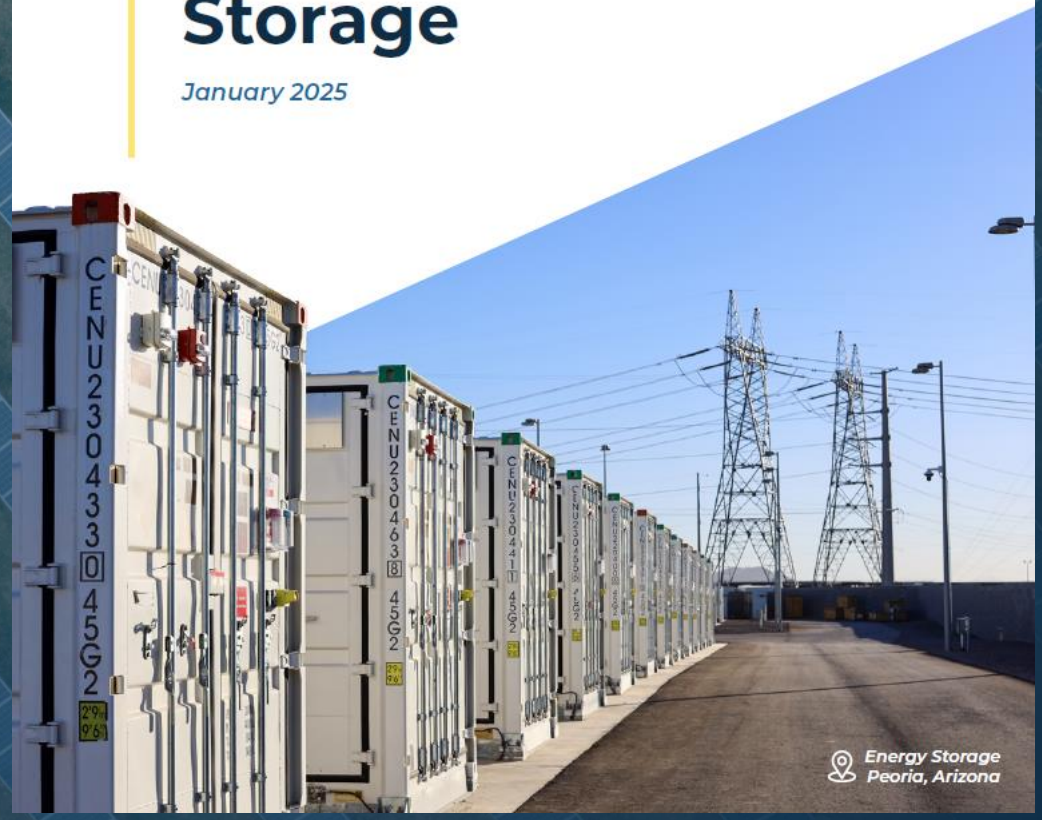
SEIA Solar Energy Industries Association®

SEIA Solar Energy Industries Association®

SEIA Solar Energy Industries Association®

SEIA's Vision for **American Energy Storage**

January 2025



SEIA Solar Energy Industries Association®

Goal

700 GWhs by 2030

10 million residential systems

540 GWhs in utility-scale

Energy storage needs the support of policymakers

Storage can only thrive in a policy environment where it has equal access to the grid and where market barriers have been removed. To support the transition to a clean, reliable grid that maximizes the potential of energy storage, public policy investments must be made to support new storage projects and manufacturing facilities. Federal, regional, and state policy makers should focus on the following priorities to unleash the full potential of energy storage:

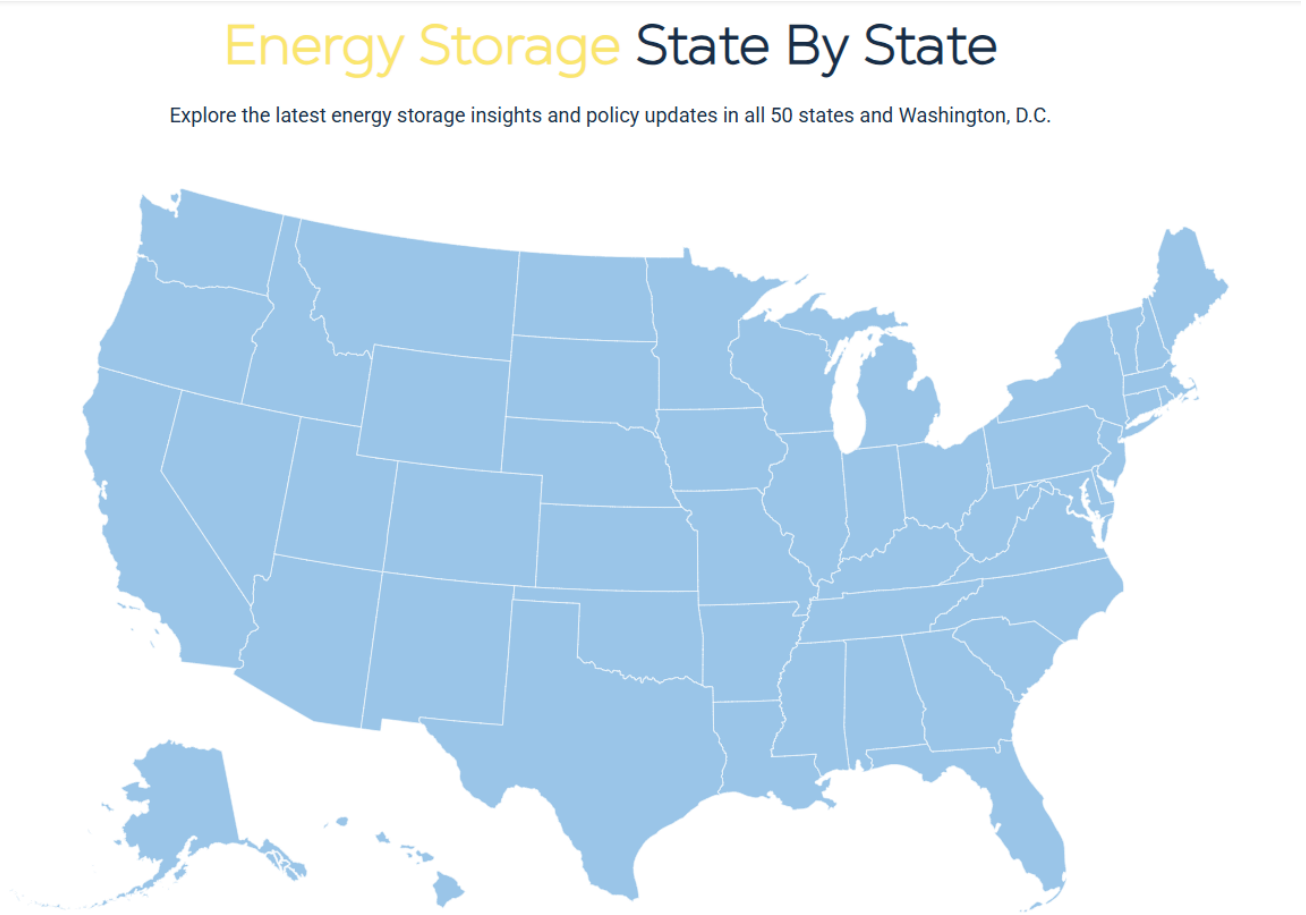
Level the playing field for storage by ensuring equal access to the grid and providing fair compensation for energy storage and the grid services it can provide

Maintain and build financial support for storage projects

Promote storage adoption incentives for vulnerable communities or those disproportionately impacted by extreme weather events

SEIA Solar Energy Industries Association®

50-state guide



[Energy Storage – SEIA]

SEIA Solar Energy Industries Association®

Questions

State of the U.S. Energy Storage Industry – 2024 in Review and a Look Ahead to 2025

Russ Weed
CleanTech Strategies

Energy Storage Technology Advancement Partnership (ESTAP)
Clean Energy States Alliance

February 5, 2025

Outline

- **CleanTech Strategies' Credentials**
- **2024 in Review**
- **A Look Ahead to 2025: Private Tolling Agreements**
- **Toll Agreement Price in 2025 for 10-hour ESS**

CleanTech Strategies – Business Advisors

Russ Weed, president

- Energy storage expert with 13 years industry experience
- Founding management of leading flow battery company in 2012
- Established subject matter expert firm CleanTech Strategies LLC in 2018
- J.D.; executive at General Electric, mid-market companies, start-ups

Chris Murray, advisor

- Washington, DC veteran with 20+ years experience in "the Beltway"
- Served U.S. Senator, White House, FERC, US Navy
- J.D.; manager at Washington, D.C. utility

CleanTech Strategies – Technical Advisors

Curt Kirkeby, fellow engineer

- Electrical engineer with 41 years utility experience
- Innovation and technology grid-edge strategist for 20+ years
- Advanced grid automation control development for 15+ years
- P.E.; technology patent holder for multiple grid edge technologies

Dave Ridley, engineer

- Electrical engineer with 15+ years experience in ESS product development
- Developed zinc, vanadium, and lithium-based products for MW-scale deployment
- B.S.; expertise in battery management control and power electronics integration

2024 in Review

Energy Storage Systems (ESS)

- **Lithium-ion ESS still need to mature in TRL***
  - **Thermal management, unit segmentation, fire suppression**
- **US-deployed lithium ESS will increasingly require US manufacturing**
  - **Content requirements (DOD, DOE, ITC, utility) and tariffs**
  - **US manufacturing will need to achieve high MRL****

- **Non-lithium ESS are maturing in TRL* and MRL****
  - **Flow Batteries: Metal, Non-Metal**
  - **Mechanical Storage: Gravity, CO_2**
  - **Sodium Batteries: Metal, Ion**
  - **Zinc Batteries: Manganese**

***TRL = Technology Readiness Level ****MRL = Manufacturing Readiness Level**

2024 in Review

US Energy Storage Markets

- **Organized markets (ISO's/RTO's, States) need to speed up developing and implementing compensation structures for ESS providing:**
  - **Daily 4-10hrs energy discharge**
  - **Power capabilities which in fossil-fueled systems treated as "internalities": system inertia (frequency support), black-start**

- **Private transaction structures need to be better understood, used, and financed in the US energy storage industry**
  - **Compensation for MWh throughput: $/MWh (PPA)**
  - **Compensation for MW dispatchable capacity: $/MW (tolling agreement)**
  - **Hybrid compensation: $/MWh and $/MW**

Looking Ahead in 2025 and Beyond: Tolling Agreements for LDES

"Long used for natural gas power plants, a tolling agreement is a type of offtake contract in which the buyer pays the seller a set amount to effectively 'rent' a[n] asset from the owner. The owner is responsible for operating and maintaining the asset as well as ensuring its availability, while the buyer controls its dispatch . . ."

https://www.edf-re.com/emerging-trends-in-utility-scale-renewables/

What is a Tolling Agreement?

Summing up for the toller

+ fixed fee regardless of commercial results
- responsibility for the technical setup and all administrative aspects
- no authority over asset use

Summing up for the off-taker

+ authority over how the asset is operated (for ancillary services, wholesales etc)
+ mitigated risk across critical project areas (development, commissioning, round trip efficiency, maintenance, operation etc)
- responsibility to supply fuel to the asset
- obligation to pay the tolling fee even if the asset commercially underperforms

https://hub.enspired-trading.com/blog/tolling-agreements-and-floor-pricing-for-bess

Present Day Example of ESS Tolling Agreement

ESS:	
Contract Year 1 PPA ESS Capacity Price ($/MW-month)	
Capacity Price Escalation Percentage each Contract Year (%/year) [If applicable]	
Storage Term (years, excluding any extension options)	
If option to extend storage term is being offered, how many 5-year increments (not to exceed PPA term)?	
Extended Storage Term Capacity Price ($/MW-month)	
Extended Storage Term Capacity Price Escalation Percentage each Contract Year (%/year) [If applicable]	
Guaranteed Capacity (MW)	
Guaranteed Energy Capacity (MWh)	

NVEnergy

BID PROTOCOL
2024
ALL-SOURCE
REQUEST FOR PROPOSALS

The Fixed Fee under a Tolling Agreement: $/kW-month

ESS:	
Contract Year 1 PPA ESS Capacity Price ($/MW-month)	
Capacity Price Escalation Percentage each Contract Year (%/year) [If applicable]	
Storage Term (years, excluding any extension options)	
If option to extend storage term is being offered, how many 5-year increments (not to exceed PPA term)?	
Extended Storage Term Capacity Price ($/MW-month)	
Extended Storage Term Capacity Price Escalation Percentage each Contract Year (%/year) [If applicable]	
Guaranteed Capacity (MW)	
Guaranteed Energy Capacity (MWh)	

NVEnergy

BID PROTOCOL
2024
ALL-SOURCE
REQUEST FOR PROPOSALS

2015 Example of ESS Tolling Agreement

UTILITYDIVE

Ontario turns to storage for renewables integration, grid services

Ontario's system operator is pushing for more storage, but its approach differs from many organized markets in the US

Published Jan. 5, 2016

https://www.utilitydive.com/news/ontario-turns-to-storage-for-renewables-integration-grid-services/411363

2015 Example of ESS Tolling Agreement

RENEWABLE ENERGY WORLD

In Canada, Ontario has also mandated the procurement of energy storage through a two-part solicitation that concluded in November. The province's Independent Electricity System Operator (IESO) has awarded contracts for 50 MW of storage to 10 companies. Most of the contracts were designed to support or improve grid functions by providing frequency regulation service or voltage support.

The province is using contracts because IESO does not have market mechanism such as a capacity market to compensate those resources. But IESO is using the solicitation to test the waters for the economic viability of using storage to balance its grid and to aid in integrating an expected influx of intermittent renewable resources.

https://www.renewableenergyworld.com/storage/one-good-year-deserves-another-energy-storage-in-2016/

$/kW-month for 4-hour / 8MWh ESS - 2015

~$23/kW-month

2025 Example of ESS Tolling Agreement

https://www.publicpower.org/periodical/article/ameresco-signs-battery-storage-contract-with-snohomish-county-pud

$/kW-month for 4-hour / 100MWh ESS - 2025

~$14/kW-month

What is competitive pricing for 10-hour ESS in 2025?

~$35/kW-month

[$35 / 30 days / 10-hours discharge = 11.6 cents per kWh]

Compared to 4-hour / 100MWh in 2025:

[$14 / 30 days / 4-hours discharge = 11.6 cents per kWh]

* **Sizing of 100+ MWh. Does not include adders for additional benefits of 4-10hr non-lithium ESS.**

Thank You. Questions?

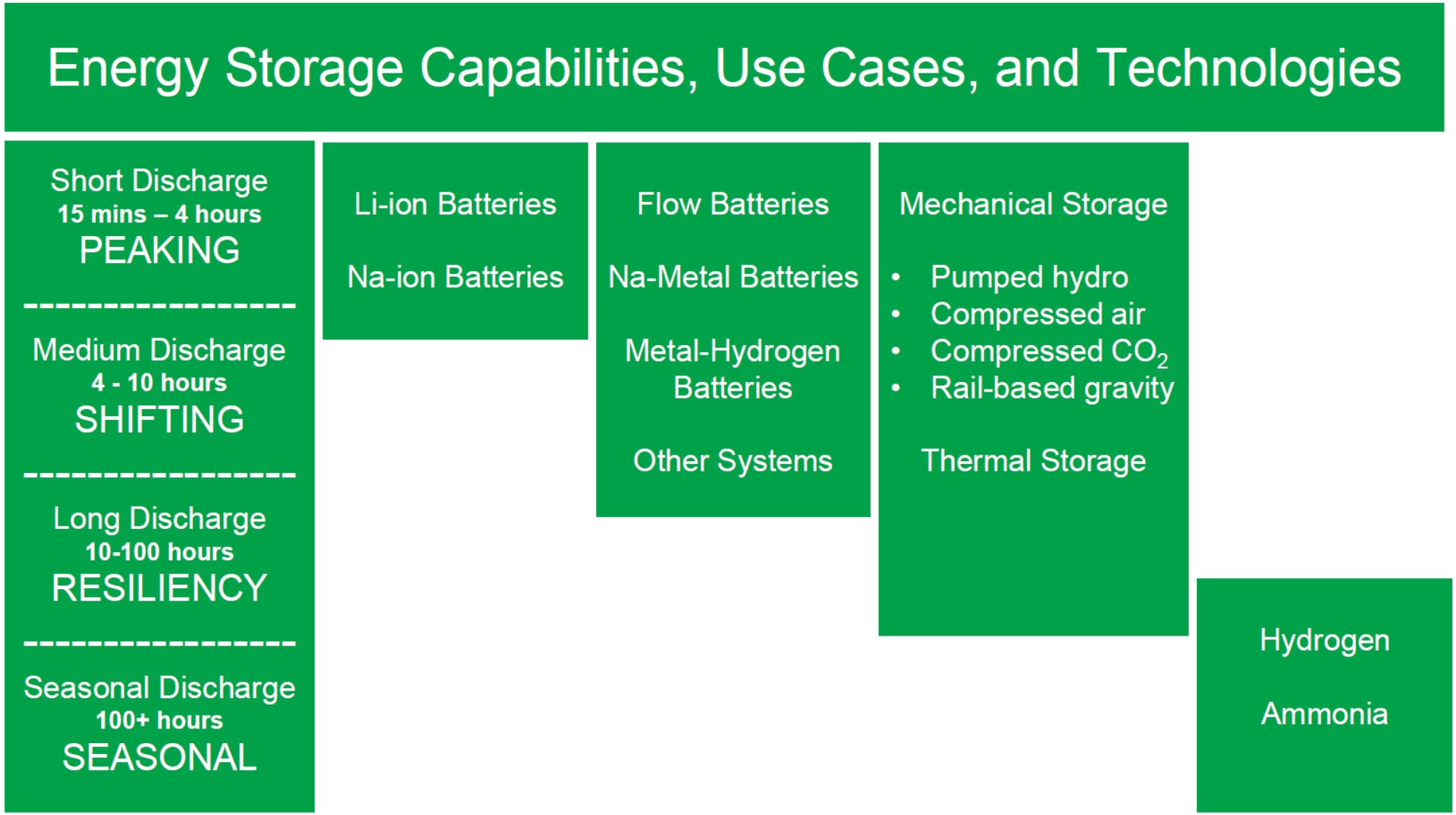
Russ Weed
President

CleanTech Strategies

russ.weed@cleantechstrategies.us
(206) 851-1653 mobile
Russ Weed | LinkedIn
CleanTech Strategies | LinkedIn

APPENDIX

ESS Segmentation



Origin of “LDES”

BEFORE THE PUBLIC UTILITIES COMMISSION

OF THE STATE OF CALIFORNIA

Order Instituting Rulemaking to Oversee the Resource Adequacy Program, Consider Program Refinements, and Establish Annual Local Procurement Obligations.	R.11-10-023 Filed October 20, 2011

MOTION FOR PARTY STATUS
OF IMERGY POWER SYSTEMS, INC., PRIMUS POWER,
ZBB ENERGY CORPORATION, ENERVAULT CORPORATION
AND UNIENERGY TECHNOLOGIES, LLC

February 18, 2014

Origin of “LDES”

“Joint LDES Companies”

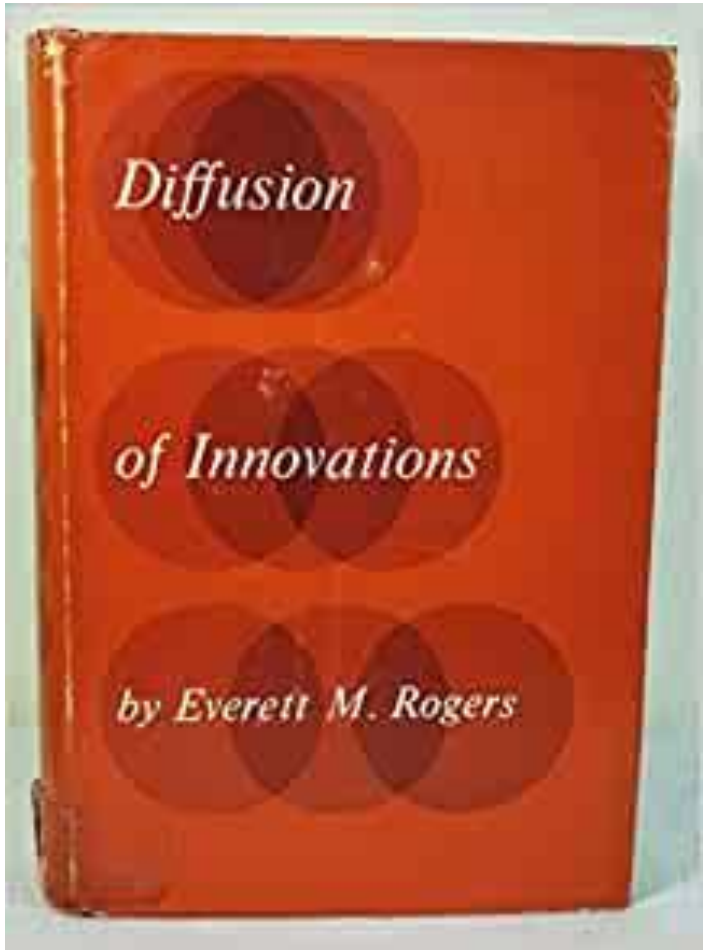
Origin of “LDES”

1. LDES originated related to 4-hour Resource Adequacy (RA) in California

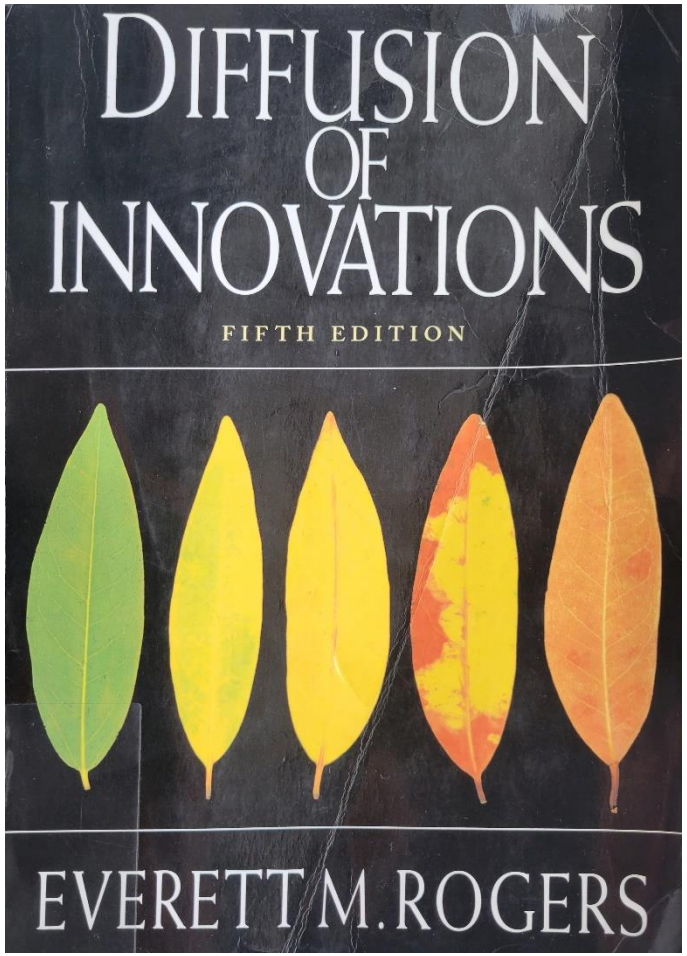
2. LDES originated more than a decade ago in 2013

3. Each of the original LDES proponent companies failed, but the demand for 4+ hours energy storage has developed (≠ matured)

“Diffusion of Innovations,” Dr. Everett Rogers



First Edition, 1962



Fifth Edition, 2003

Adoption of Innovations (idealized)

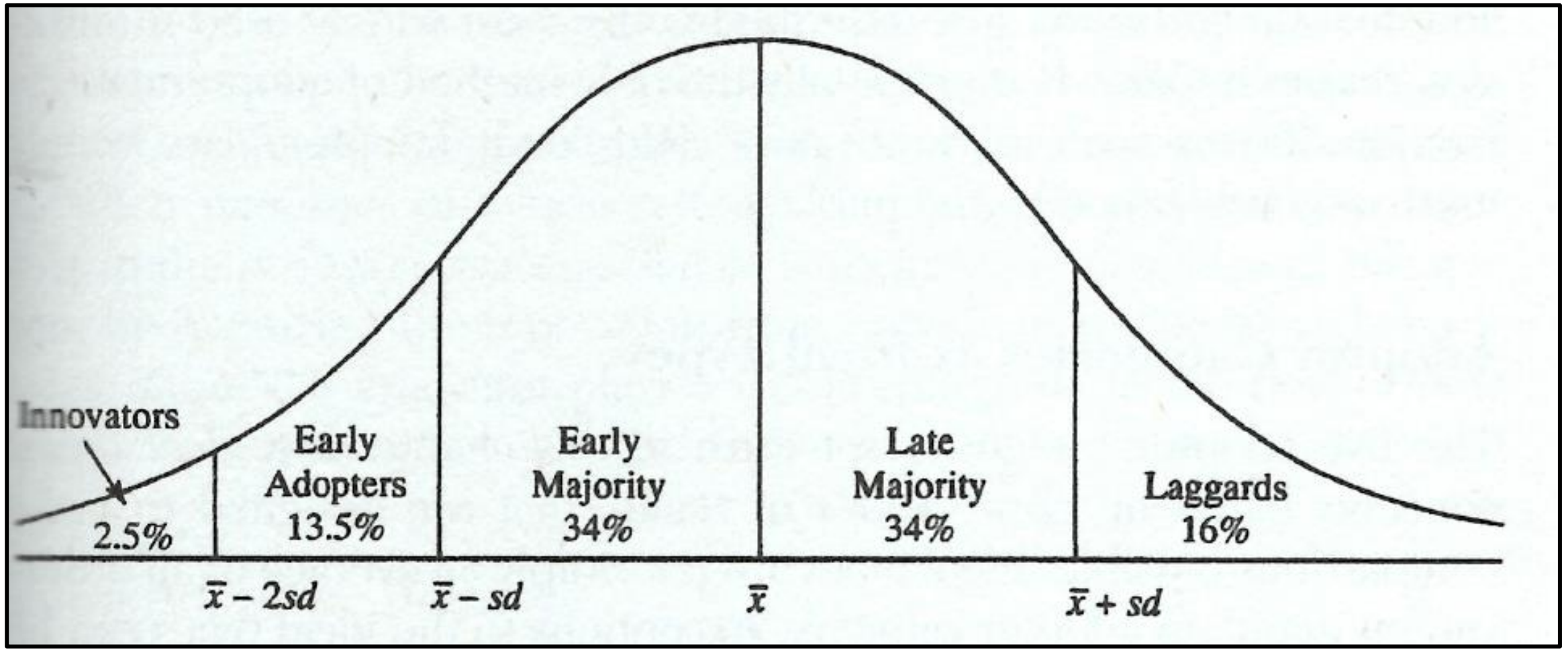


Figure 7-3, Page 281

Adoption Causes

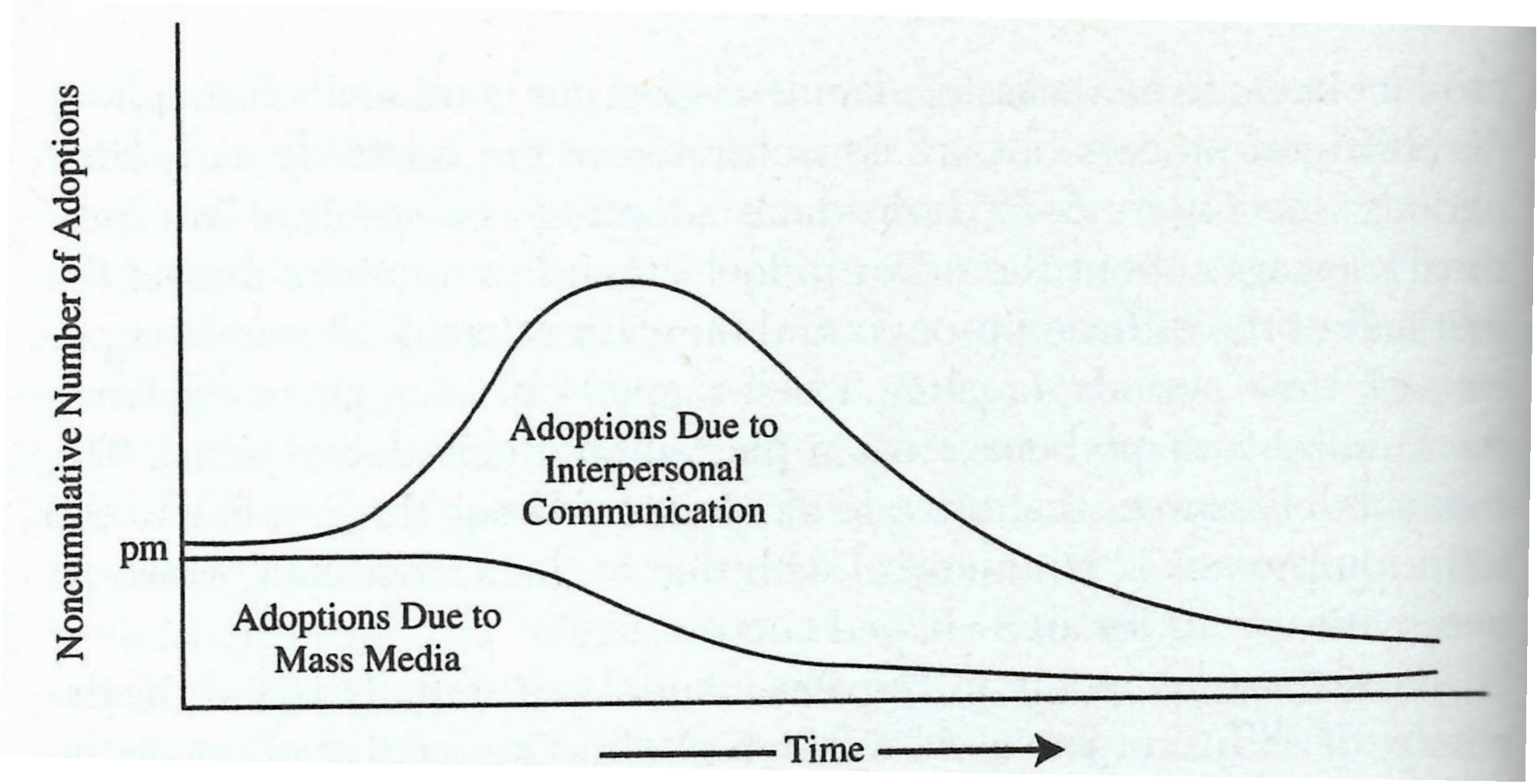


Figure 5-2a, Page 210

Innovation Adoption in Reality

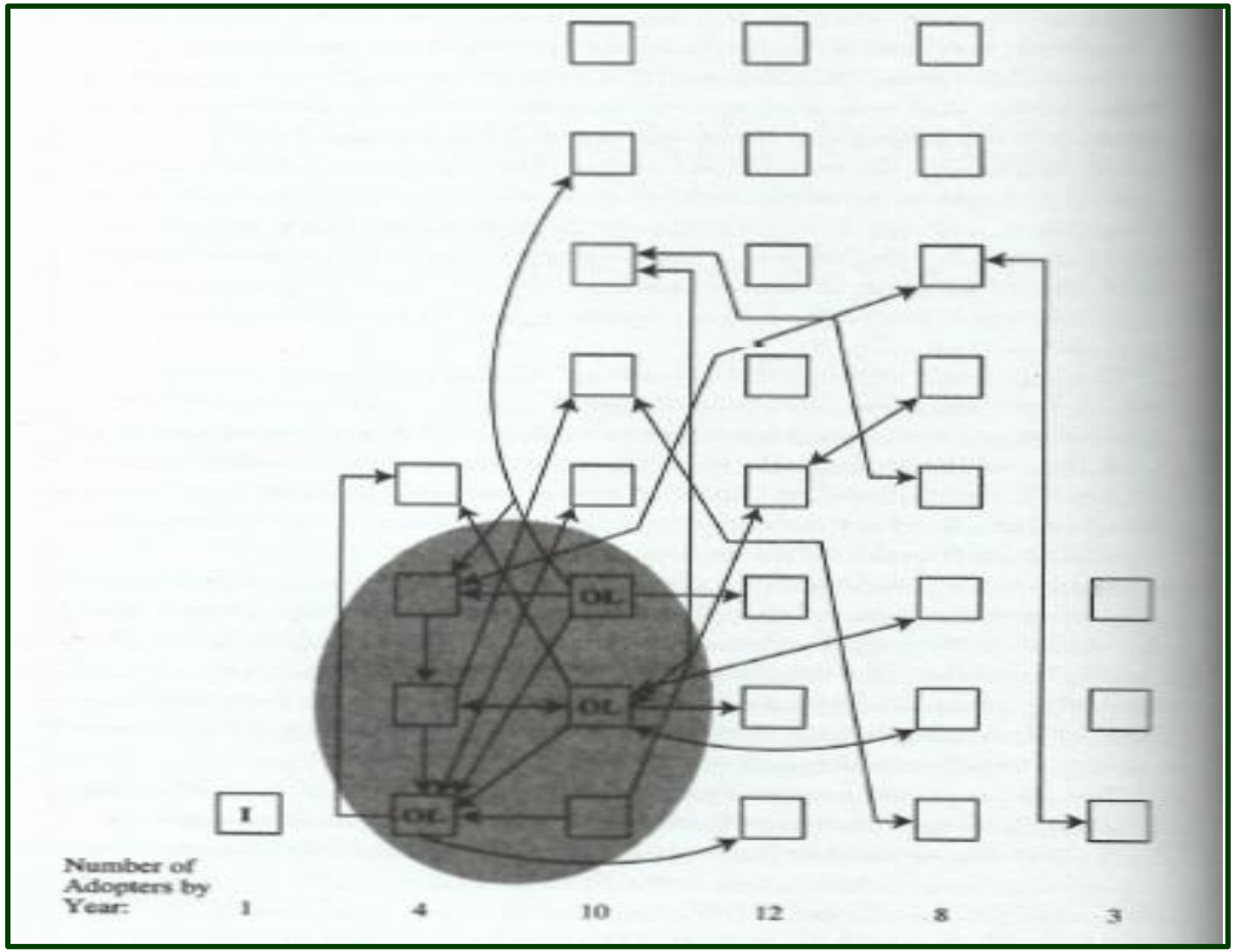


Figure 8-1, Page 302