Energy Storage Policy Best Practices from New England

TEN LESSONS FROM SIX STATES

AUGUST 2021

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Clean Energy Group
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ABOUT THIS REPORT

This report, prepared by Clean Energy Group (CEG) and the Clean Energy States Alliance (CESA), presents energy storage policy best practices and examples of innovative policies from the New England states. The report describes what has worked best and provides a list of recommendations to guide states looking to expand energy storage markets with effective programs and policies. It is available online at https://www.cesa.org/resource-library/resource/energy-storage-policy-best-practices-from-new-england.

ABOUT THE AUTHOR

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DISCLAIMER

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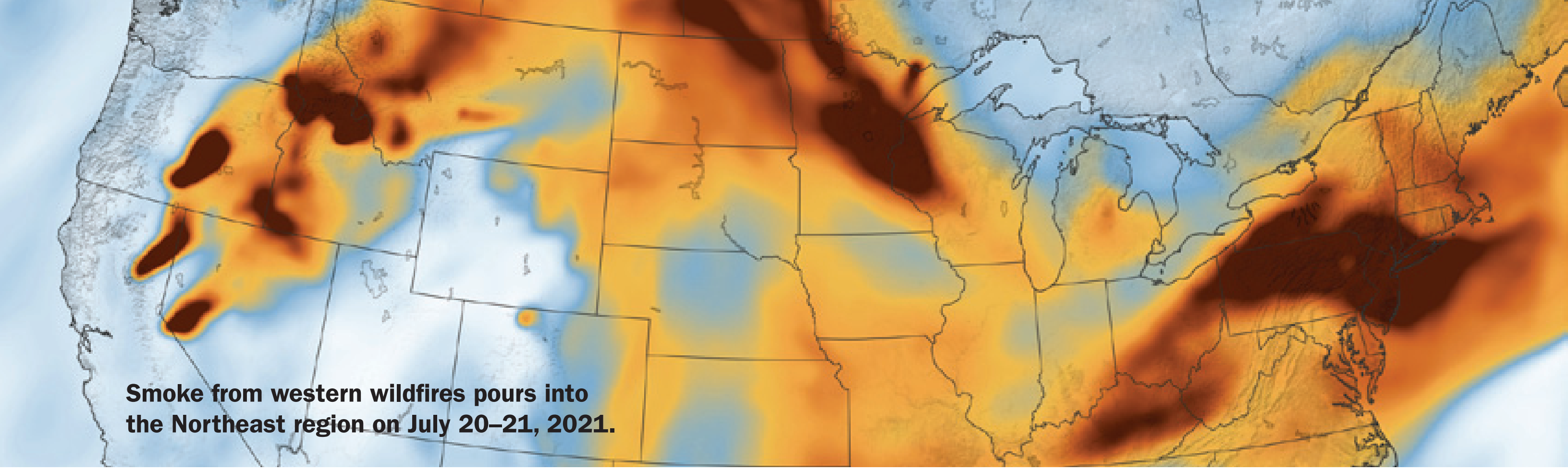
Sixteen flywheels are co-located with existing solar PV at the West Boylston Municipal Light Plant in Massachusetts. The 128 kW/ 512 kWh flywheel energy storage system provides peak load reduction and energy arbitrage to reduce costs and increase grid reliability. The project was supported by a grant from the MassCEC ACES grant program. Source: MassCEC and West Boylston MLP

A Samsung battery system at the Vermont Capitol building will provide emergency backup power in the event of a power outage. Source: Green Mountain Power

Homeowner Melissa Buttaro of Rhode Island installed a 13.5kWh Tesla Powerwall battery in her home to store solar power for later use, as well as providing time-based control and backup. Her existing rooftop solar system plus battery storage will pay for itself in 10 years and generate $44,000 in electricity bill savings over the next 25 years. Source: Rhode Island Office of Energy Resources

Green Mountain Power's Panton, VT solar+storage project combines 5 MW of solar PV with 4 MWh of battery storage. The utility is using this project to pilot its "resilience zones" concept. Source: Green Mountain Power

A 1-MWh battery installed at a large farm on Martha's Vineyard was supported with an ACES grant from MassCEC. The battery is paired with a new solar array and is used for solar smoothing to reduce voltage flicker on the feeder. Net metered power from the solar PV is sold to local nonprofits at a discount. Source: MassCEC and WH Bennett



Smoke from western wildfires pours into the Northeast region on July 20–21, 2021.

NASA Earth Observatory/Joshua Stevens

Executive summary

It is a truism that every state faces unique circumstances and has unique needs. One state cannot simply adopt wholesale the energy policies and programs of another. Nevertheless, policy best practices for energy storage are starting to emerge. This report presents best practices and lessons learned from the New England states, and provides recommendations that all states interested in developing energy storage markets might consider.

There are many reasons states may want to increase deployment of energy storage. From a policy perspective, most states already have adopted goals that storage can support. These include renewable energy standards, grid modernization initiatives, emissions reduction targets, and grid resilience and reliability goals.

From the perspective of electricity customers, however, the primary motivation for adopting storage is more immediate: extreme weather, wildfires and other natural disasters have become both more frequent and more severe in recent years, leading to increasingly disruptive and expensive grid outages that deprive populations of electricity just when they need it the most.

Consider the impacts of some of these events:

- The Texas “deep freeze” of February 2021 resulted in deaths estimated to number between 200 and 700, most due to the power outage, and an estimated $90 billion in damages.[1]
- Wildfires in California have caused utilities to institute recurring preemptive power outages. Damages from Pacific Gas & Electric’s preemptive outages have been estimated at $2.5 billion in 2019 alone.[2]
- Hurricane Maria caused some 3,000–4,000 deaths in Puerto Rico,[3] many attributable to power outages, with damage estimates ranging from $45 billion to $95 billion.[4]
- Superstorm Sandy caused 8.5 million customer outages across 21 Eastern states, some lasting weeks or even months, with damages estimated up to $26 billion.[5]

Because energy storage can provide both increased grid reliability and backup power for homes and businesses, batteries are increasingly demanded by both customers and forward-looking electric utilities. Nevertheless, strong and supportive state policies are needed to enable energy storage markets to develop and come to scale.

Over the past few years, New England has taken a leadership position in energy storage, with several states pursuing groundbreaking programs and policies. As a result, energy storage deployment in the region has leapt ahead of many areas of the country. About 20 MW of grid-scale battery storage projects

1 Domonoske, Camil, “The Power is Back on in Texas. Now Comes The Recovery, And It Won’t Be Cheap,” *NPR.org*, February 27, 2021, https://www.npr.org/2021/02/27/970877890/the-power-is-back-on-in-texas-now-comes-the-recovery-and-it-wont-be-cheap.

2 Stevens, Pippa, “PG&E power outage could cost the California economy more than $2 billion,” *CNBC*, October 10, 2019, https://www.cnbc.com/2019/10/10/pge-power-outage-could-cost-the-california-economy-more-than-2-billion.html.

3 Alexia Fernández Campbell, “It took 11 months to restore power to Puerto Rico after Hurricane Maria. A similar crisis could happen again,” *Vox*, August 15, 2018, https://www.vox.com/identities/2018/8/15/17692414/puerto-rico-power-electricity-restored-hurricane-maria.

4 Jill Disis, “Hurricane Maria could be a $95 billion storm for Puerto Rico,” *CNN Business*, September 28, 2017, https://money.cnn.com/2017/09/28/news/economy/puerto-rico-hurricane-maria-damage-estimate/index.html.

5 Center for Climate and Energy Solutions, “Resilience Strategies for Power Outages,” *C2es.org*, August 2018, https://www.c2es.org/site/assets/uploads/2018/08/resilience-strategies-power-outages.pdf.

New England states have been particularly successful in innovating policies and programs to support distributed or behind-the-meter (BTM) energy storage.

have come online in the region since 2015, but this is only the precursor to a much larger expected level of growth. According to the ISO New England interconnection queue, energy storage now accounts for 15 percent (3,771 MW) of the region's proposed new energy resources (see Figure 1).

New England states have been particularly successful in innovating policies and programs to support distributed or behind-the-meter (BTM) energy storage—both to provide resilient power to homes and businesses, and to contribute regional electricity services through virtual power plant (VPP) structures. Every state in the region now has some variety of BTM storage funding program; in Vermont alone, a utility battery program has placed storage in more than 3,000 homes, and this aggregated system is dispatched to reduce peak demand, saving ratepayers millions of dollars. Although ISO New England doesn't track most small, BTM storage installations, it is notable that in 2019, Sunrun bid 20 MW of BTM energy storage into the New England Forward Capacity Market for 2022. More recently, more than 630 MW of battery storage was secured in Forward Capacity Auction 15, for 2024-2025.[6] Such growth is remarkable, considering that just a few years ago, the total installed megawatts of advanced energy storage[7] on the New England grid could be counted in single digits.

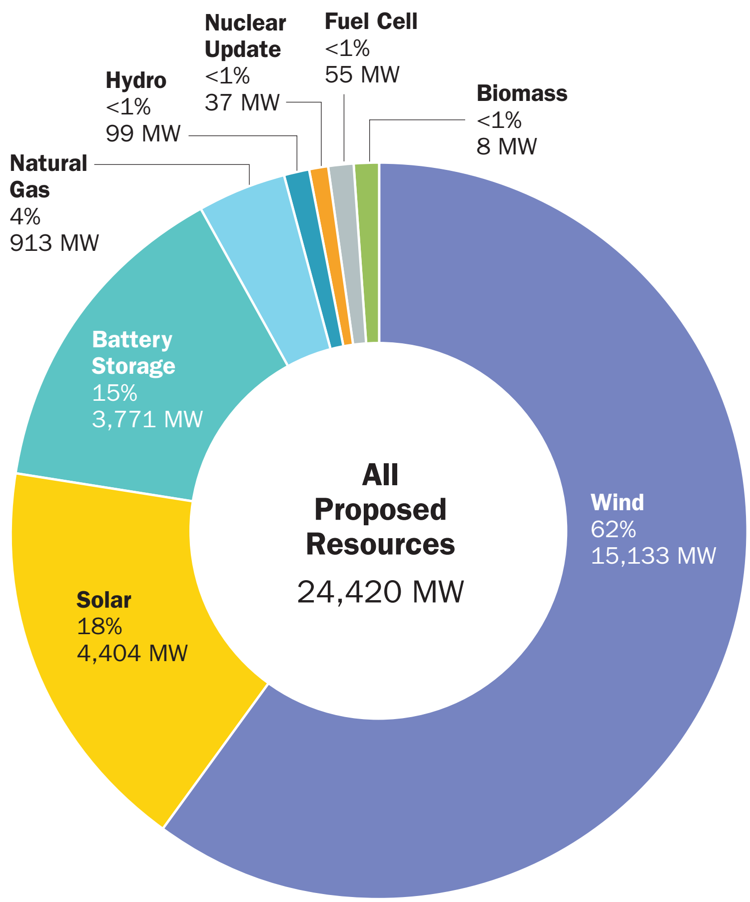
But despite this impressive progress, much remains to be done to bring advanced energy storage to scale, optimize storage markets, and fully integrate this new technology into the New England grid. Much of the needed work—including development of new policies and regulations, implementation of new programs, and updating of existing programs—falls to state policymakers and regulators.

The challenges are formidable. The six New England states have not all adopted storage policy and programs at the same rate, with the result that some states are seeing much more rapid growth in storage deployment than others. Even where states have taken the lead in goal setting and program implementation, uptake has sometimes been hampered by interconnection barriers, out-of-date regulations, and immature markets. Many of the potential health, safety, efficiency, and economic benefits that can be provided by energy storage are still not monetizable. And despite having the greatest need for these benefits, low-income and underserved communities in New England have not yet gained equitable access to energy storage and related clean energy technologies.

These challenges are not unique to New England. They will be faced by every state in every region of the country. As states address these challenges, it will be helpful to consider lessons learned, both from within New England and across the nation.

FIGURE 1

ISO-New England 2021 Regional Electricity Outlook—Clean Energy Leads Proposed New Resources



Battery storage accounts for 15 percent of proposed new resources in the ISO-New England interconnection queue. Some natural gas, wind, and solar proposals also include battery storage.

Source: ISO-New England 2021 Regional Electricity Outlook, https://www.iso-ne.com/static-assets/documents/2021/03/2021_reo.pdf

6 ISO New England Resource Mix, see https://www.iso-ne.com/about/key-stats/resource-mix.

7 Excluding two legacy large-scale pumped hydroelectric storage facilities that serve the region.

Green Mountain Power

Green Mountain Power's Panton, VT solar+storage project combines 5 MW of solar PV with 4 MWh of battery storage. The utility is using this project to pilot its "resilience zones" concept. By adding switches to the existing distribution grid circuit, GMP can provide backup power from the solar and batteries to surrounding homes and businesses in case of a grid outage.

This report is intended to provide state policymakers and regulators with a set of principles and lessons learned from experience in New England, as well as several other leading states. It does not prescribe a particular suite of energy storage policies, but does provide recommendations that each state should consider as it charts its own course:

1. Identify benefits of energy storage that are not priced or monetizable in existing markets; recognize and accommodate the multi-use nature of energy storage resources.
2. Establish a monetary value for each storage benefit and use those values when calculating cost effectiveness and setting incentive rates. Estimated value is better than no value at all.
3. Create incentives to support storage operations that further state policy goals. Incentivize storage use, not just storage deployment.
4. Set ambitious clean energy and/or emissions reduction goals and explicitly include energy storage as an eligible technology. Define how storage is expected to be deployed and operated to help meet the goals.
5. Incorporate energy storage into existing clean energy and efficiency programs.
6. Incorporate equity considerations into energy storage program design from the start, not as an afterthought. This should include significant incentive adders for qualifying participants.
7. Support a wide variety of storage ownership, application, and business models.
8. Anticipate and proactively address needed regulatory changes.
9. Replicate and improve on successful programs implemented in other states.
10. Fund demonstration projects when needed, but do not rely on grants alone to build a market.

The report addresses each of these recommendations separately to provide context, examples, and suggestions for implementation. State policy and program resources for policymakers are listed in the Appendix (p.39).

As the energy storage industry continues to grow, it will benefit New England to maintain its momentum and solidify its leadership position. And it will benefit other states to learn from the experience of New England.

Bigstock/kentoh

Ten lessons from six states

Since 2012 when Superstorm Sandy hit the East Coast, damaging electric grid infrastructure in 24 states, Clean Energy Group (CEG) and the Clean Energy States Alliance (CESA) have been working with state energy agencies to support energy storage policy development and related regulatory reform.

Our efforts began, as did those of many Northeastern states, with the idea that advanced battery storage—especially when combined with rooftop solar and other energy resources—could provide clean, resilient backup power, allowing critical facilities such as emergency shelters and health clinics to ride through future grid outages. However, it soon became clear that batteries were capable of providing much more than resilience alone. As experience with energy storage grew, utilities and customers began using batteries to provide numerous other energy services: demand management, frequency regulation, grid infrastructure investment deferral, renewables integration, and load shifting. As the list of possible storage applications expanded, state storage policy would need to become more sophisticated, and state utility commissions would need to review many regulations that had been written prior to the widespread availability of advanced battery storage, which now needed to be revised to accommodate this new technology.

Federal regulators also took notice. Since 2012, the Federal Energy Regulatory Commission (FERC) has promulgated several rules aimed at breaking down barriers that prevented energy storage from participating in wholesale energy markets, including Rule 841, which directed ISOs and RTOs (like ISO New England) to amend market rules to allow energy storage to participate, and Rule 2222, which prohibits the exclusion of distributed energy resources from these markets.

Meanwhile, utilities were experimenting with innovative storage ownership and business models, such as the aggregated dispatch of distributed customer- and third-party-owned storage (a model that has become known as the "virtual power plant" or "VPP"). Green Mountain Power (GMP) in Vermont has built large-scale battery storage plants while simultaneously offering small batteries to residential customers in a kind of demand response program. The distributed batteries provide both backup power to customers and an aggregated capacity and transmission cost-reducing resource to the utility. Within a few years, GMP has placed 3,000 residential battery systems and several large-scale batteries into operation, and now saves millions of dollars through reduced capacity and transmission costs. In Massachusetts, distributed storage was integrated into the Commonwealth's three-year energy efficiency program, creating an aggregated pay-for-performance resource that harnesses customer-owned batteries to meet regional grid needs. This program, dubbed "ConnectedSolutions," has spread to Rhode Island and Connecticut, and similar programs are proposed in New Hampshire and Maine.[8]

The combination of state policy initiatives and clean energy goals, state and regional regulatory reform, and forward-looking utility programs has resulted in an astonishing number of energy storage programs and policies in the New England region. At this writing, every state in the region has both large- and small-scale operational advanced energy storage systems, and every state has developed energy storage programs and policy. This makes the region a good source of lessons learned and best practices that can be applied both in the Northeast, and across the nation.

In the following pages, we present ten key energy storage policy lessons from New England.

8 Clean Energy Group and Clean Energy States Alliance have supported numerous storage deployments as well as policy and program development in the New England region. For more information, see our reports, webinars and case studies at https://www.cesa.org/projects/energy-storage-technology-advancement-partnership and www.resilient-power.com.

1 Identify all storage applications and benefits

WHAT IS VALUABLE IS NOT ALWAYS PRICED OR MONETIZABLE IN CURRENT MARKETS

Advanced energy storage can provide a wide variety of energy services, and storage owners frequently need to "stack" multiple services (each representing a revenue stream or cost savings opportunity) in order to make storage investments economic. It is therefore important to identify all the potential benefits of energy storage, even if many of these services may not yet be monetizable in existing markets. Where markets do not yet exist, or market rules prevent storage owners from monetizing services that batteries can provide, state incentives can help bridge the revenue gap. This can be essential to creating a viable market for energy storage investment.

For example, behind-the-meter (BTM) resilient power (the ability to support critical facilities and infrastructure during an electric grid outage) is widely recognized as having value—otherwise, there would not be a thriving market for backup generators. Battery storage, when properly configured, can provide resilient power, and this is one of the storage applications that customers value most highly. In fact, a 2020 national survey conducted by EnergySage found that "65% of installers say that resilience—having backup power in the event of a major storm event or power outage—is the primary driver of consumer interest in storage."[9] This finding is identical to that of a 2020 Navigant Consulting report on the Massachusetts ConnectedSolutions pay-for-performance BTM battery program offered to residential participants in National Grid's service territory. That study also found that 65 percent of battery owners enrolled in the program identified resilience as their primary motivation for installing a battery.[10]

Likewise, improved grid reliability is increasingly identified as a priority by state regulators who seek to avoid costly, prolonged power outages. A report from Lawrence Berkeley National Laboratory and the University of Texas studied major outages caused by extreme weather events in Texas and five other states. The study concluded that despite the acknowledged high cost of outages, the true costs are even greater:

> *We have a very incomplete picture of the full economic cost of big power outages.... It's easy to imagine that utilities are under-investing right now because they are only factoring in part of the costs and benefits.... If we could get them to internalize the broader cost to customers and society into their decision-making, then we might see quite a bit more investment in grid resilience.*[11]

Even though the estimated societal costs resulting from power outages may be incomplete, they are still quite high. For example, recent outage cost estimates include $90 billion attributed to the February 2021 Texas "deep freeze" power crisis;[12] $2.5 billion attributed to the preventative outages in California in 2019; and up to $26 billion attributed to Superstorm Sandy in 2012.[13] Most of these costs are not borne by utilities. Although there have been a few efforts to make utilities internalize some of the outage-related losses suffered by customers,[14] the greatest costs—in lives and suffering—cannot be recouped.[15]

Battery storage, when properly configured, can provide resilient power, and this is one of the storage applications that customers value most highly.

11 See EnergySage's Solar Installer Survey 2020 Results at https://www.energysage.com/press/energysage-solar-installer-survey-2020.

12 Navigant Consulting, 2019 Residential Energy Storage Demand Response Demonstration Evaluation–Summer Season, 2020, https://ma-eeac.org/wp-content/uploads/MA19DR02-E-Storage_Res-Storage-Summer-Eval_wInfographic_2020-02-10-final.pdf.

13 See article at https://news.utexas.edu/2021/03/01/true-cost-of-major-power-outages-remains-a-mystery-report-finds. The complete report can be downloaded at https://eta-publications.lbl.gov/publications/case-studies-economic-impacts-power.

14 Domonoske, Camil, "The Power is Back on in Texas. Now Comes The Recovery, And It Won't Be Cheap," *NPR.org*, February 27, 2021, https://www.npr.org/2021/02/27/970877890/the-power-is-back-on-in-texas-now-comes-the-recovery-and-it-wont-be-cheap.

15 Center for Climate and Energy Solutions, "Resilience Strategies for Power Outages," *C2es.org*, August 2018, https://www.c2es.org/site/assets/uploads/2018/08/resilience-strategies-power-outages.pdf.

Despite the high avoided-cost value of the resilience and reliability services that energy storage can provide, there is currently no market mechanism by which battery owners can offer these benefits to their communities and the local grid—and be paid for doing so. These benefits are not priced, nor are there broadly accepted metrics for measuring their value. Nevertheless, because resilience and reliability are generally understood to be valuable services, their value should be considered when states set incentive rates to support storage deployment. Similarly, other non-monetizable but valuable benefits of energy storage should also be considered (see Table 1, p.11).

Recommendations

- **When setting incentive rates, it is important to identify all the values of energy storage, including those not priced or monetizable in existing markets. These are the areas where state incentives can provide bridge funding until markets catch up.**
- **Market rules and regulations should recognize and accommodate the multi-use nature of energy storage resources.**

Because resilience and reliability are generally understood to be valuable services, their value should be considered when states set incentive rates to support storage deployment.

Market Rules and the Multi-Use Resource

Unlike many other clean energy technologies, energy storage is a multi-use resource, meaning that it can provide numerous different services to different offtakers, although not necessarily at the same time (see Figure 2, p.12). Understanding the storage value stack is important to state policymakers. Just as important is understanding how storage owners will optimize that value stack, because this will determine how energy storage resources are operated. It may be necessary to incent certain storage operations in order to align the storage owner's optimized value stack with the state's energy policies, goals, and targets.

The multi-use nature of energy storage can sometimes cause problems when battery owners attempt to access existing energy markets, which are generally designed for resources such as generators and load-reducers that provide a single service. As the California Public Utilities Commission (CPUC) observed in a 2018 rulemaking:

> *Existing rules only anticipate a very limited set of use cases—such as resource adequacy capacity providing wholesale market services—and do not anticipate that a resource may render itself entirely unavailable if it is committed to provide more than one competing service at one time. Rather, most tariffs, contract provisions, and rules assume that a resource will only provide one service. Multiple-Use Applications present a completely different paradigm.*[16]

In response, the CPUC adopted rules requiring utilities to consider the multiple uses of energy storage in resource planning, reasoning that "since contemporary market rules failed to compensate energy storage resources for all of the values that they could provide to the grid, utilities must account for those uncompensated values in their planning to ensure that the full economic value of energy storage is reflected in resource decisions."[17]

Amending electricity market rules to accommodate the multi-use nature of energy storage can be challenging, but it is necessary to enable storage to provide all the benefits of which it is capable. In the meantime, state policymakers and regulators should strive to design energy policies and programs that recognize and appropriately compensate storage for its varied uses.

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16 Recently, Connecticut PURA took steps to allow customers to recoup outage-related losses, see https://portal.ct.gov/PURA/Press-Releases/2021/PURA-Implements-Customer-Credit-and-Spoilage-Compensation-Provisions.

17 A report from Harvard researchers, published in *The New England Journal of Medicine*, estimated the death toll from Hurricane Maria in Puerto Rico at more than 5,000 people. The vast majority of these deaths were not attributed to the storm directly but were the result of prolonged electric grid outages and the lack of essential services, such as medical services, that depend on electricity. See *The New England Journal of Medicine*, "Mortality in Puerto Rico after Hurricane Maria," *NEJM.org*, July 12, 2018, https://www.nejm.org/doi/full/10.1056/NEJMsa1803972?query=featured_home.

TABLE 1

Energy Storage Benefits in Massachusetts

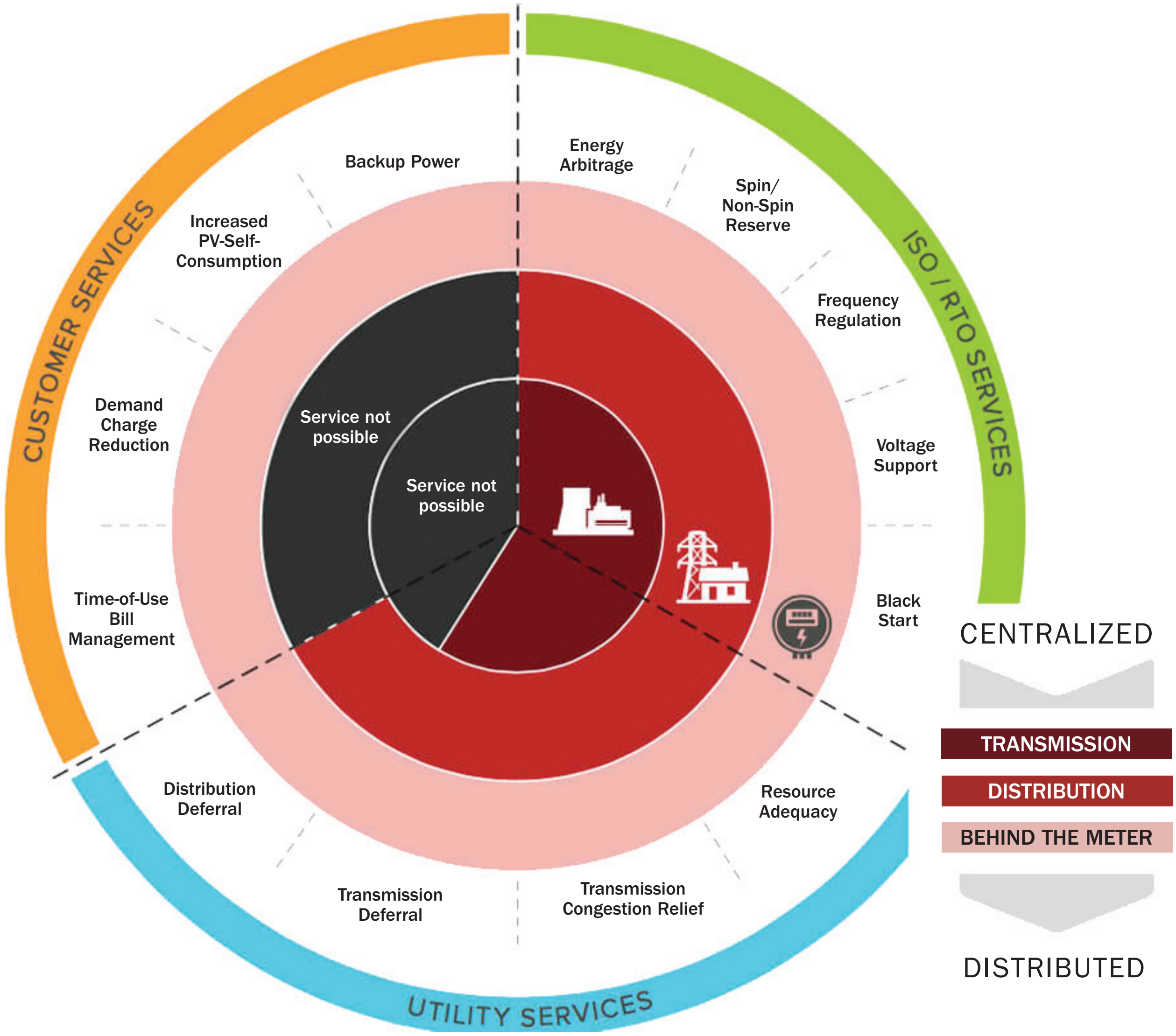
Benefit Description	Ratepayer Savings
Energy Cost Reduction	
Energy storage uses lower cost energy stored at off-peak to replace the use of higher cost peak generation: • reduced peak prices • reduced overall average energy price	**$275 Million**
Reduced Peak Capacity	
Energy storage can provide peaking capacity to: • defer the capital costs peaker plants • reduce cost in the capacity market	**$1.093 Billion**
Ancillary Services Cost Reduction	
Energy storage would reduce the overall costs of ancillary services required by the grid system through: • frequency regulation • spinning reserve • voltage stabilization	**$200 Million**
Wholesale Market Cost Reduction	
Energy storage provides system flexibility, reducing the need to ramp generators up and down and resulting in: • less wear and tear • reduced start up and shut down costs • reduced GHG emissions (lower compliance cost)	**$197 Million**
T&D Cost Reduction	
Energy storage: • reduced the losses and maintenance of system • provides reactive power support • increases resilience • defers investment	**$305 Million**
Integrating Distributed Renewable Generation Cost Reduction	
Energy storage reduces cost in integrating distributed renewable energy by: • addressing reverse power flow at substations • avoiding feeder upgrades at substations	**$219 Million**
Total System Benefits	**$2.288 Billion**

Some non-monetizable benefits of energy storage are quite valuable.

Source: Massachusetts *State of Charge* report, 2016

FIGURE 2

Battery Storage Services



Batteries can provide up to 13 services to three stakeholder groups.

Source: Rocky Mountain Institute

2 Value energy storage benefits in cost-benefit analyses

VALUE DOES NOT EQUAL *PRICE*

As discussed in Section 1, energy storage benefits have value, even if markets for them do not yet exist. Monetizable energy storage benefits may include peak demand reduction, frequency regulation, and energy arbitrage. Non-monetizable benefits may include increased resilience, improved air quality, reduced land use, and job creation.

The issue of non-monetizable benefits becomes critical to energy storage policymaking when states (or utilities) conduct cost-benefit tests, which are generally required when adding a new technology to a state incentive program. While energy storage costs are relatively easy to ascertain, the benefit side of the equation can vary widely depending on which benefits are included in the test, and what values are attached to them. If a benefit has no monetary value attached to it, its value defaults to zero in cost-benefit analyses.

According to the Massachusetts *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."[18] In other words, market failures prevent storage owners from monetizing numerous benefits they can provide to the state, utilities, ratepayers, and the grid. For example, energy storage could enable utilities to defer investments in transmission and distribution grid infrastructure (see Table 1, p.11). But it is often difficult for non-utility energy storage owners to know where to locate a storage device to most effectively provide this service, and there are no market mechanisms by which non-utility storage owners can be paid for delivering this service.[19] This lack of market mechanisms results in a lack of price-setting; and non-priced benefits are often left out of cost-benefit analyses.

Liberty Utilities

This Liberty Utilities residential battery system was installed as part of their 250-customer pilot program in New Hampshire. The system includes two Tesla Powerwall batteries that can support the entire house during a grid outage. Participating customers have time-of-use electric rates and save money because the batteries provide power to the home during peak demand hours when rates are highest. Participants also benefit from having resilient backup power. Other ratepayers benefit because the utility uses the batteries to save money by reducing its load during monthly peak demand hours.

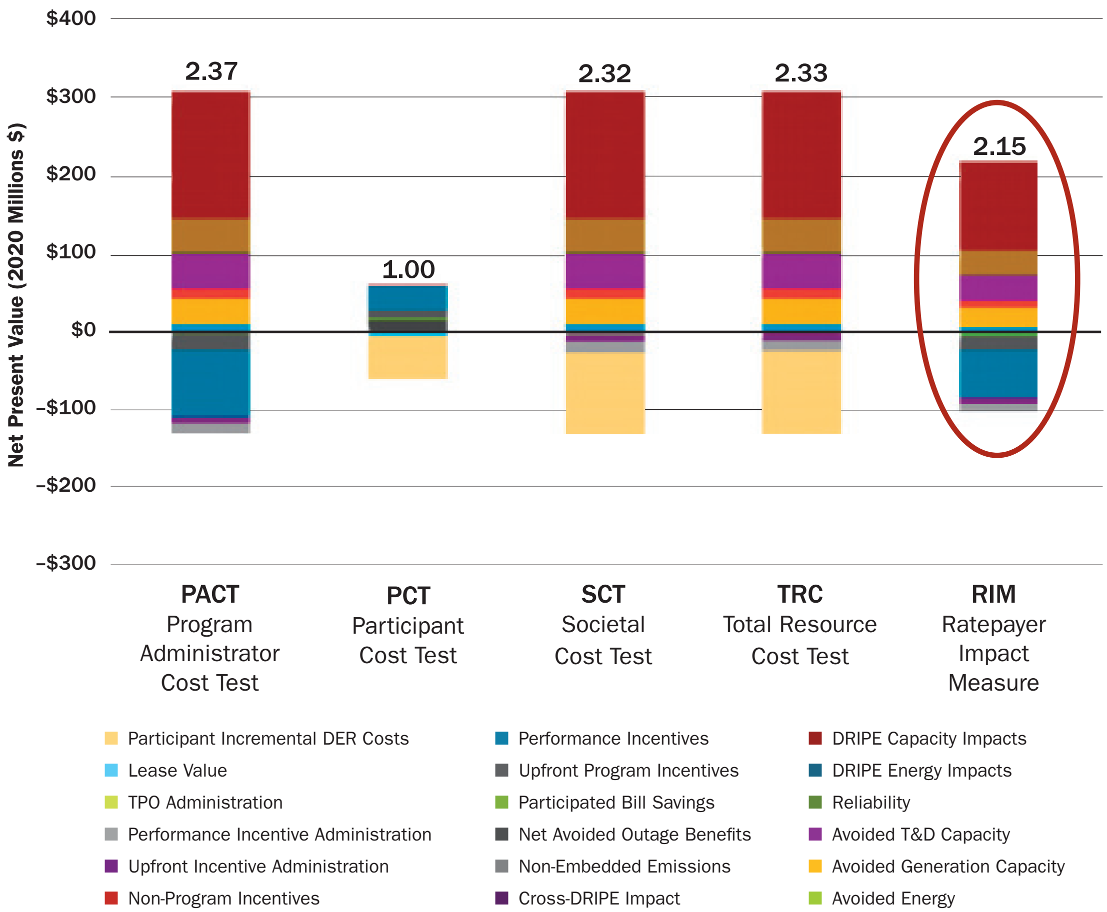
Public clean energy incentive programs are intended in part to compensate for such market failures. To enable them to do so, the non-monetizable benefits of energy storage must be included and assigned value in the cost-benefit analyses that are conducted to qualify storage technologies for these programs (see Figure 3, p.14).

18 Massachusetts Department of Energy Resources and Massachusetts Clean Energy Center, *State of Charge*, 2016, https://www.mass.gov/service-details/energy-storage-study.

19 A 2015 study by The Brattle Group for Oncor concluded, "deploying electricity storage on distribution systems across Texas could provide substantial net benefits" but added, "Storage investments could not be undertaken at an efficient scale solely by merchant developers . . . because the value that a merchant storage developer can monetize through transacting in the wholesale power market alone is too low compared to costs. For instance, we find that approximately 30–40% of the total system-wide benefits of storage investments are associated with reliability, transmission, and distribution functions that are not reflected in wholesale market prices and, therefore, cannot be captured by merchant storage investors." See Judy Chang, et al, "The Value of Distributed Electricity Storage in Texas: Proposed Policy for Enabling Grid-Integrated Storage Investments," *Brattle.com*, March 2015, http://files.brattle.com/files/5977_the_value_of_distributed_electricity_storage_in_texas_-_proposed_policy_for_enabling_grid-integrated_storage_investments_full_technical_report.pdf.

FIGURE 3

Connecticut Customer Battery Program Cost-Benefit Analyses



Cost-benefit analyses by the Connecticut Green Bank show BTM energy storage passes numerous cost effectiveness tests used by states—but scores depend heavily on which benefits are valued in the tests. Note the score greater than 1.0 on the RIM test indicates there is no cost-shifting from storage customers to non-storage customers.

Source: Connecticut Green Bank

Valuing all allowable storage benefits in cost-benefit calculations is important even if some of these benefits are perceived to be of low value or seem insignificant on their own. This is because value stacking is necessary in order for storage to be cost effective in many places, and because values for energy storage services can shift dramatically over a short time period.

Program Examples

- In ISO-New England, capacity prices were $9.55/kW-month in 2019. By 2024, they will have fallen to $2/kW-month.[20] This change has made a huge difference in financing and investment calculations for energy storage developers in the region. Where the ability to reduce annual capacity peaks once dominated storage economics for utilities, now reducing monthly peaks to manage transmission service costs is more important to the storage value stack.[21]
- In California, as late as 2016, when the Self-Generation Incentive Program (SGIP) was revised to devote 75 percent of its funds to support energy storage deployment, there were no adders for customers installing resilient systems

20 We know this because capacity prices in ISO-New England are determined through a three-year forward capacity market process.

21 A transmission tariff revision now underway could change or eliminate the ability of utilities to manage transmission costs through peak load reduction, and this would have a significant impact on what sorts of energy storage projects are economically viable in New England. For more information, see the ISO-New England Internal Market Monitor Spring 2020 Quarterly Markets Report at https://www.iso-ne.com/static-assets/documents/2020/07/2020-spring-quarterly-markets-report.pdf. Also, see the meeting minutes of the NEPOOL Transmission Committee at https://www.iso-ne.com/committees/transmission/transmission-committee.

TABLE 2

Values for Seven Non-energy Benefits of Distributed Energy Storage in Massachusetts

	Non-Energy Benefits (2018$)
Avoided Power Outages	
Battery storage helps avoid outages, and all of the costs that come with outages for families, businesses, generation and distribution companies.	• Residential, $1.72/kwh • Commercial/Industrial $13.84/kWh
Higher Property Values	
Installing battery storage in buildings increases property values for storage measure participants by: 1. Increasing leasable space; 2. increasing thermal comfort; 3. increasing marketability of leasable space, and 4. reducing energy costs	• $5,325/housing unit for low-income single family participants • $510/housing unit for owners of multi-family housing
Avoided Fines	
Increasing battery storage will result in fewer power outages and fewer potential fines for utilities	• $24.8 million in 2012
Avoided Collections and Terminations	
More battery storage reduces the need for costly new power plants, thereby lowering ratepayer bills, and making it easier for ratepayers to consistently pay their bills on time. This reduces the need for utilities to initiate collections and terminations	• Terminations and Reconnections: $185/year/participant • Customer Calls: $0.77/year/participant
Avoided Safety-Related Emergency Calls	
Increasing battery storage results in fewer power outages, which reduces the risk of emergencies and the need for utilities to make safety-related emergency calls	• $10.11/year/participant
Job Creation	
More battery storage benefits society at large by creating jobs in manufacturing, research and development, engineering, and installation	• 3.3 jobs/MW • $310,000/MW
Less Land Used for Power Plants	
More battery storage reduces the need for peaker plants, which are more land-intensive than storage installations—benefiting society by allowing more land to be used for other purposes	• 12.4 acres/MW

CEG contracted with Applied Economics Clinic to identify and value seven additional non-energy benefits of energy storage in Massachusetts.

Source: Applied Economics Clinic/Clean Energy Group.

(storage configured to provide islanded power). At that time, resilience was not perceived as a high-value service (or a need) in California. Today, after years of recurring wildfires and the attending preemptive utility service interruptions, resilience is highly valued. A 2020 program revision offered an Equity Resilience incentive of $1,000/kWh for disadvantaged customers and those in high fire risk areas—four times the then-current block rate of $250/kWh for standard residential systems.

If a definitive value for an energy storage service cannot be calculated, an estimated value should be used until more information becomes available. If no value is assigned to a service, the default value for that service in cost-benefit analyses is zero. Therefore, any estimated value—even a low one—is better than no value at all.

Recommendations

- **Establish a monetary value for each energy storage benefit, including those not already priced in existing markets (see Table 2).These value can be used when calculating the cost effectiveness and setting incentive rates for energy storage programs.**
- **In a cost-benefit analysis, estimated or low value for storage services is better than no value at all.**

3 Provide meaningful incentives

INCENTIVIZE OPERATION, NOT JUST DEPLOYMENT

States wishing to support energy storage deployment may want to develop an incentive program. Remember, however, that clean energy incentives generally support broader policy goals such as energy sector decarbonization, electrification, sustainability, modernization, efficiency, resilience, and reliability. An energy storage incentive program should not be about "storage for storage's sake," but should be designed to support specific policy goals.

This is particularly true of energy storage because its multi-use nature differentiates it from other clean energy resources. For many traditional clean energy and energy efficiency technologies, it is sufficient merely to incentivize adoption of the technology. This is not necessarily the case for energy storage.

Solar PV, for example, can be depended upon to do one thing: to generate electricity when the sun shines. But battery storage can provide several different services depending on how it is used. Therefore, simply supporting energy storage deployment may not ensure that state policy goals are being served. To be effective, a state energy storage program must actively link the *use* of battery systems to applications that support specific policy objectives. In other words, incentives should not merely support battery deployment, but should also be linked to productive battery operations.

Incentives should not merely support battery deployment, but should also be linked to productive battery operations.

Program Examples

- Initially, the Massachusetts SMART solar incentive battery adder required that participating batteries be cycled at least 52 times per year, but with no requirements as to when batteries were to charge or discharge (on peak vs. off peak).[22] The more recent ConnectedSolutions program uses performance payments to focus battery discharges on regional peak demand hours to support the Commonwealth's peak demand reduction goals. The Commonwealth has stated that SMART program enrollees who also signed up for ConnectedSolutions will be allowed to follow the ConnectedSolutions discharge schedule rather than the SMART schedule, in recognition of the fact that discharging batteries during peak hours—even if that means less frequent cycling—is more beneficial than discharging weekly at random times.[23]

- The California PUC's original SGIP rebates carried no operational requirements for rebate recipients regarding the charging and discharging of their BTM batteries. Program analysis concluded that this resulted in an increase in emissions because battery owners were optimizing battery operation to maximize financial returns without regard to the emissions impacts (see Figure 4a, p.17).[24] The state then modified the program[25] to include a time-based incentive designed to support state emissions reduction goals (see Figure 4b, p.17), which resulted in a marked decrease in emissions (see Figure 4c, p.18). The SGIP program is now supporting the state's efforts to meet emissions targets rather than working against them.

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22 Massachusetts Department of Energy Resources, *Solar Massachusetts Renewable Target Program Guideline on Energy Storage,* July 13, 2018, https://www.mass.gov/doc/energy-storage-guideline-draft-071318/download.

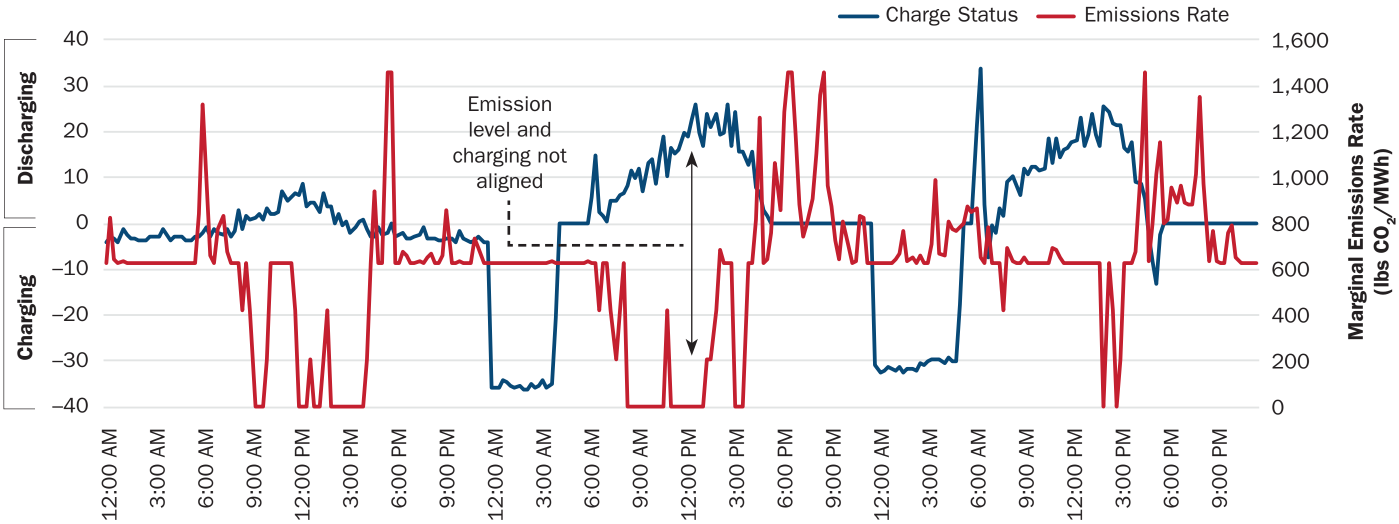
23 See MassSave Program Materials for ConnectedSolutions for Small Scale Batteries at https://www.masssave.com/-/media/Files/PDFs/Save/Residential/connectedsolution-batteries/Program-Materials-for-ConnectedSolutions-for-Small-Scale-Batteries.pdf?la=es&hash=E0351B58FEFA348CA648AE508FA43D2F021A0C52.

24 Itron, 2016 SGIP Advanced Energy Storage Impact Evaluation, August 31, 2017, https://s3.documentcloud.org/documents/4901261/Itron-2016-SGIP-Evaluation.pdf.

25 California Public Utilities Commission—Energy Division, Decision Approving Greenhouse Gas Emission Reduction Requirements For The Self Generation Incentive Program Storage Budget, 2019, https://docs.cpuc.ca.gov/PublishedDocs/Published/G000/M309/K988/309988017.PDF. See also Energy Division, California Public Utilities Commission, Self-Generation Incentive Program Greenhouse Gas Staff Proposal, September 6, 2018, https://s3.documentcloud.org/documents/4901259/CPUC-SGIP-Proposed-Rules.pdf

FIGURE 4A

Misaligned Financial Signals

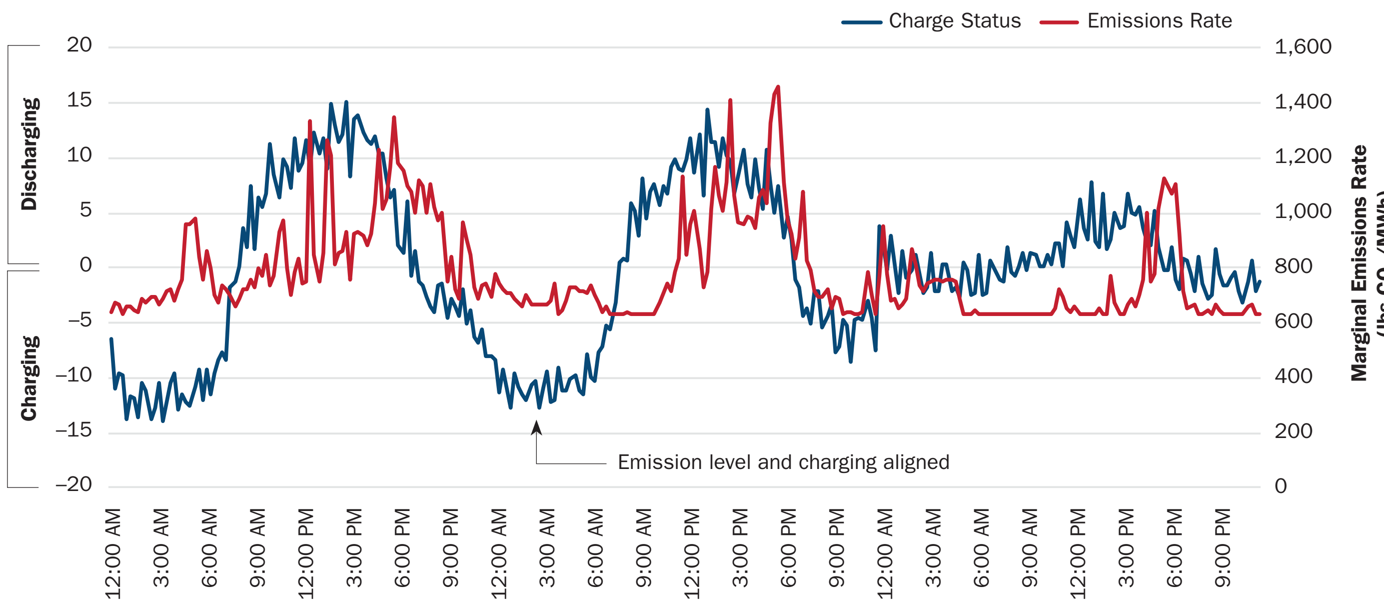


The California SGIP program initially suffered from financial signals that were not aligned with state emissions data. As a result, battery owners frequently discharged their batteries during low emissions periods, rather than charging when emissions were low and discharging when they were high.

Source: WattTime

FIGURE 4B

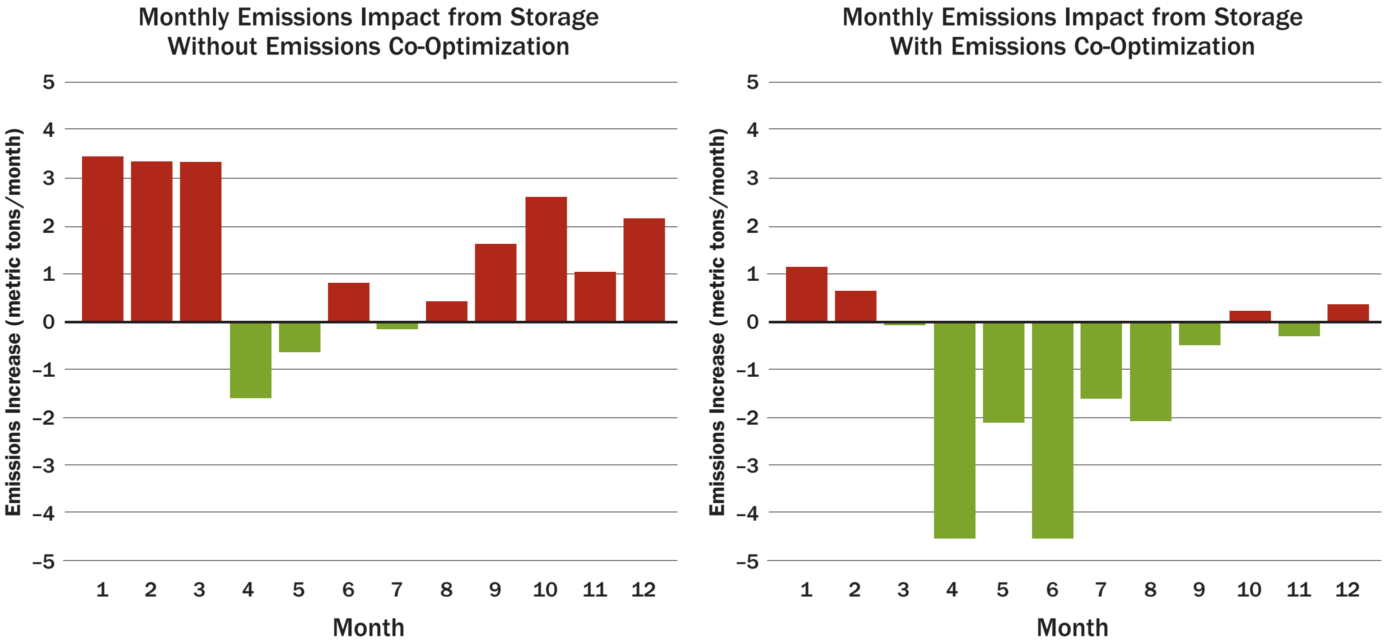
Emissions Aligned Operation



After program incentives were revised to encourage battery discharge during periods of high emissions, customer battery use became much better aligned with state emissions reduction goals

Source: WattTime

FIGURE 4C
Emissions Optimization Results



California solved its energy storage emissions problem by making 50% of the SGIP battery incentive contingent on customers charging and discharging their batteries at the right times. As a result, customer batteries went from being part of the state's emissions problem, to being part of the solution.

Source: WattTime

Since the California SGIP program is the premier stand-alone energy storage incentive program in the US (and one of very few in existence), it provides important information for any state contemplating developing a similar program. For example, a small equity adder and carve-out were initially unsuccessful, but when SGIP administrators substantially increased the equity adder, the equity budget was fully subscribed. Fortunately, SGIP is well-documented, with reports and statistics readily available.[26]

Recommendations

- **Incent energy storage operations, not just deployment. State policymakers should decide which storage operations support state policy goals, and design incentives to support these operations.**
- **States should pay particular attention to recent amendments to established energy storage incentive programs, such as low-income, environmental justice and resilience incentive adders, as these corrections point to features that should be baked into new programs from the start.**

Connecticut DEEP

A 40-kW battery system installed at the Parsons Government Center in Milford, CT with funding from Connecticut Department of Energy and Environmental Protection's Microgrid Grant and Loan Program. This battery is part of a microgrid that includes a 400-kW combined-heat-and-power (CHP) generator. Facilities supported include City Hall, a middle school, a senior center and apartments.

26 SGIP program reports are available here: https://www.cpuc.ca.gov/General.aspx?id=7890 and SGIP statistics are available here: https://sites.energycenter.org/sgip/statistics. News about the program, including CPUC decisions, can be found here: https://www.cpuc.ca.gov/sgip.

4 Set goals; define the role of storage

ENERGY STORAGE PROGRAMS SHOULD SUPPORT A GREATER PURPOSE

Not every state will adopt an energy storage procurement mandate or target (such as the storage procurement targets adopted by Massachusetts, California, New York and other states). But every state in New England has set goals around related policy objectives, such as advancing renewable energy, decarbonization, and grid modernization (as have many states across the nation). Connecting storage deployment and operations with these larger state policy goals will help to define the structure of state storage incentives and market-based programs. States should explicitly include energy storage among the eligible resources for clean energy goals and define how storage is to be used to help meet the goals.

Program Examples

- The Connecticut Microgrid Grant and Loan Program guidelines state that to be counted toward a microgrid's islanded generation capacity, solar and wind generation must be paired with energy storage that will allow 24/7 utilization of the power produced by these resources (when islanded). The guidelines also provide minimum islanding durations and other conditions microgrids must meet to be eligible for a grant.[27]
- The Massachusetts Clean Peak Standard guidelines[28] state that energy storage output can generate program credits if the storage resource is 1) co-located with a qualified Renewable Portfolio Standard (RPS) resource, 2) contractually paired with a qualified RPS resource, 3) certified to charge when renewables are at their highest percent of the generation mix and discharge during peak demand hours, or 4) used to directly support the performance and functionality of clean energy generation (as evidenced by its interconnection service agreement operational schedule).

Although the two programs described above are very different—the Connecticut program is grant-based while the Massachusetts program is market-based (utilities are required to turn in a certain number of clean peak credits each year)—each demonstrates clear requirements for how energy storage must be used in order to qualify for, and further the goals of the program.

States should explicitly include energy storage among the eligible resources for clean energy goals and define how storage is to be used to help meet the goals.

The New England states have been relatively aggressive in setting broad clean energy and decarbonization goals, including Renewable Portfolio Standards (RPSs), 100% clean energy goals, and net zero emissions goals. It is worth noting that in many cases, the specific role that energy storage is expected to play in helping states meet these goals—and the required qualifications for doing so—have not yet been developed. However, it is never too late. Notably, Vermont recently added energy storage as a qualifying resource for its RPS Tier III program, which is designed to reduce fossil fuel consumption by customers of the state's distribution utilities, including through electrification.[29] In its 2021 report, the Vermont Department of Public Service noted that energy storage now accounts for 7 percent of the state's Tier III RPS portfolio (see Figure 5, p.20). The state's largest utility, Green Mountain Power, has placed more than 3,000 batteries behind residential customer meters.

27 *See Connecticut DEEP, Request For Proposals, Microgrid Program, Notice Of Available Funds, 2014,* http://www.dpuc.state.ct.us/DEEPEnergy.nsf/c6c6d-525f7cdd1168525797d0047c5bf/dbd7e9fe5adcdfce85257c93004522f4/$FILE/FINAL%20RFP%20-%20Round%202.pdf.

28 See Clean Peak Energy Standard Guidelines, https://www.mass.gov/info-details/clean-peak-energy-standard-guidelines.

29 Vermont Department of Public Service, *Vermont RES Tier III Verification Report*, 2019, https://publicservice.vermont.gov/sites/dps/files/documents/2019_Tier_III_Report_20-0644-INV.pdf

Maine's 2019 *Act to Reform Maine's Renewable Portfolio Standard* allows energy storage systems to count toward RPS procurement under certain conditions. Primarily, the storage resource must be paired with an eligible generator or contribute toward greenhouse gas emissions reductions.[30] Bids including energy storage must include two separate bid proposals, one with the energy storage system and one without. The Maine Public Utilities Commission then assesses both bids based on the benefits to ratepayers, which may include, but are not limited to:

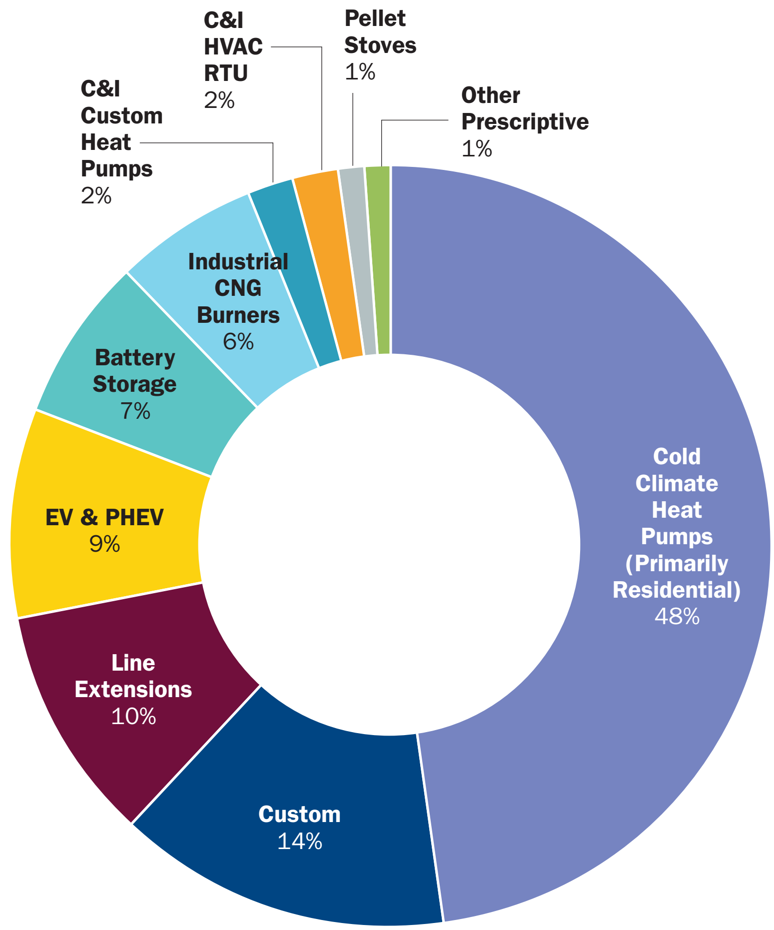
- Reduction in costs
- Decrease in peak electricity demand
- Deferral of investments in the transmission and distribution system
- Deferral of capital investments in new generating capacity
- Increase in the electricity grid's overall flexibility, reliability and resiliency
- Reduction in greenhouse gas emissions[31]

Recommendations

- **States should set ambitious clean energy or emissions reduction goals and explicitly include energy storage as an eligible technology.**
- **Program guidelines should define how energy storage is expected to be deployed and operated to help meet the state's goals, and incentive and market-based programs should be designed around these operational parameters.**
- **If the state does not already have an energy storage roadmap, consider writing one, or incorporate energy storage into the state's existing energy plan. This can help to memorialize the role of energy storage in supporting state clean energy goals.**

FIGURE 5

Vermont RPS Tier III 2020 Savings Profile



Distributed battery storage now accounts for seven percent of Vermont's RPS Tier III, which is aimed at reducing customer use of fossil fuels.

Source: 2021 Annual Energy Report: A summary of progress made toward the goals of Vermont's Comprehensive Energy Plan (VT DPS) *https://publicservice.vermont.gov/sites/dps/files/documents/Pubs_Plans_Reports/Legislative_Reports/2021 Annual Energy Report Final.pdf*

30 For more information about storage in state renewable portfolio standards, see Holt, Ed and Todd Olinsky-Paul, "Does Energy Storage Fit in an RPS?" *cesa.org*, June 29, 2016, https://www.cesa.org/resource-library/resource/does-energy-storage-fit-in-an-rps.

31 See http://www.mainelegislature.org/legis/statutes/35-A/title35-Asec3210-G.html.

5 Integrate storage into existing programs

USE THE TOOLS AT HAND

In addition to procurement targets, states can support uptake of clean energy technologies through the use of incentives. Ideally, states interested in supporting the deployment of energy storage might combine a utility storage procurement mandate with a stand-alone customer storage incentive—essentially creating a market for both large- and small-scale storage to be deployed at various locations on the grid. This is the approach adopted in California, and it has proved to be very successful, as California consistently leads the nation in deployed capacity.[32]

However, there are few examples of stand-alone energy storage incentives outside of California. Instead, states have tended to incent storage by adding it to existing programs. These programs may include solar incentives, energy efficiency plans, demand response programs, electrification initiatives and emissions reduction programs.

The reasons for adding storage into an existing program are twofold:

1. Storage can enhance previously eligible resources and/or directly support the program goals. For example, adding storage to a solar incentive program is a way to encourage the development of solar photovoltaic (PV) systems backed by battery storage, which can increase the value of the solar energy by making it dispatchable (shifting solar production to high value/peak demand hours), increasing its capacity value, reducing curtailment, and adding a resilience benefit (allowing BTM solar to function during grid outages). Adding storage to an energy efficiency program can help shift demand from peak to off-peak hours, thereby achieving economic efficiencies and reducing the need for future generation and transmission capacity investment.
2. Adding storage may be the most immediate and effective way for state policymakers to support advanced energy storage deployment. For example, adding storage to an existing solar incentive or energy efficiency program may

MassCEC and WH Bennett

This 1-MWh battery was installed at a large farm on Martha's Vineyard with an ACES grant from MassCEC. The battery is paired with a new solar array and is used for solar smoothing to reduce voltage flicker on the feeder. It also reduces GHG emissions by displacing diesel generation used on the island. Due to a high saturation of solar PV, adding a battery to make the solar dispatchable was the only way the utility serving the island would allow the solar system to interconnect. Net metered power from the solar PV is sold to local nonprofits at a discount.

States have tended to incentivize storage by adding it to existing programs. These programs may include solar incentives, energy efficiency plans, demand response programs, electrification initiatives and emissions reduction programs.

32 *The nation's leading energy storage incentive program is California's Self Generation Incentive Program (SGIP). For more information on SGIP,* https://www.cpuc.ca.gov/sgip.

be more expedient than developing a new, stand-alone energy storage incentive program with a new budget.

Ideally, both conditions will be true; that is, adding storage to existing programs helps to meet program goals, and at the same time, helps provide incentives and other supports to speed the deployment of energy storage and the development of markets for storage services.

Program Examples

- Massachusetts and Rhode Island have added energy storage to existing solar incentive programs (Massachusetts SMART solar program with storage adder, Rhode Island Energy Storage Adder pilot program)
- Massachusetts, Rhode Island, Connecticut, and Maine have added storage to existing energy efficiency programs (ConnectedSolutions energy efficiency battery programs in Massachusetts, Rhode Island, Connecticut, and a similar program under development in Maine)
- Vermont and New Hampshire have approved utility-administered customer battery programs, essentially allowing residential storage incentive programs similar in design to existing utility commercial demand response programs (Green Mountain Power's Resilient Home program in Vermont, Liberty Utilities' residential battery pilot program in New Hampshire)

In most cases, these existing programs were developed before battery storage was considered a viable and price-competitive option, and before the role of storage in supporting renewables and enhancing efficiency was well understood. Therefore, adding storage will likely require a review of relevant program rules, policy, and regulation to ensure that storage can be effectively integrated.

Adding storage to an existing clean energy incentive program does not necessarily take the place of developing a stand-alone storage incentive, and in fact, may leave out many potential storage customers (for example, offering a storage adder along with a solar incentive leaves out those customers who cannot install solar). It may also require new LMI provisions to ensure equitable access. However, this method does offer numerous advantages, among which are that it can often be more easily accomplished, makes use of existing administrative and marketing structures, and does not require a new budget.

Recommendations

- **States should review existing clean energy incentive programs to see where and how energy storage could be added as an eligible resource.**
- **Existing program rules and related regulation may need to be revised to accommodate energy storage.**
- **Equity provisions may need to be reviewed to ensure they are sufficient to make energy storage accessible to low-income participants.**

NHEC/Gary Lemay

New Hampshire Electric Cooperative (NHEC) and Engie 2.45 MW/2 hr. battery storage project with solar PV, located in Moultonborough, NH. This is the state's first large-scale battery installation. Engie will own and operate the unit, which will charge from NHEC's distribution system during times of low demand and discharge during peak demand periods. NHEC estimates the battery system will save its members $2.3 million over the next 12 years.

Storage in Utility IRPs

Many states have utility integrated resource plans (IRPs) or other long-term energy planning requirements. In recent years, some states have taken steps to ensure that energy storage is considered in IRPs.[33] This is generally seen as a positive step for energy storage deployment; but, it can be tricky because many of the services that storage can offer are outside the scope of traditional IRP models.

A Pacific Northwest National Laboratory (PNNL) report on energy storage in IRPs notes, "Placing an energy storage resource in a traditional IRP model alongside other resource options results in a process that identifies all of the costs of energy storage, but few of the benefits." The report explains that while IRPs traditionally plan for peak capacity and energy needs and may also seek to deploy and integrate renewable resources, this limited set of objectives omits many valuable contributions energy storage can make. "To fully account for all benefits of batteries," the report concludes, "IRPs need to look beyond these three benefits to capture the transmission and distribution benefits as well as sub-hourly services."[34]

State energy policymakers and regulators should pay attention to how storage is treated in IRPs. Policymakers should consider designing incentive programs to help compensate for storage values that may be missing from IRP cost-benefit analyses.

For example, following the Connecticut governor's Executive Order directing state regulators to lay out a plan to reach 100% carbon-free electricity by 2040, the Connecticut Department of Energy and Environmental Protection (CT DEEP) issued a draft IRP that specifically called for the development of energy storage for load reduction, grid balancing, and renewables integration. The Connecticut Public Utilities Regulatory Authority (PURA) subsequently approved a nine-year distributed energy storage incentive program. The PURA Electric Storage Program includes a set of cost-benefit analyses conducted by Connecticut Green Bank that include additional benefits such as participant bill savings, increased reliability, and demand reduction induced price effects (DRIPE), which were not included in the IRP.[35]

Policymakers should consider designing incentive programs to help compensate for storage values that may be missing from IRP cost-benefit analyses.

Some states have also started exploring Integrated Distribution Planning (IDP) to better integrate distributed energy resources into utilities' future distribution grid investments. This approach may be helpful, although care should be taken to avoid delaying or excessively constraining the deployment and use of energy storage. Policymakers and regulators interested in learning more about IDP will find numerous reports on the subject available online.

33 Energy Storage Association, "Advanced Energy Storage in Integrated Resource Planning (IRP)," *Energystorage.org*, 2018, https://energystorage.org/wp/wp-content/uploads/2019/09/esa_irp_primer_2018_final.pdf.

34 Cooke, Twitchell and O'Neill, 2019, Energy Storage in Integrated Resource Plans, PNNL, https://energystorage.pnnl.gov/pdf/PNNL-28627.pdf

35 See the Connecticut PURA Investigation into Distribution System Planning of the Electric Distribution Companies—Decision, Docket No. 17-12-03RE03 FD, July 28, 2021, http://www.dpuc.state.ct.us/dockcurr.nsf/8e6fc37a54110e3e852576190052b64d/38cb46347a645ee585258720004d0e3e/$FILE/171203RE03-072821.pdf.

6 Provide for low-income access

INCORPORATE EQUITY PROVISIONS FROM THE START, NOT AS AN AFTERTHOUGHT

Low-income and underserved communities spend proportionally more of their income on energy costs than other segments of the population. They are also more likely to suffer from energy-related environmental and health burdens; and they are hit hardest by natural disasters and the accompanying grid outages and have fewer resources with which to recover. In short, they are most in need of the cost savings, resilience, and health benefits energy storage can offer.[36]

Yet, the history of clean energy innovations shows the adoption of new technologies will bypass low- and moderate-income (LMI) communities and communities of color unless governments provide specific programmatic supports to ensure equitable access. The most effective (and ethical) way to do this is to include equity provisions as a central element of clean energy programs and policy from the start, rather than adding them in later.

Program Examples

- In Massachusetts, the ConnectedSolutions program that established pay-for-performance incentives for BTM battery storage through the Commonwealth's Three-Year Energy Efficiency Plan did not have significant equity provisions or budget in its initial three-year implementation (2019–2021). Advocacy groups have identified the lack of LMI provisions as one of the aspects of the program most in need of improvement in the coming 2022–2024 program cycle.
- By contrast, Connecticut PURA's distributed Electric Storage Program, which was approved in July 2021 and based on and adapted from the ConnectedSolutions program, features several specific LMI provisions including an up-front rebate with a 2x multiplier for LMI participants, and an on-bill payment option.

When incorporating equity provisions into energy storage programs, carve-outs[37] and small incentive adders may not be sufficient. In general, front-loaded incentives and significant LMI adders, combined with favorable financing, are needed to overcome the added costs and risks faced by developers in underserved communities.

- The California SGIP program initially offered a $72 million equity budget carve-out (25 percent of the overall program budget at the time) for energy storage, but only a small equity adder to help overcome the added costs and risks of LMI projects. Not a single equity project resulted. When the equity incentive rate was increased from $0.50/Wh to $0.85/Wh, the program was fully subscribed in a matter of days.

There is a great need to innovate new tools to make energy storage more accessible to historically underserved communities.

In addition to the traditional clean energy equity strategies—rebates, adders and multipliers, favorable financing, credit backstops, on-bill payment, community resource models, tax credits, education, marketing, technical assistance, etc.—there is a great need to innovate new tools to make energy storage more accessible to historically underserved communities.

Some of the barriers, such as low rates of home ownership, are similar to those faced in the solar industry and may be

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36 Equity disparities in disaster-related grid outages have been documented over many years. See for example University of Massachusetts Amherst, "Frozen Out: Minorities Suffered Four Times More Power Outages in Texas Blackouts," https://www.umass.edu/news/article/frozen-out-minorities-suffered-four-times and Brookings, "Hurricanes Hit the Poor the Hardest," https://www.brookings.edu/blog/social-mobility-memos/2017/09/18/hurricanes-hit-the-poor-the-hardest.

37 A "carve-out" is a policy tool that requires overall procurement to include a minimum amount of a specified type or application. For example, a 25 percent LMI carve-out for utility storage procurement would mean that utilities are directed to procure at least 25 percent of their target capacity from LMI sources.

38 Some evidence has come to light indicating that through a program loophole, some equity resilience budget funds were directed toward second-home owners rather than low-income and disadvantaged communities—underlining the need to carefully define eligibility for equity budget funds. See https://pv-magazine-usa.com/2020/10/18/californias-lucrative-energy-storage-incentive-gets-fiscally-abused-once-again.

39 For more information on the community storage model, see the SMUD Storage Shares program webinar recording on the Clean Energy States Alliance website, https://www.cesa.org/event/smud-energy-storageshares.

Clean Energy Group/Samantha Donalds

The McKnight Lane affordable housing project redeveloped defunct mobile home park with the first examples of resilient, zero-energy, modular housing in rural Vermont. Solar+storage systems at each home provide tenants with backup power and zero energy costs. This project was supported by US DOE-OE, Sandia National Laboratories, CESA, and CEG.

addressed by adapting low-income solar strategies. For example, community storage programs such as SMUD's new Energy StorageShares offer subscribers energy cost savings through virtual demand charge management.[39]

Other barriers can be addressed by providing technical support. For example, Clean Energy Group has provided free economic analysis and solar+storage system optimization for more than 250 multifamily affordable housing facilities and community buildings.

There are also examples of utility energy storage projects that serve low-income communities both at the utility scale (such as the Stafford Hill microgrid project in Rutland, VT)[40] and at the distributed residential scale (such as the McKnight Lane Redevelopment affordable housing project in Waltham, VT),[41] both in the Green Mountain Power utility territory.

Still, this is an area where more innovative solutions are needed. State policymakers should think creatively and work with community advocates and industry to innovate new equity strategies, such as the Kresge Foundation/Clean Energy Group's Financing Resilient Power project, which provides technical assistance grants, loan guarantees, and capacity grants for approved lenders to accelerate solar+storage market development in historically underserved communities.[42]

Recommendations

- **Equity considerations should be incorporated into energy storage program design from the start, not left to be addressed in later revisions.**
- **New policy and financing tools are needed to make energy storage technology more accessible to low-income and historically underserved neighborhoods; however, the traditional tools, such as rebates, adders, credit enhancement, low-cost financing, and on-bill payment, can still be effective and should be employed when states develop new programs.**
- **Equity carve-outs and small incentives, while they may be helpful and necessary, are likely not sufficient to enable LMI access. Because underserved communities face greater economic barriers, significantly increased economic incentives are needed to provide equitable access to energy storage benefits.**

40 Clean Energy Group, "Stafford Hill Solar Farm and Microgrid," *cleanegroup.org*, https://www.cleanegroup.org/ceg-projects/resilient-power-project/featured-installations/stafford-hill.

41 Clean Energy Group, "McKnight Lane Redevelopment Project," *cleanegroup.org*, https://www.cleanegroup.org/ceg-projects/resilient-power-project/featured-installations/mcknight-lane.

42 Clean Energy Group, "Financing Resilient Power—Fact Sheet," *cleanegroup.org*, September 2020, https://www.cleanegroup.org/wp-content/uploads/Financing-Resilient-Power.pdf.

Energy Storage in Affordable Housing, Health Clinics, and Schools

One way to provide energy storage services to underserved communities is to support placement of solar+storage systems in facilities that serve those communities and can provide emergency services during grid outages. Multifamily affordable housing facilities, health clinics, and schools are three good candidates.[43]

Clean Energy Group has conducted analysis and provided technical support to more than 250 solar+storage projects at multifamily affordable housing facilities, both in New England and elsewhere.[44] Developers in this sector face significant barriers in adopting energy storage,[45] yet housing is among the most promising ways to provide storage benefits to low-income communities, because it can both lower home energy costs for residents and provide backup power during grid outages, so residents can shelter in place.

The size of this opportunity is significant. There are more than 1,800 affordable housing properties available through federal programs in Massachusetts alone, representing more than 130,000 units.[46] Across New England, there are more than 5,000 properties.[47] Additionally, there is a large unrealized opportunity to bring energy storage to individual affordable housing units. Although this can be challenging, there are existing projects from which to learn, such as the McKnight Lane redevelopment project in Vermont,[48] the GMP/VLITE low-income battery storage project,[49] also in Vermont, and the Alternate Power Source pilot project in Norwood, Massachusetts (in development).[50]

Federally qualified health clinics (FQHCs) represent another opportunity. Every state hosts multiple FQHCs licensed by the U.S. Health Resources and Services Administration. These centers provide vital services, yet many are not equipped with backup power that would enable them to serve their communities in a grid outage, when health care services are often needed the most.[51] Again, there are examples of successful projects to look at when considering solar+storage solutions for health care centers. For example, many similar facilities were retrofitted with resilient solar+storage systems in Puerto Rico, following the devastation of Hurricane Maria.[52]

Finally, schools represent an enormous untapped opportunity to provide energy storage benefits, such as energy cost savings and resilience, to LMI communities. Schools provide community services year-round, and often serve as community shelters during emergencies; they pay significant energy costs; and they are often good candidates for solar+storage because they usually have plenty of space for solar panels, as well as outdoor locations for batteries. According to the Solar Foundation,[53] more than 600 schools in New England already have solar PV. Adding battery storage would allow these schools to realize energy cost savings through demand charge management, as well as enabling them to provide resilient power so they could function as community emergency shelters during power outages and disasters. Schools not already solar-equipped may be interested in adding solar, as well as storage, to take advantage of solar and net metering revenues. And school bus fleets represent a huge potential electric vehicle/storage resource that could provide another set of benefits through battery storage and off-peak charging.[54]

Although all these opportunities exist in New England, it is unlikely that they will be realized without specific action on the part of state policymakers. Targeted programs and incentives are needed to help developers overcome heightened cost barriers and other hurdles in serving this important market.

43 Other facility types that can provide emergency services include YMCA/YWCAs, hospitals, and municipal/community buildings.

44 Since 2013, CEG has provided nearly $1 million in technical assistance grants to solar+storage resilient power projects serving low-income and historically underserved communities. For more information, see the Resilient Power Project featured installations page at https://www.cleanegroup.org/ceg-projects/resilient-power-project/featured-installations, and the technical assistance impact document, https://www.cleanegroup.org/ceg-resources/resource/resilient-power-project-impacts.

45 See CEG's publication Overcoming Barriers to *Solar+Storage in Affordable Housing: A Survey of Multifamily Affordable Housing Developers*, https://www.cleanegroup.org/ceg-resources/resource/overcoming-barriers-to-solar-storage-in-affordable-housing.

46 See https://affordablehousingonline.com/advocacy/Massachusetts.

47 Housing data from Affordablehousingonline, https://affordablehousingonline.com/advocacy/Massachusetts.

48 See https://www.cleanegroup.org/ceg-projects/resilient-power-project/featured-installations/mcknight-lane.

49 See https://vermontbiz.com/news/2018/august/20/150000-vlite-grant-will-ensure-power-reliability-low-income-gmp-customers.

50 The Norwood Project, which received a grant from MassCEC and a technical assistance grant from CEG, will demonstrate a low-cost residential battery+solar+demand response system that can connect to the grid to provide peak demand reduction services as well as providing resilient power to the home.

51 FEMA, "Healthcare Facilities and Power Outages: Guidance for State, Local, Tribal, Territorial, ad Private Sector Partners, *FEMA.gov*, August 2019, https://www.fema.gov/sites/default/files/2020-07/healthcare-facilities-and-power-outages.pdf.

52 Kantrow, Michelle, "Direct Relief announces $3M in resilient power projects for Puerto Rico health centers,"*newsismybusiness.com*, May 31, 2021, https://newsismybusiness.com/direct-relief-announces-3m-in-resilient-power-projects-for-puerto-rico-health-centers.

53 Generation180, "Brighter Future: A Study on Solar in U.S. Schools—Third Edition," generation180.org, September 2020, https://generation180.org/brighter-future-2020

54 St. John, Jeff, "Electric School Bus Fleets Test the US Vehicle-to-Grid Proposition," *GreentechMedia.com*, November 16, 2020, https://www.greentechmedia.com/articles/read/electric-school-bus-fleets-test-the-u.s-vehicle-to-grid-proposition.

7 Pay attention to regulatory friction points

THIS IS WHERE THE RUBBER MEETS THE ROAD

In Massachusetts, 900 MW of SMART program solar (and potentially storage) applications were delayed for many months due to utility "cluster studies" needed to determine hosting capacity on large areas of the grid. This led the Commonwealth's energy regulator to call for an independent management audit of a major utility.

This sort of problem is not unique to a single state or utility; it is seen frequently when technology uptake, policy and program development outpace regulatory reform and utility preparedness. As more distributed resources seek grid connection, seemingly minor issues can become major roadblocks. Examples of issues to look out for include the following:

- **Interconnection cost and process**—how much will storage customers have to pay to interconnect to the grid? Will the process create deployment bottlenecks?
- **Hosting capacity**—can the distribution grid accommodate an inrush of new storage customers? What upgrades will be needed?
- **Metering**—how will utilities deal with NEM customers adding batteries?
- **Capacity and REC creation/ownership**—who owns BTM storage attributes?

If not addressed early, friction points such as these can derail new programs, frustrate customers, and delay success in meeting policy goals.

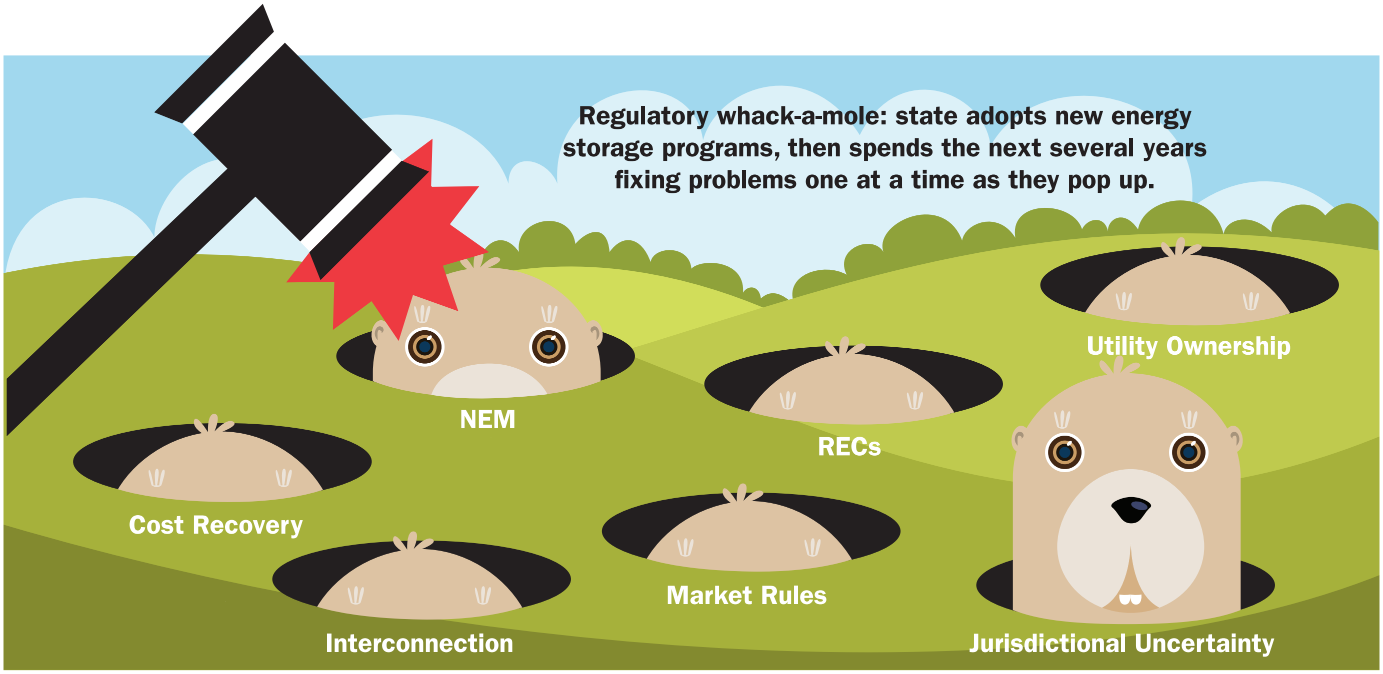
It is important to note that there are numerous ways to address these issues. Policymakers and regulators should seek independent, third-party recommendations to help resolve these issues in the simplest, most cost-effective way that supports state policy and program goals and safeguards the rights of energy storage owners and customers. Involving both utilities and industry in discussions can also help to uncover solutions.

Addressing regulatory reform proactively and holistically can be a difficult and lengthy process. Big umbrella-type proceedings (like the New York REV process) can become all-consuming and may themselves delay program implementation. However, failing to anticipate regulatory hurdles when creating policy and programs can also lead to program delays or, worse, to programs not working as intended or not achieving targets on schedule.

For example, in some states utilities have objected to solar net metering (NEM) customers installing BTM batteries on the grounds that this makes it impossible for them to certify NEM credits (because a customer could charge a battery from the grid or another non-renewable source, and then export that power to generate fraudulent NEM credits). This problem has been solved in various ways, but in many cases the unfortunate by-product has been interconnection applications put on hold while regulators decided the issue. In Massachusetts, the Department of Public Utilities (DPU) opened a docket on the question of energy storage net metering and capacity credit

Rhode Island Office of Energy Resources

Homeowner Melissa B. of Rhode Island installed a 13.5kWh Tesla Powerwall battery in her home to store solar power for later use, as well as providing time-based control and backup. Her existing rooftop solar system plus battery storage will pay for itself in 10 years and generate $44,000 in electricity bill savings over the next 25 years. She was able to use several incentive programs to finance the project, including the federal investment tax credit, 0% financing through the Rhode Island HEAT Loan program, and the ConnectedSolutions program, which allows property owners to sell their stored solar energy to National Grid during peak demand periods to reduce costs for all ratepayers.



ownership in October 2017. The DPU issued an order in the docket in February 2019, which required utility tariff revisions; related questions were not settled until February 2020.[55] A similar process was undertaken by the California PUC.[56]

Following the regulatory investigation described above, Massachusetts utilities and the Commonwealth's regulator determined that some NEM customers adding batteries would need up to three revenue grade electric meters to safeguard the integrity of net metering credits—adding considerable expense to solar+storage projects. By contrast, Green Mountain Power in Vermont told its battery customers they no longer need an electric meter at all—the utility takes the needed data directly from the battery's inverter.

Recommendations

- **Assume that regulatory changes will be needed when new energy storage policy and programs are adopted.**
- **To the extent possible, policymakers should engage with regulators, utilities, industry and advocates early in energy storage program development to anticipate the need for regulatory changes, make program adjustments as needed, and frame necessary proceedings in an organized fashion. This can help to avoid the "whack-a-mole" approach whereby regulatory issues arise and are addressed sequentially over an extended period, creating programmatic delays and uncertainty.**
- **There may be numerous possible solutions to a problem. Reviewing what other states have done to address common problems can help policymakers and regulators choose the simplest, most effective and least costly solution.**

Policymakers should engage with regulators, utilities, industry and advocates early in energy storage program development to anticipate the need for regulatory changes, make program adjustments as needed, and frame necessary proceedings in an organized fashion.

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55 See Massachusetts Energy and Environmental Affairs, Docket No. 17-146, https://eeaonline.eea.state.ma.us/DPU/Fileroom/dockets/bynumber/17-146.

56 See California Public Utilities Commission, Rulemaking 14-07-002, Decision 19-01-030, January 31, 2019, https://static1.squarespace.com/static/54c1a3f9e4b04884b35cfef6/t/5c5a02ff104c7b5f073745dc/1549402881064/STORAGE+DEVICES+PAIRED+WITH+NET+ENERGY+METERING+GENERATING+FACILITIES.pdf and Gerza, Adam, "Energy storage net metering: An illustration of why it's so valuable," *Solarpowerworldonine.com,* April 21, 2020, https://www.solarpowerworldonline.com/2020/04/energy-storage-net-metering-an-illustration-of-why-its-so-valuable.

57 American Public Power Association, "GMP offers customers batteries that double as meters," 2019, https://www.publicpower.org/periodical/article/gmp-offers-customers-batteries-double-meters See also Green Mountain Power, "GMP Pioneers Patent-Pending System Using Energy Storage to Make Meters Obsolete," 2019, https://greenmountainpower.com/gmp-pioneers-patent-pending-system.

8 Support a varied and competitive storage market

COMPETITION AND DIVERSITY MAKE MARKETS MORE EFFICIENT

Energy storage can act as both a generator and a load. It can integrate renewables and make regional grids more efficient, reduce transmission congestion, defer distribution grid investments, and make variable generators dispatchable. And it can flatten demand peaks, balance microgrids, make critical infrastructure resilient, and provide ancillary services. As storage deployment grows and prices fall, the list of storage applications also grows.

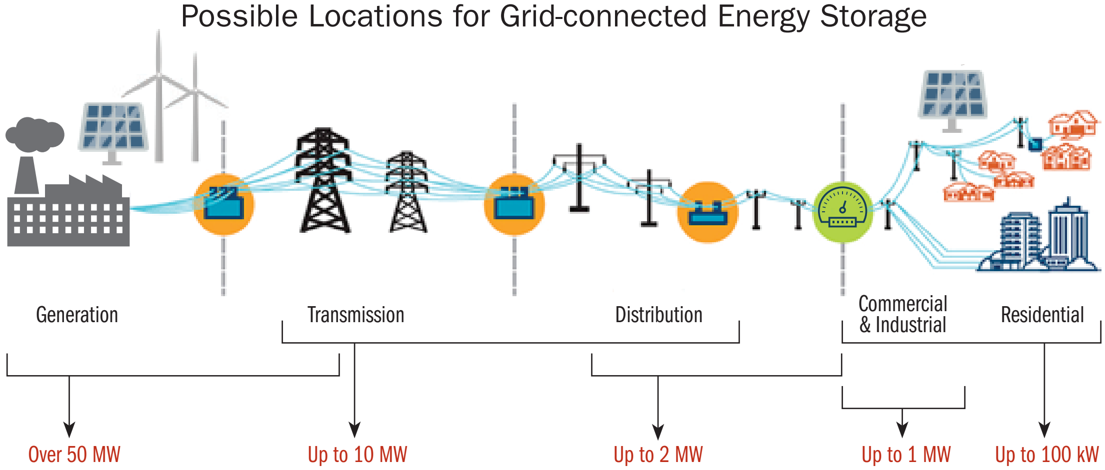
This flexibility means that energy storage carries a lot of locational and operational value; in other words, it is a multipurpose tool that can provide a wide range of services depending on where it is located, and how it is used. A highly diverse storage market allows the technology to provide the broadest set of services most efficiently and cost-effectively.

For example, utility-scale storage placed at strategic points on the distribution grid can provide a lot of value through transmission and distribution (T&D) investment deferral, while small, customer-sited storage can provide backup power and demand charge management to commercial facilities. In theory, utility-scale storage can also provide customer resilience (if connected to a microgrid or islandable circuit), and customer-sited storage can also provide T&D value (if properly sited and made available for utility dispatch). But the simpler approach is to allow for diverse storage ownership and business models. A diverse storage marketplace allows storage resources to flow to where they can create the most value (see Figure 6).

For this reason among others, states should guard against the monopolization of storage ownership by any one sector (utility, customer, or third party/merchant) and instead encourage a wide variety of ownership, financing, and business models. A diverse market should include large, medium, and small scale/distributed storage; front-of-meter and BTM placement; and varied ownership models (utility owned, merchant owned, customer owned, leasing, power purchase agreements (PPAs), and virtual power plants (VPPs)).

FIGURE 6

Possible Locations for Grid-connected Energy Storage



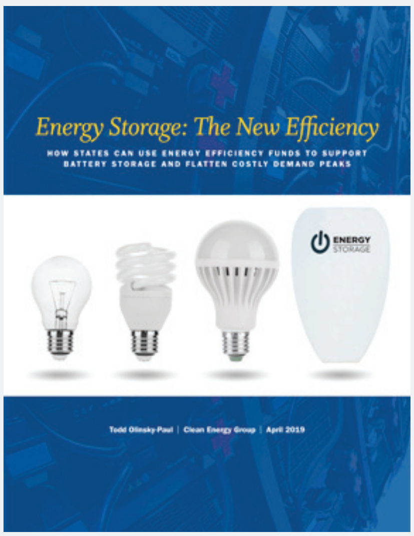
Energy storage can be added at any point on the electric grid, from generation to customer. Benefits will depend somewhat on where storage resources are located; supporting varied storage size, placement, ownership and applications—along with appropriate revenue models—allows resources to flow to where they are most needed.

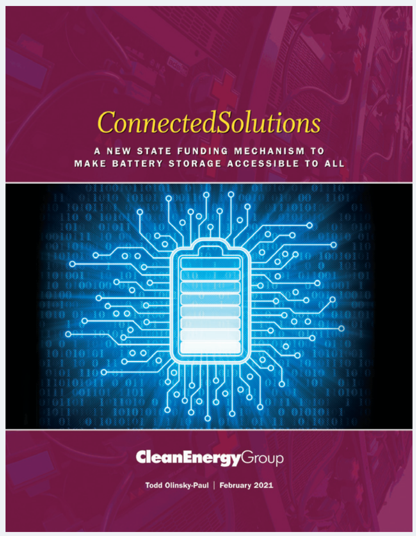
Source: International Energy Agency.

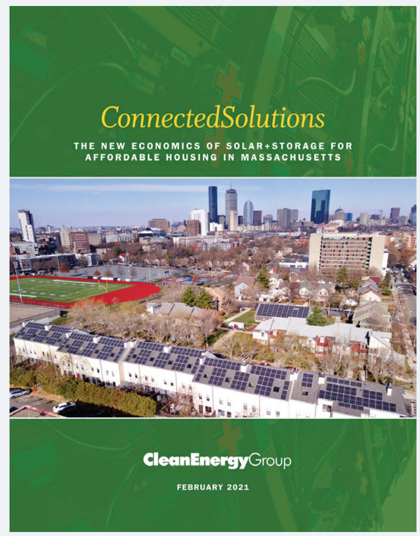
Recommendations

- **State policymakers should develop varied energy storage programs, and regulators should support varied storage ownership models.**
- **Utility ownership of energy storage in fulfillment of procurement targets should be limited, and alternative ownership structures enabled.**
- **Distributed storage funding models, like Connected-Solutions, present a valuable opportunity to harness customer-sited storage to meet regional grid needs. These programs make storage available to all customers and can be used to address issues of equitable access.**

Virtual Power Plants: BYOD and ConnectedSolutions







To view these reports online or to download PDFs, click on the images above or access them online at *www.cleanegroup.org*.

In most New England states, utilities have been granted the right to own energy storage assets.[58] This can be helpful in driving large-scale energy storage markets. However, utility ownership is not a right in all states. And regardless of whether utilities can own storage, there are many advantages to enabling customer- and third-party-owned BTM storage, which can be deployed quickly and offers distinctive benefits due to its location (such as home and commercial resilient power, demand charge management, and direct customer energy cost savings).

To maximize benefits, it can be helpful to harness BTM energy storage resources to address regional grid needs so that the benefits are shared by all ratepayers, and cost-shifting among customers is avoided. States should therefore create programs that provide for the formation of “virtual power plants (VPPs),” in which distributed energy storage, through a variety of ownership structures, can contractually provide services to distribution utilities (and be paid for these services). The VPP structure has

States should create programs that provide for the formation of “virtual power plants (VPPs),” in which distributed energy storage, through a variety of ownership structures, can contractually provide services to distribution utilities (and be paid for these services).

— continued —

58 In Maine, utility storage ownership rights may still need some clarification.

Virtual Power Plants: BYOD and ConnectedSolutions (CONTINUED)

the added advantage that it reduces utilities' perception of risk associated with BTM storage by giving them some measure of control over how customer-sited storage is used.

One such structure that has seen early success in New England is the pay-for-performance "Bring Your Own Device" (BYOD) model, marketed to National Grid and Eversource customers as "ConnectedSolutions." ConnectedSolutions participants purchase or lease batteries and then sign a multi-year contract allowing their electric utility to aggregate and dispatch these BTM batteries at peak demand times to reduce regional peak-related costs.[59] In return, customers are paid based on their batteries' performance. This model allows for both customer and third-party ownership, gives utilities some control over patterns of battery dispatch, and offers customers a way to pay for BTM battery storage, providing home or commercial property owners resilience and reduced energy costs. And it ensures that distributed energy storage provides broad ratepayer benefits, rather than potentially shifting costs from battery owners to other ratepayers. Because it is administered through state energy efficiency programs, ConnectedSolutions has access to sizeable budgets and is subject to some degree of oversight by state policymakers.

The ConnectedSolutions model, developed in Massachusetts, is now offered in Rhode Island and Connecticut, and it has been proposed in New Hampshire and Maine. It offers numerous societal benefits, is popular with customers, and is an effective tool for flattening demand peaks and increasing the efficiency and cost effectiveness of the grid.

Although the ConnectedSolutions model has been successful to date in New England, it should be expanded and brought to scale, as was recently approved in Connecticut.[60] It is also worth noting that states need to pay much more attention to making this program model accessible to low-income and underserved communities. Specific recommendations for doing so can be found in CEG's publication, *ConnectedSolutions: A New State Funding Mechanism to Make Battery Storage Accessible to All*.[61] (See report cover with link on p.30.)

A related model, developed by Green Mountain Power (GMP) in Vermont and emulated by Liberty Utilities in New Hampshire, allows residential customers to lease utility-owned batteries that are installed behind their home meters. GMP has placed more than 3,000 batteries behind customer meters using this model, and regularly discharges this distributed resource to reduce capacity and transmission costs. The resulting savings are shared with all GMP ratepayers. This model is similar to the ConnectedSolutions model, with the key difference being that the utility, rather than the customer, owns the batteries, and that the program is not run through the state energy efficiency program (electric distribution utilities do not administer the state energy efficiency program in Vermont, as they do in many other states—instead, the Vermont efficiency program is administered by a special efficiency utility). The relative merits of the two program models are discussed in *ConnectedSolutions: A New State Funding Mechanism to Make Battery Storage Accessible to All*, linked from p.30.

CEG has published several reports on the ConnectedSolutions funding model. Links to these publications are listed in the Appendix. Each has accompanying webinars with recordings available.

This model allows for both customer and third-party ownership, gives utilities some control over patterns of battery dispatch, and offers customers a way to pay for BTM battery storage, providing home or commercial property owners resilience and reduced energy costs.

59 This model is sometimes referred to as "Bring Your Own Device" or BYOD.

60 See Connecticut PURA Final Electric Storage Program Decision at http://www.dpuc.state.ct.us/dockcurr.nsf/8e6fc37a54110e3e852576190052b64d/38cb46347a645ee585258720004d0e3e/$FILE/171203RE03-072821.pdf.

61 See https://www.cesa.org/resource-library/resource/connected-solutions-policy.

9 Take good ideas from other states; share good ideas with other states

WHY REINVENT THE WHEEL?

As previously stated, each state is unique in its energy needs and challenges; one state cannot simply replicate the programs and policies of a neighboring state. On the other hand, New England states have developed nation-leading energy storage programs, published groundbreaking energy storage reports, and funded first-of-their-kind demonstration projects. Clearly, there is much that states can learn from one another, both within and outside the New England region.

Lessons learned from neighboring states may be particularly applicable because these states may share the same regional wholesale energy markets. In the case of New England, all six states in the region operate within the ISO New England wholesale energy market. This means many of the values for energy services that storage can provide, such as capacity supply, peak demand reduction, and frequency regulation, are similar across the region.

Furthermore, when states participate in regional wholesale energy markets, no single state within the market acts in a vacuum. Energy policies implemented in one state can affect other states in the region. While cost-saving policies may benefit all states, cost-shifting policies may benefit some states while burdening others.

Project Examples

- Due to Demand Reduction Induced Price Effects (DRIPE), using energy storage to reduce regional peak demand creates cost savings across the region by reducing the need to procure or build new peaking resources.[62]
- Because much transmission investment is a sunk cost, using energy storage to reduce a utility's share of its transmission tariff obligation may cause near-term shifting of these costs to other utilities in the region—although in the long term, significant investment in energy storage may reduce the need for future transmission investments, thereby lowering costs regionally.[63]

Clean Energy Group/Maria Blais Costello

A lithium-ion and lead acid battery storage system was installed by Green Mountain Power at the Stafford Hill Solar Farm and Microgrid in Rutland, VT. The Stafford Hill solar farm includes 7,700 solar panels capable of producing 2.5 megawatts (MW) of electricity, enough to power 2,000 homes. The 4.5 MW of batteries reduce peak load costs and can provide backup power during a grid outage to a nearby school that serves as the community emergency shelter. This project was supported by grant funding from Vermont Department of Public Service and US DOE Office of Electricity, as well as by technical support from Sandia National Laboratories and Clean Energy States Alliance.

Working collaboratively with neighboring states—even sharing information on energy regulatory reform—may be difficult, but there are clear advantages to some regulatory standardization across state lines. If energy storage products and services are allowed in some states but not in others that share the same wholesale energy markets, it can make it difficult for industry and utilities—whose territories cross state lines—to operate cost-effectively in the region.

From a policy perspective, innovation is a good thing; but there is no need for each state in the region to reinvent the wheel. If something is working well in a neighboring state, it is probably worth consideration for adoption and improvement.

62 For more information on DRIPE, see https://www7.eere.energy.gov/seeaction/system/files/documents/DRIPE-finalv3_0.pdf and http://www.raponline.org/wp-content/uploads/2016/05/efg-ri-dripewebinarslidedeck-2015-mar-18-revised.pdf.

63 A transmission tariff revision currently underway may change the rules under which utilities can affect their share of transmission costs. For more information, see the NEPOOL transmission committee, https://nepool.com/event/transmission-committee.

Recommendations

- **States should pay attention to what their neighbors are doing; energy storage policy and programs that work in one state should be considered for adoption by neighboring states. Replicate, improve, and expand successful programs like SMART and ConnectedSolutions.**
- **To the extent possible, coordinate energy storage policy and program development and share information with neighboring states.**
- **Regional regulatory consistency, to the degree it can be achieved, could help to reduce market fragmentation.**

The Appendix to this report provides reports, program documents, and legislation related to key state energy storage policies and programs, which may be useful to policymakers.

Increase Expertise

Because energy storage is still a relatively new technology with evolving markets and applications, state energy agencies may not have in-house storage experts. It can be daunting to develop energy storage programs and policy without the benefit of prior experience.

Different states have addressed this challenge in various ways. Some have hired an energy storage analyst. Others have assigned energy storage to an existing staff person who already works on other clean energy programs, and has the bandwidth to add a new technology. Still others have contracted with consulting firms or taken advantage of free resources.

Fortunately, states have numerous free resources to draw upon. The national laboratories, particularly Sandia National Laboratories, Pacific Northwest National Laboratory, and the National Renewable Energy Laboratory, offer energy storage technical, policy, and regulatory support to states. Nonprofit organizations such as Clean Energy States Alliance and Clean Energy Group offer similar support. Resources are available from industry groups such as the Energy Storage Association and Northeast Clean Energy Council (NECEC), and from policy shops such as the Regulatory Assistance Project (RAP). Energy storage is the subject of much analysis, so there are numerous reports on every aspect of the technology, including policymaking, regulatory issues, and markets.

With such an abundance of information sources, states may want to consolidate knowledge before embarking on policymaking. To this end, it may be helpful to form a state energy storage advisory committee and/or create a state storage roadmap. If energy storage is not already incorporated into the state energy plan, doing so can help to guide various state agencies in working together rather than at cross-purposes.

An energy storage advisory committee or working group should include representatives from relevant state policy agencies (such as energy and environmental agencies and energy efficiency advisory groups) as well as from the utility regulatory agency, to help address issues that arise in a coordinated way. It is also a good idea to involve stakeholders in the policymaking process to get the benefit of knowledgeable advocates. Stakeholders may include environmental groups, municipal organizations, clean energy advocates, energy equity groups, and others.

While gathering information, it may be helpful to provide funds for demonstration projects. If operating energy storage projects do not already exist in your state, this can be a good way to expand the knowledge base, and supplement theoretical understanding with practical experience. For more information on demonstration projects, see Section 10, “Put Steel in the Ground.”

10 Put steel in the ground

LET'S KICK THE TIRES

Theories and models are nice, but they are no substitute for having energy storage projects installed and operational in your state. To get those first projects built, many states offer energy storage demonstration project grants. Note, however, that there are already many operational battery storage projects in New England—so, for the present, the need for more state grant programs in this region is limited. For example, there is little need to demonstrate another utility-scale lithium-ion battery providing peak demand reduction and frequency regulation services when numerous such projects already exist in the region.

However, as energy storage technology progresses and new applications and business cases emerge, states may once again find it useful to support demonstration projects through grants. Examples of areas where future grants may be helpful include long-duration energy storage technologies, storage paired with offshore wind, storage for transmission and distribution infrastructure investment deferral, and emerging technologies such as flow batteries and compressed air storage. In addition, grants may still be useful to demonstrate energy storage projects serving historically underserved and low-income communities.

Operational projects demonstrate much more than whether the technology functions as anticipated: they also give utilities, customers, regulators, and industry concrete data about applications, economics, operations and maintenance, safety, environmental issues and more. Grant programs like the Community Clean Energy Resiliency Initiative and Advancing Commonwealth Energy Storage (ACES) grant programs in Massachusetts, and the Microgrid Grant and Loan Program in Connecticut, have been very helpful in getting demonstration projects built in their respective states.

Program Examples

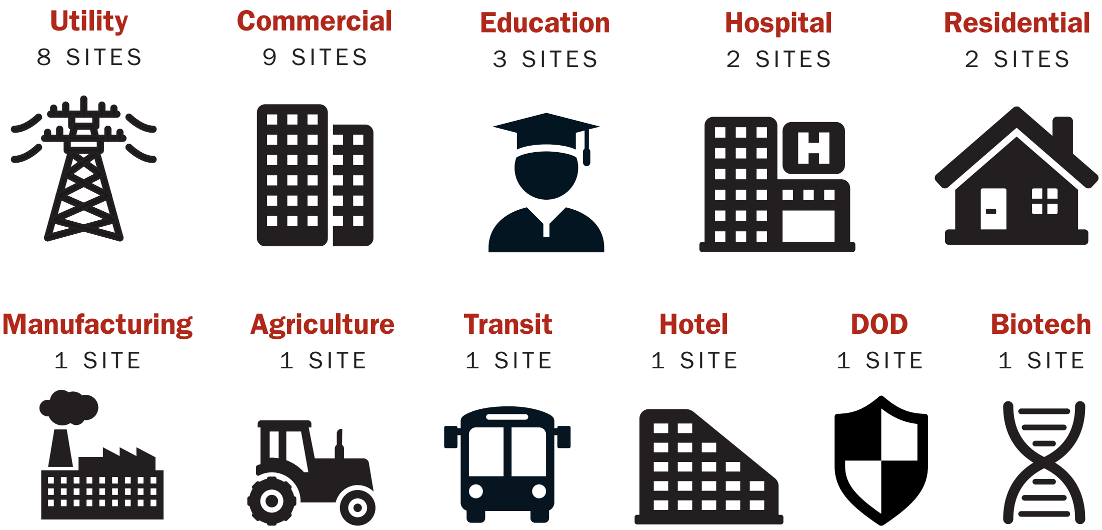
- The Massachusetts ACES grant program awarded a total of $20 million to 26 energy storge project proposals demonstrating nine use cases and 14 business models. The demonstration projects were expected to increase the state's total energy storage capacity from 7 MWh to 90 MWh. This is an example of a grant program designed to jump-start the energy storage market across numerous sectors of the economy. (See Figure 7, p.35.)

Green Mountain Power

This Milton, Vermont solar and storage project is one of several such installations developed by Green Mountain Power. The 8-MWh batteries provide value to customers by reducing peak demand costs and participating in the ISO New England Frequency Regulation market. GMP is also looking into developing what it calls "resilience zones," by adding islanding switches to distribution grid circuits surrounding batteries such as this one. This would allow whole neighborhoods to be supported with backup battery power in case of a grid outage.

FIGURE 7

ACES Grants Support Various Host Types



The ACES grant program demonstrated numerous applications and business models, across a wide range of sectors.

Source: Massachusetts Clean Energy Center

- Not every state can devote millions of dollars to grant projects, but in many cases this level of investment is not required. For example, the Stafford Hill energy storage project in Vermont was supported by a $40,000 state grant, $250,000 in federal matching funds from US DOE Office of Electricity, and technical support from Sandia National Laboratories and CESA. The balance of the $5.5 million battery investment was made by the project owner, utility Green Mountain Power (GMP), based on a positive business case.[64] GMP has gone on to install several other large battery systems on its grid, and has innovated customer battery programs as well.

One key to funding successful demonstration projects is to provide technical support. By definition, a demonstration project should break new ground, so it is unrealistic to expect all grantees to know how to optimize project designs and identify unrealistic vendor claims. While utilities may have in-house technical experts (or may be able to attract free technical assistance from a national laboratory), municipal, commercial, and nonprofit grantees may need state-provided technical support to ensure projects are successful. It is also very helpful to provide up-front technical guidance to help inexperienced applicants shape promising ideas into viable project proposals. States should build this into grant programs or allow grantees to use some portion of their award to procure engineering and analysis services.

Another key to successful energy storage grantmaking is to look for projects that are replicable. When proposing a project for grant funding, applicants should be able to explain not only why the proposed project represents a positive opportunity for the prospective project owner, but also how it will demonstrate positive opportunities for others. Quantifying the potential for replicability may be difficult, but it can be an important exercise in order to understand the value of the proposed demonstration project.

When proposing a project for grant funding, applicants should be able to explain not only why the proposed project represents a positive opportunity for the prospective project owner, but also how it will demonstrate positive opportunities for others.

Program Example

- A grid-scale energy storage project developed by the Sterling Municipal Light Department in Sterling, Massachusetts has drawn visitors not only from other municipal utilities

64 Learn more about the Stafford Hill Solar Farm and Microgrid, https://www.cleanegroup.org/ceg-projects/resilient-power-project/featured-installations/stafford-hill.

in Massachusetts, but from across the nation and the globe. The site has been toured by visitors from 13 countries as well as from US DOE, several national laboratories, numerous utilities, and many US states. In addition, the project won awards, the site was used for regional fire safety training, and the project has been replicated by other utilities and electric co-ops across the nation. The Sterling project received grant support from the Commonwealth of Massachusetts as well as matching funds from US DOE and technical support from Sandia National Laboratories and CESA.

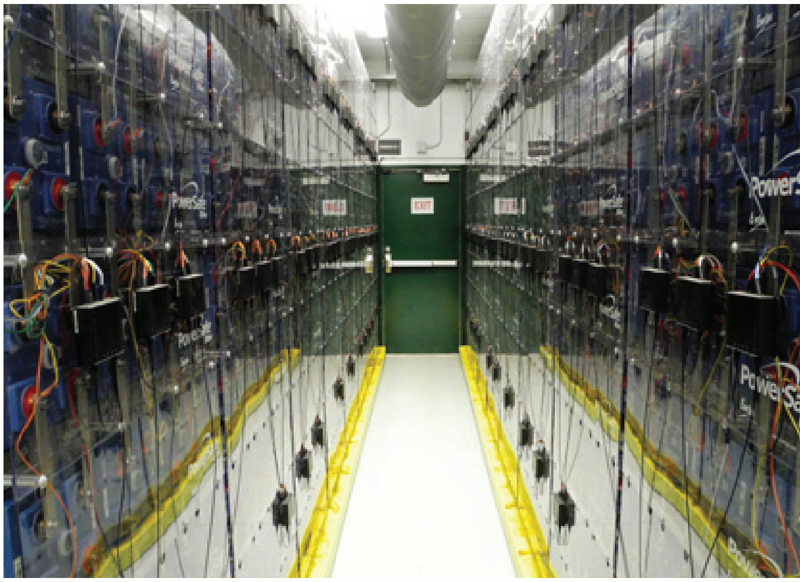
A third principle of successful energy storage grant programs may seem contradictory: Don't over-rely on grants!

Although grant programs can be very helpful to get the first energy storage projects installed, once these initial projects are up and running, further grant-supported projects offer diminishing returns. Grant-supported projects tend to be relatively expensive one-off efforts; and while some, like the Sterling project in Massachusetts, have been widely studied and emulated, not all demonstration projects will be so impactful. Moreover, once the technology, applications, or business models of interest have been demonstrated, there is little need for further grant-supported deployment. Instead, states that have already demonstrated the technology should turn to more sustainable incentives and market-based programs to build capacity and grow markets. Individual developers may be happy to receive a grant, but industries need predictable revenue opportunities and a supportive regulatory ecosystem in order to flourish.

Because the New England states already host numerous operational lithium-ion battery storage projects serving a variety of business cases, it now makes sense for these states to direct their resources toward developing longer-term incentives, setting and meeting procurement targets, ensuring equitable access, and incorporating energy storage into market-based programs. In the future, as new energy storage technologies and applications arise, there may again be opportunities for the New England states to sponsor novel technology demonstration projects, such as the grant-supported energy resilience projects that were developed in the wake of Superstorm Sandy in Connecticut and Massachusetts.

For other states that do not have operational energy storage projects, demonstration grant programs may still be needed. In this case, New England provides numerous examples of such programs to consider.

Clean Energy Group/Maria Blais Costello



Interior of a lead acid battery container installed at the Stafford Hill Solar Farm and Microgrid in Rutland, VT. The Stafford Hill Solar Farm was one of the first microgrids in the US powered solely by solar and battery backup, with no other fuel source. It was supported by grants from Vermont Department of Public Service and US DOE Office of Electricity, as well as by technical support from Sandia National Laboratories and Clean Energy States Alliance.

Recommendations

- **If demonstration project grants are needed, design programs that will support energy storage projects in a variety of settings to support various applications, business models, and economic cases.**
- **Leverage resources. If a project proposal is a good one, utilities and industry should be willing to make a meaningful investment. State grant funds should account for no more than 50 percent of project installed costs, and ideally less.**
- **Replicability should be a key requirement for grant-supported projects. There is little to be gained by demonstrating a technology or application that nobody will be able to replicate.**
- **Improve chances of grantee success by providing technical support resources.**
- **Do not rely too much on grants. In the short term, grants can be an invaluable tool to get demonstration projects built. But over the long term, markets are moved more by incentives, regulatory reform, and market-based programs.**

iStockphoto/Denis Tangney Jr.

Conclusion

New England states have led on energy storage policy and program development, but these policy advances are not undertaken in a vacuum. Utility programs can span multiple states; a regional transmission tariff revision, now underway, could have an outsized impact on regional energy storage economics; storage technology advances and price reductions continue to open new applications; and FERC orders are requiring energy storage market rule changes at the ISO level. With numerous moving parts, the energy storage landscape is changing quickly, and it can be challenging for state policy and regulations to keep up.

In such a fast-changing environment, it can be tempting to delay energy storage policymaking, program development and regulatory reform until the dust settles—or, if the opportunity exists, to hold off implementing major new initiatives until other states have tried them first.

With numerous moving parts, the energy storage landscape is changing quickly, and it can be challenging for state policy and regulations to keep up.

Nevertheless, it is important for states to push ahead and continue the good work that has already begun. There are many drivers pointing to the need for energy storage deployment:

- Old electric grids, designed around centralized generation to accommodate one-way flows of power, are in need of modernization
- Renewable generation must be better integrated and more dispatchable (increasing solar penetration has already recreated the California "duck curve" phenomenon in the Northeast; offshore wind build-out is on the horizon)
- Extreme weather and related grid outages are causing heightened customer demand for resilient power
- Traditional energy efficiency investments, such as lighting upgrades, are beginning to show diminishing returns
- Capacity and transmission needs can no longer be adequately addressed solely by adding more fossil fuel generation, pipelines, poles, and wires
- Electrification is advancing in the building and transportation sectors, requiring more flexible grids and pointing to long-term changes in demand (models show that if this trend continues, the New England region may flip from summer to winter peaking)[65]
- States have committed to ambitious clean energy and decarbonization goals that can only be achieved through significant increases in the deployment of renewable generation and advanced energy storage

With falling battery prices, increasing adoption of state clean energy and decarbonization goals, and forward-looking utilities (and ratepayers), many states have a strong foundation for success. In this report, we have offered some suggestions to policymakers for building on that foundation. It is worth noting a few additional issues that state energy officials should consider.

At present, not all states in the New England region are moving ahead on energy storage policy development at a comparable pace, with the result that some states have become much more attractive to storage developers than others. This makes for unequal markets. If the current uneven pattern of storage deployment continues in New England, storage-rich states may eventually be seen as shifting some regional energy costs, in the near term, to their storage-poor neighbors—and this pattern could be repeated in other ISO and RTO regions. Better regional

65 For more about electrification and changing peak load in the Northeastern US, https://www.nrel.gov/docs/fy18osti/71500.pdf.

coordination, updated market rules, and regulatory reform could encourage a more equitable distribution of storage adoption, and result in a more even distribution of benefits from state to state.

Likewise, it is important for all states to address a more basic inequity in storage benefit distribution—the tendency for storage, like other advanced clean energy technologies, to be adopted by tech-savvy businesses and wealthy individuals while bypassing the underserved communities that are most in need of its benefits. Historically, low-income communities pay a far greater portion of their income for energy, are hit hardest by natural disasters and the associated power outages, and have a harder time recovering; yet, they have been the last to benefit from solar PV, efficiency measures, electrification and other improvements. State policymakers must act quickly to ensure this pattern is not repeated with energy storage.

Finally, the New England states should recognize that the region is poised to solidify its role as a national leader in energy storage innovation, policymaking, and deployment, especially in aggregated distributed energy storage. At this writing, all six New England states have adopted some variety of the ConnectedSolutions/BYOD model, which allows customers and utilities to work together to form virtual power plants. This puts New England in a unique position, and provides a powerful tool to achieve grid transformation, increase resilience, expand energy equity, and reduce the high cost of meeting regional peak demand. If this momentum continues, there is strong potential for cascading economic benefits as the energy storage industry grows in New England, with expanding job creation and investment. As the ConnectedSolutions model spreads beyond New England, other states may also see these benefits.

Clean Energy Group/Maria Blais Costello

Sterling Municipal Light Department deployed a 2-megawatt/3.9-megawatt-hour battery storage system at its Chocksett Road Substation that is able to isolate from the main grid in the event of a power outage and, with an existing solar PV array, provide up to 12 days of emergency backup power to the Sterling police station and dispatch center. The project was supported by grants from the Commonwealth of Massachusetts and from US DOE Office of Electricity and received technical support from Sandia National Laboratories and CESA. The project has been widely studied and replicated, in part because it has been extraordinarily successful in producing energy cost savings for Sterling, MA ratepayers.

iStockphoto/itan1409e & iStockphoto/petmal

Appendix

STATE POLICIES AND ORDERS

ARIZONA

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See the CEG/CESA Publications Library at www.cleanegroup.org/publications-library for more reports, case studies, analyses, and other materials related to energy storage policy, programs, and deployment. Upcoming and archived webinars on energy storage topics are available at www.cleanegroup.org/webinars.

Energy Storage Policy Best Practices from New England

TEN LESSONS FROM SIX STATES

CLEAN ENERGY GROUP (CEG), a leading national nonprofit advocacy organization, works to provide technical assistance, independent analysis, and policy support to address climate mitigation, adaptation, and energy justice. CEG collaborates with partners across private, governmental, and nonprofit sectors to accelerate the equitable deployment of innovative clean energy technologies and the implementation of inclusive clean energy programs, policies, and financial tools. CEG's emphasis on enabling greater access to distributed clean energy technologies, primarily solar and battery storage, compliments its work with frontline communities, environmental justice advocates, technical experts, and transformative leaders to advance a just energy transition to a resilient, clean energy future. Founded in 1998, CEG has been a thought leader on effective strategies to address the climate crisis by expanding clean energy for more than 20 years. *www.cleanegroup.org*

CLEAN ENERGY STATES ALLIANCE (CESA) is a leading US coalition of state energy organizations working together to advance the rapid expansion of clean energy technologies and bring the benefits of clean energy to all. Our vision is to ensure that state-led efforts advance a just transition to 100% clean energy by 2050. Established in 2002, CESA is a national, member-supported nonprofit that works with its members to develop and implement effective clean energy policies and programs. CESA's members include many of the nation's most innovative, successful, and influential implementers of clean energy policies. CESA facilitates the expansion of state clean energy policies, programs, and innovation, with an emphasis on renewable energy, energy storage, energy equity, and resiliency. CESA and its members perform an essential role in moving the nation from fossil fuels to affordable clean energy. *www.cesa.org*

CEG and CESA are headquartered in Montpelier, Vermont, with staff located in Maine, Maryland, Massachusetts, South Carolina, Vermont, and Virginia.

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