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States Energy Storage Policy

Best Practices for Decarbonization

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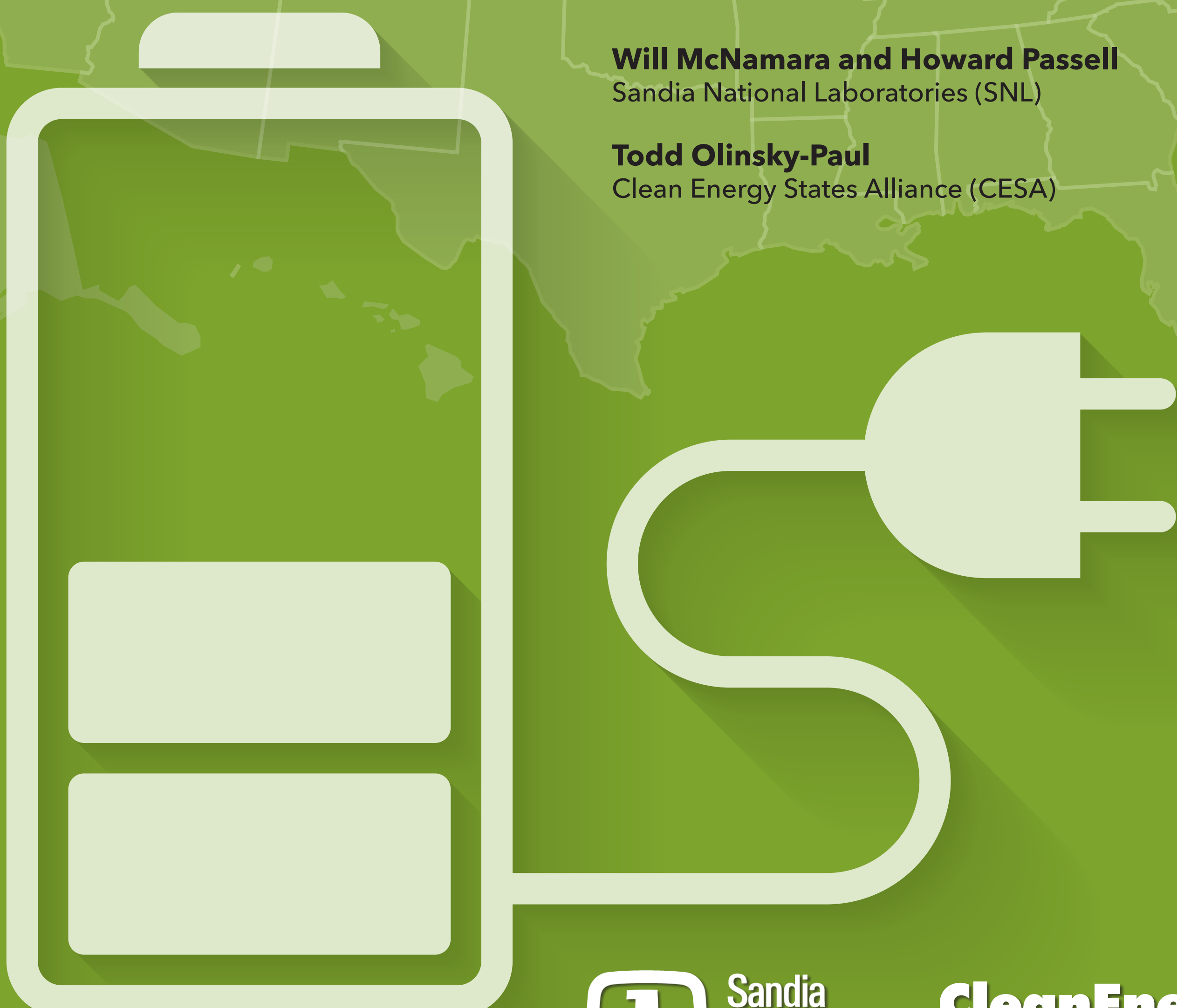

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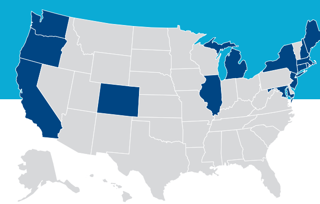

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ABOUT THIS REPORT

This report, prepared by Sandia National Laboratories (SNL) and the Clean Energy States Alliance (CESA), summarizes findings from a 2022 survey of states that are leading the nation in establishing decarbonization goals and programs. It also summarizes findings from a 2022 survey of energy storage developers, and it provides a "deeper dive" into key state energy storage policy priorities and the challenges being encountered by some of the leading decarbonization states, with several case studies.

The report is based on the idea that dramatic expansion of renewable energy resources is essential to the decarbonization of the US power sector, and that the inherent variability of many renewable energy sources, like photovoltaics and wind, will demand vast amounts of strategically sited energy storage systems. These energy storage systems will enable variable resources to become more dispatchable and to shift electricity from times of high generation to times of high demand. Because clean energy policy and regulation are largely implemented at the state level, effective state energy storage policies will be crucial to achieving greater decarbonization nationwide.

Taken altogether, the elements comprising this report provide important perspectives on how the leading states are approaching energy storage policy to support decarbonization goals. The authors' intent is to highlight best practices, identify barriers, and underscore the urgent need to expand state energy storage policymaking to support decarbonization in the US.

ACKNOWLEDGMENTS

The report's authors would like to thank Sandia National Laboratories and Dr. Imre Gyuk at the US Department of Energy, Office of Electricity for their generous support of our work; and CESA Executive Director and Project Director for the 100% Clean Energy Collaborative Warren Leon, CESA Project Associate Anna Adamsson, CESA Director of Program Administration Maria Blais Costello, and CESA Communications Manager Samantha Donalds for their invaluable contributions to this report. David Gerratt of DG Communications designed the report.

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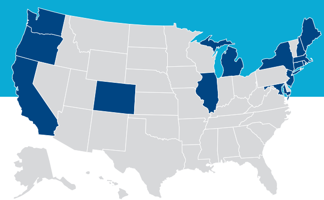

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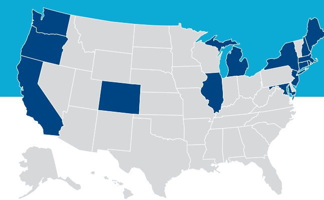

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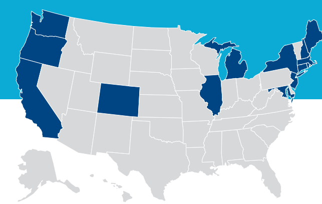

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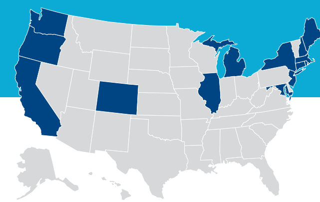


Introduction

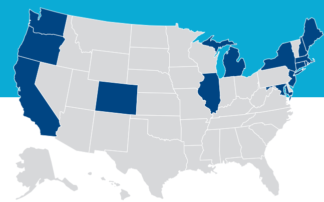
Defining the pathways toward decarbonizing the US electric grid is among the most urgent challenges facing policymakers today. Decarbonization of electricity generation is one of the most pressing issues of our time, and yet the most effective approaches for achieving it are far from clear.

By definition, decarbonization means a comprehensive and tactical move away from the historic reliance on fossil fuel resources and toward renewable energy (RE) resources, such as wind and solar. However, the inherent variability of these clean resources requires energy storage systems to achieve higher levels of reliability. As more RE resources replace fossil fuel resources, more and longer duration energy storage technologies will need to be deployed. A key challenge is determining how energy storage technologies will be enabled, used, and compensated so that these technologies can support distribution grid operations and participate in wholesale and retail energy markets, such as those regulated by regional grid operators and state regulatory commissions. State policymakers will play a key role in defining how quickly the nascent energy storage industry will come to scale in retail markets, and how storage technologies will be interconnected to distribution grids.

To achieve their ambitious decarbonization goals, policymakers in the leading states will need to create new policies, rules, and regulations that will enable an unprecedented amount of energy storage to be deployed and operated in ways that will support decarbonization while improving grid reliability and resilience. In return, storage owners must be provided with access to retail and wholesale energy markets where they can receive appropriate compensation for these services.

At this time, nearly half of US states have established well-defined policies relating to decarbonization; many of the leading decarbonization states have also developed some level of policy and regulation to support energy storage deployment as a key element of a decarbonization roadmap. Collectively, these state efforts represent a substantive policy framework.

This paper, prepared by Sandia National Laboratories (SNL) and the Clean Energy States Alliance (CESA), identifies and summarizes these existing trends in state energy storage policy in support of decarbonization, as reported in a survey the authors distributed to key state energy agencies and regulatory commissions in the spring of 2022. It also contrasts state energy storage policy trends with the preferences of energy storage development firms (gathered through a second survey); and it provides a deeper look into key state energy storage priorities and challenges through five case studies based on interviews with state policymakers. Altogether, the report intends to outline state policy best practices and priority issues and to outline an energy storage policy framework that can be adopted by other states to support decarbonization goals.



Survey Methodology

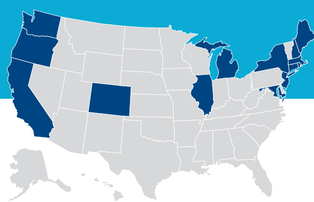
In the spring of 2022, the Clean Energy States Alliance (CESA) and Sandia National Laboratories (SNL) distributed a survey to regulatory and energy agency officials from the leading decarbonization states (that is, the states that have established 100 percent decarbonization or clean energy goals). Most of these states are participants in CESA's 100% Clean Energy Collaborative. The survey comprised 15 questions pertaining to decarbonization and energy storage policies being adopted at the state level, primarily by state utility commissions and energy agencies, but also by legislatures and governors.

The survey aimed to gather information across a broad array of topics related to energy storage and regulatory and policymaking efforts for decarbonization in place at the state level. Within the context of the survey and this report, state-level policymaking refers to the processes of developing legislation, regulatory rules, executive orders, or other instruments that are formally issued by a state.

A key aspect of the survey was the offer of anonymity. Survey respondents were assured that their names would not be revealed in connection with particular survey responses. This was done in order to encourage candid responses. For several key states, follow-up interviews were conducted, which provided a basis for case studies. For these interviews too, the interviewers pledged to maintain the anonymity of individual respondents.

In order to obtain a different perspective on state policymaking trends, a second survey was distributed to representatives of the energy storage industry, focusing on firms engaged in energy storage development at various scales (bulk power, distribution and behind-the-meter (BTM) storage). Included in this report is a summary of the responses to the industry survey.

The states survey may be viewed in Appendix A. The industry survey may be viewed in Appendix B. State case studies appear at the end of the report.

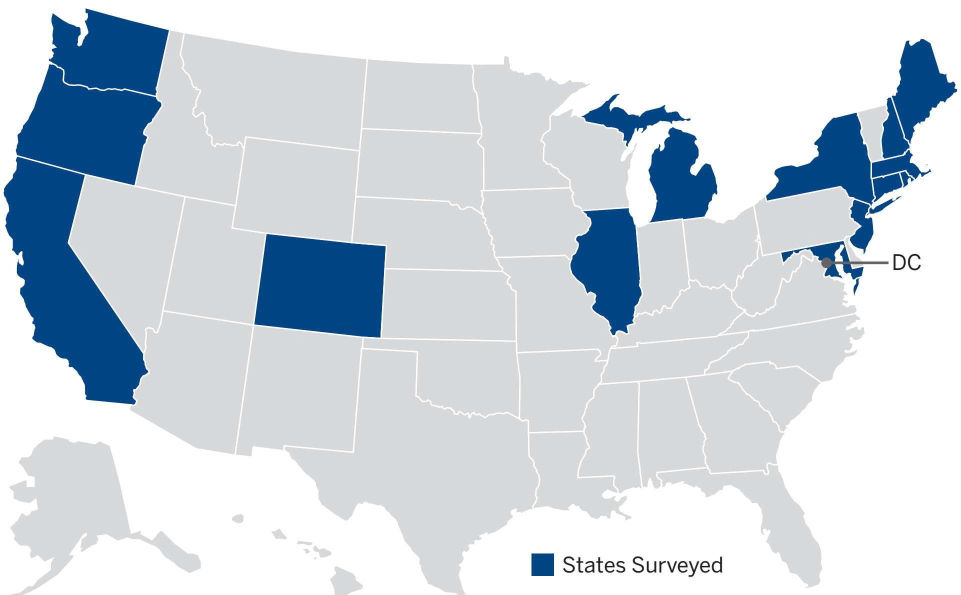


The State Survey

The state survey distribution resulted in 22 responses from 14 states plus the District of Columbia. The following states were represented in the survey responses:

- California
- Colorado
- Connecticut
- District of Columbia
- Illinois
- Maine
- Massachusetts
- Maryland
- Michigan
- New Jersey
- New Hampshire
- New York
- Oregon
- Rhode Island
- Washington

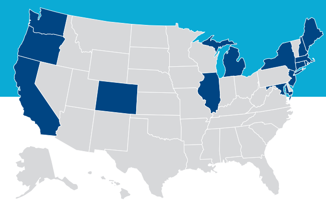
FIGURE 1
States Surveyed for this Report



The survey specifically asked about electrochemical battery systems in their various forms (lead-acid, lithium-ion, zinc alkaline, and flow), which have become increasingly prominent in the marketplace.[1] The survey addressed policy considerations for both front-of-meter (FTM) and BTM energy storage.

Survey results show a wide variety in state energy storage objectives, scopes, applications, and overall maturity of policies and programs. The spectrum of state-level policy development specific to energy storage is populated at one end with states that have

1 Historically, pumped-hydro storage has been the most widely used energy storage technology globally, but its environmental and geographical requirements significantly limit development of new, large-scale pumped hydro facilities in the United States. Other non-battery electric energy storage technologies, such as gravity systems, compressed air and hydrogen, are not yet widely commercially available. Thus, while other forms of energy storage unquestionably play a role in achieving decarbonization goals, to maintain a manageable focus, the authors have chosen to limit the scope of this paper to short duration batteries because those are most widespread now and are addressed most frequently in state regulatory and legislative policy.



no substantive policy development, and at the other end with states that have numerous and sophisticated polices, some of which have been in place for nearly a decade.

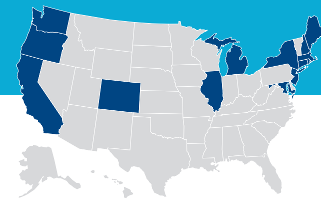
The value of the survey results is the insight they offer into how the leading decarbonization states are approaching the issue of energy storage and the commonalities that are emerging, which can be considered to constitute "best practices" in the effort toward constructing a policy framework. The policy best practices described here were selected because they were most commonly mentioned in the responses. No attempt was made to establish statistical significance within the responses. The full text of the state survey may be reviewed in Appendix A.

The Industry Survey

The industry survey was completed by representatives of six energy storage development companies, plus one industry consultant who formerly worked for an energy storage development company:

1. Enel North America
2. Key Capture Energy
3. New Leaf Energy (formerly Borrego)
4. Nostromo Energy
5. Sunrun
6. Tesla
7. An industry consultant (name withheld)

The industry survey asked essentially the same questions as the state survey, except that the questions were worded so as to elicit the opinions of the respondents regarding various state energy storage policies, programs, and regulatory initiatives. These responses are summarized in the Industry Survey section of the report. The full text of the industry survey may be reviewed in Appendix B.



Background

Policy Pathways to Decarbonization

In the United States the drive toward renewable generation and away from traditional fossil-fuel generation is being accelerated by the adoption of aggressive decarbonization goals by individual states. At this writing, 22 states (plus the District of Columbia and Puerto Rico) have decarbonization goals that commit their energy production to 100 percent renewable or clean energy by an identified future deadline. (Depending upon a state's policies, clean energy may allow for the inclusion of nuclear power or carbon capture and storage, while renewable energy relies solely on renewables.)

Integration of renewables, energy storage, and grid modernization technologies will be crucial to meeting these goals. State regulatory commissions and energy offices are pioneering policies designed to achieve that integration and in so doing are establishing the best practices, to date, for achieving ambitious decarbonization goals.

Energy storage is critical to help smooth variable renewable generation, enable load shifting, provide "non-wires alternatives" for grid improvements and investments, and provide ancillary services that will enhance grid modernization. Moreover, energy storage systems are envisioned to expand electrification, maintain reliability on the electric grid, and significantly support the replacement of fossil-fuel-fired peaker plants.

Despite its many obvious benefits, energy storage does not enjoy a clear pathway to widespread adoption.

But despite its many obvious benefits, energy storage does not enjoy a clear pathway to widespread adoption. In part, this is because energy grid and electricity market regulations are a "patchwork quilt," meaning that storage faces different market and regulatory environments from state to state and region to region. When developing energy storage policies and programs, state policymakers may find they need to accommodate or, in some cases, attempt to compensate for the various regulatory and market environments they find themselves in. In this section, we summarize some of the underlying structural differences in energy markets and regulations that can impact the ways in which different states approach energy storage policymaking.

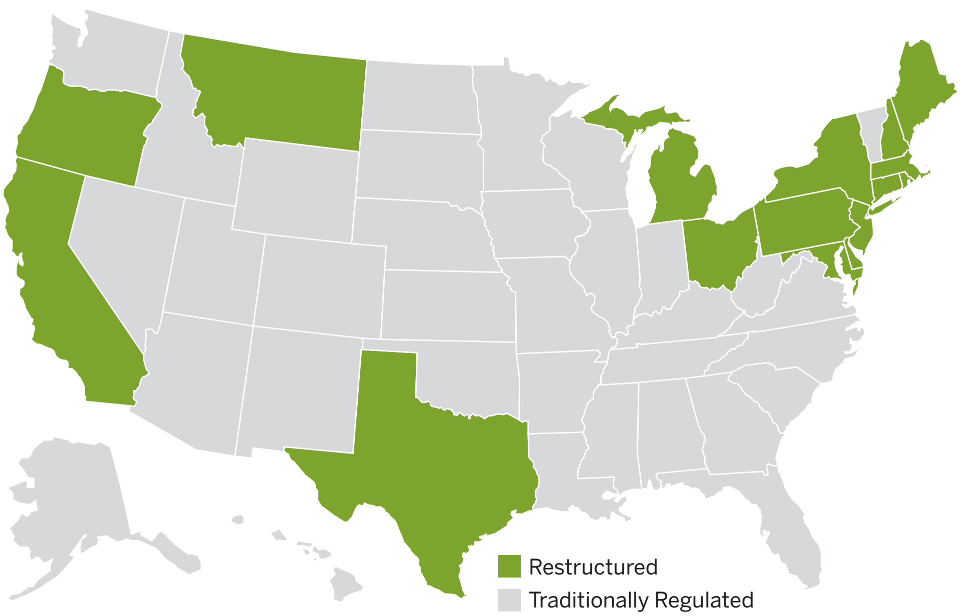
REGULATED VERSUS RESTRUCTURED STATES

State electricity markets are distinguished at a basic level as either a regulated (i.e., vertically integrated) or a deregulated (i.e., restructured) marketplace (see Figure 2, p. 11). This distinction results from decisions made by individual states to open their electricity generation markets to competition, which began to take place in the late 1990s. In vertically integrated markets, incumbent utilities maintain ownership and control over generation, transmission, and distribution assets. In restructured markets, utilities generally are prohibited from owning generation assets so that a competitive electricity marketplace can be introduced.

Restructured markets consequently place emphasis on how generation assets (and often energy storage resources) will produce revenue for asset owners in wholesale market transactions, rather than primarily providing distribution system reliability services. By contrast, vertically integrated markets may put more emphasis on utility planning, and less on third-party ownership and market-based policy. Presently most US states remain vertically integrated.

FIGURE 2

Map of Retail Electric Power Markets in the US



Restructuring in the electric utility market has resulted in some states becoming "competitive," meaning third parties can sell retail power supply directly to customers. In these restructured states, utilities are generally not allowed to own electricity generation; whether and under what conditions they are allowed to own energy storage differs from state to state.

Source: US EPA

Policymaking approaches, including energy storage and decarbonization policymaking, can be significantly influenced by whether a state is vertically integrated or restructured.[2]

In vertically integrated, regulated states, policymakers and regulators may view energy storage as a means to solve grid operational problems at the distribution level and may place their focus on the following:

2 In many states, energy storage is considered a generation asset for purposes of regulation; however, this is not always the case. For example, utilities may own energy storage in Massachusetts, a restructured state, although they may not own generation. Increasingly states are recognizing that storage cannot simply be defined as a type of generator; it is a multi-use resource.

- Expanding policies that encourage value stacking of BTM energy storage services
- Developing policies that encourage a wider range of energy storage services at the grid scale
- Evaluating integrated resource planning (IRP) requirements for opportunities to encourage energy storage consideration
- Adopting energy storage targets or mandates, and/or expanding renewable energy targets to align with storage objectives
- Incorporating energy storage into distribution system planning and modeling simulations.

However, this does not mean that vertically integrated states are all taking the same approach to energy storage policymaking. Some differences were immediately apparent from the survey responses, including the extents to which these states are looking to:

- Emphasize BTM versus FTM energy storage development
- Incentivize BTM storage development, and the amount of those incentives
- Prioritize energy equity, by crafting policies designed to provide historically underserved communities with access to energy storage technologies
- Use energy storage to shave peak demand as a critical step towards reducing a historical reliance on dirty and inefficient fossil fuel peaker plants.

By comparison, restructured states are those that have opened their electricity generation markets to competition, allowing for third-party providers to sell power directly to end-use customers. In regulated markets, vertically integrated utilities maintain ownership and control of generation, transmission and distribution; but in restructured markets, utilities are typically prohibited from owning generation and transmission assets but must still oversee distribution networks. The involvement of a regional transmission organization (RTO) or independent system operator (ISO) in restructured markets is a central feature in restructured states as these entities assume responsibility for inter- and intra-state transmission under FERC regulation.

In restructured markets, considerations for investments in energy storage will tend to be driven toward competitive-market services (i.e., how storage can generate revenue and provide a return for investors), as opposed to necessary operational services, such as maintaining reliability on the distribution network.

In restructured markets, considerations for investments in energy storage will tend to be driven toward competitive-market services (i.e., how storage can generate revenue and provide a return for investors), as opposed to necessary operational services, such as maintaining reliability on the distribution network. Also, given the restrictions on utility ownership that are typical in restructured markets, customers and third parties often become the primary owners of energy storage assets.

The distinctions between regulated and restructured markets are illustrated in Figure 3 (p. 13).

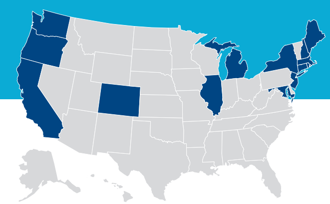


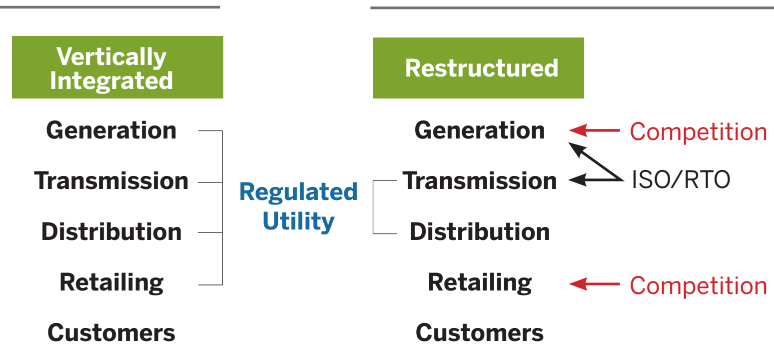
FIGURE 3

Key Differences Between Regulated and Restructured US Utility Markets

Regulated Markets

"Vertically integrated" utility **owns or controls** generation, transmission, and distribution.

Regulated by states (public utility commissions). Cost recovery via rates charged to customers.



Restructured Markets

Market is **competitive**.

Utilities usually prohibited from owning generation and transmission assets.

RTOs/ISOs responsible for inter/intra-state Transmission, Distribution, and Operations & Maintenance with oversight from FERC.

Role of PUC varies state to state.

The U.S. electric utility sector is not homogeneous. There are key differences between regulated markets and restructured markets.

Source: Sandia National Labs

STATE COMMITMENTS TO DECARBONIZATION

An increasing number of states have adopted decarbonization goals that include aggressive timelines for eliminating traditional fossil-fuel generation and shifting to 100 percent renewable or clean energy generation. Table 1 (p. 14) provides a list of those states that have adopted a decarbonization goal as of September 2022, along with the self-imposed deadline for reaching the goal and the originating source of the goal.

ENERGY STORAGE POLICYMAKING

State-level policymaking—which has the potential to shape the deployment, use, and compensation for energy storage technologies, and therefore support state decarbonization plans—has been gaining momentum in some states for the last several years. However, when evaluating the US as a whole, state policymaking specific to energy storage remains very much a "patchwork" of varying programs, incentives, and goals. Indeed, when comparing the 50 states against each other, there is wide variation in the maturity of energy storage policymaking. There are a few examples of states with very advanced and sophisticated policy measures (e.g., California, New York), but there are many more examples of states that have only recently begun the process of assessing their own policy needs specific to energy storage. Consistent with this, there is also a broad spectrum of policies reflecting the level and maturity of regulatory action taken by public utility commissions.

When evaluating the US as a whole, state policymaking specific to energy storage remains very much a "patchwork" of varying programs, incentives, and goals.

It may be helpful to consider what motivates a state to begin developing energy storage policy in the first place. The impetus can originate in various ways. For example, regulated

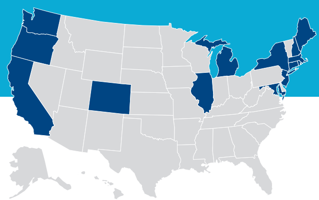


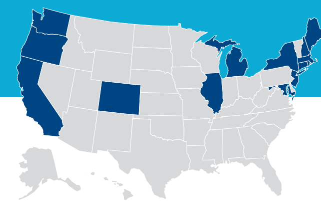
TABLE 1

States that have Adopted Decarbonization Goals

State	Goal	Year	Origin	Notes
California	Clean energy	2045	Legislation	
Colorado	Clean energy	2050	Legislation	Only applies to Xcel Energy, which covers ~60% of the state
Connecticut	Clean energy	2040	Executive order	
District of Columbia	Renewable energy	2032	Legislation	
Hawaii	Renewable energy	2045	Legislation	
Illinois	Clean energy	2050	Legislation	
Louisiana	Net zero GHG emissions	2050	Executive order	
Maine	Clean energy	2050	Legislation	
Massachusetts	Net zero GHG emissions	2050	Legislation	
Michigan	Economy-wide carbon neutrality	2050	Executive order	
Minnesota	Carbon-free electricity	2040	Executive order	MN adopted a decarbonization plan in February, 2023 and therefore was not included in the states survey conducted in 2022
Nebraska	Net zero GHG emissions	2050	Public utility goals	All three public utilities that serve vast majority of state residents have adopted 100% clean energy goals
Nevada	Clean energy	2050	Legislation	
New Jersey	Clean energy	2050	Executive order	
New Mexico	Clean energy	2045	Legislation	
New York	Clean energy	2040	Legislation	
North Carolina	Carbon-neutral electricity	2050	Legislation	
Oregon	GHGs 100% below 2040 baseline	2040	Legislation	
Puerto Rico	Renewable energy	2050	Legislation	
Rhode Island	Renewable energy	2033	Legislation	
Virginia	Clean energy	2050	Legislation	
Washington	Zero emissions electricity	2045	Legislation	
Wisconsin	Clean energy	2050	Executive order	

Many states have adopted decarbonization goals, which can include either renewable energy only (i.e., solar, wind, etc.) or clean energy (allowing for the inclusion of nuclear power).

Source: Sandia National Laboratories



utilities seeking cost recovery for investments in new energy storage technologies may request regulatory action. In some states, third-party developers want to bring storage offerings to market but have identified gaps in interconnection rules or valuation standards that the regulatory commission must address. In other cases, energy planning from the executive or legislative branches may require action by regulators and policymakers to meet new state clean energy goals.

Energy storage policymaking at the state level is generally intended to create enabling policies (i.e., removing the barriers that have prevented energy storage technologies from being adopted, and paving a pathway for these technologies to be better utilized). Enabling policies typically have three core objectives:

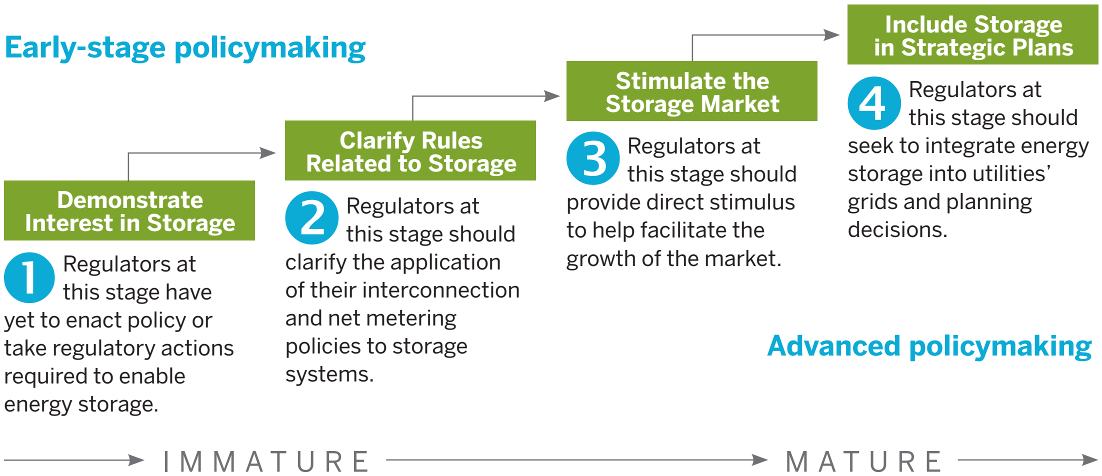
1. To enable energy storage to access the distribution grid and retail markets
2. To enable energy storage to compete against traditional resources in utility planning and procurements
3. To enable appropriate valuation and compensation of energy storage services.

Figure 4 provides a trajectory from early-stage investigative steps to advanced policymaking with multiple policies adopted. This trajectory of state-level policymaking on energy storage is illustrated in an informal 1-4 ranking representing four maturity levels of policymaking as follows:

1. State is demonstrating early interest in energy storage
2. State is clarifying its rules related to energy storage

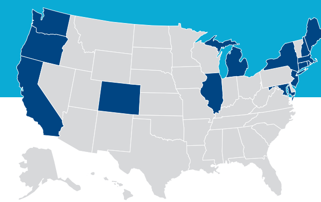
FIGURE 4

Policy Development Maturity Phases



Approaches to energy storage policymaking at the state level vary across U.S. states. Some states have demonstrated very little or no activity as of yet, while other states have developed sophisticated policy frameworks.

Source: Sandia National Laboratories



3. State is developing policies to stimulate the development of an energy storage marketplace

4. State is taking specific steps to integrate energy storage into utility grid planning decisions

The majority of US states remain at the far left of this trajectory.[3] Arguably less than a handful of states nationwide have reached the maturity phase of advanced policymaking on the far right of the trajectory.

The states that responded to the SNL/CESA survey also represent a wide range of energy storage policy development maturity, which provides a broad range of perspectives to be analyzed. Table 2 shows where the survey respondents fall on the above energy storage policy maturity scale.

TABLE 2

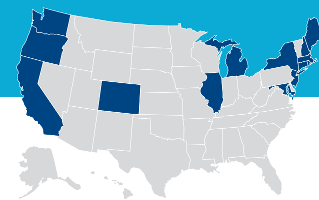
Survey States: Energy Storage Policymaking Maturity Levels

State	Policymaking Maturity Level	Status of Electric Restructuring
California	4	Restructuring suspended
Colorado	Between 1–2	Vertically integrated; not pursuing restructuring at this time.
Connecticut	4	Restructured
District of Columbia	1	Transition to restructuring has begun
Illinois	Between 1–2	Restructured
Maine	4	Restructured
Maryland	3	Restructured
Massachusetts	Between 2–3	Restructured
Michigan	1	Restructured
New Hampshire	1	Restructured
New Jersey	4	Restructured
New York	4	Restructured
Oregon	3	Vertically integrated; not pursuing restructuring at this time.
Rhode Island	3	Restructured
Washington	Between 1–2	Vertically integrated; not pursuing restructuring at this time.

Based on the Policy Development Maturity Trajectory and specific policy actions that have been undertaken by each state, the surveyed states can be evaluated on their energy storage policymaking maturity.

Source: CESA/Sandia National Laboratories

3 Table 2 lists only those states that have adopted deep decarbonization goals. These states also tend to be among those with the most energy storage policies in place. Most states that have not adopted decarbonization goals would therefore fall even farther to the left on the energy storage maturity scale above.



State Survey Findings

High Level Observations, Challenges, and Approaches

High-level Observations

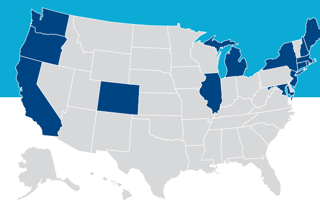
The survey responses affirmed that even states that have adopted advanced decarbonization goals are still grappling with whether and how to deploy sufficient amounts of energy storage, both FTM and BTM, to achieve these goals. While most of these states have accepted the general idea that energy storage is a necessary tool to achieve decarbonization—because energy storage deployment at scale is required to enable an electric grid serviced primarily by variable renewable resources—even the most advanced states face significant challenges in bringing energy storage to scale within their decarbonization timeframes.

While specifics still need to be defined, most of the decarbonization states surveyed envision their future energy infrastructures to include the following:

- A mix of central and local generators, energy storage, and other distributed energy resources
- A significant expansion of batteries and other energy storage technologies to be used for both emergency backup generation and as peak shaving resources, along with an enhancement of the ability to build infrastructure that can accommodate this significant expansion of energy storage resources
- The use of microgrids or other distributed energy resources (DERs) and their associated management systems to integrate and optimize an increasing amount of on-site intermittent renewable generation and energy storage.

However, there was a wide range of perspectives from the states about the centrality and importance of energy storage to meeting their decarbonization goals. States on the far right of the policy-maturity trajectory illustrated in Figure 3 tended to be unequivocal about the importance of energy storage to their decarbonization goals. A representative from one fully restructured state in the Northeast stated, "[Energy storage] is absolutely essential to decarbonization…. Grid reliability, renewable integration, and other services provided by storage will be key in hitting our decarbonization targets."

By comparison, other states were less certain about the specific role that energy storage has at this time. A respondent from one vertically integrated state commented, "Is energy storage integral to decarbonization in our state? A little bit. [Our] clean electricity law encourages development of storage resources. [However], power system modeling typically shows little immediate need for these resources, perhaps because of the flexibility provided by the state's large hydro resources." While this state has adopted a policy statement supporting energy storage investments by regulated utilities, storage is not



a primary component of its current decarbonization efforts. Instead, this state is investing in BTM storage primarily for resilience/reliability purposes. States such as this one may value both energy storage and decarbonization, and may have policies supporting both, but these policies may not be linked; in other words, there may be no requirement or price signal that would cause energy storage resources to be installed and operated in support of decarbonization goals.

Many of the states surveyed are on the lower end of the energy storage policy-maturity scale. These states cited diverse reasons for not moving more aggressively to develop energy storage policy and programs, including:

- Lack of clarity as to which use cases storage is best suited to serve in decarbonization efforts
- A belief, based on modeling, that storage may become more important later in the decarbonization process
- Ongoing assessments of best practices for energy storage policy development
- The high cost of energy storage

Challenges to Energy Storage Policymaking

Regardless of their ranking on the energy storage policy maturity scale, the states surveyed cited numerous challenges in attempting to develop energy storage policy and regulation as part of a larger decarbonization effort. These challenges included:

- Lack of bandwidth within the relevant state agencies to develop energy storage policy
- Lack of information, which makes it difficult to craft policy addressing multiple technologies, applications, and markets still in development
- Potential environmental impacts
- Challenges in tracking or accounting for renewable generation paired with storage
- Challenges in determining the level of ownership and control that utilities can (or should) have for large-scale energy storage projects (in restructured states)
- Barriers or uncertainty about where to site large-scale energy storage projects for best effect on the grid
- Challenges associated with legacy grid infrastructure, such as limited hosting capacity
- Challenges associated with legacy interconnection standards and permitting processes
- Uncertainty about whether energy storage projects should be co-located with other distributed energy resources
- The perceived high cost of energy storage technologies, coupled with supply chain disruptions that have exacerbated costs and caused procurement delays
- Uncertainties around the "market readiness" of certain storage technologies

- The immaturity of storage technologies, which can make it difficult to meet future grid needs (such as the need for long duration energy storage to back up wind generation)
- Disconnects between wholesale market rules (set by regional system operators and approved by the Federal Energy Regulatory Commission) and rules developed at the state/retail level

This last point shows the difficulty of crafting effective state policies when wholesale market rules are outside the state's jurisdiction. One state respondent explained this frustration, felt most keenly in restructured markets, this way: "Our RTO's market rules make it impossible to get all benefits from storage because of conflicting obligations, and the way storage is modeled is not accurate to how it would function [within retail markets or on the distribution grid]. There are efforts happening to change the rules and maximize the benefits of storage but we aren't there yet, which makes it hard to make effective energy storage plans."

Another state representative remarked, "The bifurcated energy market and the fragmented regulatory regime [in our state and region] have made it very difficult to plan for and support storage development. Deeper coordination between utilities, the ISO and our regulators [is necessary] to streamline the efforts in the future. In the present moment, there are issues at the ISO level that prevent the state from getting all of the benefits that storage can provide which further limits the perception that storage is integral to decarbonization right now."

Approaches to Energy Storage Policymaking

The survey responses were illuminating regarding the approaches that state regulatory commissions and energy agencies are taking, at a high level, on some key themes associated with energy storage, including:

- BTM storage versus FTM storage
- Duration expectations and requirements for storage assets
- Applications of energy storage technologies

We address these individually below.

BTM VERSUS FTM

Through policy and regulation, states can prioritize BTM storage, FTM storage, or some combination thereof for market development through procurement mandates, ownership requirements, and incentive programs. Perhaps the most well-known examples of BTM storage prioritization are California's carve-out of a specific amount of BTM storage in the procurement requirements placed on the state's investor-owned utilities; California's Self-Generation Incentive Program (SGIP), which provides customer rebates for installation of BTM energy storage; and several pay-for-performance customer storage programs in the Northeast, which provide a mechanism for BTM storage owners to contract with their electric utilities to provide grid services, such as peak demand reduction, on a utility signal, and receive compensation for the services provided. FTM storage prioritization is often accomplished through setting utility storage procurement targets or mandates, by requiring storage to be included in utility IRPs, and by requiring storage to be included in large-scale renewable generation projects (an example of this is the SMART solar incentive program in Massachusetts).

Themes that emerged from the survey responses included:

- FTM storage is perceived as being cheaper per kilowatt hour (kWh) than BTM storage, and thus easier to deploy through incentives or procurement mandates.
- In addition to being more expensive on a per-kWh basis, BTM storage is not able to provide grid benefits in many places (the technology is capable of doing so, but it requires a mechanism to both receive utility dispatch signals and to be compensated for grid services provided). Some early-stage programs, such as ConnectedSolutions in Massachusetts and Energy Storage Solutions in Connecticut, are starting to engage BTM storage in providing grid services, but most states have not yet adopted such programs.
- Despite the challenges associated with harnessing BTM resources to provide grid services, the opposite may be even more challenging—that is, large-scale, grid-based resources cannot easily provide local, BTM services such as energy resilience and demand charge management (although Green Mountain Power in Vermont and Sacramento Municipal Utility District in California have pilot programs showing that this can be achieved).
- At present, BTM storage is primarily installed for energy resilience, while FTM storage is more often linked to decarbonization goals.
- Most states would ideally like to achieve a mix of FTM and BTM energy storage

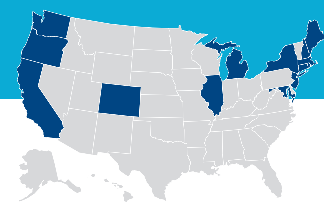
DURATION

Decarbonization by definition requires an increasing reliance on variable renewable energy (VRE), primarily wind and solar resources; and if these VREs are to displace legacy baseload generators, long-duration energy storage will be needed to store renewably generated power for days, weeks, or perhaps even months. Under these future scenarios, short-term storage technologies such as lithium-ion batteries will not be sufficient, and some states are already looking toward a new generation of energy storage technologies with ever-longer duration capabilities to prevent power supply and demand imbalances, accommodate changes in distribution and transmission flow patterns, and mitigate increased occurrences of generation disturbances and voltage deviations.

Although only a few states support basic technology research and development, state policymakers do have an opportunity to define long-duration energy storage (LDES) and begin to plan for integration of LDES with the anticipated scale-up of renewables (for example, planned offshore wind installations).

Survey responses pointed to several strategies states are using with regard to the need for LDES, including:

- State-funded research and clean energy incubators for longer-duration storage technologies, such as flow batteries, thermal storage, compressed air, hydrogen, pumped hydro and other gravity systems



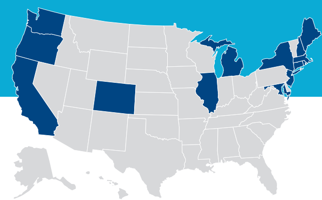
- Funding of longer-duration energy storage pilots and demonstration projects
- Development of technology-neutral energy storage policies intended to allow for ongoing technological development
- Identification of key needs in medium- and long-duration storage technologies in order to be ready for deployment of those technologies as they become commercially available

APPLICATIONS

Energy storage technologies have unique performance characteristics that can lead to new opportunities and challenges for policymakers. For instance, battery storage acts as both load (when charging) and supply (when discharging), it is dispatchable, and it is capable of fast response, making it very accurate when following a dispatch signal. This flexibility of usage allows energy storage to serve multiple uses or applications, sometimes simultaneously, and therefore energy storage owners may be able to layer on more than one revenue stream in both retail and wholesale markets. However, the many potential uses of energy storage technologies can make them appear unpredictable to utilities and grid operators, and this can add to the perception of risk associated with customer- or third-party storage ownership.

Survey responses indicated that policymakers and regulators are wrestling with how to maximize the benefits of energy storage while reducing uncertainty and risk. Policy priorities included the following:

- Use of energy storage to support electric reliability and resilience on the distribution grid
- Use of advanced metering infrastructure (AMI), including both software and hardware, and advanced distribution system management technologies to enable applications that support the reduction of peak load on the distribution system
- Use of storage for cost control through enabling electrification, avoidance of costly transmission and distribution (T&D) upgrades, increased flexibility of end-use loads (such as EV charging), and peak demand reduction
- Use of storage to enable higher levels of solar PV interconnected with the grid, and the use of solar coupled with storage for interconnection upgrade mitigation
- Exploration of energy storage applications and use cases through demonstration projects and programs
- Exploration of locational benefits, such as resilience and peak cost reductions
- Interest in price signals and performance payment mechanisms that can allow distributed energy storage to be aggregated and dispatched to meet grid needs
- Interest in energy storage solutions that lower costs for ratepayers while helping to meet state decarbonization objectives
- The pairing of solar plus energy storage for higher adoption rates, building electrification, and resilience



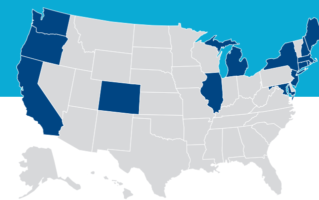
State Survey Findings

Energy Storage Policy Mechanisms

Prior to developing this survey with CESA, SNL had identified 13 energy storage policy types that are most likely to be employed by states seeking to increase energy storage deployment. These policy types (listed here in no particular order) have the potential to shape the production, usage, and compensation for both BTM and FTM energy storage technologies, and can also be used to support a state's pathway to decarbonization:

1. Procurement mandates, targets, or goals for energy storage procurement by regulated utilities
2. Utility ownership of energy storage assets
3. Inclusion of energy storage in utility Integrated Resource Plans (IRPs)
4. Incentives, tax credits, or other subsidies for energy storage
5. State prioritization of specific use applications for energy storage technologies
6. State-sanctioned benefit-cost analysis (BCAs) of energy storage
7. Distribution system modeling for location-specific siting of energy storage technologies
8. Changes to existing net metering programs to accommodate BTM energy storage
9. Changes to legacy interconnection standards to enable deployment of BTM energy storage
10. Changes to existing renewable portfolio standard (RPS) programs to include or specifically carve out energy storage requirements
11. Use of time-variant electric rates to spur the development of BTM storage technologies;
12. Retail rate re-design
13. Equity policies (supporting deployment of storage in or for the benefit of low-income and historically underserved populations)

The survey sought to ascertain the extent to which these policy issues are being prioritized in the leading decarbonization states, how they are being applied to help advance decarbonization efforts, and the extent to which key, preliminary outcomes from state activities can be measured. Results indicated that the following five policy issues have been embraced by these states more frequently than others:



1. Procurement mandates, targets, or goals for energy storage procurement by regulated utilities
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3. Incentives, tax credits, or other subsidies for energy storage
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A discussion of these five policy issues and key findings from the survey follows.

Procurement Mandates, Targets, and Goals

POLICY ISSUE

Should states set an artificial target for utility energy storage procurement, to accelerate the market? If so, how should the target be defined, and should it be mandatory?

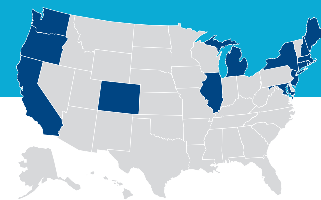
State energy storage procurement standards (ESPSs) are generally similar to the widely used renewable portfolio standard (RPS) model, but they are focused on utility procurement of a defined energy storage capacity goal rather than procurement of renewable generation capacity as a percentage of overall generation. States are increasingly adopting ESPSs, which may take the form of a mandate, target, or goal. Mandates, targets, and goals are distinct and generally defined as follows:

- **A Mandate** is a goal with legal liability for non-attainment
- **A Target** means a defined goal with measures for follow-through
- **A Goal** is a number without defined accountability.

The central issue confronting states considering an ESPS is whether the state should allow an energy storage marketplace to develop organically, or artificially accelerate market development by setting procurement standards for regulated utilities.

There are well developed arguments on both sides of this issue. In support of procurement policies at the state level, proponents have tended to focus on the following arguments:

1. Procurement policies are necessary to stimulate market development and drive market readiness of energy storage technologies
2. Regulatory procurement policies guarantee cost recovery for utilities in an uncertain market
3. Precedent for ESPSs has been established by the long and successful history of RPSs adopted by the vast majority of states.



Opponents of procurement policies have offered the following rebuttals:

1. The energy storage marketplace should be allowed to develop on its own, as energy storage becomes cost-competitive with other technologies
2. Utility resource planning is sufficient to drive the development of energy storage technologies without a regulatory procurement standard, particularly as utilities develop more renewable-based resources
3. Given uncertainties about energy storage valuation, combined with immature or non-existent energy markets for energy storage services, regulatorily established procurement levels may be arbitrary and not in the best interests of ratepayers

As of 2022, five states have opted to set a procurement mandate, and four more have set non-binding procurement targets or goals, as summarized below and illustrated in Table 3 (p. 25).

- **California:** The first state (in October 2013) to put an energy storage procurement mandate into place, with a requirement that the three investor-owned utilities in the state (PG&E, SCE, and SDG&E obtain 1,325 MW of energy storage by 2020. Four years later, in 2017, California expanded this mandate to include an additional 500 MW for BTM energy storage (which is still quite unusual in state requirements). The state had installed about 2,500 MW of battery storage by the end of 2021, and now California is looking at long-duration storage that can last at least eight hours.
- **Oregon:** House Bill 2193, adopted in June 2015, required the two largest utilities in the state, Portland General Electric and Pacific Power, to each procure 5 MWh of storage energy capacity by January 2020. This mandate has been exceeded, but the state has not moved to set a higher target.
- **Massachusetts:** House Bill 4857 (An Act to Advance Clean Energy), adopted in August 2018, directed the Massachusetts Department of Energy Resources to set an energy storage procurement target of 1,000 MWh by 2025.
- **New York:** In October 2018, New York announced a procurement mandate of 3,000 MW of energy storage by 2030. In December 2022, this target was doubled to 6,000 MW by 2030.
- **New Jersey:** In May 2018, New Jersey enacted the Clean Energy Act, P.L. 2018, which set an energy storage procurement mandate of 2,000 MW of energy storage by 2030.
- **Virginia:** In February 2020, Virginia passed House Bill 1526, which sets a 3,100 MW energy storage procurement requirement by 2035. Like California, the Virginia mandate includes a carve-out for BTM energy storage, although Virginia requires a set percentage (10 percent) rather a specified amount in megawatts.

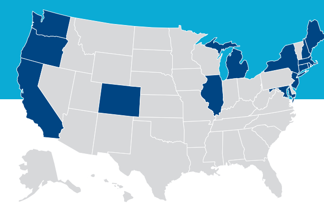


TABLE 3

Energy Storage Procurement Policies (as of mid-2022)

State	Megawatts/Year	Originating Source	Mandate/Goal/Target
California	1,825 MW by 2020. Carve-out of 500 MW for BTM	Legislative and regulatory	Mandate
Connecticut	1,000 MW by 2030. Carve-out of 580 MW for BTM	Legislative	Goal
Maine	400 MW by 2030	Legislative	Goal
Massachusetts	1,000 MW by 2025	Legislative	Target
Nevada	1,000 MW by end of 2030	Regulatory	Target
New Jersey	2,000 MW by 2030	Legislative	Mandate
New York	6,000 MW by 2030	Legislative with increase set by governor	Mandate
Oregon	5 MW by 2020	Legislative	Mandate
Virginia	3,100 by 2035. Carve-out of 10% for BTM	Legislative	Mandate

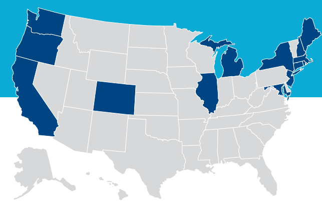
Procurement mandates, adopted through legislation and/or regulatory statute, require a specific amount of energy storage to be developed by regulated utilities by a fixed date. Procurement targets or goals are aspirational in nature and do not require compliance.

Source: CESA/Sandia National Laboratories

Some states have a carve-out for a specific amount of BTM storage development in their procurement mandates. Maine's 400 MW storage target includes a 15 MW carve-out for backup power at critical facilities and an incentive program for BTM storage. Connecticut's target of 1,000 MW includes a 580 MW carve-out for BTM storage and an income-based incentive program. And, as previously mentioned, California's procurement mandate included a customer-sited tier, and was subsequently increased to add another 500 MW of BTM storage.

Survey responses regarding state energy storage procurement policies showed that states are using several different approaches to meeting procurement goals, including utility rate design and utility planning reforms. Examples include the following:

- **Maine:** In response to the legislature setting the goal of 400 MW of storage by the end of 2030, the Maine Public Utilities Commission launched an investigation into how rate design could further that goal.
- **Massachusetts:** The Commonwealth has supported its target of 1,000 MWh of energy storage by 2025, with a regulatorily-governed program ("ConnectedSolutions") offering performance payments to BTM storage customers who allow energy to be drawn from their batteries during times of peak demand.
- **Nevada:** Due to the fact that the state's 1,000 MW by 2030 goal is being targeted largely through utility planning reforms, current regulatory proceedings are focused on how requirements for utility integrated resource plans (IRPs) will need to be revised.



In addition, some states have used grant, incentive, and RPS programs as a way to stimulate storage deployment. Examples of these approaches include:

- **California and New York:** The CA Self Generation Incentive Program and NY Energy Storage Program bridge incentives have made hundreds of millions of dollars available to subsidize energy storage installations in those states.
- **Illinois:** Existing solar customers can apply for a storage-capacity rebate for net-metering-eligible systems through their utility.
- **Massachusetts:** The Commonwealth incorporated an energy storage adder into its SMART solar incentive program, and also requires that any incentivized solar development over 500 kW includes an energy storage component.
- **Others:** Several states have made energy storage eligible within their RPS programs.[4]

Moreover, the adoption of a procurement policy often leads to a discovery of gaps in legacy interconnection rules, which can slow developers' ability to interconnect new energy storage capacity into the distribution grid. This has spurred some states to update interconnection rules and, in the case of Massachusetts, to abandon the traditional cost-causation approach to funding grid upgrades required for the interconnection of new distributed resources in favor of a new model intended to more equitably distribute the costs of DER interconnection.[5]

Although only nine states have adopted ESPSs to date, more may emerge soon, as several states are currently considering procurement standards as a potential tool to accelerate energy storage deployment.

Utility Ownership of Energy Storage Assets

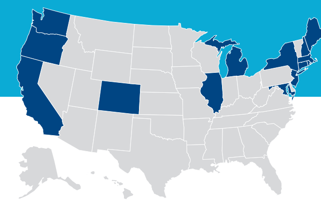
POLICY ISSUE

Should electric utilities be allowed to own energy storage? If so, how can utility ownership advance storage deployment while avoiding utility monopolization of storage resources? If not, how can third-party and customer-owned storage assets best provide services to utilities and grid operators when the latter do not own or directly control storage resources?

Survey results from participating states indicated that the question of utility ownership of energy storage assets is the second most prominent energy storage policy issue on the minds of state policymakers. As noted previously, the direction that policymaking on this issue will take may be influenced to a great degree by whether or not the state retains a vertically integrated electricity market. In restructured markets, utilities are almost always required to divest themselves of generation assets, based on the idea that this will enable third-party providers to enter the market and spur price competition. Nevertheless, regulatory rules governing which entities should be allowed to own and operate energy storage

4 For more information, see the CESA report, *Does Energy Storage Fit in an RPS*, at https://www.cesa.org/wp-content/uploads/Energy-Storage-and-RPS-Holt.pdf.

5 CESA's sister organization Clean Energy Group (CEG) is investigating interconnection barriers to energy storage deployment, and potential solutions to these barriers. Forthcoming reports on this topic may be found in the CEG publications library at https://www.cleanegroup.org/publications-library/



assets have long been a source of contention in electricity markets, regardless of the state of restructuring—especially because energy storage is not a form of generation and needn't be classified as such. While energy storage technologies may sometimes be regulatorily defined as generation assets, in fact they behave as a load as frequently as they behave as generation.

Fundamental policy questions at the core of this issue are:

- What kind of asset does energy storage represent? (generation, load, distribution or transmission asset?)
- What services will energy storage assets be capable of performing, what services will they be allowed to perform, and what services can they be compensated for in markets?
- Who should pay for energy storage assets? Should the ratepayers incur the cost, or should energy storage be funded through free market investment?

The question of utility ownership of energy storage is gaining momentum as costs for storage technologies continue to decrease. As recently as five years ago, utility-scale FTM energy storage was considered to be too expensive and too risky by many utilities, particularly without a solid benefit-cost analysis and rationale behind the need for the investment that would justify rate recovery. Today, battery storage offers utilities a proven way to reduce wholesale demand and energy costs, increase capacity, improve reliability, support renewables integration, and defer transmission upgrades. And while batteries are still considered expensive in many markets, they are increasingly becoming cost-competitive, especially in the provision of short-term/high-value energy services such as frequency regulation and peak demand management.

Moreover, there are multiple benefits for utilities that can be achieved through the ownership and control of energy storage assets:

1. **Cost Savings:** Batteries allow power to be deployed at the most strategic times, insulating utilities against rising wholesale demand and peak energy costs. Batteries can store electricity when it is cheapest and dispatch it when it is most expensive, reducing costs for customers.
2. **Reliability & Resilience:** Batteries can be used to enhance the reliability of the grid (the ability to avoid outages and/or reduce the length of outages on an energy system) and resilience (the ability of an energy system to withstand potential threats and come back online after a major outage).
3. **Renewables Integration:** Battery storage can be used to support portfolio standards/procurement mandates for renewable energy and energy efficiency resources.
4. **Capacity:** Battery storage can provide capacity by providing stored electricity to the grid at times of highest demand.
5. **Deferral of Transmission or Distribution Upgrades:** Energy storage can be used as a Non-Wires Alternative (NWA) to traditional "poles and wires" upgrades, deferring the need for more costly capital investments.

6. **Ancillary Services:** Energy storage can be used to support a wide range of ancillary services that support the transmission of electricity from generation to end user or help maintain its usability throughout the system, including active control of power frequency and voltage on various timescales.

However, the issue remains contentious as third parties often argue against granting utilities the right to own energy storage asserts, primarily due to concerns about creating "market power" or monopoly scenarios in which third parties would be precluded from entering a market that is dominated by a utility. Furthermore, given the distinction discussed above between the different approaches toward energy storage assets taken by vertically integrated versus restructured markets, opponents of utility ownership frequently express a concern that an emphasis would be placed on reliability services over revenue-generating applications.

In some cases, utilities themselves may be reticent to push for ownership of energy storage assets. This can be due to several concerns, including 1) Uncertainties about cost recovery through the rate base, 2) Risk of utility profit erosion tied to the increase of customer- and third party-owned DERs (which utility-owned energy storage may enable) and 3) Concerns about inequitable treatment of customers across rate classes.

This third concern may require some explanation. Historically, utilities in multiple states have petitioned to dismantle existing solar net-metering programs on the basis that solar customers are being subsidized by non-solar customers. Their argument has been that when owners of DERs do not pay a utility bill because their electricity production equals their consumption, they do not cover the costs of maintaining the wires and transmission lines, and these costs fall disproportionately on disadvantaged communities that frequently do not have the same opportunities to benefit from DER adoption. To date this argument has been used against solar net-metering programs, but it could also be used against customer energy storage incentive programs (especially because many of these programs offer combined incentives for solar+storage systems).

Some restructured states are re-evaluating existing policies that prohibit utility ownership of energy storage assets. Maryland is noteworthy here as it has implemented a pilot program specifically to evaluate different ownership models for energy storage assets. Under Maryland's Energy Storage Pilot Project Act (SB 573, 2019), each of the state's four investor-owned utilities (Baltimore Gas & Electric Company, Delmarva Power & Light, Potomac Electric Power Company (Pepco), and Potomac Edison), must solicit offers for at least two of four ownership models as outlined in Table 4 (p. 29).

Beyond Maryland, ownership models are emerging following similar structures built around: 1) utility ownership, 2) third-party ownerships, 3) aggregated customer ownership, or 4) some hybrid between the three.

Survey responses on the topic of policy approaches to utility ownership of energy storage assets included the following perspectives:

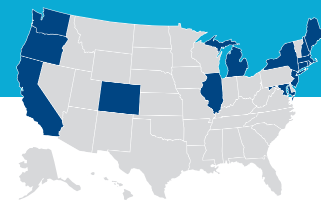


TABLE 4

Maryland Pilot Project Explores Four Energy Storage Ownership Structures

Utility-Owned	Utility-/ Third-Party-Owned	Third-Party Owned	Virtual Power Plants
• Utility owns and controls storage project for grid reliability • Utility operates storage in wholesale markets when it is not needed for distribution reliability	• Utility owns and controls project for grid reliability • Third party operates project in wholesale markets	• Utility contracts with a storage project that is owned by a third party for grid reliability • Third party operates the project for wholesale markets	• Utility aggregates, or uses a third-party aggregator, to receive grid services from multiple DER projects owned by customers or third parties

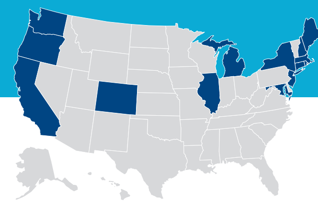
Ownership models for energy storage assets can take various forms. Restructured states typically require utilities to divest generation assets, which can be defined as inclusive of storage assets. A recent pilot program in Maryland offers a perspective on four ownership models that are starting to emerge.

Source: Maryland Public Service Commission

- Where utilities are regulatorily or legally precluded from owning storage, states are relying on third-party investment.
- Where utilities are allowed to own storage, utility participation in storage ownership is an integral part of energy storage planning.
- Regardless of utility ownership, utilities are perceived as critical to storage adoption, as third-party and customer owners will have to work with and through utilities to interconnect to the grid and participate in both incentive programs and wholesale energy markets.

Note that a majority of the states that responded to the survey, but not all of them, exist within an ISO/RTO territory, and are therefore engaging in policymaking in competitive wholesale markets subject to rules developed by the presiding ISO/RTO (and under FERC jurisdiction). This presumably had a significant impact on the perspectives expressed by these states, because third-party ownership of storage assets is likely to be more common in restructured states, given the prohibitions against utility ownership of generation assets. An example of this is the state of New York, where utilities can own storage assets only in very limited circumstances, such as when it is placed on a utility substation specifically to provide resilience benefits.

By comparison, in areas outside of ISO/RTO grid management—in which vertically integrated utilities continue to own generation, transmission, and distribution assets—energy storage asset ownership presumably would be driven primarily by operational needs at the distribution level and the reliability enhancements that energy storage can provide. In these regulated markets, it is more difficult for non-utility storage development to gain market entry because market opportunities are less clear and interconnection to utility networks may be more difficult for third parties.



Incentives and Tax Credits for Energy Storage Deployment and Use

POLICY ISSUE

Should states directly subsidize the deployment of energy storage? If so, how should such programs be structured, how should incentive rates be set, and how will subsidies be paid for?

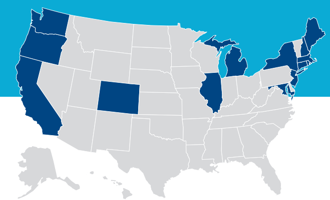
State-level incentive programs and tax credits offered to energy storage projects became important in the absence of a federal tax credit for standalone storage projects. When the states survey was conducted, the federal investment tax credit (ITC) provided a 26 percent credit (plus accelerated depreciation) for solar PV; this credit could also be applied to energy storage, but only to storage paired with (and charged from) solar PV. Even for batteries paired with solar, this tax credit was not always enough to provide sufficient returns on investment to spur development, and the requirement that the storage be charged from solar was not workable for some energy storage business cases. Furthermore, the tax credit provided no direct support to tax-exempt entities, such as nonprofits and municipalities, who were forced to partner with a third-party investor with a tax appetite in order to realize any shared savings. This situation recently changed with the passage of the federal Inflation Reduction Act (IRA), which offers both a stand-alone energy storage tax credit and a direct payment option in lieu of the credit for tax-exempt entities such as non-profits and municipalities.

Regardless of the new federal ITC for energy storage, state-level incentives are still likely to be viewed by many states as an important tool to accelerate and direct the storage market, although some states may choose to revise incentive rates and rules to reflect the impact of the storage ITC. State incentives can serve as "bridge funding" until storage becomes more cost-competitive in existing markets; or they can be used to direct storage development to areas and applications where market opportunities are lacking, such as resilient power applications in low-income and historically underserved communities. Critically for this report, state incentives can also be used to direct storage use to support broad, overarching state policy goals, such as decarbonization.

State energy storage incentives can take various forms, including the following:

- **Rebates:** Here states provide a direct cash payment to the storage system owner, typically after the battery is installed and interconnected to the grid. Since they are awarded based on system installation, rebates are good tools for spurring storage deployment, but less useful for directing storage use.

- **Performance payments:** These are payments based on battery use rather than battery installation. Performance payments typically require battery owners to charge and discharge their systems at certain times or in response to utility signals, to provide grid services such as peak demand reduction. They are good for linking battery use to state policy goals, but they provide less help in defraying initial capital costs. In some cases, states may offer both a rebate to lower up-front costs, and a performance payment to align energy storage dispatch with state policy goals.



- **Grants:** These incentives are typically offered on a competitive basis and can be quite prescriptive. For example, states have offered grants for microgrids, municipal resilient systems, and innovation/demonstration projects. Grants are often used to support high-profile projects that demonstrate new technologies, applications, or business cases. However, they tend to require significant administrative effort on the part of both the grantor and the grantee, which increases the per-project cost, and are not generally viewed as a long-term, market-sustaining form of incentive.

- **Incentive adders:** These are often used when storage is added into an existing renewable energy incentive program—for example, a storage adder in a solar incentive—to encourage the pairing of the two technologies. Adders may be easier to achieve than stand-alone storage incentives because they don't require states to develop and administer an entirely new program, but they are also limited in the kinds of systems they incentivize.

- **Storage as efficiency:** This model, developed in Massachusetts (and known as ConnectedSolutions) and adopted by several other Northeastern states, is similar to an adder in that it incorporates storage into another existing program—in this case, a state energy efficiency plan. By declaring that energy storage qualifies as an efficiency measure (usually because of its ability to lower peak electricity demand), states can allow storage to access existing efficiency incentives. This type of utility program generally includes performance payments to storage-owning or -leasing customers though utility contracts and may also allow storage owners to access low- or no-cost financing.

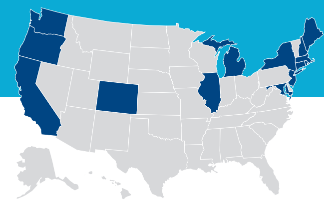
- **State tax credits:** These are relatively rare and may become even less common now that the IRA provides for a federal standalone storage tax credit.

Examples of state-level incentive programs for energy storage include the following:

- **California:** California's Self-Generation Incentive Program (SGIP) provides a dollar per kilowatt ($/kW) rebate for installed energy storage systems. The rebate rate steps down as more homes and businesses add storage. In 2020, the state updated SGIP to provide more funding and higher levels of incentives for customers in high fire threat districts, and for low-income customers, to help provide emergency backup power to those who need it most.

- **Connecticut:** In its Energy Storage Solutions program launched in January 2022, a coalition of the state's regulatory commission, utilities, and the Connecticut Green Bank is offering a combination of upfront incentives and performance payments for BTM energy storage. Incentives range up to $7,500 for residential customers, starting at $200 per kWh. Commercial and industrial customers may receive incentives of up to 50 percent of project costs for storage installations. Performance payments are based on storage discharge in response to a utility signal, which allows distributed systems to be aggregated and dispatched to lower peak electricity demand. Additional incentives are available to low-income and underserved communities.

- **Maryland:** At the time of writing, Maryland was the only US state that offered a storage-specific tax credit. The tax credit covered 30 percent of the cost of a storage system, up to $5,000 for residential batteries and up to $150,000 for com-



mercial batteries. However, this program was only authorized through the 2022 tax year; Maryland Energy Administration is currently in the process of launching a replacement energy storage incentive program, which will be grant based.

- **Massachusetts:** Massachusetts offers a storage adder under the Commonwealth's solar-focused SMART incentive program. For residents installing storage with a solar PV system, the per-kilowatt-hour solar production incentive increases as a result of purchasing storage as well. Massachusetts has also incorporated battery storage into its energy efficiency plan through the ConnectedSolutions program, and customers can now enroll their BTM batteries into the program through a utility contract, making them eligible to receive performance payments. And, Massachusetts has developed the nation's only Clean Peak Energy Standard, which requires utilities to procure increasing amounts of clean peaking power from renewables and energy storage.

Survey responses shed light on how the leading decarbonization states have structured energy storage incentive programs. Although not all of these storage incentives have an explicit correlation to decarbonization goals, examples of those that do include the following states:

- **California:** The SGIP incentive did not initially include any dispatch requirements; however, after finding that merely adding energy storage to the grid did not in itself reduce Greenhouse Gas (GHG) emissions, the state revised the SGIP incentive structure so that half the incentive is now awarded only if the incented storage is dispatched so as to achieve GHG reductions.
- **Massachusetts:** The SMART solar incentive with storage adder includes a minimum cycling requirement for BTM batteries paired with solar, but it defers to utility peak demand signals for batteries enrolled in grid support programs such as Connected-Solutions, which targets BTM battery dispatch at peak demand hours (these tend to be both the most expensive and some of the most polluting hours for electricity generation). The Clean Peak Energy Standard specifically directs utilities to purchase renewable electricity for use at peak demand hours. Energy storage is used in the program to shift renewable electricity from times of high generation to times of high demand, and to make it dispatchable.
- **New Jersey:** The state's energy storage incentive program straw proposal would incentivize grid supply storage with a combination of rebates and performance payments. For bulk energy storage systems, payments would be calculated based on greenhouse gas (GHG) emissions reductions achieved by storage dispatch.

Benefit-Cost Analysis for Energy Storage

POLICY ISSUE

Given that current market structures lack clear mechanisms to identify, value and capture the full value of energy storage, should a state conduct a BCA specific to energy storage, that would become the basis on which energy storage investments are justified going forward?

Benefit-cost analysis (BCA) is important for most state clean energy programs, which require that program administrators demonstrate benefits will outweigh costs before public money is invested to support a new clean energy technology or application.

BCAs are relevant to both wholesale and retail markets. While ISOs and RTOs increasingly can accommodate energy storage, these regional wholesale energy markets generally do not fully value all energy storage capabilities at this time. Further, regional planning and modeling may not accommodate all market functions, particularly those that provide value at the distribution level. Preparation of BCAs at the state level for application to the retail/distribution market can identify specifically where energy storage provides value, thereby helping regulators and policymakers know which applications to incentivize.

California, Maine, Massachusetts, Minnesota, Nevada, and New York and are among those states that have completed BCAs with robust modeling. These studies all demonstrate a net benefit to customers in various storage deployment scenarios.

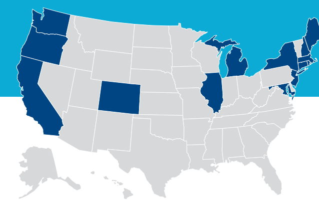
- **California:** In 2013, the California Public Utilities Commission (CPUC) used an EPRI energy storage valuation tool to assess the cost effectiveness of energy storage in 31 different prioritized use case scenarios. In all but three use cases, the test returned a positive net present value for energy storage. This finding helped to support California's landmark energy storage procurement mandate, issued the same year, of 1,325 MW by 2020.

- **Maine:** Legislation signed into law in 2021 established state energy storage targets and ordered an Energy Storage Market Assessment, which was commissioned by the Governor's Energy Office.

- **Massachusetts:** A noteworthy BCA was included in the Massachusetts *State of Charge* report, a detailed and voluminous state-funded study performed as part of the Massachusetts Energy Storage Initiative. The purpose of the study was to analyze the statewide economic benefits of storage, as well as to develop policy recommendations for promoting the deployment of energy storage in Massachusetts. Across a range of use cases and possible value streams, the study identified roughly 1,800 MW of cost-effective storage potential in 2020. This study is one of the most comprehensive state energy storage studies to be produced.

- **Minnesota:** Minnesota was one of the first examples of a state requiring through statute the preparation of a BCA specific to energy storage. Legislation in the state directed the Minnesota Department of Commerce to conduct an energy storage BCA in order to determine the value of adding storage resources to the state's electric grid. The BCA was conducted in 2019 and included the following key findings:

  - Solar+storage was already cost effective in Minnesota at the time of the study
  - Stand-alone storage was projected to become cost effective in 2025
  - Over the next decade, storage was expected to show increasingly positive benefit-cost ratios for more and more use cases as technology costs decline



- **Nevada:** The Nevada Governor's Office of Energy (GOE) commissioned a BCA to provide information for the Public Utility Commission of Nevada (PUCN) when evaluating at what levels energy storage deployment would be economically beneficial for the state, whether procurement targets for energy storage systems should be set and, if so, at what levels.

- **New York:** The New York Department of Public Service (DPS) and the New York State Energy Research and Development Authority (NYSERDA) have also used state-sanctioned benefit-cost analyses to explore the feasibility of achieving the state's energy storage procurement requirement, as well as the overall cost-effectiveness of energy storage adoption. The New York study identified nearly 2,000 MW of cost-effective storage potential by 2025, exceeding the state's proposed deployment target.

Survey responses show that the leading decarbonization states are addressing the following issues in conducting energy storage BCAs:[6]

- Identifying the value that storage can provide by shifting energy consumption, both now and in the future as state electrification goals are achieved
- Using BCA tests that determine whether storage incentives could result in cost shifting between storage owners and non-owners, such as the Ratepayer Impact Measure (RIM)
- Using tests that effectively value storage on both the large (MW) and small (kW) scales
- Finding ways to integrate storage into utility IRP BCAs without undervaluing storage benefits (utility IRPs are not typically designed to value non-energy benefits, and thus may not fairly value energy storage)[7]
- Assessing or assigning monetary value to storage benefits and services not currently monetizable in open markets, such as resilience

Distribution System Planning

POLICY ISSUE

Given that storage is expected to be connected to distribution feeders, should utilities be required to develop distribution modeling and submit regular integrated distribution plans (IDPs) that include proposals to site energy storage at specific locations across the distribution grid? If so, what data sets should be included in that modeling approach?

Over the past several years, a handful of states—California, New York, Hawaii, and most recently, Nevada—have taken on the challenge of integrating DERs like rooftop solar, energy storage and plug-in electric vehicles into the way utilities plan for and operate their distribution grids. Distribution system analysis of potential hosting capacity and locational value are increasingly being used in state-sanctioned initiatives to plan and prepare for the integration of new DERs, including energy storage.

6 For more information on state energy storage benefit-cost analyses, see https://www.cesa.org/resource-library/resource/energy-storage-benefit-cost-analysis-a-framework-for-state-energy-programs.

7 For more information on energy storage in utility IRPs, see https://www.pnnl.gov/main/publications/external/technical_reports/PNNL-28627.pdf.

At a high level, data used in energy storage-specific distribution system modeling exercises have included:

- Granular load growth projections by location and time
- System capacity planning projections
- Existing and projected distribution generation and production by location and time of day and year
- Line loss studies
- System reliability studies, including voltages, protection, and phase balancing
- System-wide and location-specific cost information
- System-wide and location-specific demand growth rates
- Embedded and marginal cost of service studies.

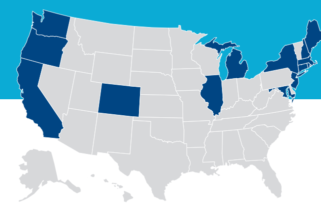
In addition, states have employed three different categories of energy storage tools relative to distribution system planning:

1. Distribution system analysis and power flow analysis tools
2. Valuation tools that look at the economics of different battery systems in different market and operational contexts
3. Tools for locating and sizing energy storage systems.

A key step in this analysis is distribution system modeling, which identifies distribution grid needs under various scenarios and evaluates solutions such as changes to system configuration, infrastructure replacement, upgrades and modernization investments, and non-wires alternatives. These studies are generally conducted annually with a 5- to 10-year planning horizon and with considerable input from stakeholders regarding planning assumptions. IDPs also tend to use forecasts with multiple load and DER scenarios to assess current system capabilities, identify incremental infrastructure requirements and enable analysis of the locational value of DERs.

Survey responses related to distribution system modeling indicated that the leading decarbonization states are confronting a number of related issues, including:

- How to model storage in resource planning
- Whether to conduct independent studies as part of DSPs, to ensure that storage benefits are included and fairly valued
- How to include decarbonization as a part of a DSP effort, such that utility IRPs will show the amount of energy storage needed to contribute to decarbonization in different scenarios



Industry Survey

In addition to the survey of states with 100% decarbonization goals, we also surveyed a small group of energy storage developers in order to compare their policy priorities with the policy types most used by the states.[8] In other words, we wanted to find out whether the policies most frequently adopted by states to support expanded energy storage deployment were the policies most valued by non-utility energy storage developers.

The industry survey was completed by representatives of seven energy storage development companies—firms that sell and install energy storage systems of all sizes, from residential batteries to bulk power/grid supply systems. The firms represented by the industry survey respondents were the following:

- Enel North America
- Key Capture Energy
- New Leaf Energy (formerly Borrego)
- Nostromo Energy
- Sunrun
- Tesla
- An independent consultant to the energy storage industry

As part of the survey, the following list of 11 policy types was presented, and respondents were asked to assess the importance of these policy types to their businesses:

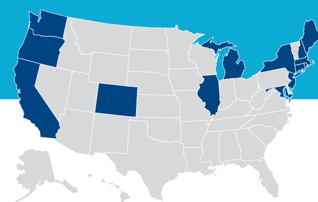
1. Procurement mandates, targets, or goals
2. Utility Ownership of Energy Storage
3. Inclusion of Storage in Utility IRPs
4. Storage Incentives/Tax Credits
5. Multiple Use Applications
6. Storage Cost/Benefit Analysis
7. Distribution System Modeling
8. Changes to Net Metering Policies
9. Changes to Interconnection Standards

8 To view the industry survey, see Appendix B.

10. Changes to RPS Programs
11. Rate design

Takeaways from the results of this industry survey include the following:

- Industry respondents unanimously agreed that state energy storage policies, programs, and regulations are essential to their businesses; and they affirmed that their companies invest most of their efforts toward building market share in those states that adopt the most favorable energy storage policies.
- Industry respondents unanimously cited incentives/tax credits as being the single most helpful type of state energy storage policy. It is worth noting that the respondents' companies would likely be in a position to materially benefit from state energy storage incentives, which essentially buy down the cost of their products and services, making them more attractive to consumers.
- Industry respondents were nearly unanimous (6 out of 7) in citing utility ownership of energy storage as the least helpful policy. This may be because the respondents were third-party storage developers who might view storage-owning utilities as competition (and perhaps unfair competition) to their business. Distribution system modeling and changes to solar net metering regulations were also cited by several respondents as being among the least helpful state policies.
- Industry respondents were nearly unanimous (6 out of 7) in viewing states with decarbonization goals or policies as generally more welcoming to energy storage development than states without decarbonization goals or policies.
- Asked which energy storage policy types they most want to see states adopt, industry respondents gave a range of answers, among which incentives/tax credits, procurement/RPS requirements, and changes to interconnection standards were the most popular choices.
- While affirming the importance of state policies, two respondents noted that wholesale market policies are also very important to the success of their business. Both cited Texas as an example of a state that lacks energy storage-supportive policies but is attractive to storage companies due to storage-friendly wholesale energy markets.



Conclusions about Survey Results

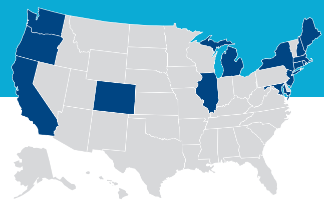
The survey results that have been summarized in this paper reflect a wide range of thinking and approaches taken by the leading decarbonization states with regard to energy storage policymaking in support of decarbonization goals. The policy types most employed by these states can be considered as constituting an early set of policy "best practices" that other states should take into account when approaching energy storage policymaking. Likewise, the issues and barriers most frequently cited in this report—particularly those described in the case studies—provide a preview of issues that will likely arise in other states.

However, it is important to view these results in context. The number of states that have set advanced decarbonization goals is still fewer than half the states in the nation, and the subset of those states that have developed a relatively mature suite of energy storage policies to support those goals is an even smaller fraction of the whole. The nature of state-level policymaking and energy regulation dictates that different states face different challenges and operate in different energy market and regulatory environments; therefore, as increasing numbers of new states develop decarbonization goals and energy storage programs, novel policy and program types may emerge and become dominant. Furthermore, as energy storage technologies advance, manufacturing costs fluctuate, and new applications for the technology are explored, the economics of energy storage are likely to change. Therefore, this report should be viewed as highlighting early-stage results in a highly changeable field.

It is the consensus among the states that responded to the survey that grid reliability, renewable integration, and other services provided by energy storage will be key to hitting decarbonization targets.

This in itself is a notable result of this report. However much or little policy development they have engaged in, it is the consensus among the states that responded to the survey that grid reliability, renewable integration, and other services provided by energy storage will be key to hitting decarbonization targets. Given this common understanding, the monumental decarbonization goals that the states have adopted, and the deadlines they have set for doing so, it is noteworthy that many of the leading decarbonization states remain in the early stages of energy storage policy development. The fact that fewer than half of the leading decarbonization states have set an energy storage procurement goal suggests that even among many of the most advanced clean energy states, energy storage still represents an uncertain quantity in their energy planning.

It may also be worth noting the similarities and differences between the policy types favored by state policymakers, and those favored by energy storage developers. Storage developers surveyed for this report overwhelmingly agreed with state policymakers that



storage procurement mandates/targets and storage incentives/tax credits are among the most helpful state policy types. However, storage developers and state policymakers disagreed on the value of two other policy types: utility ownership, and distribution system modeling.

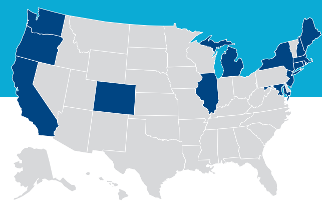
While state policymakers included these two among their top five policy types, storage developers identified utility ownership and distribution system modeling as among the policy types least helpful to their businesses. This may indicate that third-party energy storage developers tend to view electric utilities as competitors or impediments, rather than allies, in the energy storage market; while state policymakers tend to view utilities as helpful or necessary partners in meeting their energy storage procurement goals. Furthermore, the storage developers surveyed identified changes to interconnection standards among the policy types they would most like states to adopt. This again points to tensions between utilities and third-party storage developers; state policymakers and regulators should take a hard look at the points of friction between utilities and third-party storage developers, as these friction points can frustrate even the best-designed energy storage policies and programs.

It is also worth noting that despite the obvious disparities between different state energy storage goals and programs, a number of common barriers have arisen. These barriers, which are explored in more detail in the case studies, include the following:

Despite the obvious disparities between different state energy storage goals and programs, a number of common barriers have arisen.

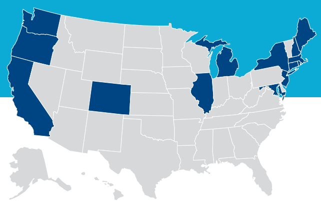
- Grid interconnection barriers
- Questions of equity in energy storage program development
- Uncertainties about storage valuation, especially with regard to non-energy and non-monetizable benefits
- Difficulties in harnessing storage to meet specific state energy and environmental goals, especially with regard to distributed storage
- Knowledge barriers, especially with regard to future energy needs and future storage capabilities
- Uncertain or divided regulatory authority
- Insufficiently developed markets
- Questions about who should pay for energy storage investments, and how to allocate costs equitably
- High costs
- Uncertainties about how to bring energy storage to scale, especially with regard to provision of longer-duration grid services

States contemplating the development of energy storage policies would do well to consider these barriers, and the experiences of states that have already begun to address them.



Energy storage developers surveyed unanimously agreed that state energy storage policies, programs, and regulations are essential to their business, and affirmed that their companies invest most of their efforts toward building market share in those states that adopt the most favorable energy storage policies.

Finally, state policymakers may take comfort in the fact that the energy storage developers surveyed unanimously agreed that state energy storage policies, programs, and regulations are essential to their business, and affirmed that their companies invest most of their efforts toward building market share in those states that adopt the most favorable energy storage policies. Further, these industry respondents unanimously cited incentives/tax credits as being the most helpful state energy storage policy types. This result validates the importance of state policymaking to the energy storage industry, and it gives policy-makers a clear direction when considering which types of policies may be most effective in jump-starting the storage market in their state.



Case Studies

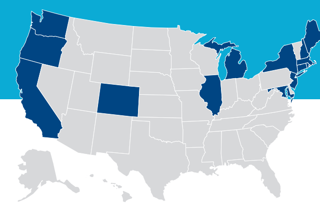
In order to dig deeper into energy storage policy barriers and issues that are being encountered by the leading decarbonization states, the authors selected five states from among the survey respondents. For each of these five states—California, Illinois, Massachusetts, New York, and Oregon—the authors conducted interviews with state energy agencies representatives and, based on these interviews as well as independent research, produced the following case studies.

California

TABLE 5

California Snapshot

Policy or Program	Mechanism	Target	Details
Clean Energy Goal	Decarbonization target	100 percent carbon-free electricity by 2045	The California Clean Energy Goal was established in 2018 by legislation (SB 100) that extended and expanded the existing state Renewable Portfolio Standard (RPS). The new goal is 100 percent carbon-free electricity by 2045. Additionally, California Executive Order B-55-18 (also 2018) set a goal of statewide carbon neutrality by no later than 2045, with net negative GHG emissions thereafter. And a recently-enacted bill sets a new interim goal of 90 percent decarbonization by 2035.
Energy storage procurement target	Procurement mandate	Regulated utilities must procure 1,825 MW of storage by 2020, with carve-out of 500 MW of BTM storage	CPUC Decision No. 13-10-040 (2013) established that regulated utilities must procure at least 1,325 MW of energy storage by 2020. This was subsequently expanded to 1,825 MW, with the addition of a requirement for 500 MW of BTM storage. The procurement requirement is divided among the state's regulated utilities, and the target amount is further subdivided for each utility into transmission, distribution, and customer storage procurement goals.
Self-Generation Incentive Program (SGIP)	Rebate	In its current budget cycle, SGIP is funded at more than $1 billion	California's Self-Generation Incentive Program (SGIP) provides a dollar per kilowatt ($/kW) rebate for installed energy storage systems. In 2020, the state updated the SGIP to provide more funding and higher levels of incentives for customers in high fire threat districts, and for low-income customers. The state also made 50 percent of the per-system rebate contingent on storage owners operating systems in support of the state's emissions reduction goals.
Distribution System Modeling	Modeling		The California Public Utilities Commission (CPUC) requires investor-owned utilities to file an annual grid needs assessment and distribution deferral opportunity report to identify specific deficiencies of the distribution system (by circuit; identify the cause of the deficiency; and serve as the basis for an annual project list of necessary distribution system upgrades). Utilities must then identify non-wires alternative (NWA) opportunities and identify DERs) that could address the deficiency.
Property and Sales/Use Tax Incentives	Tax exemptions		Property tax exclusion for solar energy systems and solar plus storage systems, amounting to 100 percent of system value; 75 percent of system value exemption for dual-use equipment. Sales and use tax exemption for electric power generation and storage equipment.
Grants	Grants offered for long-duration energy storage demonstration projects	$380 million in long duration energy storage grants	California is awarding large grants to companies that can field large-scale, long duration energy storage technologies (defined as at least 50 MW and 8 hours duration). Lithium-ion and pumped-hydro technologies are excluded.



California Summary

California emerged as an early leader in energy storage policy when it adopted the nation's first energy storage procurement mandate in 2013, requiring investor-owned utilities in the state to procure 1,325 MW of energy storage by 2020 (this was subsequently expanded to 1,825 MW, with a 500 MW requirement for BTM storage added). California also refocused its Self-Generation Incentive Program (SGIP) from solar to storage, and continued to expand and improve the program, adding an emissions reduction requirement and carving out budgets for low-income customers and those at high risk from wildfires. SGIP, currently capitalized at more than $1 billion, remains the best-funded and longest-standing energy storage incentive in the country.

While continuing its legacy programs, California has embarked on new paths to achieving its clean energy goals, with a focus on developing new long-duration energy storage technologies. This groundbreaking work has brought with it new challenges.

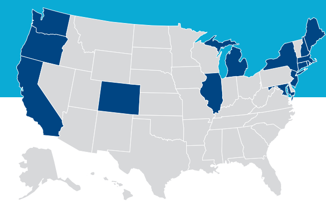
California is grappling with a number of issues, including the following.

Harnessing BTM storage to meet grid needs. SGIP has incentivized a lot of BTM energy storage, but California has struggled to find ways to use these distributed resources to meet the needs of the electric grid (such as addressing the "duck curve" midday solar overpro-duction problem and responding to peak demand)—especially with regard to exporting power from behind customer meters. Building owners are optimizing systems to achieve bill savings and, with the recent update of the SGIP program requirements, to reduce GHG emissions, but most BTM batteries are not yet able to respond to grid signals in real time, and export is allowed only during a grid emergency.

Reducing life cycle impacts. There is not yet a battery services ecosystem that allows for recycling of lithium-ion batteries, nor is there a pathway for "second life" reuse of EV batteries in stationary storage applications. At the beginning of the battery supply chain, lithium mining creates both humanitarian and environmental issues. All of these problems must be solved in order to achieve a closed-loop system that would make lithium-ion battery use sustainable, and California is working on all three—in the short term, by increasing in-state lithium sourcing, and in the long term, by developing second life and recycling for lithium-ion batteries.

Deciding who pays. As in other states, the emergence of DERs in California has brought with it questions of how to equitably pay for upgrades in the distribution and transmission grids that are needed to accommodate more BTM solar and storage. Costs, rates and equity were explored in a 2021 report from the CA PUC, but the issue continues to spark debate.

Scaling up. In combination, the California energy storage procurement mandate and the SGIP incentive program have been very successful. However, there is a long way to go: to meet the state's clean energy and energy storage goals, energy agency officials estimate that California will need to deploy renewables at three times its current rate, and storage at eight times its current rate; and much of the additional storage will need to be longer duration storage. Because pumped hydroelectric storage is both expensive and difficult to site, California has begun a push to develop new LDES technologies (see below).



Longer-duration storage. It is becoming clear that while lithium-ion may be an excellent technology to meet short-duration needs of the grid, such as frequency regulation and peak demand management, it is not going to meet long-duration needs, such as displacing fossil baseload generation and enabling the state to get through long periods of insufficient wind and solar generation. In order to push the industry toward longer-duration storage technologies (defined by California as 8 hours or longer), California is working with the US Department of Energy and the national labs to field numerous demonstration projects showcasing new technologies. The state has a 10-year R&D program and has begun awarding grants to non-lithium and non-pumped hydro long duration storage demonstration projects. The goal is to advance 4-6 companies, each developing a storage technology capable of at least 50 MW/8-hour systems. Ideally, costs for these long-duration systems will come down over time so that they can compete on an economic as well as a performance basis.[9]

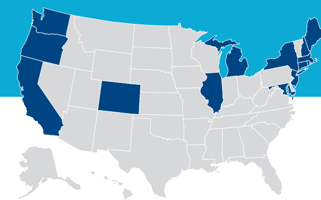
Optimizing the mix. Assuming viable long-duration energy storage technologies are developed, the state will need to determine the optimal mix of storage durations for future procurements. In other words, how much 10-hour storage will be needed? How much 20-hour, 50-hour, or seasonal storage? Is there a mixture of technologies and durations that makes the best economic sense to get the job done?

Interconnection and monetization. Even in the relatively advanced California energy storage market, interconnection remains an issue. Currently, utility-scale storage projects may face a 2-4 year wait to obtain approval from CA-ISO to participate in wholesale markets. And even after interconnection is complete, storage providers may not be able to make money for another year or two, due to FERC and CA-ISO rules. For this reason, most large-scale storage providers in California seek to execute a PPA with a direct off-taker. This allows for faster monetization of storage services, and reduced risk for the end user; but it also increases transaction costs and reduces the revenue potential for storage owners. If the state is to fully integrate storage into wholesale markets, interconnection and monetization barriers will have to be addressed.

California Takeaways

California has done an excellent job of getting a lot of energy storage deployed in a short time on all parts of the grid (transmission, distribution and customer-sited) and has emerged as a leader in energy storage policy. The state is now challenged to better integrate storage to meet electric grid needs and achieve state policy goals, as well as to address lingering issues such as recycling and materials sourcing that have not been solved by markets. California is also looking to the future, scaling up storage deployment and investing in innovative, long-duration energy storage technologies.

9 To put the preceding discussion in context, it may be useful to consider that an independent study commissioned by the California Energy Storage Alliance determined that meeting an interim goal of 60 percent renewable penetration by 2030 will require between 2 GW and 11 GW of LDES. Further, if California is to achieve its target of net-zero carbon emissions by 2045, the state will need to deploy 45 GW to 55 GW of LDES, with an interim goal of 2 to 11 GW by 2030.

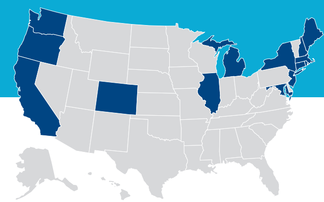


Illinois

TABLE 6

Illinois Snapshot

Policy or Program	Mechanism	Target	Details
Renewable Portfolio Standard	Legislative mandate	25 percent renewables by compliance year 2025–2026	The Illinois Power Agency Act, enacted in August 2007, requires specified electric utilities and alternative renewable energy suppliers (ARES) to get a certain percentage of electricity from renewable sources. According to this law, renewable sources must make up 25 percent of overall electric sales by 2025, with wind energy accounting for 75 percent and solar accounting for 6 percent and increasing to 50 percent by 2040.
Clean Energy Target	Emissions reduction mandate	100 percent clean energy by 2050	The Climate and Equitable Jobs Act (CEJA) established a goal of 100 percent clean energy by 2050, with interim targets of 40 percent by 2030 and 50 percent by 2040. All natural gas facilities must eliminate greenhouse gas (GHG) emissions by 2045 and all coal facilities must eliminate emissions by 2035. GHG emissions refers to both carbon dioxide and other harmful air emissions such as fine particulates, Nitrogen Oxides (NOx) and Sulfur Oxides (SOx). Additionally, there are intermediate deadlines based on characteristics of the facilities that stipulate accelerated phase out dates for some plants (e.g., private coal generating facilities must phase out by 2030).
Coal-to-solar+storage	Procurement mandate	Up to 625,000 renewable energy credits (RECs) to be procured from solar+storage sited at retired coal plants.	CEJA created a Coal-to-Solar+Storage program to transition retired coal plants to renewable energy facilities. The Illinois Power Agency is required to procure no more than 625,000 annual RECs at a price of $30 per renewable energy certificate (REC) from these coal plant-sited solar+storage resources. The cost for this program can be up to $375 million.
Energy storage installation grant	Grant	40 new energy storage facilities	CEJA authorized the Department of Commerce and Economic Opportunity ("DCEO") to provide grants to support the installation of 40 energy storage facilities at the sites of up to three qualifying current or former coal-fired electric generating facilities located in the Midcontinent Independent System Operator, Inc. ("MISO"), region in Illinois and the sites of up to two qualifying electric generating facilities located in the PJM Interconnection, LLC ("PJM") area. In each case, the proposed energy storage facility at the site will have energy storage capacity of at least 37 MW. The DCEO is authorized to utilize up to $280.5 million for such grants.
Customer storage rebate program	Tariff	Establishes a base rebate of $250 per kilowatt-hour of nameplate capacity for customer-owned energy storage providing grid services.	Requires utilities to establish a tariff that rebates customers who install solar+storage for benefits they provide the distribution grid. base rebate of $250 per kilowatt-hour of nameplate capacity may be adjusted upward based on the value of services provided, but not lowered.



Illinois Summary

Illinois is a restructured state with supply choice. This means that investor-owned utilities such as Commonwealth Edison and Ameren provide electricity delivery services but do not own generation. Utility customers can choose to receive retail electric supply (which consists of energy and capacity) either from their delivery utility or from an Alternative Retail Electric Supplier (ARES). Electricity supply purchased by residential and small commercial customers that have not chosen service from an ARES is procured by the Illinois Power Authority (IPA). All other retail electric supply is contracted directly between end-use customers and their chosen ARES under fixed price, hourly, or other rate structures. In both instances, Commonwealth Edison and Ameren deliver power via their transmission and distribution infrastructures.

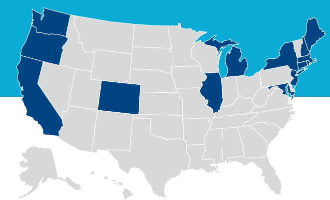
The Illinois Commerce Commission (ICC) does not regulate the ARES supply rates (although the ICC does have some limited authority over the terms and conditions of ARES service). ARES are free to procure energy and capacity to supply energy to their customers however they like (they may contract with wholesalers directly, self-supply if they own generation, or rely on the wholesale energy and capacity markets).

In 2021, the Climate and Equitable Jobs Act (CEJA) (SB2408) established a goal of 100 percent clean energy by 2050, with interim targets of 40 percent by 2030 and 50 percent by 2040. The Act also called for three main energy storage efforts: a coal-to-solar+storage program, under which legacy coal generation facilities will be retrofitted with utility scale solar PV and battery storage; a customer storage rebate and pay-for-performance program, to be implemented by the state's regulated electric utilities; and a study to investigate other policy options. That study, completed by the IPA in 2022, recommended that Illinois not adopt an energy storage procurement target right away, but did recognize that energy storage will be needed to help the state meet its 100 percent clean energy requirements and decarbonization goals. Toward that end, the study recommended that the IPA engage a technical consultant to conduct optimization modeling, which would help quantify how much storage will be needed to achieve decarbonization. It also recommended moving forward with programs that could be developed under the IPA's existing authority.

CEJA has been hailed as a major step forward for the state in the areas of clean energy goals and energy storage adoption, but some challenges remain.

Knowledge barriers. The ICC, in its statutorily required "Energy Storage Program Report" submitted on May 25, 2022, identified the need to "gather additional information about the costs and benefits of energy storage to enable [the ICC] to better analyze what future regulatory, legislative or executive actions are necessary to further advance the implementation of energy storage in Illinois."

Limited legislative authority. The ICC also acknowledged that it faces barriers when considering additional energy storage programs that may further state policy goals but are not possible under existing legislative authority, and the associated need to identify the legislative changes necessary to authorize the implementation of such programs.

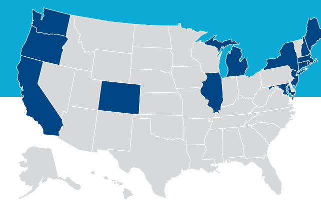


Split authorities. In Illinois, responsibility for clean energy initiatives is split among several state agencies, and this multi-agency structure can make it difficult to incentivize DERs. For example, the IPA is empowered to run competitive procurements for energy and capacity, but renewables programs must be approved by the ICC, which is also responsible for approving utility tariffs. The IPA has no direct mechanism for incentivizing rooftop solar. The only vehicle for this is the REC program. If IPA wanted to introduce a storage adder it would have to be structured as a payment for RECs, and the storage would have to be charged from solar to keep the RECs pure; and such a change would require approval by the ICC.

Unclear responsibilities. Because clean energy authorities can lie across numerous state offices, it's also not clear which agency should take the lead in developing markets for new energy technologies such as energy storage. Similarly, there is uncertainty about where innovation responsibilities lie, since the state has no agency tasked with supporting clean energy research and development.

Illinois Takeaways

Illinois has taken significant steps with its coal-to-solar-and-storage mandate and (yet to be developed) customer energy storage program. However, while acknowledging that energy storage is essential to meet its decarbonization goals, Illinois stopped short of establishing an energy storage procurement target, and currently has no comprehensive energy storage program. Energy agencies and utilities are moving ahead with programs called for in the recent CEJA legislation; but beyond that, divided authority makes it difficult to develop new programs at the policymaking/regulatory level.

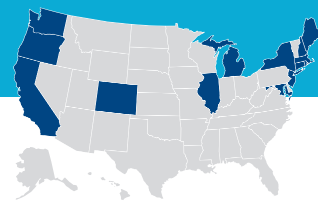


Massachusetts

TABLE 7

Massachusetts Snapshot

Policy or Program	Mechanism	Target	Details
Clean Energy Goal	Net-zero target	Net-zero greenhouse gas emissions by 2050	In 2020, the Massachusetts (MA) Secretary of Energy and Environmental Affairs set a 2050 net-zero GHG emissions goal under the authority of 2008 legislation. The same goal was then included in a March 2021 climate action law (Bill S.9). A decarbonization roadmap was released at the end of 2020.
Energy storage procurement target	Aspirational goal	Regulated utilities have a goal to procure 1,000 MWh of storage by 2025	MA set an aspirational storage procurement target of 1,000 MWh by December 31, 2025 (established in 2018, House Bill 4857), with an earlier, interim target of 200 MWh by January 1, 2020. The Commonwealth also has an RPS goal of 40 percent by 2030 (established in 2021), and a Clean Energy Standard of 40 percent by 2030, 80 percent by 2050 (established in 2018).
SMART solar incentive program	Rebate	Storage incentive adder within solar rebate program	MA offers a storage adder under the commonwealth's solar-focused SMART incentive program. For residents installing storage with a solar PV system, the per-kilowatt-hour incentive for solar production increases as a result of installing a connected energy storage system.
Connected Solutions pay-for-performance program	Performance incentive	Storage as an efficiency measure; customers are paid for peak demand reduction	The ConnectedSolutions program introduced energy storage into the Massachusetts Energy Efficiency Plan as an efficiency measure; utilities may now enroll storage customers into the program via a 5-year, pay-for-performance contract that provides compensation in exchange for customer battery dispatch at peak demand hours, in response to a utility signal.
Clean peak energy standard	RPS-style program for energy storage	Utility procurement requirement for storage to provide an increasing percentage of peak power	The Clean Peak Energy Standard sets increasing utility targets for clean power at peak demand hours and establishes alternative compliance payments for utilities that fail to meet the standard.
Energy storage and resilience grants	Grant programs	Grants offered for municipal resilience and energy storage demonstration projects	Shortly after Superstorm Sandy, MA launched the Community Clean Energy Resiliency Initiative to advance municipal-led clean resilient power projects. This was followed by the Advancing Commonwealth Energy Storage grant program, which aimed to demonstrate a variety of storage technologies, applications and business models.
Utility ownership	Regulation	Utilities may own energy storage	In MA, a deregulated state, utilities may own energy storage, although they may not own generation.



Massachusetts Summary

Massachusetts has been a leader in state energy storage policy. The Commonwealth's energy storage initiative began with the *State of Charge* report, a detailed road mapping exercise published in 2016, and has grown to include grant programs, solar+storage incentives, the ConnectedSolutions program (which incorporates behind-the-meter batteries into the Massachusetts energy efficiency plan, allowing utilities to purchase peak-reducing services from storage owners), the nation's first and only Clean Peak Standard, and ambitious state procurement goals.

In many ways this suite of programs has been successful. From just 2 MW of energy storage in 2016, deployment has grown to more than 200 MW, bringing Massachusetts into the top five states for storage deployment. The ConnectedSolutions program has been adopted by several other states in the region and early results indicate that storage deployment has a significantly higher cost/benefit ratio than was anticipated.

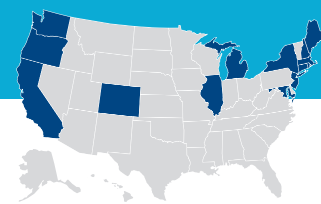
Despite this success, Massachusetts still faces challenges in meeting both its energy storage and decarbonization goals. Two challenges of note are overcoming interconnection barriers and planning for future resource needs. A third, identified in the *State of Charge* report, is the need for open energy markets where storage benefits can be monetized.

Interconnection Barriers. One major barrier to increased energy storage deployment is the cost of transmission and distribution (T&D) upgrades required for interconnection of distributed energy resources (DERs) like solar and storage. In part this is due to the way such costs are allocated. Until recently, Massachusetts (like many states) used a pure cost causation process that allocated the full cost of line upgrades to the first project interconnection that triggered the upgrade. This resulted in punishingly high costs for the first project to exceed existing hosting capacity in any given area of the electric grid. Faced with such high interconnection costs, many projects became uneconomic and were withdrawn from the interconnection queue, functionally capping energy storage capacity in those areas of the grid.

Massachusetts recently switched to a new capital improvement projects system that clusters prospective new projects and divides upgrade costs between the clustered projects, future projects, and the ratepayers. However, this is meant to be a temporary solution, as it is locationally based, does not entail much detailed planning, and has caused long delays while utilities conduct lengthy "cluster studies."

Currently, Massachusetts is developing a new five-year grid modernization process intended to provide longer-term planning for grid upgrades. Every five years, electric utilities will be required to produce a 5-, 10- and 30-year plan for grid upgrades to accommodate anticipated demand for DERs interconnections. Utilities would work with a Grid Modernization Advisory Council, similar to the Energy Efficiency Advisory Council, that works with utilities to guide the utility-administered energy efficiency program. This is a very new process and details are still being worked out.

Underlying the Commonwealth's interconnection barriers are two separate issues worthy of note: cost-benefit mismatch and utility risk perception.



- ***Costs and benefits mismatch.*** One of the underlying reasons for interconnection barriers is a mismatch in how the benefits and costs of new energy storage systems are allocated. This occurs because state incentive programs designed to support storage deployment are usually designed to capture system-wide benefits, such as peak demand reduction, while the costs of interconnection (and T&D upgrade planning) associated with interconnecting new energy storage systems are local to specific geographic areas of the electric grid. This mismatch in the scale of costs and benefits means that, even when interconnection costs are shared among a cluster of new projects, a relatively small number of energy storage system owners still end up paying a large portion of the cost for local grid upgrades. On the other hand, if interconnection costs were fully socialized across the rate base, those benefits that accrue to system owners and their communities (such as emergency backup power) would end up being paid for by ratepayers not sharing in these local benefits. The question of interconnection-related cost allocation is one that Massachusetts is beginning to confront—and one that other states will also need to address, if interconnection barriers to storage deployment are to be overcome.

- ***Utility perception of risk.*** Another issue is utilities' perception of risk when new DERs such as behind-the-meter (BTM) energy storage are interconnected onto the grid. Added BTM storage resources represent increased risk to utilities and grid operators, who are tasked with maintaining system reliability. Although incentive programs such as ConnectedSolutions and the Clean Peak Standard allow battery owners to enter into contracts with their utilities to discharge batteries during peak demand hours, the customer-owned resources are not directly controlled by utilities, and there are no penalties in these programs for customers who charge and discharge their batteries outside of the prescribed or signaled times. Therefore, for planning purposes, utilities (and ISO-New England) assume the worst case scenario, meaning they assume that a new battery will charge during peak demand hours and discharge during demand valleys (such as during the night, when additional power is not needed).[10] These worst-case assumptions are incorporated into the modeling of new storage projects, and become the basis for interconnection requirements (which may include costly upgrades), no matter how unlikely storage owners may be to dispatch their systems in this way. Essentially, utilities prefer physical rather than contractual or incentives-based controls and may not feel they can rely on the latter to ensure grid function and stability. In order to address this issue, the Commonwealth is working to adopt advanced metering and operational controls that would give utilities more information and control over customer and third-party batteries, and eventually the utilities hope to put distributed energy resources management systems (DERMS) in place; but it is unclear how long it will take to achieve widespread deployment of such controls—and whether customers will accept them.

Future needs planning. Another issue for Massachusetts is identifying and planning for energy storage as a contributor to meeting the Commonwealth's future energy needs. Three major variables driving future needs are 1) the changing generation resource mix;

10 The issue of electric vehicle batteries is even more complex. While stationary batteries cannot be depended upon, in the absence of DERMs, to charge and discharge at specific times, EVs are unpredictable in both the time and the location of charging.

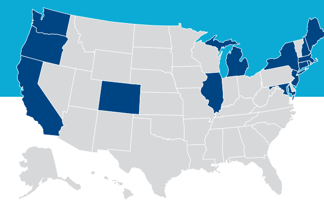
2) changing weather due to climate change; and 3) increasing electrification of the building and transportation sectors.

Changing generation mix. In terms of its generation portfolio, Massachusetts is increasing renewables deployment, but solar PV has not yet become a large enough fraction of the resource mix to require more storage across the grid (although storage may be needed close to pockets of high PV penetration). What is anticipated to be more impactful is offshore wind. The Commonwealth expects future offshore wind development to contribute significantly to the generation mix, and this will be especially important during the winter, when gas supply can be constrained, solar output is low, and increasing electrification is expected to increase winter demand peaks. However, even offshore wind doesn't blow all the time, and Massachusetts energy planners anticipate needing fossil fuel plants as back-up generators to fill in during lulls in the wind. Essentially, the Commonwealth is contemplating transforming baseload gas plants into "long-term peakers" to back up the output of offshore wind turbines. In this scenario, long-duration battery storage would be preferable, but is not yet perceived as a cost-competitive alternative.

Climate change and extreme weather. Massachusetts has always seen its highest electric demand peaks in the summer months, but state energy officials anticipate the Commonwealth will flip to winter peaking in the 2030s, and that winter peaks will become extreme in 2040s. This is partly due to the ongoing electrification of the building sector, which increases the need for electricity in the winter months for space heating; but it is also a product of the changing climate. Models predicting future grid needs are extremely sensitive to assumptions about the weather, meaning that colder winters will have an outsized impact on winter peak demand as well as on the availability of various resources to meet that demand. While short-duration battery storage is already cost-competitive in Massachusetts, there is concern about whether longer-duration storage will be a viable and cost-effective option by the time the resource is needed.

Electrification. Studies have shown that electrification of the transportation and building sectors will significantly alter the way the electric grid operates. While it offers many opportunities for emissions reduction, electrification will also increase demand for electricity, and in cold-weather climates such as Massachusetts, it will cause the highest demand peaks to occur in winter rather than summer months as is presently the case. This almost certainly results in expanding market opportunities for energy storage; however, there are questions as to whether technological advances and cost declines, especially in medium- and long-duration energy storage technologies, will be able to keep pace with changing demand. At present, a primary value of energy storage for decarbonization in Massachusetts is T&D investment deferral, which can lower electric rates and promote electrification, leading to long-term reductions in emissions. Flexible end-use loads such as electric vehicle charging have also been found to offer significant value in limiting the need for T&D upgrades following high levels of electrification in transportation and buildings. However, existing markets do not provide a way for third-party storage developers to monetize T&D investment deferral services, and there is no clear way for developers to know where on the grid such an asset would be most usefully placed.

Market development. As stated in the *State of Charge* report, "the biggest challenge to achieving more storage deployment in Massachusetts is the lack of clear market mechanisms to transfer some portion of the system benefits (e.g. cost savings to



ratepayers) created to the storage project developer." In other words, energy storage may be able to provide many valuable services, but unless the storage owner can monetize these services in markets, there is little incentive to invest in storage deployment.

Since the *State of Charge* report was published in 2016, this situation has improved somewhat, in part due to FERC rulings that have forced ISOs and RTOs to open wholesale markets to storage and other distributed resources, and in part due to efforts by Massachusetts itself to provide storage incentives to compensate for market failures. The new federal energy storage tax credit created by the Inflation Reduction Act may provide another significant boost to storage deployment.

Nevertheless, there remain significant energy storage services to which markets are closed, partially closed, or simply do not exist. Services such as critical infrastructure resilience/backup power and T&D investment deferral, while they are universally acknowledged as valuable and needed services, still cannot be easily monetized by storage developers. Because of this, some storage market segments remain underdeveloped.

The *State of Charge* report recommended a suite of program and policy development to address these market failures. Recommendations included:

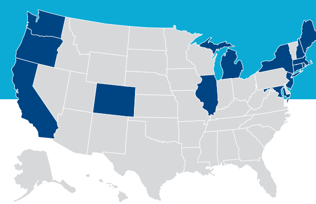
- Grant and rebate programs
- Storage in state portfolio standards
- Establishing/clarifying regulatory treatment of utility storage
- Options that include statutory change to enable storage as part of clean energy procurements
- Other changes: easing interconnection, safety and performance codes and standards, and customer marketing and education

Massachusetts has implemented a number of these recommendations, while others remain to be implemented. And, while the Commonwealth has seen significant increases in storage deployment, much remains to be done to meet its energy storage procurement and decarbonization goals.

For more information about the *State of Charge* report recommendations, see https://www.mass.gov/doc/state-of-charge-report/download.

Massachusetts Takeaways

The overall message from Massachusetts is that energy storage has arrived as a policy priority. No longer a niche technology, energy storage is now part of every major energy policy developed in Massachusetts, with all pathways being considered to help reach the Commonwealth's energy and decarbonization goals. However, these goals are ambitious, and may outpace the ability of energy storage to meet some of the Commonwealth's energy needs in the near term. Significant advances in longer duration storage and DERMs are needed, as are energy storage cost reductions. On the regulatory side, grid modernization planning and cost allocation barriers need to be solved if storage deployment is to scale up quickly and provide all the benefits of which it is capable. And for some important energy storage services, markets and price signals still do not exist.

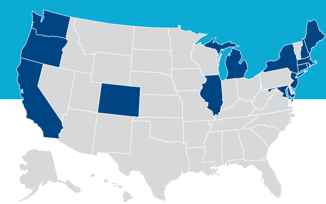


New York

TABLE 8

New York Snapshot

Policy or Program	Mechanism	Target	Details
Clean Energy Target	Emissions reduction mandate	GHG emissions from the electricity sector must be reduced 100 percent by 2040	2019 Climate Leadership and Community Protection Act (S6599) sets clean energy and emissions reduction goals: • 6,000 MW of Solar by 2025 • 70 percent Renewable Energy by 2030 • 3,000 MW of Energy Storage by 2030 • 9,000 MW of Offshore Wind by 2035 • 100 percent Carbon-free Electricity by 2040 • 85 percent Reduction in GHG Emissions from 1990 levels by 2050
Statewide energy storage goal	Procurement mandate	6 GW of energy storage must be procured by 2030	2018 Public Service Commission order established 3 GW by 2030 energy storage target. In December 2022, the state doubled this goal to 6 GW by 2030
Reforming the Energy Vision (REV) initiative	Regulatory and policy initiative	REV is an overarching reform of the state's energy policy, regulatory structures and programs	In New York, energy storage policy has been subsumed under a much larger overarching Public Service Commission initiative called Reforming the Energy Vision (REV). REV's goals include spurring clean energy innovation; improving consumer choice and affordability; aligning markets and the regulatory landscape with state policy objectives; promoting demand elasticity and efficiency, and increasing integration of renewable energy resources (including storage).
Value of Distributed Energy Resources tariff	Tariff	VDER establishes a value stack for distributed energy resources	The Value of Distributed Energy Resources (VDER) is a new mechanism to compensate energy created by distributed energy resources (DERs) in the form of bill credits. Compensation is determined by a DERs: • Energy Value (LBMP) • Capacity Value (ICAP) • Environmental Value (E) • Demand Reduction Value (DRV) • Locational System Relief Value (LSRV) Additionally, certain Community Distributed Generation (CDG) projects may have a Market Transition Credit (MTC) or Community Credit (CC).

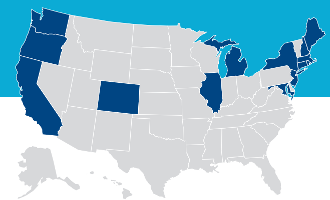


Policy or Program	Mechanism	Target	Details
NYSERDA Market Acceleration Incentives **NYSERDA Retail Energy Storage Incentive Program (rebate program)**	$/kWh rebate structured in declining MWh blocks Primary use case must be load management or shifting on-site electric generation to more beneficial time periods (resiliency may be secondary) For customer-sited systems, the customer must be enrolled and participate in one of the following for five years: • Distribution utility demand response • NWA contract • Granular delivery rate (currently Standby tariff or Con Edison's Rider Q) • VDER Value Stack tariff • Entire incentive payment made upon project entering commercial operation and NYSERDA's quality assurance (QA) inspection	$400 million in total incentive funding through 2025 (retail and bulk storage programs draw from the same budget) • $350M for IOU service territories. Initial allocations: – $130M for retail incentives – $150M for bulk incentives – $70M is currently unallocated – Flexibility to adopt to market conditions and project economics – $53M in RGGI funds to enable deployment on Long Island	Provides commercial customers funding for standalone, grid-connected energy storage or systems paired with a new or existing clean on-site generation. Energy storage systems must: • Be sized up to 5 MW of alternating current (AC) power • Be new, permanent, and stationary • Be located in New York State • Use thermal, chemical, or mechanical commercially-available technology primarily operated for electric load management or shifting on-site renewable generation to more beneficial time periods • Provide value to a customer under an investor-owned utility rate, including delivery charges or New York State's VDER • Interconnect either behind a customer's electric meter or directly into the distribution system Two Paths to Receive a Bulk Incentive: 1. NYSERDA Standard Offer declining incentive (not currently available in Con Ed/Long Island) 2. Utility Bulk Dispatch Rights contract projects may alternatively seek a NYSERDA REC payment for a paired renewable + storage project

New York Summary

New York State has set ambitious decarbonization and energy storage targets, with an accompanying energy storage roadmap; launched its Reforming the Energy Vision (REV) initiative for grid modernization; and developed the Value of Distributed Energy Resources (VDER), a value stack mechanism to compensate distributed energy resources (DERs) based on their value contributions in the areas of energy, capacity, environmental quality, demand reduction, and locational system relief. Further, New York has funded a major microgrid grant program, provided a bridge funding incentive for energy storage deployment, and recently announced investments in long-duration energy storage technology development and deployment. However, energy storage regulation and markets have not kept pace with policy and technological development, and the state faces challenges in deploying battery storage and harnessing it to support decarbonization goals. Issues include the following.

Lack of centralized or coordinated planning around decarbonization and energy storage. New York's energy planning is conducted at a number of different levels, including NYISO, NYSERDA, utilities, and municipalities. The result is a sometimes confusing proliferation of regulatory structures that don't necessarily work together toward a common goal. "Nobody's centrally planning how the markets need to evolve for decarbonization," commented one state energy official, "and nobody's centrally planning how storage needs to be sited, owned, operated to support decarbonization."



Problems with dispatch optimization. After efforts to develop software that would facilitate smart market optimization proved frustrating, NYSERDA ended up with a model that only addresses peak load discharge. Although its adoption did allow storage to be operated in New York, concerns remain that it may not be truly optimizing storage dispatch, and does not align storage operations with other state goals, such as decarbonization.

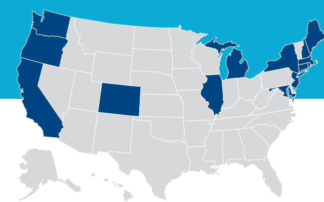
Insufficient controls and price signals. In addition to market optimization issues, storage at any scale in New York lacks sufficient dispatch signals. For example, a 5 MW FTM battery in New York receives a day-ahead hourly signal and one annual capacity signal, but no real-time dispatch or carbon signal. This leads to the suboptimal use of storage systems. Larger batteries receive a signal from NYISO but are still not optimized and, like smaller systems, receive no carbon signal. VDER tariffs and ISO programs do not optimize with each other, and neither has decarbonization as a primary goal.

Market barriers. Market barriers continue to frustrate storage developers wishing to enter wholesale energy markets in New York. For example, NYISO exempted energy storage from the day-ahead marginal assurance payments that serve as a backstop for other generators, thereby increasing risk for storage resources entering the Day-Ahead Energy, Regulation Service or Operating Reserve energy markets. Currently, there are no storage resources being dispatched by NYISO.

Bifurcated energy regulatory regimes. In New York, energy storage falls into different regulatory regimes depending on size (5 MW and larger, which can operate as an ISO resource, vs smaller systems operating under the VDER tariff) and location (FTM vs BTM). However, there are cases when it is unclear which regulatory bucket a particular storage installation should fall into. For example, larger-scale storage resources interconnecting on smaller distribution lines that are below bulk system voltages may fall into the cracks of the fragmented regulatory system, which in turn makes it unclear which rules should govern these projects. Furthermore, most state electricity regulations predate state decarbonization goals, and likely need to be updated to support these goals, as well as to account for technological advances.

Cost and market barriers, especially for BTM storage. NYSERDA has determined that BTM battery projects are about twice as expensive to develop compared to FTM projects on a per-unit basis ($1,100/kw vs $500-$600/kW). That means BTM storage needs to have significantly more monetizable value on a per-unit basis to balance its higher cost. However, in New York the opposite is true: FTM storage can inject power and earn revenues by responding to signals aligned with system benefits (peak reduction, reliability, distribution deferral, energy price balancing). By contrast, most BTM systems cannot export power, and even if they could, there is no mechanism for them to align with FTM signals. However, even FTM projects struggle to break even without incentives. The result of all this is that even when the value of resilience benefits is stacked with incentives and cost savings, such as demand charge management, the resulting economics are still not enough to entice customers to purchase batteries and enroll in incentive programs.

Distribution upgrades needed for BTM power export. Most residential and small commercial storage customers in New York cannot export power to the grid unless they pay for expensive grid upgrades needed to accommodate this export. This means that many

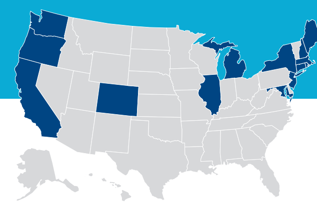


small storage customers are functionally limited to reducing on-site load, and this in turn caps the viable size of BTM batteries at or below the host facility's load. Furthermore, interconnection processes are onerous; for example, storage resources applying for interconnection may be studied twice, once as a load and once as an injecting resource, which can delay interconnection. (For more information on interconnection barriers, see the Massachusetts case study, p.48.)

Siting issues. Battery installation is still difficult in parts of New York, notably in New York City, where until very recently fire codes prohibited batteries in buildings. And in most of New York City batteries are not allowed to inject power onto the grid. Elsewhere in the state, siting and permitting typically defaults to local planning and zoning boards, which may not have the experience and expertise needed to deal quickly and efficiently with battery storage applications.

New York Takeaways

New York has made impressive commitments to both energy storage deployment and decarbonization. However, planning and regulatory structures are fragmentary, and electricity regulation has not kept pace with technological advances and state policy goals. The result is that customers cannot easily monetize many storage services, and do not receive sufficient command or price signals to align storage cycling with grid needs and state decarbonization goals. In the near term, New York needs higher battery incentive rates to overcome cost barriers, and more granular dispatch signals and tariffs (for example, New York time-of-use rates that have 8-10 hour on-peak windows and 14-16 hour off peak windows are too broad to effectively guide peak-reducing energy storage operations). To encourage energy storage development, the state also needs streamlined interconnection and siting processes. Equity considerations should also be incorporated into programs and policy if New York wishes to ensure that energy storage provides benefits to underserved communities without adding to energy burdens in these communities.



Oregon

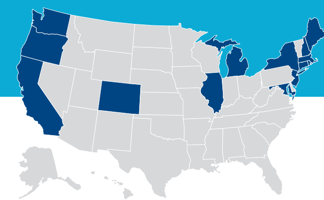
TABLE 9

Oregon Snapshot

Policy or Program	Mecha-nism	Target	Details
Clean Energy Target	Emissions reduction mandate	GHG emissions from regulated utilities must be reduced 100 percent below baseline by 2040	2021 legislation (HB 2021) requires regulated utilities to reduce greenhouse gas emissions associated with the electricity they sell to 80 percent below baseline emissions levels (established in the years 2010-2012) by 2030, 90 percent below baseline emissions levels by 2035, and 100 percent below baseline emissions levels by 2040.
Energy storage procurement target	Procure-ment mandate	Regulated utilities must procure at least 5 MWh of energy storage by 2020	2015 legislation (HB 2193) requires utilities with 25,000 or more customers (Portland General Electric and PacifiCorp) to procure one or more energy storage systems with the ability to store at least 5 MWh of electricity storage by January 1, 2020, but not more than 1 percent of the company's peak load in 2014.
Solar+storage rebate	Rebates	$14.4 million	Rebate for residential and low-income service providers. Includes a carve-out and incentive adder for low- and moderate-income customers.
Community renewable energy grant	Grants	$50 million	HB 2021 established a competitive grant program for community renewables and resilience projects. The program is open to Oregon Tribes, public bodies (municipalities), and consumer-owned utilities. Priority is given to projects that support equity goals; demonstrate community energy resilience; and include energy efficiency and demand response.

Oregon Summary

Oregon has committed to eliminating greenhouse gas emissions from investor-owned utilities by 2040. The state was also among the first to set an energy storage procurement target, although that target was not large: the state's two largest utilities were required to procure at least 5 MWh of energy storage by 2020, and they have exceeded this target. Rather than increase the procurement target, the state has shifted its focus to incentivizing residential and community resilience storage paired with solar. This resilience focus is due in part to persistent wildfires, and in part to the risk of cataclysmic earthquakes caused by the Cascadia Subduction. To encourage deployment, Oregon Department of Energy (ODOE) has launched a solar+storage rebate program and a resilience grant program that includes storage; uptake has been good, and more than half the community projects proposed include energy storage. There is no requirement that energy storage resources be designed or dispatched to support state emissions targets, but the state's two investor-



owned utilities are starting to see energy storage as a tool to meet those targets. There are also 38 consumer-owned utilities, already zero-carbon because they obtain all their power from the Bonneville Power Authority's hydroelectric facility. These electric cooperatives see resilience as the opportunity for energy storage. Energy storage is being paired with renewable generation in both utility-scale and community-scale clean energy projects. Barriers include the high cost of energy storage in a small market, comparatively low costs for electricity, and the lack of market opportunities for energy storage to generate revenues and cost savings.

High costs for storage. The Oregon market is relatively small, and storage costs remain high. ODOE studied the residential storage market and found that costs are $1,500/kWh to $2,000/kWh for residential systems. Costs have been going up for the past two years due to Covid-19, workforce shortages, and material supply issues. The state has little information regarding costs for large-scale energy storage, but it is likely cheaper than behind-the-meter storage, and more easily monetized.

Low electricity rates. In addition to the high cost of batteries, the energy storage market in Oregon is challenged by the relatively low cost of electricity. About one-third to one-half of the state's electric demand is supplied by low-cost hydroelectric generation; in addition, coal and natural gas generation remain relatively inexpensive. This makes it difficult for renewables and energy storage to be cost-competitive.

Lack of market opportunities. Oregon lacks both wholesale energy markets, such as those administered by ISOs and RTOs in other regions, and retail market opportunities that could drive customer storage adoption. For example, the state has no significant time of use (TOU) rates or demand charge management (DCM) opportunities for commercial customers. Where TOU rates and demand charges exist, rates are too low to provide cost-saving opportunities sufficient to drive storage adoption. There has been some movement toward the development of capacity and transmission sharing mechanisms, but there is strong resistance in the Pacific Northwest to the idea of an independent grid operator, which could provide price signals and market opportunities for energy storage.

Oregon Takeaways

Oregon's energy storage policy is shaped by several unique factors, including a prioritization of resilience due to earthquake and wildfire concerns; an abundance of low-cost and emission-free hydroelectric power; relatively high storage costs; and an absence of the kinds of market opportunities found in regions served by regulated regional wholesale power markets. The state's energy storage procurement mandate was small and has been exceeded, but there does not seem to be interest in increasing it; instead, Oregon is relying on its emissions reduction mandate to motivate utilities to deploy storage, while the distributed solar+storage rebate supports BTM resilience projects.

Appendix A
States Survey

Energy Storage in Decarbonization Best Practices Report–Survey Questions to SEAs

INTRODUCTION

Energy Storage in Decarbonization Best Practices Project

Clean Energy States Alliance/DOE Energy Storage Program/Sandia National Labs

We greatly appreciate your participation in our effort to better understand the best practices for applying energy storage policies and technologies to state decarbonization efforts. The questionnaire responses will help inform our report, which you will receive and which will be made public. "Energy Storage" in this context refers to electrochemical battery systems.

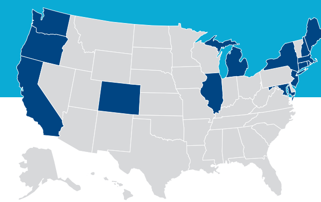
We will not quote you or name you in any way without your advance permission. We may contact you to ask about your responses.

Answer as many questions as you like and at any level of detail. Please include links for relevant information. We understand there may be energy storage applications that simultaneously serve decarbonization and other purposes. Please add comments and ANY info that you think may be relevant. Thanks very much for participating!

QUESTIONS

1. Name
2. What are the best practices that you have identified for integrating energy storage with decarbonization objectives? Please answer at any length.
3. To what extent are energy storage policies perceived to be integral to decarbonization in your state?
    a. Not at all
    b. A little bit
    c. A lot
    d. Absolutely essential
    e. Comments
4. Does your state have explicit plans for using energy storage to meet decarbonization objectives? If so, what are they?

5. Does your state have any previously developed energy storage policies or programs that have been, or soon will be, integrated into decarbonization efforts? If so, what are they?
6. What successes has your state had implementing energy storage in ways that advance decarbonization efforts?
7. What are the main challenges to creating and implementing effective energy storage plans or policies for decarbonization in your state? How can these challenges be overcome?
8. To what extent is your state relying on utility-scale vs behind-the-meter (BTM) energy storage in its decarbonization efforts?
    a. We're relying mostly on utility-scale batteries
    b. We're striving for a mix of utility-scale and BTM batteries
    c. We're mainly focused on distributed, BTM batteries
    d. Comments
9. To what extent is your state relying on utilities vs third parties (merchant storage or customer-owned storage) for investing in energy storage?
    a. We're mainly relying on utilities for storage investment
    b. We're seeing/working towards a mix of utility and third-party investment
    c. We're relying on third-party investment/utilities can't own storage in our state
    d. Comments
10. To the extent that you state is developing energy storage polices for decarbonization, is the state focused on (check all that apply):
    a. Short duration storage (0-4 hours)
    b. Medium duration storage (4-10 hours)
    c. Long duration storage (>10 hours)
    d. Name the technologies/chemistries your state is focused on
11. Energy storage policies at the state level have often been structured around the 11 policy, regulatory and market issues below. Indicate which, if any of these energy storage polices are being applied to help advance decarbonization efforts in your state
    a. Procurement mandates, targets, or goals
    b. Utility ownership
    c. Inclusion of storage in utility IRPs
    d. Incentives/tax credits
    e. Multiple use applications
    f. Cost/benefit analysis
    g. Distribution system modeling



h. Changes to net metering polices

i. Changes to interconnection standards

j. Changes to RPS programs

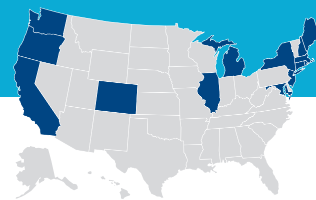
k. Rate design

l. Are there other types of energy storage policies not listed above that are being applied to help advance decarbonization in your state? If so, please explain.

12. With regard to rate design, what changes do you anticipate being necessary to enable adoption of BTM storage?

13. Is your state creating a formal process for research & development, piloting, and/or commercialization for new storage technologies as applied to decarbonization? If so, how?

14. Would you or someone else in your organization be willing to further discuss some of these topics with our team? If so, whom in your organization should we contact for further discussion?



Appendix B

Industry Survey

State Energy Storage Policy Survey for Industry

CESA/SANDIA NATIONAL LABS ENERGY STORAGE IN DECARBONIZATION BEST PRACTICES PROJECT - INDUSTRY SURVEY

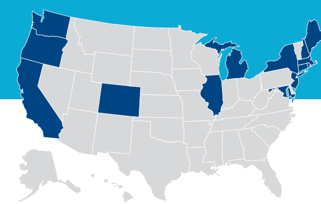
We greatly appreciate your participation in our effort to better understand the best practices for applying energy storage policies and technologies to state decarbonization efforts. The questionnaire responses will help inform our report, which you will receive and which will be made public. "Energy Storage" in this context refers to electrochemical battery systems.

Our purpose in asking you to complete this survey is to gain a better understanding of which state energy storage policies are most useful or valuable to energy storage developers. We already know which policies states are adopting; what we hope to gain from you is a better understanding of how useful these measures are from an industry perspective, and what state policies you consider most helpful in making energy storage markets attractive to you and your firm.

We will not quote you or name you in any way without your advance permission. We may contact you to ask about your responses.

Answer as many questions as you like and at any level of detail. Please include links or attachments for relevant information. Please add comments and ANY info that you think may be relevant. Thanks very much for participating!

1. Name
2. Title
3. Affiliation/Company
4. Email address where we can contact you
5. States where your company currently does energy storage business
6. States you anticipate expanding your energy storage business into
7. Please describe your business (services, products, customers)
8. Does your company focus on large/utility scale energy storage, smaller/behind the meter (BTM) energy storage, or both?
    - We're focused on large/utility scale storage
    - We're focused on a mix of large/utility scale and smaller/BTM batteries
    - We're focused on smaller, BTM batteries



COMMENTS

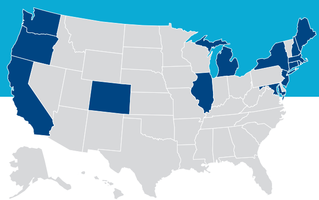
9. From your perspective, what are the main challenges to deploying energy storage? How can these challenges be overcome?
10. Energy storage policies at the state level have often been structured around the following 11 policy, regulatory and market issues.
    a. Procurement mandates, targets, or goals
    b. Utility Ownership of Energy Storage
    c. Inclusion of Storage in Utility IRPs
    d. Storage Incentives / tax credits
    e. Multiple Use Applications
    f. Storage Cost/Benefit Analysis
    g. Distribution System Modeling
    h. Changes to Net Metering Policies
    i. Changes to Interconnection Standards
    j. Changes to RPS Programs
    k. Rate design

Considering these types of policies:

Which, if any, of these energy storage policy types tend to be most helpful to your business?

11. Which, if any, of these energy storage policy types tend not to be helpful?
12. What are the top four policy types from the list above, which you most want to see states adopt? Please list them in order, from most important (1) to least important (4).
13. Are there other types of energy storage policies, programs or regulations not listed here that you would like to see adopted by states? If so, please explain:
14. To what extent does your business rely on states developing storage-friendly policies, programs or regulations?
    - These things are very important; we tend to focus our business mostly in states with favorable policies, programs and regulations
    - It's important but not the main factor when we decide where to focus our business
    - It's not something we consider
15. If state policies programs and regulations are not very important in deciding where to focus your business, what factors are important?

16. Do you generally view states with decarbonization goals or policies as more welcoming to energy storage deployment than states without decarbonization goals or policies?
    - No, states with decarbonization goals are not more welcoming to our business
    - Yes, states with decarbonization goals tend to be a little bit more welcoming than those without
    - Yes, states with decarbonization goals tend to be a lot more welcoming than those without
    - State decarbonization goals are absolutely essential to our business
17. Would you or someone else in your company be willing to further discuss some of these topics with our team? If so, whom in your organization should we contact for further discussion?



State Energy Storage Policy
Best Practices for Decarbonization

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About 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. CESA facilitates information sharing, provides technical assistance, coordinates multi-state collaborative projects, and communicates the views and achievements of its members. www.cesa.org

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