

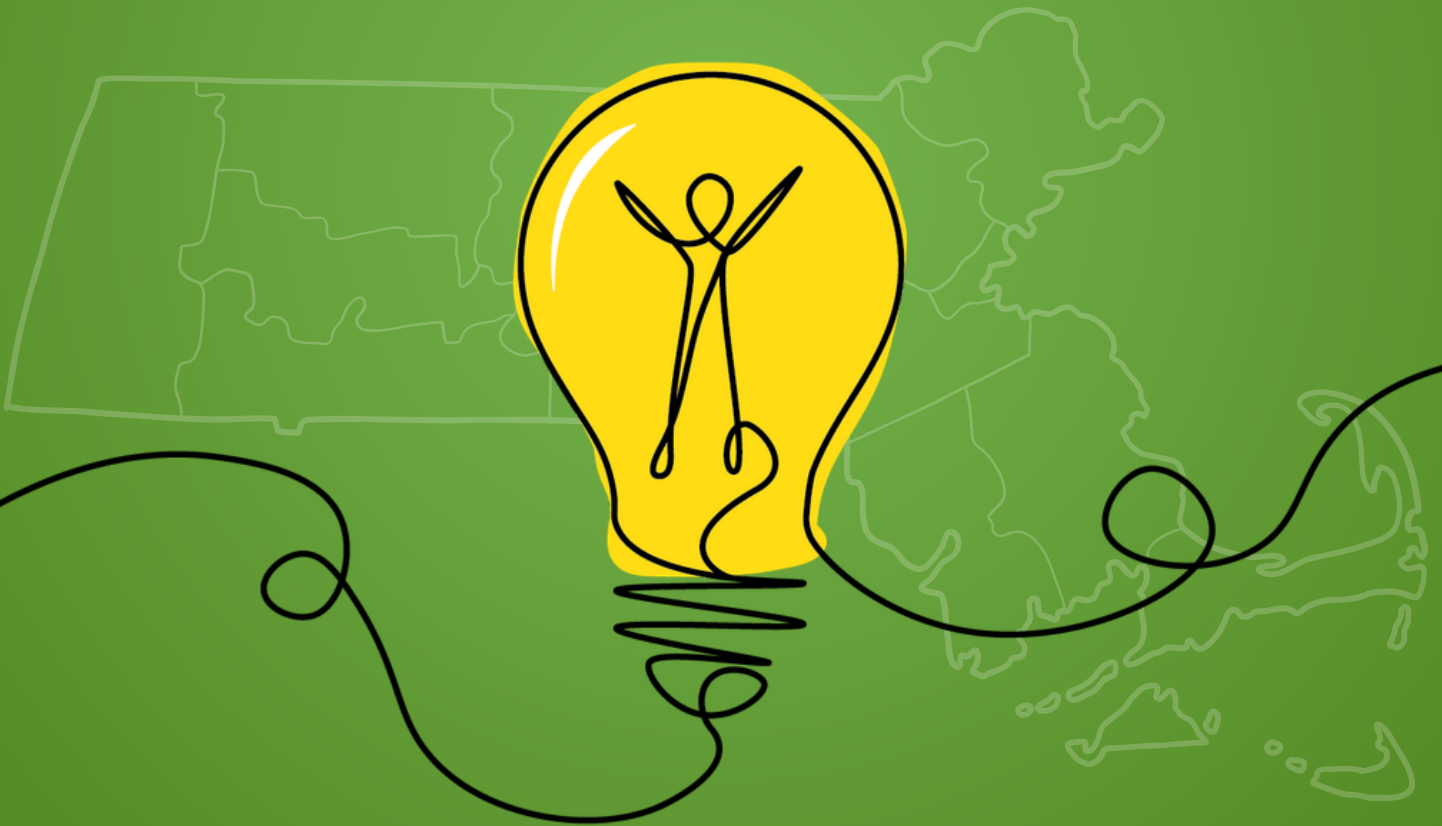
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Electrification With Equity

PART

1

The Opportunity for Behind-the-Meter
Solar and Storage in Massachusetts



May 2026

Electrification with Equity, Part 1:

The Opportunity for Behind-the-Meter Solar and Storage in Massachusetts

Prepared by Applied Economics Clinic
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About This Report

To meet its emissions reduction targets and decarbonization goals, Massachusetts – like many states – is working towards the electrification of its building and transportation sectors. While this will help reduce air pollution, it will also increase the region’s electric demand, which could lead to a new round of investment in fossil fuel generation. This report evaluates the opportunity for distributed solar and solar+storage to offset forecasted peak demand growth that will result from electrification in Massachusetts.

This report is the first in a two-part series. Part 2 identifies barriers to solar and storage adoption in Massachusetts environmental justice neighborhoods and advances recommendations to address these barriers through revisions to the Commonwealth’s existing programs and policies. That report, *Electrification with Equity, Part 2: Scaling Behind-The-Meter Solar and Storage in Massachusetts Environmental Justice Neighborhoods*, is available at: www.cleanenergygroup.org/publication/electrification-with-equity-part-2.

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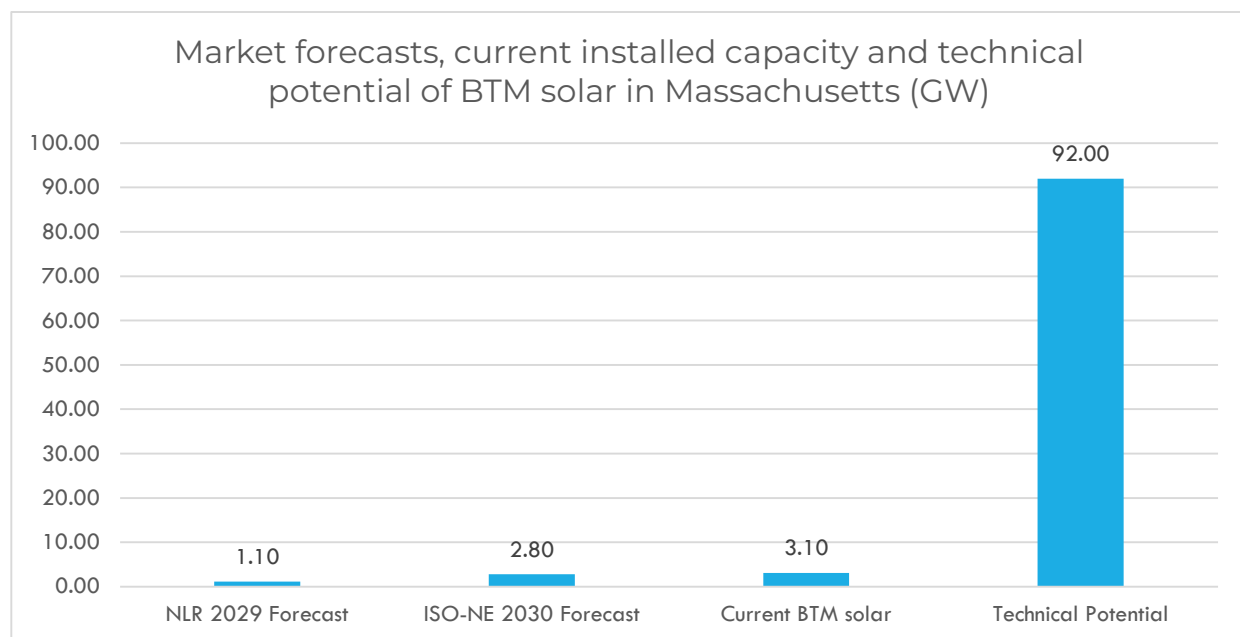


Foreword

Massachusetts is at an energy crossroads. The Commonwealth has committed to electrification of the transportation and building sectors as a key strategy to reach its goal of net-zero greenhouse gas emissions by 2050; but this electrification is projected to cause peak electricity demand to rise steeply, doubling by 2050. To protect decarbonization gains, this new demand must be supplied by clean, renewable generation. But federal tax credits for solar are ending, undercutting state efforts to scale up renewable generation. And in light of Massachusetts’ rising energy costs, affordability must be central to an equitable clean energy transition.

This report makes the case that distributed energy resources (DERs), especially behind-the-meter (BTM) solar and solar paired with energy storage, are underutilized but essential to meeting Massachusetts’ rising electricity demand cleanly, affordably and equitably – and that, with the right program and policy adjustments, clean distributed resources could offset increases in electric demand from electrification, rendering new fossil fuels investments unnecessary.

To understand the opportunity presented by distributed clean resources in Massachusetts, it is important to understand their enormous potential. The *Massachusetts Technical Potential of Solar* report¹ estimates the technical potential of distributed solar (ground-mounted solar <1 megawatt (MW), rooftop, and canopy solar) on properties that are “highly suitable” for solar at 92 gigawatts (GW), far more than the Commonwealth’s projected 2050 peak demand of 24 GW. Of course, technical potential is not market potential; but the best market potential forecasts to date fall far short. For example, the current installed capacity of BTM solar in Massachusetts exceeds both National Laboratory of the Rockies’ 2029 forecast and ISO-New England’s 2030 forecast.



¹ Knight, P., Griot, O., Carlson, E., et al., *Massachusetts Technical Potential of Solar Study*, prepared by Synapse Energy Economics for Massachusetts Department of Energy Resources (DOER), July 2023, www.mass.gov/info-details/technical-potential-of-solar-study.



So far, Massachusetts is barely scratching the surface of its technical potential for distributed solar, and the distributed storage that could be paired with it. The technology itself is not the barrier, but rather program design; the Commonwealth can realize a greater portion of this technical potential with the right energy policies. This is one of the takeaways from this report.

A second insight is that the tools to achieve this are already in place. Massachusetts boasts some of the best solar and storage programs in the country, including the Solar Massachusetts Renewable Target (SMART) solar and storage incentive, the groundbreaking ConnectedSolutions program (one of the earliest virtual power plant programs), the nation's only Clean Peak Energy Standard, and an ambitious Energy Storage Initiative that includes comprehensive analysis, a statewide procurement target and well-funded grant programs. In addition, the landmark Cape & Vineyard Electrification Offering offers a blueprint for a statewide program combining efficiency, electrification, and solar+storage in a single residential offering. But if Massachusetts is to reach its 2050 goals, these programs will need to be scaled up significantly.

The need for program reform is nowhere clearer than clean energy program performance for Massachusetts' low-income households. As we documented in our 2024 report, *Energy Storage Equity: An Assessment of Three Massachusetts Programs*,² the Commonwealth's otherwise excellent solar and storage programs do not meaningfully serve low-income households. Strong equity revisions for these programs should include not only equity incentive adders but also goals, reporting and tracking, and education and outreach. There is much work to be done to overcome other barriers to accessibility as well – a subject we address in the companion report to this one, *Electrification with Equity, Part 2: Scaling Behind-The-Meter Solar and Storage in Massachusetts Environmental Justice Neighborhoods*,³ which focuses on how Massachusetts can overcome barriers to DER adoption in environmental justice neighborhoods – and why it matters.

As Massachusetts considers its energy options, two paths emerge. One leads to big new investments in fossil fuel generators and the pipelines to feed them, creating a legacy of costly and polluting infrastructure that will remain with us for half a century or more. This path looks much like the road behind. The other path looks very different. Instead of utility-scale plants burning fossil fuels, it focuses on networks of smaller clean energy resources located in homes and businesses. Instead of investments that benefit big corporations and out-of-state hedge funds, it focuses on thousands of smaller investments benefiting our homes and neighborhoods. This second path enables electrification with equity. It brings real benefits to Massachusetts communities: cleaner air and water, more efficient and less costly energy, and backup power for when the grid goes down.

We hope this report will help advocates both within and without state government to advance the Commonwealth toward a clean, equitable and affordable energy future.

Todd Olinsky-Paul
Senior Project Director, Clean Energy Group

² Stasio, T. et al., *Energy Storage Equity: An Assessment of Three Massachusetts Programs*, Clean Energy Group and Applied Economics Clinic, September 2024, www.cleanenergygroup.org/publication/energy-storage-equity-massachusetts.

³ Stasio, T. and Seliga, E., *Electrification with Equity, Part 2: Scaling Behind-the-Meter Solar and Storage in Massachusetts Environmental Justice Neighborhoods*, Applied Economics Clinic, Clean Energy Group, Union of Concerned Scientists, Vote Solar, April 2026, www.cleanenergygroup.org/publication/electrification-with-equity-part-2.



Executive Summary

To meet its required emission reduction targets and decarbonization goals, Massachusetts, like other New England states, is working towards electrification of its building and transportation sectors. But electrification will significantly increase electric demand, creating the need for additional electric generating capacity. Meeting rising demand with a mix of renewable energy, energy storage, energy efficiency efforts, and load management solutions will be challenging, but necessary, if the Commonwealth is to achieve net-zero greenhouse gas emissions by 2050.

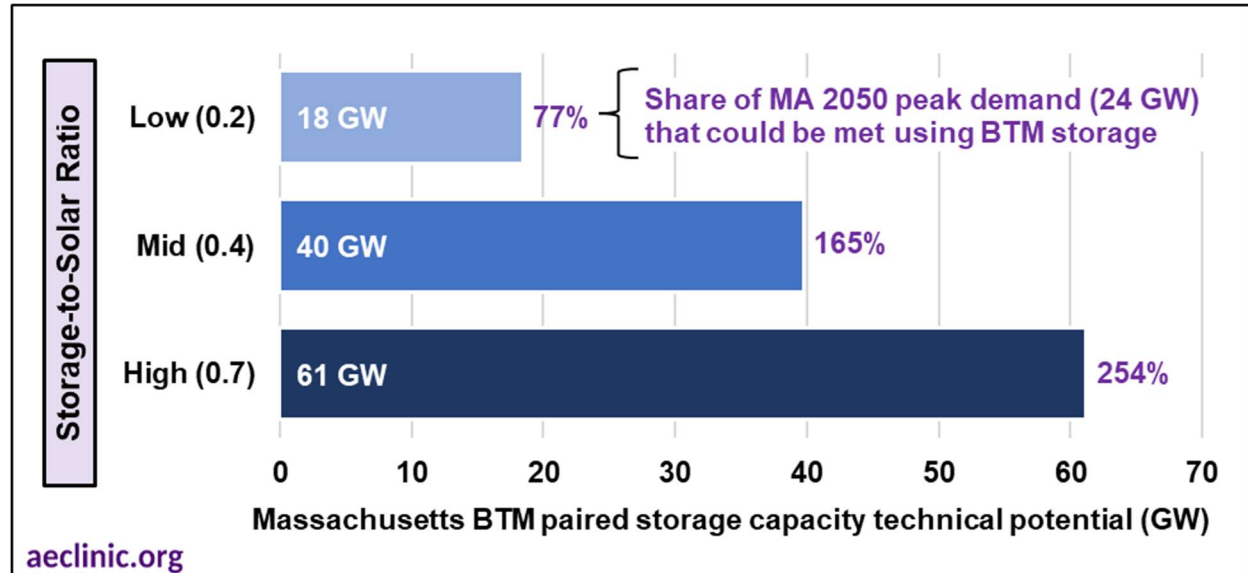
Distributed energy systems like behind-the-meter (BTM) solar and BTM solar paired with storage can help meet this challenge while providing customers with an opportunity to reduce their energy bills and increase their energy resilience. BTM solar can reduce customers' demand for grid-provided electricity and thereby reduce the need for utility-scale resources to supply that demand—and if paired with storage, can shift customer demand to off-peak periods, improving system efficiency and reliability across the grid.

This report—prepared by Applied Economics Clinic (AEC) on behalf of Clean Energy Group and Vote Solar—estimates the technical potential of BTM storage paired with solar resources in Massachusetts at properties that are highly suitable for solar. The technical potential of a resource is the maximum capacity that could be available given physical and land-use constraints, but not considering market forces, costs, or policies. Thus, this assessment of technical potential shows the maximum possible deployment for BTM solar and paired BTM storage (i.e., the total capacity if all residential and commercial electric customers were to install canopy, rooftop, and/or small (< 1 megawatt (MW)) ground-mounted solar wherever physically possible). Achieving the full technical potential of a resource, even for the most highly suitable locations as in this case, is not typically economically feasible, but this maximum estimate provides a useful metric for comparison to current and planned deployment levels.

Based on technical potential estimates for BTM solar from the Massachusetts Department of Energy Resources (DOER) 2023 *Technical Potential of Solar Study*⁴ and assuming a storage-to-solar capacity ratio of 0.4, AEC estimates that the technical potential of BTM storage paired with solar is 40 gigawatts (GW) (see ES-Figure 1). To put this in perspective, 40 GW is more than one and a half times (165 percent) of Massachusetts' forecasted 2050 peak demand of 24 GW, and 254 times the Massachusetts current BTM storage capacity of just 157 MW.

⁴ Knight et al., *Massachusetts Technical Potential of Solar*.



ES-Figure 1. Low-, mid-, and high- estimates of Massachusetts BTM storage technical potential

This report identifies ten preconditions or barriers to developing BTM solar and paired storage systems that, if addressed, could narrow the gap between the technical potential and current deployment levels. These preconditions or barriers are:

1. **Insufficient financial incentives.** The high upfront cost of behind-the-meter (BTM) resource purchase and installation is out of reach for many households, especially low-income households and those that lack access to credit.
2. **Insufficient equity incentives and lack of equity goals and carve-outs.** Low-income participation is not supported or tracked for some state-led programs, and the Solar Massachusetts Renewable Target (SMART) solar and storage incentive has not successfully incentivized adoption at low-income properties.
3. **Need for electric system or building upgrades.** Some buildings, particularly older buildings, may require electric system or building upgrades to be compatible with BTM resources.
4. **Workforce limitations.** Solar installations are growing faster than the number of workers needed to design, install, and maintain these systems.
5. **Solar and storage ownership barriers and split incentives between renters, landlords, and condo owners.** Renters and condo owners often lack the authority to install BTM resources onsite, while landlords may lack the incentive to cover the upfront cost of solar and storage installations, especially when tenants pay utility bills.
6. **Program complexity and lack of coordination.** Businesses and residents may not be aware of the programs and tax incentives available to support BTM resources.
7. **Lack of trust between customers, utilities, and solar developers.** Customers may distrust utilities and solar developers, making them reluctant to participate in programs.

8. **Interconnection and permitting issues.** Permitting and interconnection of BTM resources to the electric grid can be difficult and time-consuming for both customers and utilities.
9. **Lack of solar panel and battery recycling and disposal options.** Recycling processes for silicon and cadmium telluride PV modules, as well as lithium-ion batteries, are available in the United States but remain expensive.
10. **Lack of internet access to learn about, or participate in, solar and storage programs.** More than 110,000 Massachusetts households lack internet access, limiting their ability to access information about available programs.

Increased BTM solar and storage capacity will lower Massachusetts' peak electric demand, defer or avoid further investments in expensive gas-fired power plants, and achieve building electrification goals, while providing underserved communities with access to household savings, energy resilience, workforce development, increased resource ownership and energy autonomy.

In addition to the above-mentioned benefits, BTM deployment that targets low-income and environmental justice (EJ) neighborhoods advances the Commonwealth's equity commitments. Massachusetts' 2025/2030 Clean Energy and Climate Plan (CECP) lays out a commitment to equity in which "all Massachusetts residents can fully access and participate in the transition to a low-carbon economy" and states that "differences in income-level, location, English proficiency, and previous marginalization" must not prevent anyone from participating in the benefits created by a new, low-carbon economy.⁵ However, in past work, AEC has found that Massachusetts' storage incentive programs lack equity provisions necessary to align with this commitment. Furthermore, data from Massachusetts' clean energy programs show very low participation rates for low-income communities. In a companion report, *Electrification with Equity, Part 2: Scaling Behind-the-Meter Solar and Storage in Massachusetts Environmental Justice Neighborhoods*,⁶ AEC assesses the technical potential for BTM solar paired with storage in Massachusetts EJ neighborhoods.

To scale up adoption of BTM storage paired with solar in Massachusetts, this report presents 23 policy recommendations:

1. Set statewide BTM solar and BTM solar paired with storage capacity targets for 2030 and 2050 that are commensurate with 2025/2030 CECP and 2050 CECP.
2. Expand SMART, Clean Peak Energy Standard (CPS), and ConnectedSolutions program budgets commensurate with new BTM deployment targets, including up-front financial incentives for low-income households.
3. Restore the SMART storage adder for solar <25 kW to support residential and small commercial BTM solar paired with storage.
4. Establish a 50 percent EJ participation target for statewide programs. EJ participation rates should be available publicly and reviewed annually with incentive rates adjusted accordingly.

⁵ Massachusetts Clean Energy and Climate Plan for 2025 and 2030, Massachusetts EEA, June 2022, www.mass.gov/info-details/massachusetts-clean-energy-and-climate-plan-for-2025-and-2030.

⁶ Stasio et al., *Electrification with Equity, Part 2: Scaling Behind-the-Meter Solar and Storage in Massachusetts Environmental Justice Neighborhoods*.



5. Implement statewide program budget carve-outs for EJ neighborhoods to ensure financial assistance is available to areas that need it most.
6. Increase or add low-income incentive adders within existing programs to be adjusted annually if participation targets are not being met.
7. Develop an online tracking tool to enable residents and businesses to stay up to date on clean energy program participation for low-income and/or EJ neighborhoods and to identify municipalities with lower participation rates.
8. Require Massachusetts utilities' Electric Sector Modernization Plans to include strategies employed to achieve participation targets.
9. Amend the existing Massachusetts Residential Energy Tax Credit to 1) increase the maximum credit cap for low-income households and 2) establish an additional credit adder for solar paired with storage.
10. Provide financial incentives for electric system building upgrades on low-income properties.
11. Amend the Stretch and Specialized codes to include BTM solar and storage readiness.
12. Assess workforce trends and identify opportunities for expanding existing workforce training programs, including follow-through measures to help trainees to secure employment in the field.
13. Investigate incentive mechanisms for multifamily master-metered building owners.
14. Expand budget for BTM community solar and storage, including planned investment in educational materials and outreach.
15. Integrate and coordinate across state energy programs to improve the ease of enrollment, increase participation, and streamline customer outreach and education. Programs should be offered as a package whereby customers could sign up for energy efficiency upgrades, electrify their home or commercial building, and sign up for SMART, CPS, and/or ConnectedSolutions at the same time. Program implementation should be coordinated for cost-effectiveness and optimum efficiency across programs.
16. Require Massachusetts utilities to provide information on the suite of available financial incentives to customers with their monthly bills, send reminders to customers with existing BTM solar or storage to enroll in eligible programs.
17. Replicate the Cape & Vineyard Electrification Offering (CVEO) as a statewide offering through ConnectedSolutions.
18. Establish outreach and transparency requirements for utilities and clean energy developers to ensure customers understand system costs, expected bill impacts, and programs available to offset these costs.
19. Investigate additional measures to improve transparency and trust between customers and their utilities and clean energy developers.



20. Design and implement required standards for better ease and speed of BTM interconnection.
21. Set maximum total interconnection costs that can be charged by utilities to project developers.
22. Investigate recycling and reuse solutions for solar and storage systems.
23. Require utilities to host workshops in EJ neighborhoods for customers to learn about and enroll in existing programs.

I. Introduction

Over the past two decades, New England’s electric production has shifted away from coal- and oil-fired resources towards a system dominated by gas (51 percent), nuclear (23 percent), and renewables as its constituent states, like Massachusetts, move towards decarbonizing their electric supplies to meet their respective climate targets. Still, in 2024, renewables (not including hydro) and storage comprised just three percent of New England’s summer capacity supply obligations; by 2034, ISO-New England expects just over six percent of capacity to be from solar, wind, and battery resources.⁷ While nearly 18 gigawatts (GW) of new battery storage is proposed by developers for construction in the region, not all of those systems will be built;⁸ as of May 2025, ISO-New England expected summer peak storage capacity of just 0.9 GW for standalone batteries and 0.5 GW for batteries co-located with solar by 2034.⁹

Concurrent with efforts to increase the share of electricity generated from renewable energy sources, New England states are electrifying their buildings and transportation sectors (i.e., moving away from gas- and oil-fired heating and gasoline- and diesel-fueled vehicles). The residential heating and cooling and transportation sectors in New England are expected to reach 92 to 97 percent electrification by 2050, while the commercial heating and cooling and industrial processes sectors are expected to reach 38 to 54 percent (see Table 1 below).¹⁰ This shift is expected to significantly increase the region’s electric demand in the future.¹¹ In addition, Massachusetts Department of Energy Resources’ (DOER) and Massachusetts Clean Energy

⁷ *2025 Capacity, Energy, Loads, and Transmission (CELT) Report*, ISO-NE, 2025, www.iso-ne.com/system-planning/system-plans-studies/celt/, [“1.3 Summer by Fuel-Unit Class” tab].

⁸ “New England Power Grid 2024–2025 Profile,” ISO-NE, April 2025, www.iso-ne.com/static-assets/documents/100010/new-england-power-grid-regional-profile.pdf.

⁹ “2025 CELT Report” [Workbook], [“1.3 Summer by Fuel-Unit Class” tab], ISO-NE, 2025.

¹⁰ Forecasted electrification rates are based on the base portfolio from the Massachusetts *Clean Energy and Climate Plan* (CECP) 2050 “Phased” scenario. See: Mettetal, L. et al., *Charging Forward: Energy Storage in a Net Zero Commonwealth*, prepared by Energy + Environmental Economics (E3) for MassCEC and DOER, December 2023, www.mass.gov/doc/charging-forward-energy-storage-in-a-net-zero-commonwealth/download, p. 96-97.

¹¹ (1) Bergam, M. et al., “Accelerating Building Electrification in New England,” The Harvard Institute of Politics Environmental Policy Group, January 2020, https://iop.harvard.edu/sites/default/files/2023-02/IOP_Policy_Program_2020_Accelerating_Building_Electrification_in_New_England_0.pdf; (2) “Final 2024 Transportation Electrification Forecast,” ISO New England, 2024, www.iso-ne.com/static-assets/documents/100011/transfx2024_final.pdf; (3) Goldberg, D., Frost, J., Hurley, D., and Takahashi, K., *New England Electrification Load Forecast*, prepared by Synapse Energy Economics for E4TheFuture, 2020, <https://e4thefuture.org/wp-content/uploads/2020/06/New-England-Electrification-Load-Forecast.pdf>.



Center’s (MassCEC) 2023 report, *Charging Forward: Energy Storage in a Net Zero Commonwealth* (*Charging Forward* report), predicts that the New England grid will shift from a summer to a winter peaking system by 2040, due in large part to the shift to electric heating in the building sector.¹²

Table 1. Charging Forward report predicted New England electrification rates for 2030 and 2050

Sector	2030	2050
Residential Heating and Cooling	38%	92%
Commercial Heating and Cooling	14%	54%
Light-Duty Transportation	19%	97%
Medium and Heavy-Duty Transportation	10%	93%
Industrial Processes	32%	38%

Note: Residential Heating and Cooling share is the percentage of households heating with electricity, Commercial Heating and Cooling and Industrial Processes share is the percentage of service demand met with electricity, and Transportation sector shares are the percentage of vehicles that are electric.

Data source: Mettetal et al., *Charging Forward: Energy Storage in a Net Zero Commonwealth*, p. 97.

In addition to its decarbonization and electrification goals, Massachusetts has made commitments to energy and environmental equity, intended to ensure that the Commonwealth’s energy transition will not place further burdens on its most vulnerable residents. However, in a 2024 report, AEC found that this commitment has not been reflected in Massachusetts programs that facilitate the development of solar and storage resources.¹³ In particular, the Solar Massachusetts Renewable Target (SMART) program includes limited equity provisions for low-income customers that have not proved sufficient even to achieve the program’s modest low-income participation target; and ConnectedSolutions and the Clean Energy Peak Standard (CPS) lack program-specific equity provisions altogether.¹⁴

Massachusetts peak load is expected to rise to 14.6 GW in 2030 and to 24.1 by 2050

Charging Forward presents a forecast of Massachusetts peak load for 2030 and 2050 based on the electrification measures set out in the *Massachusetts Clean Energy and Climate Plan for 2050* (2050 CECP).¹⁵ From 12.3 GW in summer 2020, Massachusetts’ peak load is expected to rise to 14.6 GW in summer 2030 and to 24.1 GW by winter 2050 (see Figure 1 below).

¹² Mettetal et al., *Charging Forward: Energy Storage in a Net Zero Commonwealth*, p. 152.

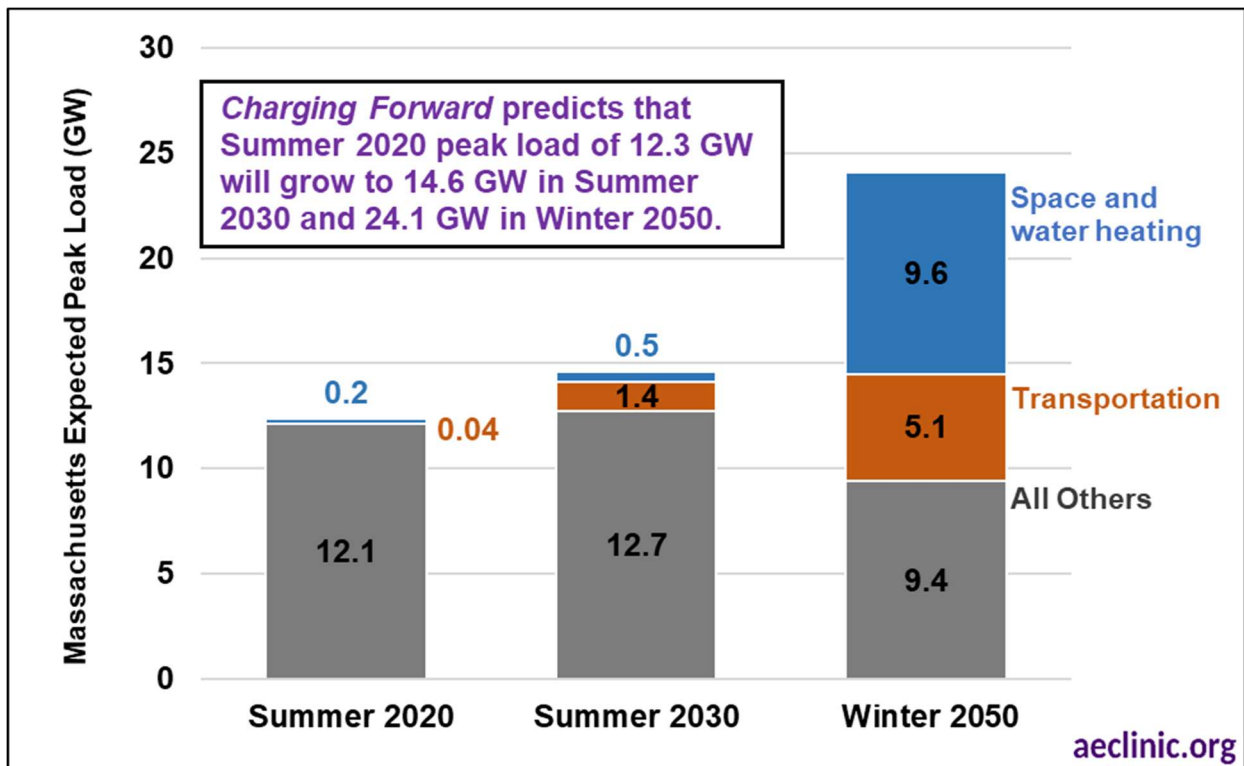
¹³ Stasio et al., *Energy Storage Equity: An Assessment of Three Massachusetts Programs*.

¹⁴ Ibid.

¹⁵ *Massachusetts Clean Energy and Climate Plan for 2025 and 2030*, Massachusetts EEA, 2022, www.mass.gov/info-details/massachusetts-clean-energy-and-climate-plan-for-2025-and-2030.



Figure 1. Charging Forward/CECP 2050 Massachusetts 2020, 2030 and 2050 peak load



Note: Charging Forward report uses 2050 CECP “Phased” scenario results, adjusted by removing electrolysis loads and associated renewable capacity to support those loads.

Data source: Mettetal et al., *Charging Forward: Energy Storage in a Net Zero Commonwealth*.

New England’s peak load is also expected to double over this same period,¹⁶ and peak electric load is expected to switch from the summer season to the winter season between 2030 and 2050 as more buildings electrify their heating systems. According to *Charging Forward*, during the winter, renewable resources like solar, offshore wind, onshore wind, and hydroelectric generators will not be sufficient to meet peak demand, leaving New England reliant on imported electricity from thermal generation (gas- and oil-fired resources). In addition, winter demand peaks are expected to last for longer periods compared to summer demand peaks, leaving limited time for storage system charging and increasing the need for long-duration energy storage (e.g., 12-hour and 100-hour storage). Long-duration storage can be dispatched for more hours to reduce peak demand over extended periods and, in turn, reduce the need for imported thermal generation. However, as of 2023, long-duration energy storage systems (apart from large-scale pumped hydro-electric storage) were not yet commercially available.¹⁷

The role of battery storage in meeting future electric demand

In addition to renewable energy like solar and wind resources, battery storage is expected to play a key role in the Commonwealth’s energy transition. Battery storage resources support renewable energy deployment by allowing excess generation to be stored and used at another time (e.g., during peak times or grid outages), thereby increasing the firm capacity value of

¹⁶ Mettetal et al., *Charging Forward: Energy Storage in a Net Zero Commonwealth*.

¹⁷ Ibid, p. 152.



variable generation and reducing the need for curtailment.¹⁸ Energy storage also offers numerous other benefits; for example, in the 2022 report *Energy Storage Benefit-Cost Analysis*, AEC identifies 25 benefits of battery storage that fall into five categories: consumer benefits, avoided system costs, environmental benefits, grid reliability, and other difficult-to-monetize benefits.¹⁹ In addition, batteries have become more affordable over time. According to *Charging Forward*, battery costs have declined from about \$700 per kilowatt-hour (kWh) in 2013 to under \$200 per kWh in 2022.²⁰

Although Massachusetts' current programs are small in scale, customer-sited (or "behind-the-meter" (BTM)) solar and storage systems have the potential to provide energy and capacity services, ancillary services, and reduce the need for additional transmission and distribution upgrades. BTM solar and storage systems can advance equity by reducing energy bills, both through potential per kWh incentives earned from Massachusetts' solar and battery storage programs and through avoided energy costs from onsite generation.²¹ Moreover, BTM solar and storage systems have the capability to provide energy during grid outages, improving reliability and resiliency for customers.²² For example, BTM solar and storage systems provide on-site access to electricity for households, buildings, and importantly, essential services (e.g., grocery stores) and emergency services (e.g., hospitals, fire and police stations) during electric grid outages or service disruptions. Lastly, expansion of renewable energy and storage in Massachusetts would reduce the need to maintain or expand fossil fuel-fired infrastructure that disparately pollutes minority and low-income areas,²³ lowering these communities' risk of adverse health outcomes.²⁴

This report, prepared by Applied Economics Clinic (AEC) on behalf of Clean Energy Group and Vote Solar, estimates the technical potential of BTM solar paired with storage to help meet Massachusetts' commitment to clean energy and environmental equity while advancing building electrification and reducing the need to maintain existing—or invest in additional—fossil fuel-fired resources. Section II provides an overview of Massachusetts' climate and energy policy landscape. Section III discusses trends in Massachusetts' BTM solar and storage resources, programs to support BTM deployment, and utilities' plans to expand BTM deployment in their service territories. Section IV reviews studies and analyses that provide estimates of BTM potential or capacity in Massachusetts. Section V estimates the technical potential of BTM solar paired with storage. Lastly, Section VI describes the barriers to expanding BTM deployment and provides policy recommendations to address these challenges and support equitable expansion of BTM deployment in the Commonwealth.

¹⁸ Mettetal et al., *Charging Forward: Energy Storage in a Net Zero Commonwealth*.

¹⁹ Woods, B.W., Peddada, S., Seliga, E., Lala, C., Tavares, E., Lewis, G., Rakotoarisoa, T., Stanton, E.A., *Energy Storage Benefit-Cost Analysis*, Applied Economics Clinic and Clean Energy States Alliance, December 2022, www.cesa.org/resource-library/resource/energy-storage-benefit-cost-analysis-a-framework-for-state-energy-programs.

²⁰ Mettetal et al., *Charging Forward: Energy Storage in a Net Zero Commonwealth*, [Figure ES-3].

²¹ Stasio et al., *Energy Storage Equity: An Assessment of Three Massachusetts Programs*.

²² *Behind-The-Meter Battery Energy Storage: Frequently Asked Questions*, NLR, August 2021, <https://docs.NLR.gov/docs/fy21osti/79393.pdf>.

²³ Jbaily, A., Zhou, X., Liu, J., Lee, T., et al., "Air pollution exposure disparities across US population and income groups," *Nature*, 601, 228-233, (2022), www.nature.com/articles/s41586-021-04190-y.

²⁴ (1) Khadke, S., Kumar, A., Al-Kindi, S., et al., "Association of Environmental Injustice and Cardiovascular Diseases and Risk Factors in the United States," *Journal of the American Heart Association*, 13(7), March 2024, <https://doi.org/10.1161/JAHA.123.033428>; (2) Beard, S., Freeman, K., Velasco, M.L. et al., "Racism as a public health issue in environmental health disparities and environmental justice: working toward solutions," *Environmental Health*, 23(8), January 2024, <https://doi.org/10.1186/s12940-024-01052-8>.



II. Massachusetts Policy Landscape

The 2008 Massachusetts *Global Warming Solutions Act* (GWSA) resulted in two required emission limits: a 25 percent reduction in statewide greenhouse gas emissions from 1990 levels by 2020; and an 80 percent reduction by 2050.²⁵ In 2021, the *Act Creating a Next-Generation Roadmap for Massachusetts Climate Policy*²⁶ strengthened Massachusetts' policy to a net-zero greenhouse gas emissions limit for 2050, with direct emissions at least 85 percent below 1990 levels.²⁷ The 2021 Act also set interim emissions reduction requirements for 2030 and 2040, and called for the Secretary of Energy and Environmental Affairs to set interim limits for 2025, 2030, 2035, 2040, and 2045.²⁸ In 2022, Massachusetts Executive Office of Energy and Environmental Affairs' (EEA's) *Determination of Statewide Greenhouse Gas Emissions Limit and Sector-Specific Sublimits for 2025 and 2030* and *Determination of Statewide Greenhouse Gas Emissions Limit and Sector-Specific Sublimits for 2050* established sector-specific greenhouse gas reduction limits for 2025, 2030 and 2050 (see Table 2Table 2).²⁹

Table 2. Massachusetts greenhouse gas emissions limits for 2025, 2030, and 2050

Sector	1990	2025 Limit		2030 Limit		2050 Limit	
	Gross Emissions (MMTCO ₂ e)	Gross Emissions (MMTCO ₂ e)	% Change from 1990	Gross Emissions (MMTCO ₂ e)	% Change from 1990	Gross Emissions (MMTCO ₂ e)	% Change from 1990
Transportation	30.2	24.9	-18%	19.8	-34%	4.1	-86%
Electric Power	28.0	13.2	-53%	8.4	-70%	2	-93%
Residential Heating and Cooling	15.3	10.8	-29%	7.8	-49%	0.8	-95%
Commercial and Industrial Heating and Cooling	14.2	9.3	-35%	7.2	-49%	1.2	-92%
Natural Gas and Distribution Service	2.3	0.4	-83%	0.4	-82%	0.5	-72%
Industrial Processes	0.7	3.6	449%	2.5	281%	0.8	27%
All Others	3.4	1	-70%	0.9	-73%	1.3	-62%
Massachusetts Statewide	94.0	63.2	-33%	47.0	-50%	14.0	-85%

Note: AEC estimated "All Others" sector values based on the Statewide emissions and emission limits. Massachusetts does not have a sector-wide greenhouse gas limit for other sectors. Data source: (1) *Determination of Statewide Greenhouse Gas Emissions Limit and Sector-Specific Sublimits for 2025 and 2030*, Massachusetts EEA, 2022; (2) *Determination of Statewide Greenhouse Gas Emissions Limit and Sector-Specific Sublimits for 2050*, Massachusetts EEA, 2022.

²⁵ *An Act Establishing the Global Warming Solutions Act*, Massachusetts General Laws Chapter 298 (2008), <https://malegislature.gov/Laws/SessionLaws/Acts/2008/Chapter298>.

²⁶ *An Act Creating a Next Generation Roadmap for Massachusetts Climate Policy*, Massachusetts General Laws Chapter 8 (2021), <https://malegislature.gov/Laws/SessionLaws/Acts/2021/Chapter8>.

²⁷ Ibid.

²⁸ Ibid.

²⁹ (1) *Determination of Statewide Greenhouse Gas Emissions Limit and Sector-Specific Sublimits for 2025 and 2030*, Massachusetts EEA, 2022, www.mass.gov/doc/2025-and-2030-ghg-emissions-limit-letter-of-determination/download; (2) *Determination of Statewide Greenhouse Gas Emissions Limit and Sector-Specific Sublimits for 2050*, Massachusetts EEA, 2022, www.mass.gov/doc/determination-letter-for-the-2050-cecp/download.



Massachusetts plans to electrify its transportation and building sectors to meet climate goals

EEA’s *Massachusetts Clean Energy and Climate Plan for 2025 and 2030* (2025/2030 CECP)³⁰ and 2050 CECP³¹ outline the strategies and actions the Commonwealth plans to use to meet its 2025, 2030 and 2050 greenhouse gas emission limits while promoting equity and reducing emissions in overburdened communities. Electrification is the main strategy identified in both the 2025/2030 CECP³² and 2050 CECP³³ for decarbonization of the Commonwealth’s transportation and residential and commercial heating and cooling sectors. As a result, the 2050 CECP predicts Massachusetts’ electric load in 2050 will be 250 percent of 2020 load and, in line with its climate commitments, the Commonwealth will need to meet 2050 electric demand with 97 percent clean and renewable resources.³⁴

Massachusetts’ Renewable Portfolio Standard (RPS), Clean Energy Standard (CES), and the CPS require growing shares of utility electric sales to be derived from clean energy sources or clean peak resources (see Table 3). The RPS and CES are not additive; resources that count for the RPS Class I also count for the CES.

Table 3. Massachusetts RPS, CES and CPS limits

Policy	Adoption Year	Measure	Cumulative Percentage (%)				
			2010	2020	2030	2040	2050
Renewable Portfolio Standard	2003	Share of retail electric sales derived from renewable energy sources	5%	15%	25%	35%	45%
Clean Energy Standard	2018	Share of retail electric sales derived from clean energy sources	-	20%	40%	60%	80%
Clean Energy Peak Standard	2018	Share of electric retail sales with clean peak certificates	-	-	25%	43%	58%

*Renewable Portfolio Standard cumulative percentages shown here correspond to Class I renewable resources only (i.e., RPS Class II obligations are not shown in the table)

** Clean Energy Standard cumulative percentages shown here correspond to CES obligations only (i.e., CES-E are not shown in the table). The RPS and CES are not additive; resources that count towards the RPS Class I requirement also count for the CES.

Data source: “Program Summaries,” Massachusetts DOER, www.mass.gov/info-details/program-summaries.

³⁰ *Massachusetts Clean Energy and Climate Plan for 2025 and 2030*.

³¹ *Massachusetts Clean Energy and Climate Plan for 2050*.

³² *Massachusetts Clean Energy and Climate Plan for 2025 and 2030*

³³ *Massachusetts Clean Energy and Climate Plan for 2050*.

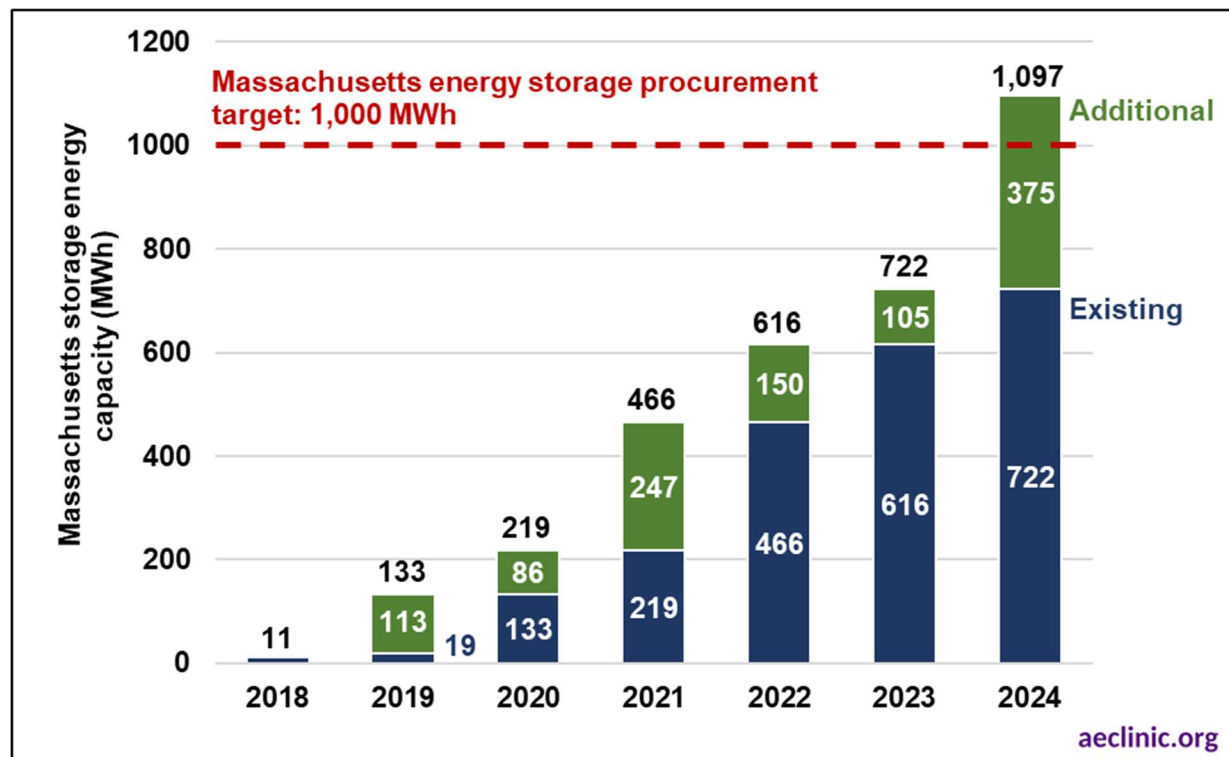
³⁴ *Ibid*, p. xiii.



Energy Storage Initiative and state-sponsored reports support the use of energy storage to serve peak electric load

Massachusetts' 2018 *Act to Advance Clean Energy*³⁵ set a 1,000 megawatt-hour (MWh) (approximately 0.25 GW³⁶) energy storage procurement target to be achieved by the end of 2025. Since 2018, Massachusetts has added 694 MWh of utility-scale energy storage (0.30 GW) and an additional 375 MWh (0.064 GW) of BTM energy storage.³⁷ According to data from the U.S. Energy Information Administration (EIA) and Massachusetts electric utilities' energy storage annual reports, the Commonwealth was home to a total of 1,097 MWh of energy storage resources in 2024, 97 MWh more than its total energy storage target for 2025 (see Figure 2).³⁸ Massachusetts' 2024 *Act Promoting a Clean Energy Grid, Advancing Equity and Protecting Ratepayers* established a 5,000 MW energy storage requirement for 2030, more than ten times current storage capacity of 460 MW.³⁹

Figure 2. Massachusetts historical storage energy capacity



Note: Form EIA-860 includes information on storage located at electric power plants with 1 MW or more of combined nameplate capacity. BTM storage is estimated using Eversource, National Grid, and Unifil annual reporting on energy storage installations; 2 percent of entries were missing information on installation type and could not be identified as BTM. Data sources: (1) Form EIA-860, U.S. EIA, 2018–2024; (2) EDC Annual Reports, Massachusetts DOER, 2018–2024.

³⁵ *An Act to Advance Clean Energy*, Massachusetts General Laws Chapter 227, Section 20 (2018), <https://malegislature.gov/Laws/SessionLaws/Acts/2018/Chapter227>.

³⁶ Approximation assuming the use of 4-hour batteries. For example, see: “Electricity Annual Technology Baseline (ATB) Data Download,” NLR, 2024, <https://atb.NLR.gov/electricity/2024/data>.

³⁷ “EDC Annual Reports,” Massachusetts DOER, 2018–2024, www.mass.gov/info-details/esi-goals-storage-target.

³⁸ “ESI Goals & Storage Target,” Massachusetts DOER, www.mass.gov/info-details/esi-goals-storage-target.

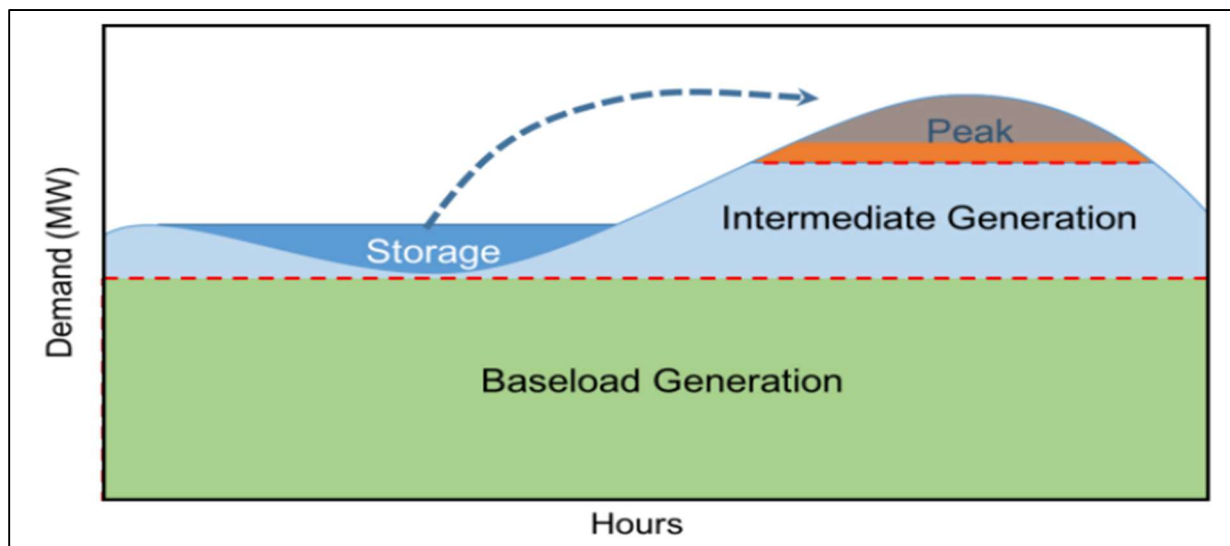
³⁹ *An Act Promoting a Clean Energy Grid, Advancing Equity and Protecting Ratepayers*, Massachusetts General Laws Chapter 239, Section 8 (2024), <https://malegislature.gov/Laws/SessionLaws/Acts/2024/Chapter239>.



Launched in May 2015, the Massachusetts Energy Storage Initiative (ESI) was established to advance storage deployment in the Commonwealth.⁴⁰ To that end, in September 2016, DOER and MassCEC published *State of Charge: Massachusetts Energy Storage Initiative*,⁴¹ a report discussing the benefits of expanding storage resources in the Commonwealth. For example, energy storage can be used to serve customer electric load during peak periods (see Figure 3 below):

“Instead of generating electricity with natural gas “peaker” plants during times of high electric and fuel prices, storage can be used to “peak shift” by using lower cost energy stored during off-peak periods to meet this demand.”⁴²

Figure 3. State of Charge illustration of energy storage using off-peak energy during peak periods



Source: Reproduced from *State of Charge: Massachusetts Energy Storage Initiative*, Figure 2-5, p. 31.

State of Charge estimated that maximum ratepayer benefits could be achieved by adding 1.8 GW of energy storage capacity in the Commonwealth by 2020, with \$986 million to \$1,355 million in capital costs outweighed by \$3.4 billion in benefits over a ten-year period. Moreover, *State of Charge* found that the additional 1.8 GW of storage capacity could result in an almost 10 percent reduction in statewide peak electric demand.⁴³ Yet, from 2015 to 2020, Massachusetts added just 0.27 GW of utility-scale storage capacity—15 percent of the *State of Charge* target.⁴⁴ The *State of Charge* report does not distinguish between utility-scale and BTM storage in its capacity estimates but estimates that 1.8 GW of storage additions provide net benefits to ratepayers, corresponding to a benefit-cost ratio of 1.7 to 2.4.⁴⁵ (This benefit-cost ratio would be higher

⁴⁰ “ESI Goals & Storage Target,” Massachusetts DOER, www.mass.gov/info-details/esi-goals-storage-target.

⁴¹ *State of Charge: Massachusetts Energy Storage Initiative*, Massachusetts DOER, September 2016, www.mass.gov/info-details/energy-storage-study.

⁴² *Ibid*, p. vii.

⁴³ *State of Charge: Massachusetts Energy Storage Initiative*, p. 77.

⁴⁴ (1) “Table 4.7.A. Net Summer Capacity of Utility Scale Units by Technology and by State, 2015 and 2014 (Megawatts),” U.S. EIA, 2015, www.eia.gov/electricity/annual/archive/2015/html/epa_04_07_a.html; (2) “Table 4.7.A. Net Summer Capacity of Utility Scale Units by Technology and by State, 2023 and 2022 (Megawatts),” U.S. EIA, 2023, www.eia.gov/electricity/annual/table.php?t=epa_04_07_a.html.

⁴⁵ *Ibid*, p. xi.

today due to lower costs of energy storage).⁴⁶

Furthermore, the benefit-cost ratio for the three-year planning period of 2025 to 2027 for Massachusetts electric utilities' ConnectedSolutions program—a Massachusetts storage program discussed in more detail in Section III below—ranged from:

- 1.4 (Eversource/Unitil) to 1.9 (National Grid) for residential customers, and
- 1.0 (Unitil) to 10.0 (Cape Light Compact) for commercial and industrial customers.⁴⁷

In a 2018 white paper, AEC staff estimate cost-effectiveness of batteries for customers in Massachusetts and found the storage benefit-cost ratios to be even higher than reported in the 2025–2027 *Three-Year Efficiency Plan*: 2.8 for single-family low-income households and 3.4 for a multifamily apartment complex.⁴⁸

III. Massachusetts BTM Resources

Utility-scale resources are large-scale front-of-the-meter energy systems that supply energy, capacity or ancillary services to the electric grid, serving utility customers throughout the region. In contrast, BTM resources are those that provide energy on-site, for example, a customer-sited rooftop solar or solar paired with a battery storage system.⁴⁹ As discussed in Section I above, BTM resources can reduce the need to expand or build new utility-scale gas-fired resources to meet increased demand from electrification.

DOER and MassCEC's 2023 *Charging Forward* report presents the base portfolio⁵⁰ from the 2050 CECP—consistent with the CECP “Phased Scenario” in which electrification of buildings is gradually phased-in—that demonstrates the need for substantial renewable energy and battery storage additions to the ISO-New England system by 2030 and 2050 to meet the Commonwealth's climate targets.⁵¹ Under all CECP scenarios, supply-side modeling is based on a set of assumptions that include the Commonwealth's compliance with its various emission reduction limits, clean energy standards, and other climate policies. CECP modeling also assumes building heating will include five percent biogas (so-called “renewable gas”) and 20 percent other biofuels in 2030.⁵² (Note: In May 2025, Massachusetts Governor Maura Healy signed the *2025 Energy Affordability, Independence, and Innovation Act*⁵³ that removes state subsidies for biomass generation and phases out the Alternative Portfolio Standard which requires increasing

⁴⁶ (1) Cole, W., and Frazier, A. W., *Cost Projections for Utility-Scale Battery Storage*, NLR, June 2019, <https://docs.NLR.gov/docs/fy19osti/73222.pdf>; (2) Cole, W., Ramasamy, V., and Turan, M., *Cost Projections for Utility-Scale Battery Storage: 2025 Update*, NLR, June 2025, <https://docs.NLR.gov/docs/fy25osti/93281.pdf>.

⁴⁷ *2025-2027 Three-Year Efficiency Plan*, Massachusetts Energy Efficiency Advisory Council, April 2025, <https://ma-eeac.org/plans-updates/>.

⁴⁸ Stanton, E.A., *Massachusetts Battery Storage Measures: Benefits and Costs*, prepared by Applied Economics Clinic for Clean Energy Group, July 2018, www.cleaneconomy.org/publication/massachusetts-battery-storage-measures-benefits-and-costs.

⁴⁹ BTM resources can also export power to the grid if configured to do so.

⁵⁰ Massachusetts' *Charging Forward*/2050 CECP base portfolio was identified using the same modeling tools as the Massachusetts *2050 Roadmap Study*. For more information, see: *Energy Pathways to Deep Decarbonization: A Technical Report of the Massachusetts 2050 Decarbonization Roadmap Study*, Massachusetts EEA, December 2020, www.mass.gov/doc/energy-pathways-for-deep-decarbonization-report/download.

⁵¹ Mettetal et al., *Charging Forward: Energy Storage in a Net Zero Commonwealth*, p. 100.

⁵² *Massachusetts Clean Energy and Climate Plan for 2025 and 2030*, [Appendix A.4], p. 6.

⁵³ *Energy Affordability, Independence, and Innovation Act*, Massachusetts House Docket No. 4707, (2025), www.mass.gov/info-details/the-energy-affordability-independence-and-innovation-act.



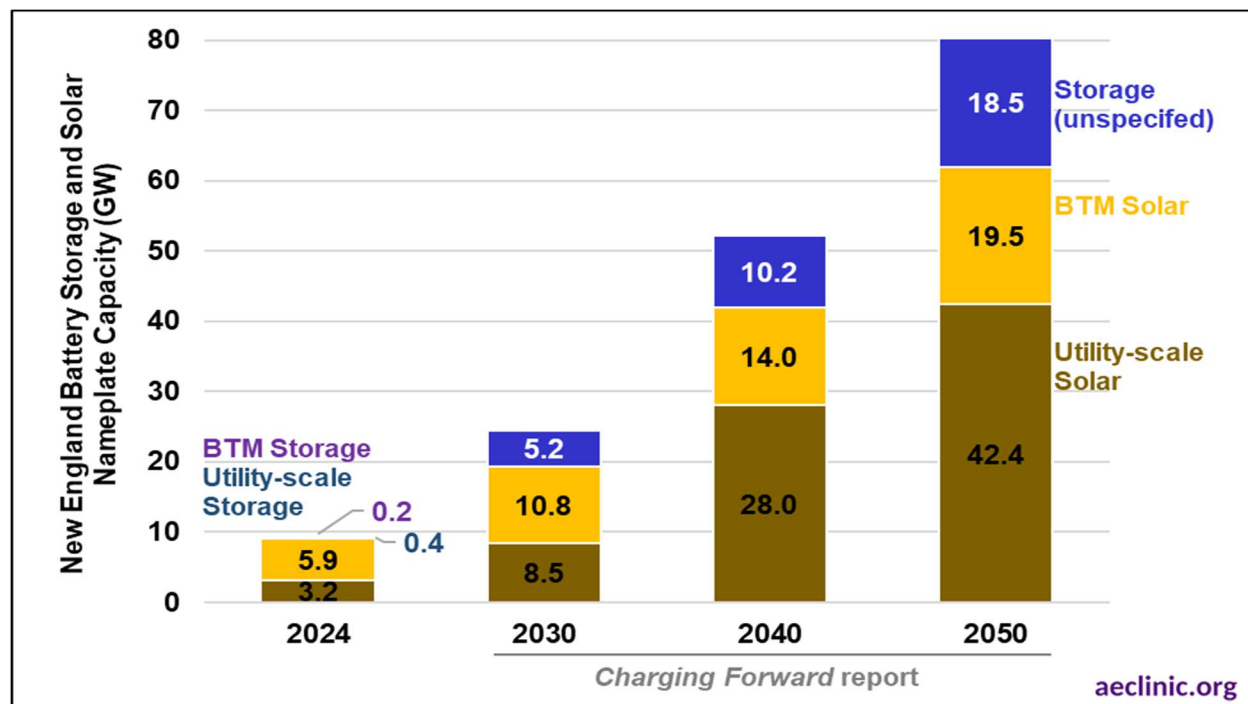
shares of annual electric sales to be attributable to alternative technologies like combined heat and power, flywheel storage, and efficient steam technologies.⁵⁴ This change may alter the Commonwealth’s use of biofuels for heating in the future.)

Modeling results presented in the 2025/2030 and 2050 CECPs, and the *Charging Forward* report are not predictions, but provide possible resource portfolio mixes that ensure the Commonwealth meets its climate targets. Under the CECP Phased Scenario, EEA projects that:

- 8.5 GW of utility-scale solar will be needed by 2030 and four times that amount (42.4 GW) by 2050;
- BTM solar will need to reach 10.8 GW in 2030, and almost double to 19.5 GW by 2050;⁵⁵ and
- New England battery storage resources will need to reach 5.2 GW in 2030, and 18.5 GW in 2050 (see Figure 4). (Neither the 2050 CECP or *Charging Forward* analyses distinguish between utility-scale and BTM storage in their scenarios of future resource portfolios.)

There are four other scenarios considered in the 2050 CECP: Clean Fuels, Hybrid, High Electrification, and Full Electrification.⁵⁶

Figure 4. ISO-New England current and Charging Forward base portfolio solar and storage capacity



Data source: (1) Form EIA-860, U.S. EIA, 2024; (2) Form EIA-861, U.S. EIA, 2023; (3) Mettetal et al., *Charging Forward: Energy Storage in a Net Zero Commonwealth*, Figure 4-9, p. 100.

⁵⁴ “Program Summaries,” Massachusetts DOER, www.mass.gov/info-details/program-summaries.

⁵⁵ Mettetal et al., *Charging Forward: Energy Storage in a Net Zero Commonwealth*, Figure 4-9.

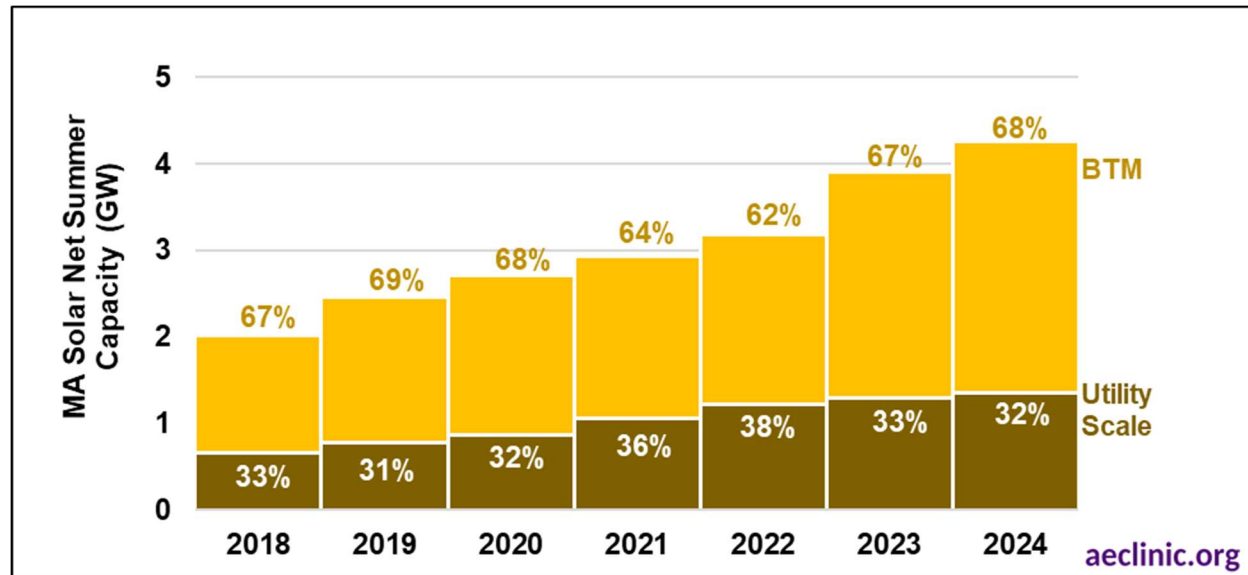
⁵⁶ *Massachusetts Clean Energy and Climate Plan for 2050*.



More than two-thirds of installed solar capacity in Massachusetts is BTM

Over the past seven years, Massachusetts’ total net summer capacity⁵⁷ for solar resources has doubled from 2 GW in 2018 to over 4 GW in 2024 (see Figure 5). Almost 70 percent of the Commonwealth’s solar resources are BTM, compared to just 34 percent of storage resources (see Figure 6 below).⁵⁸

Figure 5. Massachusetts solar net summer capacity, 2018-2024



Note: BTM values are based on “small-scale resources” defined by U.S. EIA as those with less than 1 MW of generating capacity, comprised mainly of rooftop solar. See: “STEO Between the Lines: Small-scale solar accounts for about one-third of U.S. solar power capacity,” U.S. EIA, 2023.

Data source: Electric Power Monthly, U.S. EIA, 2018-2024, Table 6.2 B, www.eia.gov/electricity/monthly.

More than one-third of installed storage capacity in Massachusetts is BTM

In 2024, according to data from U.S. EIA, 0.30 GW of Massachusetts’ battery capacity was utility-scale,⁵⁹ compared to roughly 0.16 GW of BTM battery capacity (see Figure 6 below). Massachusetts’ BTM battery storage increased by nine percent from 2023 to 2024, from 0.14 GW to 0.16 GW. Nearly all of Massachusetts’ BTM battery storage capacity is paired with BTM solar.⁶⁰ Similarly, according to 2024 data on hybrid and standalone storage plants from Lawrence Berkeley National Laboratory, 80 percent of utility-scale storage located in Massachusetts is located at solar facilities that are paired with a storage system.⁶¹

⁵⁷ Net summer capacity is the maximum capacity that can be provided by that resource during summer peak times (June 1 through September 30). See: “Net Summer Capacity,” U.S. EIA, www.eia.gov/tools/glossary/index.php?id=net%20summer%20capacity.

⁵⁸ “STEO Between the Lines: Small-scale solar accounts for about one-third of U.S. solar power capacity,” U.S. EIA, 2023, www.eia.gov/outlooks/steo/report/BTL/2023/09-smallscalesolar/article.php.

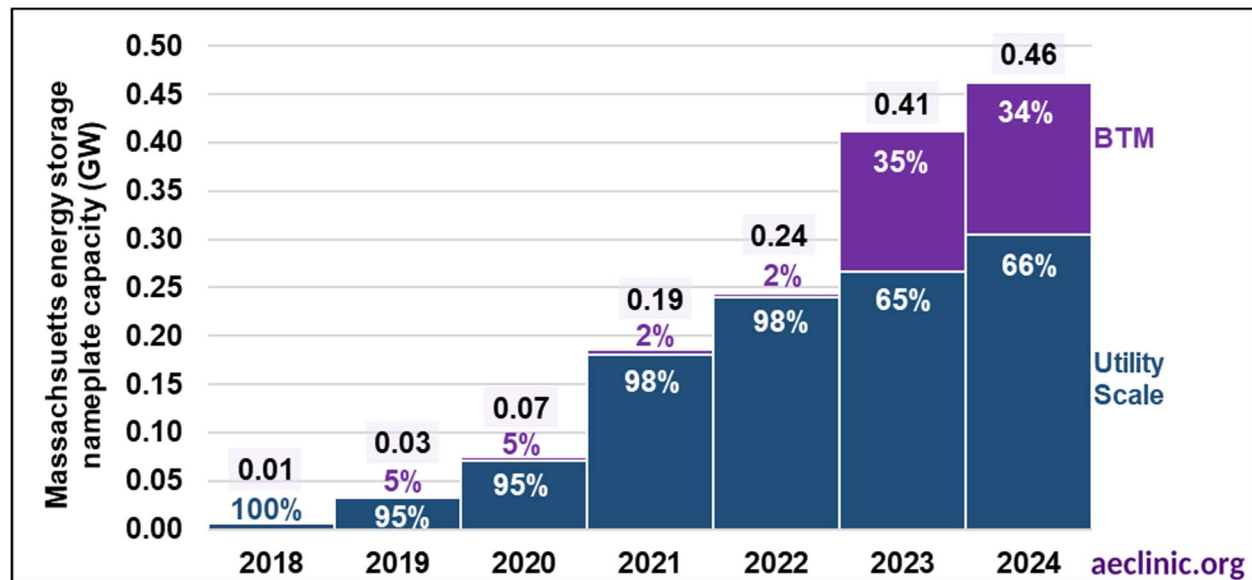
⁵⁹ Form EIA-860, U.S. EIA, 2018-2023, www.eia.gov/electricity/data/eia860/.

⁶⁰ Form EIA-861, U.S. EIA, 2024.

⁶¹ Gorman, W., Rand, J., Manderlink, N., Cheyette, A., Bolinger, M., Seel, J., Jeong, S., Wisner, R.H., *Hybrid Power Plants: Status of Operating and Proposed Plants, 2024 Edition*, Berkeley Lab, September 2024, <https://emp.lbl.gov/publications/hybrid-power-plants-status-2>.



Figure 6. Massachusetts utility-scale and BTM battery storage, 2018-2024



Data source: (1) Form EIA-860 [Generator], U.S. EIA, 2018-2024; (2) Form EIA-861 [Net Metering, Non Net Metering Distributed], U.S. EIA, 2018-2024.

BTM storage resources reduce peak load and lower electric supply costs

Deployment of BTM solar paired with storage is a key strategy for reducing peak demand while lowering emissions. By charging storage resources during low demand times and discharging them at high demand times, batteries are able to shave peak by shifting a portion of electric demand from peak hours to other times.⁶² Co-location of BTM solar and storage improves the efficiency of solar generation, allowing excess zero-emission solar generation to be stored for use at a later time,⁶³ and increases the capacity value of paired solar resources.⁶⁴ Cutting peak load by increasing the amount of paired BTM solar and storage resources in Massachusetts has the potential to both lower reliance on existing fossil fuel-fired electricity generation facilities in New England, and to reduce the need to build costly additional future utility-scale electric generating capacity needed to meet the increased peak load projected in Massachusetts’ *Clean Energy and Climate Plan for 2050 (2050 CECP)*⁶⁵ and *Charging Forward*⁶⁶ reports.

Massachusetts has launched programs to support BTM deployment

Current Massachusetts programs supporting BTM solar and BTM solar paired with storage include net metering, SMART, ConnectedSolutions, and the CPS.

Net metering: Net metering policies allow customers of Massachusetts’ regulated electric utilities (e.g., Eversource, National Grid, and Unitil) to export any excess electricity generated on-site to the grid in exchange for a net metering credit on their energy bill. In line with the 2008 Act

⁶² “Batteries perform many different functions on the power grid,” U.S. EIA, January 2018, www.eia.gov/todayinenergy/detail.php?id=34432.

⁶³ “Energy storage for electricity generation,” U.S. EIA, August 2023, www.eia.gov/energyexplained/electricity/energy-storage-for-electricity-generation.php.

⁶⁴ Hyungkwan, J., Millstein, D., Wisner, R., Mulvaney-Kemp., *Renewable-Battery Hybrid Power Plants in Congested Electricity Markets*, Berkeley Lab, October 2024, <https://emp.lbl.gov/news/new-analysis-finds-substantial-value-adding-4-hour-duration-batteries-solar-or-wind>.

⁶⁵ *Massachusetts Clean Energy and Climate Plan for 2050*.

⁶⁶ Mettetal et al., *Charging Forward: Energy Storage in a Net Zero Commonwealth*.



Relative to Green Communities,⁶⁷ Massachusetts’ net metering policy provides financial compensation to Eversource, National Grid, and Unitil customers with rooftop solar by providing credits for excess energy generated and sold back to the grid.⁶⁸ Signed into law in 2024, *An Act Promoting a Clean Energy Grid, Advancing Equity and Protecting Ratepayers* requires DPU to investigate expanding access to net metering.⁶⁹

SMART: SMART provides a dollar-per-kwh incentive for solar and solar plus storage systems (utility-scale and BTM systems are eligible). DOER launched the SMART program in 2018, replacing the Solar Carve-out Program (SREC) and Solar Carve-out II Program (SREC II) to support the Commonwealth’s climate and environmental protection targets by encouraging the development of solar technology across the state as a way to reduce peak demand, address distribution congestion and system losses, and mitigate the need for new non-renewable resources.⁷⁰ To support energy storage, the SMART program provides an energy storage adder—i.e. higher dollar-per-kWh incentive—to solar units co-located with an energy storage system.⁷¹ The value of the adder differs depending on the ratio of storage capacity to solar capacity and duration of storage.⁷²

In June 2025, Massachusetts DOER filed emergency regulations for the newest iteration of the SMART program, “SMART 3.0.”⁷³ The revised regulation (225 CMR 28.00) effective September 2025,⁷⁴ includes a few prominent changes, including variable (as opposed to fixed) annual compensation rates and capacity allotments (currently 3,200 MW).⁷⁵ In addition, the prior energy storage provisions were adjusted such that:

- Solar projects under 25 kW are no longer eligible for the energy storage adder, meaning SMART no longer supports pairing storage with most residential and small commercial solar systems. Solar projects under 25 kW are still eligible for “off-taker” based compensation rate adders (i.e., community shared, low-income property, public entity pollinator, and solar tracking adders).⁷⁶
- Solar projects with a capacity of 1 MW or greater (up from 500 kW) are required to build an energy storage system.⁷⁷

⁶⁷ *An Act Relative to Green Communities*, Massachusetts General Laws Chapter 169, (2008), <https://malegislature.gov/Laws/SessionLaws/Acts/2008/Chapter169>.

⁶⁸ 220 CMR 18.00: *Net Metering*, Massachusetts DPU (2017), www.mass.gov/files/220_cmr_18.00_final_12-1-17_1.pdf.

⁶⁹ Specifically, the policy requires DPU to “investigate expanding access to net crediting solutions for net metering facilities and solar facilities eligible to receive bill credits under any program established pursuant to section 11 of chapter 75 of the acts of 2016.” See: “Net metering laws and regulations,” Massachusetts EEA, 2025, www.mass.gov/info-details/net-metering-laws-and-regulations.

⁷⁰ 1) *Solar Massachusetts Renewable Target (SMART) Program Summary* [PowerPoint], Massachusetts DOER, 2018, www.mass.gov/doc/smart-launch-and-program-overview/download, p. 1; 2) 225 CMR 20.00: *SMART Program*, Massachusetts DOER, p. 1; (3) “Solar Carve-out and Solar Carve-out II Program Information,” Massachusetts DOER, www.mass.gov/guides/solar-carve-out-and-solar-carve-out-ii-program-information.

⁷¹ *Ibid*, p. 16.

⁷² *Solar Massachusetts Renewable Target (SMART) Program Summary* [PowerPoint], p. 10.

⁷³ “SMART 3.0 Program Details,” Massachusetts DOER, 2025, www.mass.gov/info-details/smart-30-program-details.

⁷⁴ (1) 225 CMR 28.00: *Solar Massachusetts Renewable Target (SMART) Program 3.0*, Massachusetts DOER, September 2025, www.mass.gov/doc/225-cmr-2800-redline/download; (2) “SMART 3.0 Program Details,” Massachusetts DOER, www.mass.gov/info-details/smart-30-program-details.

⁷⁵ *SMART 3.0 Regulations* [PowerPoint], Massachusetts DOER, October 2025, www.mass.gov/doc/smart-30-overview/download.

⁷⁶ 225 CMR 28.00: *Solar Massachusetts Renewable Target (SMART) Program 3.0*, Massachusetts DOER, September 2025.

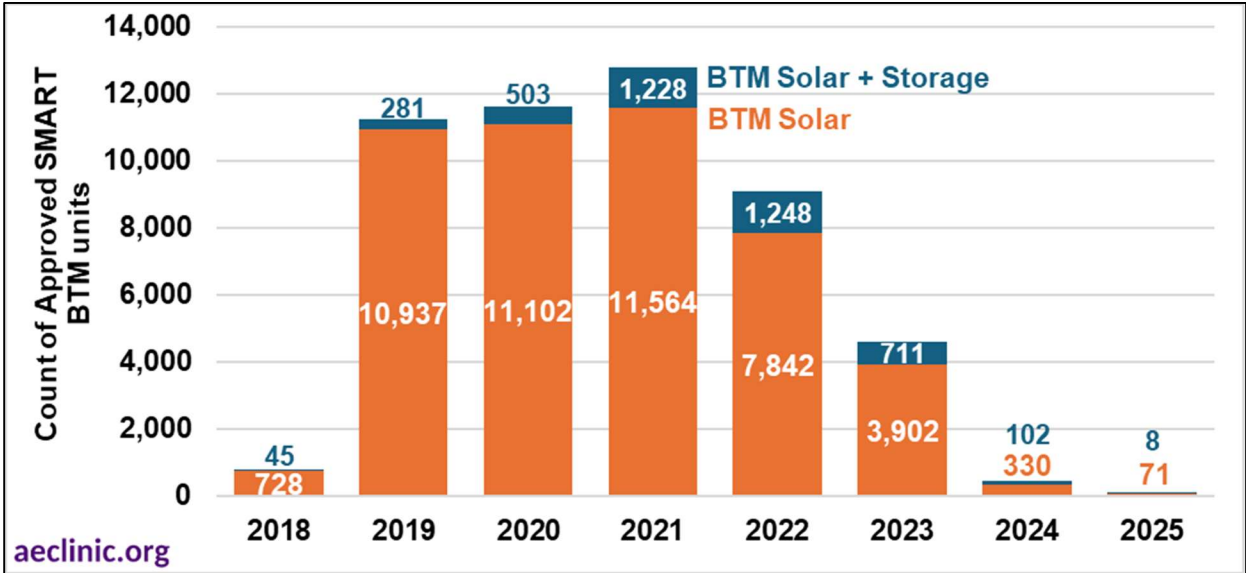
⁷⁷ *SMART 3.0 Regulations* [PowerPoint], Massachusetts DOER, October 2025.



For program year 2025, base compensation rates ranged from \$0.17 to \$0.28 per kilowatt-hour (kWh) for solar tariff generation units with a capacity ranging from 25 kW to 5,000 kW, with a fixed rate of \$0.03 per kWh for projects under 25 kW. For projects under 25 kW serving low-income customers, the compensation rate is \$0.06 per kWh.⁷⁸

From 2018 to 2025, SMART supported 4,126 BTM solar generating units that are paired with storage systems, but the majority of BTM solar units are not paired with storage (see Figure 7). Moreover, since 2021, the number of approved SMART BTM units has declined to just 79 units coming online in 2025, suggesting the incentives for participating in SMART may be insufficient.

Figure 7. Massachusetts SMART BTM solar and storage units, 2018-2024



Note: Year corresponds to commercial operation date. It is not clear why enrollment in SMART has declined substantially since 2021.

Data source: "SMART Solar Tariff Generation Units," Massachusetts DOER, January 2026, www.mass.gov/doc/smart-solar-tariff-generation-units.

ConnectedSolutions: ConnectedSolutions allows customers served by Eversource, National Grid, or Cape Light Compact to enroll BTM batteries in a virtual power plant (VPP), which electric distribution companies can draw on during peak times, and for which participating customers earn performance payments. Launched in 2019, after being demonstrated as a pilot program during the summers since 2016,⁷⁹ ConnectedSolutions is administered by Eversource, National Grid and Cape Light Compact, with the goal of lowering the cost (and associated emissions) of peak energy.⁸⁰ ConnectedSolutions offers customers incentives in exchange for allowing their electric distribution company to (1) draw on the energy stored in customer-sited batteries, (2)

⁷⁸ Solar Massachusetts Renewable Target 3.0 Annual Program Year Report: Program Year 2025, Massachusetts DOER, August 2025, www.mass.gov/doc/smart-program-year-2025-annual-report/download, PDF pp. 8-10.

⁷⁹ Woods, B., Stanton, E.A., Tavares, E., Alisalad, S., *ConnectedSolutions: A Program Assessment for Massachusetts*, Applied Economics Clinic and Clean Energy Group, September 2021, www.cleaneconomy.org/publication/connectedsolutions-assessment-for-massachusetts, p. 11.

⁸⁰ (1) Woods et al., *ConnectedSolutions: A Program Assessment for Massachusetts*, p. 8; (2) "Use your Battery Storage Device to Make the Grid More Sustainable," Mass Save, www.masssave.com/residential/rebates-and-incentives/connectedsolutions-batteries.



curtail customer energy use via smart thermostats, and (3) delay electric vehicle charging during times when demand on the electric grid is at its peak.⁸¹ In addition to ConnectedSolutions performance incentives, qualifying battery-owning customers enrolled in the program may also receive CPS incentives (see below) and the SMART program energy storage adder (see above).^{82,83}

Clean Peak Energy Standard (CPS): The Massachusetts CPS was launched in 2020, two years after the SMART program went into full effect.⁸⁴ CPS was designed to increase the use of clean energy technologies and reduce demand when electric demand is at its highest (as defined by DOER).⁸⁵ Examples of clean peak energy resources include solar and energy storage that generate, dispatch, or discharge electricity to the grid during peak periods.⁸⁶

CPS requires electric distributors to meet an increasing share of their energy sales to Massachusetts end-use customers with energy from qualified clean peak energy resources during defined periods, starting at 1.5 percent of electric sales in 2020 and increasing to 34 percent in 2034, with further increases of 1.5 percent each subsequent year, until reaching 58.0 percent in 2050.⁸⁷ Electric distributors that fail to meet CPS requirements pay an alternative compliance fee.

IV. Review of Massachusetts BTM Studies

Additional deployment of BTM solar paired with storage can reduce Massachusetts' peak demand and help the Commonwealth meet its climate goals. To estimate how much BTM solar and storage could be added in Massachusetts, AEC reviewed DOER's 2023 *Massachusetts Technical Potential of Solar*⁸⁸ (MA DOER Solar Study) that estimates the maximum possible capacity of canopy, ground-mounted, and rooftop BTM solar in the Commonwealth based on a set of physical and land-use constraints, and two scenario analyses that forecast BTM solar and include consideration of economic, market, and policy assumptions.⁸⁹ Outside of Massachusetts' CECF decarbonization pathways,⁹⁰ and limited information available in utility *Electric Sector*

⁸¹ (1) Woods et al., *ConnectedSolutions: A Program Assessment for Massachusetts*, p. 10; (2) *Program Materials for ConnectedSolutions for Small Scale Batteries*, Mass Save, 2023, www.masssave.com/-/media/Files/PDFs/Save/Residential/MA-Resi-Battery-Program-Materials---Final--5-4-2023_.pdf, p. 2.

⁸² "Use your Battery Storage Device to Make the Grid More Sustainable," Mass Save, p. 7.

⁸³ For more information about ConnectedSolutions, see CEG's ConnectedSolutions Resource Page at www.cleaneenergy.org/initiatives/energy-storage-policy-and-regulation/connectedsolutions.

⁸⁴ "Clean Peak Energy Standard History of Program Development," Massachusetts DOER, www.mass.gov/info-details/clean-peak-energy-standard-history-of-program-development.

⁸⁵ (1) *225 CMR 21.00: Clean Peak Energy Portfolio Standard (CPS)*, Massachusetts DOER, 2020, www.mass.gov/doc/225-cmr-21-clean-peak-energy-portfolio-standard-cps/download, p. 197; (2) "Clean Peak Energy Standard," Massachusetts DOER, www.mass.gov/clean-peak-energy-standard.

⁸⁶ *Clean Peak Resource Eligibility Guideline*, Massachusetts EEA, September 2021, www.mass.gov/doc/clean-peak-resource-eligibility-guideline/download.

⁸⁷ *225 CMR 21.00: Clean Peak Energy Portfolio Standard (CPS)*, Massachusetts DOER, 2020, p. 205-206.

⁸⁸ Knight et al., *Massachusetts Technical Potential of Solar*.

⁸⁹ (1) "Standard Scenarios," NLR, 2024, www.NLR.gov/analysis/standard-scenarios.html; (2) "2025 CELT Report" [Workbook], ISO-NE, May 2025, www.iso-ne.com/system-planning/system-plans-studies/celt/.

⁹⁰ *Direct Testimony of Gerhard Walker, Sophia Zhang, and Levelle Freeman*, Massachusetts DPU Docket No. 24-10, submitted on behalf of NSTAR Electric Company d/b/a Eversource Energy, January 2024, <https://fileservice.eea.comacloud.net/V3.1.0/FileService.Api/file//ibgeahij?TZLy6NV5njfEVD+5ppc4PWFJ0ioKRMXdZYr4j7i/42qk9v9pxUxyG6LkaCeWBSjgbmMINqhcSkxPf0qUr1gASPkrYE1qeivebf677PtCVStUdHoHpEGELGLGJR+ZpYgt> [Exhibit ES-Forecast 1].



Modernization Plans,⁹¹ no resource forecasts of BTM storage were found in AEC’s review of current literature.⁹²

Technical potential is the amount of a resource predicted to be available given physical and land-use constraints, for example, the square footage of available residential, commercial and industrial rooftops suitable for BTM solar. Technical potential does not consider the cost or feasibility of deployment. For example, MA DOER Solar Study provides technical potential estimates based on the physical attributes of each location.⁹³

MA DOER Solar Study report estimates 92 GW of technical potential for BTM solar on “highly suitable” ground, rooftop, and canopy locations

MA DOER Solar Study estimates that the Commonwealth’s technical potential of rooftop solar is 40 GW and the technical potential of small ground, and canopy solar are 91 GW and 14 GW, respectively, for a total technical potential for BTM solar of 145 GW (see Table 4).⁹⁴ In addition to technical potential estimates, DOER provides “highly suitable” potential estimates that include additional land constraints including: existing agriculture, biodiversity, ecosystem services, embedded carbon, electric infrastructure, and slope/aspect.⁹⁵ Massachusetts’ total “highly suitable” potential for rooftop solar and canopy solar is the same as their respective technical potential estimates, at 40 GW and 14 GW respectively.⁹⁶ In contrast, estimated “highly suitable” potential for small ground BTM solar is 39 GW, less than half its technical potential of 91 GW, lowering total “highly suitable” for BTM solar in Massachusetts to 92 GW.⁹⁷

Table 4. Massachusetts Technical Potential for Solar Study estimated BTM solar potential

Solar resource type	Technical potential (GW)	Highly suitable potential (GW)
Ground, small (< 1 MW)	91	39
Rooftop	40	40
Canopy	14	14
BTM Total	145	92
Ground, large (>= 1 MW)	359	60
MA Solar Total	506	152

Data source: Knight et al., *Massachusetts Technical Potential of Solar*, Table 1 and Table 14.

⁹¹ (1) *Electric Sector Modernization Plan*, submitted by Eversource, Massachusetts DPU 24-10, January 2024; (2) *Future Grid Plan*, submitted by National Grid, Massachusetts DPU 24-11, January 2024; (3) *Electric Sector Modernization Plan*, submitted by Unitil, Massachusetts DPU 24-12, January 2024.

⁹² The technical potential of BTM storage capacity for BTM paired systems is not typically a one-to-one solar-to-storage capacity ratio; see Section V for more information.

⁹³ Knight et al., *Massachusetts Technical Potential of Solar*.

⁹⁴ *Ibid*, Table 14.

⁹⁵ *Ibid*, p. 7.

⁹⁶ *Ibid*, Table 14.

⁹⁷ *Ibid*.



About 65 percent of Massachusetts’ “highly suitable” BTM resource potential is located on residential land or buildings, compared to just 20 percent that is sited on commercial and industrial areas (see Table 5).

Table 5. Massachusetts Technical Potential for Solar Study estimated solar “highly suitable” potential

Solar resource type	Highly Suitable Technical Potential (GW)				
	Residential - Single Family	Residential - Other	Commercial and Industrial	Other Land Use Types	MA Total
Ground, small (< 1 MW)	25	6	3	4	39
Rooftop	22	6	8	5	40
Canopy	0	1	8	5	14
BTM Total	47	14	18	13	92
BTM Share	51%	15%	20%	14%	100%
Ground, large (>= 1 MW)	10	13	10	27	60
MA Solar Total	57	26	28	41	152
MA Solar Share	38%	17%	18%	27%	100%

Data source: Knight et al., Massachusetts Technical Potential of Solar, Table 14.

ISO-NE CELT and NLR Standard Scenarios underestimate future BTM deployment in the Commonwealth

Other recent studies of BTM solar potential focus not on technical potential but on market potential, which includes consideration of technology costs, fuel prices, and state and federal policies. As of November 2025, there was 3.1 GW of BTM solar installed in Massachusetts, more than any other New England state.⁹⁸ In contrast, recent ISO-NE and NLR forecasts estimate future BTM solar capacity that is lower than 3.1 GW. ISO-NE’s annual Capacity, Energy, Loads, Transmission (CELT) reports provide 10-year projections used in power system planning and reliability studies. CELT includes forecasted BTM solar capacity in Massachusetts based on historical demand, economic and weather data, utility programs, and state initiatives.⁹⁹ ISO-NE’s 2025 CELT report forecasts 2.8 GW of BTM solar in Massachusetts by 2030 and 3.4 GW of BTM solar by 2034.¹⁰⁰ ISO-NE’s 2025 CELT report does not provide BTM battery storage capacity estimates.

NLR’s 2024 *Standard Scenarios Report: A U.S. Electricity Sector Outlook* summarizes 61 different scenarios of the U.S. electric sector, providing a wide range of forecasted solar capacity and generation estimates that consider additional factors beyond economic constraints.¹⁰¹ Under

⁹⁸ *Electric Power Monthly*, U.S. EIA, 2025, www.eia.gov/electricity/monthly, Table 6.2 B.

⁹⁹ “CELT Reports,” ISO-NE, 2025, www.iso-ne.com/system-planning/system-plans-studies/celt; (2) “Load Forecast,” ISO-NE, www.iso-ne.com/system-planning/system-forecasting/load-forecast.

¹⁰⁰ “2025 CELT Report” [Workbook], ISO-NE, May 2025, www.iso-ne.com/system-planning/system-plans-studies/celt/.

¹⁰¹ Gagnon, P., Pham, A., Cole, W., and Hamilton, A., 2024 *Standard Scenarios Report: A U.S. Electricity Sector Outlook*, NLR, 2025, <https://docs.nlr.gov/docs/fy25osti/92256.pdf>.



current policies and mid-case technology costs and fuel prices, NLR's 2024 *Standard Scenarios* model assumes central or median values for technology costs, fuel prices, electric demand growth, and assumes 2024 state and federal electric sector policies. NLR predicts Massachusetts BTM solar capacity will reach 1.1 GW in 2029 and 3.3 GW in 2050 under the mid-case, current policy scenario.¹⁰² NLR's 2024 *Standard Scenarios* report does not provide BTM battery storage capacity estimates.

Uncertain expectations limit the accuracy of all BTM estimates

BTM resource forecasts provided in the *Charging Forward*, NLR, and CELT reports are based on uncertain expectations of effective load carrying capability (ELCC) and technology costs. ELCC assumptions are typically set by electric system operators, including CAISO, ERCOT, ISO-NE, MISO, NYISO, PJM, and SPP, and play a large role in the outcomes of electric dispatch modeling exercises because they assign a share of solar, wind and storage resources' nameplate capacity that is expected to be effective in meeting peak demand and reserve requirements in a given year. All resource capacity estimates are subject to uncertain ELCC assumptions, including the analysis in the next section, and should be considered with that in mind.

System operators' current capacity credit assumptions differ dramatically by region and time period, and most operators are currently in the process of substantially revising their capacity credits mechanism.¹⁰³ For example, solar capacity credit assumptions from CAISO, ERCOT, SPP, MISO, PJM, NYISO and ISO-NE range widely from as low as 5.5 percent to as high as 90 percent.¹⁰⁴ Inconsistency across regions and frequent revisions of capacity credit methodologies and estimates result in uncertain resource capacity estimates.

Electric dispatch and resource expansion modeling also includes assumptions of the rate of advancement of solar and storage technologies that are driven by uncertain cost predictions. For example, in its 2025 *Annual Energy Outlook*, the U.S. EIA provides estimated future electric generating capacity by resource for the United States under several sensitivity scenarios, including high and low zero-carbon technology costs to account for variability in future costs for resources like solar and storage.¹⁰⁵ Like capacity credit assumptions, the wide range of possible cost scenarios adds an additional layer of uncertainty and lack of precision in resource capacity estimates.

¹⁰² "Standard Scenarios 2024," NLR, 2025, <https://scenarioviewer.nrel.gov/?project=5573be35-16d1-4bc3-8c4d-38529c7bb640&mode=download&layout=Default>.

¹⁰³ For example, (1) "Capacity Auction Reforms Key Project," ISO-NE, 2024, www.iso-ne.com/committees/key-projects/capacity-auction-reforms-key-project; (2) *Board Letter Outlining Action on Capacity Market Adjustments*, PJM, December 2024, www.pjm.com/-/media/DotCom/about-pjm/who-we-are/public-disclosures/2024/20241209-board-letter-outlining-action-on-capacity-market-adjustments-rri-and-sis.pdf.

¹⁰⁴ Capacity credit information was not available across all ISOs or all resource types. See: (1) *December 2021 Effective Load Carrying Capacity (ELCC) Report*, PJM, 2021, www.pjm.com/-/media/planning/res-adeq/elcc/elcc-report-december-2021.ashx, p. 6-9; (2) *Incremental ELCC Study for Mid-Term Reliability Procurement*, prepared for California Public Utilities Commission by Astrape Consulting and E3, 2021, www.cpuc.ca.gov/-/media/cpuc-website/divisions/energy-division/documents/integrated-resource-plan-and-long-term-procurement-plan-irp-ltpp/20210831_irp_e3_astrape_incremental_elcc_study.pdf, p.9; (3) *Duke Energy Carolinas Integrated Resource Plan*, Astrape Consulting, 2020, <https://dms.psc.sc.gov/Attachments/Matter/0ba95f94-caf4-4031-8f4c-71cd56a05d4f>, p. 48-49; (4) *Duke Energy Carolinas Integrated Resource Plan - Attachment IV*, Astrape Consulting, 2020, <https://dms.psc.sc.gov/Attachments/Matter/41d424e5-077b-4ff9-8bb3-3c31467b2638>; (5) Carden, K., 2020 *EORM Study: Storage and ELCC SAWG Presentation* [PowerPoint], prepared for Electric Reliability Council of Texas (ERCOT) by Astrape Consulting, November 2020, www.ercot.com/files/docs/2020/11/18/SAWG_Astrape_RMStudy_Storage_ELCC_11-19-2020.pdf, p.6; (6) *Solar and Wind ELCC Accreditation*, Southwest Power Pool, 2019, www.spp.org/documents/61025/elcc%20solar%20and%20wind%20accreditation.pdf, Appendices A and B.

¹⁰⁵ *Annual Energy Outlook 2025*, U.S. EIA, April 2025, www.eia.gov/outlooks/aeo/index.php.



V. Massachusetts BTM Analysis

Building electrification is one of the central decarbonization strategies presented in Massachusetts' 2025/2030 CECP¹⁰⁶ and 2050 CECP.¹⁰⁷ As a result, the 2050 CECP predicts Massachusetts' electric load in 2050 will be 250 percent of 2020 load and, in line with its clean energy commitments, the Commonwealth needs to meet 2050 electric demand with 97 percent clean and renewable resources.¹⁰⁸

Based on the “highly suitable” technical potential estimate of BTM solar from the MA DOER Solar Study¹⁰⁹ (see Table 4 above), AEC estimated the potential for paired BTM storage technical potential to reduce the increase in peak demand expected from the electrification of the Commonwealth's building and transportation sectors. AEC uses the technical BTM solar estimate provided by DOER's *Technical Potential of Solar* report instead of NLR's 2024 *Standard Scenarios* or CELT forecasted) because both models forecast Massachusetts BTM solar capacity levels that are lower than current deployment.

While potential estimates for BTM storage in Massachusetts are not available, the technical potential for BTM solar and storage systems can be estimated using storage-to-solar capacity ratios, or how much BTM storage could be paired with BTM solar under existing solar market potential estimates. In total, AEC estimates a technical potential of 92 GW BTM solar paired with 40 GW of BTM storage.

Methodology for estimating technical potential of BTM solar paired with storage in Massachusetts

Based on a review of available studies of the technical potential of BTM solar and forecasted BTM solar estimates for Massachusetts, AEC adopts DOER's technical potential BTM solar capacity (see Table 4 above) and uses these values to estimate a technical potential of Massachusetts' BTM storage to be paired with BTM solar. MA DOER Solar Study estimates 92 GW of BTM solar.¹¹⁰ Assuming a 13 percent capacity factor,¹¹¹ 92 GW of BTM solar generates about 89 terawatt-hours (TWh) of electricity per year.

AEC uses a range of storage-to-solar capacity ratios to predict a low, mid, and high level of BTM storage likely to be paired with DOER's maximum solar estimates. BTM solar and storage capacity estimates are not additive in their ability to address capacity needs at peak but rather represent solar and storage capacities in paired BTM systems. The storage capacity (multiplied by the appropriate ELCC or capacity credit) is the capacity used to address peak load; the solar capacity supports that storage but does not have a separate or additional contribution to supply at peak.

¹⁰⁶ *Massachusetts Clean Energy and Climate Plan for 2025 and 2030*.

¹⁰⁷ *Massachusetts Clean Energy and Climate Plan for 2050*.

¹⁰⁸ *Ibid*, p. 31.

¹⁰⁹ Knight et al., *Massachusetts Technical Potential of Solar*.

¹¹⁰ Knight et al., *Massachusetts Technical Potential of Solar*, Table 14.

¹¹¹ "Determination of Average Solar PV Capacity Factor (per 225 CMR 14.07(2)(e)1)" [Workbook], SREC Capacity Factor Report, Massachusetts DOER, 2022, www.masscec.com/production-tracking-system-pts.



BTM solar and storage projects, including residential and commercial and industrial systems, typically have storage-to-solar capacity ratios between 0.4 and 1.2.¹¹² AEC estimates three scenarios of paired BTM storage deployment across this range of storage -to-solar capacity ratios:

- **Low** – 0.2 storage-to-solar ratio—the amount of storage capacity installed relative to a given amount of solar capacity—based on the minimum ratio from a Berkeley Lab 2021 study of solar and storage paired systems across the United States.¹¹³ (To participate in SMART program or CPS, storage systems paired with solar must include at least 25 percent capacity of paired solar (a 0.25 storage-to-solar capacity ratio.¹¹⁴)
- **Mid** – 0.43 storage-to-solar capacity ratio; the midpoint of the low and high-capacity ratios modeled by AEC.
- **High** – 0.66 storage-to-solar capacity ratio that corresponds to a paired battery storage system with the capacity to store all solar generated electricity per AEC calculations.¹¹⁵ According to the Berkeley Lab study, about 20 percent of U.S. BTM solar and storage projects had a storage-to-solar capacity ratio of 0.6 in 2021.¹¹⁶

AEC estimates a technical potential of 40 GW BTM storage paired with 92 GW BTM solar

MA DOER Solar Study estimates 92 GW of “highly suitable” BTM solar (see Table 4 above).¹¹⁷ AEC’s estimate of BTM storage (paired with solar) technical potential ranges from 18 GW to 61 GW depending on assumptions regarding how much storage can or should be paired with a given amount of solar (see Figure 8). Using the mid storage-to-solar ratio, 40 GW of paired BTM storage potential is more than one and a half times (165 percent) Massachusetts’ projected 2050 peak demand.

¹¹² Barbose, G., Elmallah, S., and Gorman, W., *Behind-the-Meter Solar+Storage: Market Data and Trends*, prepared by Berkeley Lab for U.S. Department of Energy Solar Energy Technologies Office, 2021, https://eta-publications.lbl.gov/sites/default/files/btm_solarstorage_report_-_factsheet.pdf, Figure 2.

¹¹³ Barbose et al., *Behind-the-Meter Solar+Storage: Market Data and Trends*, Figure 2.

¹¹⁴ (1) 225 CMR 20.00: SMART Program; (2) *Clean Peak Resource Eligibility Guide*, Massachusetts DOER, September 2021, www.mass.gov/doc/clean-peak-resource-eligibility-guideline/download.

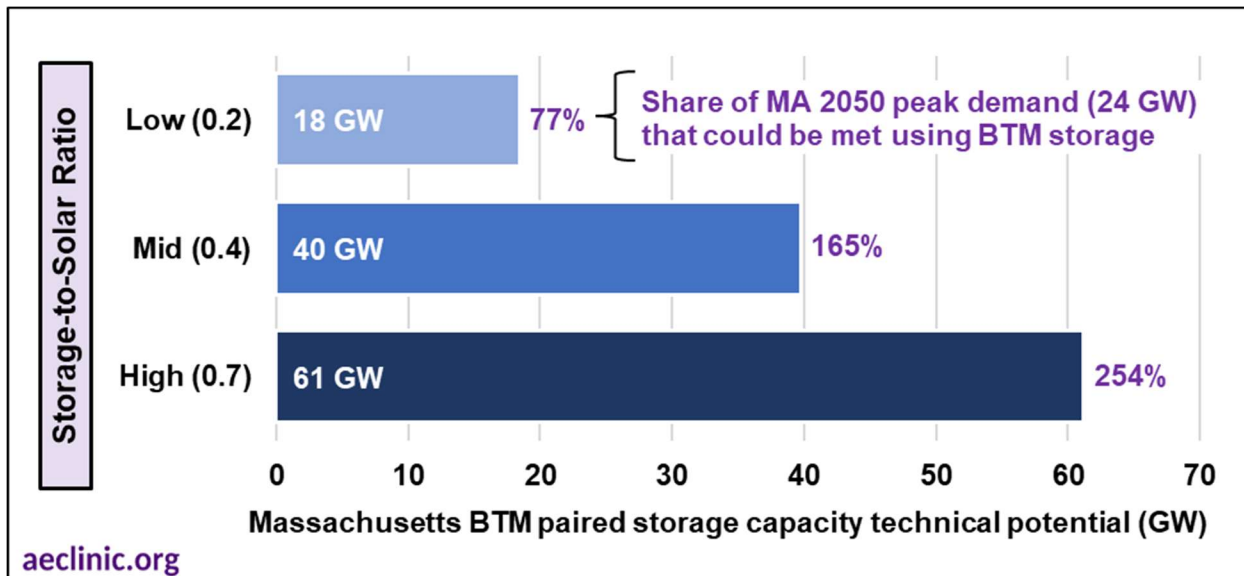
¹¹⁵ A 4-hour battery produces 4 MWh of electric generation per MW of electric capacity, with an assumed capacity factor of 16.7 percent. AEC assumes an 85 percent BTM battery roundtrip efficiency rate based on with NLR’s 2024 Electricity Annual Technology Baseline. For example, AEC multiplies 105 TWh of solar technical potential by an 0.85 roundtrip efficiency, which results in 89 TWh of stored solar generation. Multiplying this value by the number of hours in a year, 8760, and the 16.7 storage capacity factor results in an estimated 61 GW of battery storage potential.

¹¹⁶ Barbose et al., *Behind-the-Meter Solar+Storage: Market Data and Trends*, Figure 2.

¹¹⁷ Knight et al., *Massachusetts Technical Potential of Solar*, Table 14.



Figure 8. 2050 Low-, mid-, and high- estimates for technical potential of Massachusetts BTM storage



Note: BTM paired storage capacity is estimated using “highly suitable” technical potential of solar from the MA DOER Solar Study and an assumed storage-to-solar ratio of 0.43.

Data source: AEC calculation. See above for methodology.

These estimates should not be interpreted as economically or politically feasible targets; instead, technical potential estimates are an upper bound of possible BTM capacity in the Commonwealth and do not consider market conditions, costs, or policies. The purpose of these estimates is to put in perspective the substantial impact that BTM solar paired with storage could have in reducing Massachusetts’ future peak electric demand, if the Commonwealth realizes a larger fraction of its “highly suitable” technical potential. Addressing preconditions and barriers to BTM deployment, as discussed in Section VI below, can facilitate greater adoption of BTM solar paired with storage, thereby reducing the need for utility-scale polluting power generation.



VI. Recommendations for Addressing Barriers to BTM Deployment

Massachusetts' ability to invest in BTM solar plus storage is limited by several key technical considerations that could be addressed through policy changes and updates to existing programs. We identify ten preconditions or barriers to solar and storage deployment (see Table 6). For each barrier we offer a brief discussion followed by one or more recommendations.

Table 6. Barriers and pre-conditions to equitable BTM deployment in Massachusetts

Barriers to BTM deployment	Description
1 Insufficient financial incentives	The high upfront cost of BTM resource purchase and installation is out of reach for many households, especially low-income households and those that lack access to credit
2 Insufficient equity incentives and lack of equity goals and carve-outs	Low-income participation is not supported or tracked for some state-led programs and SMART has not successfully incentivized adoption at low-income properties
3 Need for electric system or building upgrades	Some buildings, particularly older buildings, may be in need of necessary electric system or building upgrades to be compatible with BTM resources
4 Workforce limitations	Solar installations are growing faster than the number of workers needed to design, install, and maintain these systems
5 Solar and storage ownership barriers and split incentives between renters, landlords, and condo owners	Renters and condo owners lack the ownership rights to install BTM resources onsite and landlords lack the incentive to cover the upfront cost of solar and storage installations, especially if utilities are paid for by the tenant
6 Program complexity and lack of coordination	Businesses and residents may not be aware of programs and tax incentives that support BTM resources
7 Lack of trust between customers and utilities and solar developers	Customers are often mistrustful of their gas and electric utilities and solar developers and may be reluctant to participate in programs
8 Interconnection and permitting issues	Permitting and interconnection of BTM resources to the electric grid can be a difficult and time-consuming process for both customers and utilities
9 Lack of solar panel and battery recycling and disposal options	Recycling processes for silicon and cadmium telluride PV modules and lithium-ion batteries are available in the United States but expensive.
10 Lack of internet access to learn about, or participate in, solar and storage programs	Over 110,000 Massachusetts households lack access to the internet where most information on programs is available



Barrier: Insufficient financial incentives

The high upfront cost of BTM solar and storage systems—including the system itself coupled with installation and interconnection costs—is out of reach for many households, especially low-income households or those that lack access to credit. Existing BTM solar and storage programs provide performance-based incentive payments (either through a rebate or on-bill credit) but do not reduce the upfront cost of these systems for customers. As of late 2025, the average cost of a 5-kW solar panel installation in Massachusetts was \$15,510, and the average price for storage was \$1,690 per kWh, or \$21,970 for a 13 kWh storage system.¹¹⁸ Massachusetts’ solar tax credit reduces this cost by 15 percent of the price paid (up to \$1,000).¹¹⁹ This leaves customers responsible for at least 85 percent of upfront costs of solar and 100 percent of upfront costs of storage, a significant financial barrier to BTM resource installations for some customers, particularly low-income households, customers who lack access to credit, and households that have net zero or positive tax outcomes (i.e., customers that do not owe taxes in a given year are unable to take advantage of tax credits available for BTM solar and storage installations).

Massachusetts’ SMART program provides incentive payments based on the amount of solar energy produced, with an energy storage adder, but does not provide support to cover the cost of installation,¹²⁰ and the recent SMART program revision removed the storage adder for solar systems of 25 kW or less altogether, meaning residential and small commercial systems are no longer incentivized for paired storage through SMART.¹²¹ Additionally, under some circumstances, customers might receive no incentive payment at all; for example, in 2023, higher electricity rates and the declining incentive rate structure resulted in some SMART program customers receiving no solar incentive payment.¹²²

Almost all (98.4 percent) of SMART-approved solar generating units are BTM units with just 8.1 percent of those BTM solar units paired with battery storage.¹²³ Similarly, Mass Save’s ConnectedSolutions program provides performance payments to customers with batteries that lower or shift energy usage during peak times, but does not support the upfront cost of installing BTM storage.¹²⁴ (A proposed program revision will add additional incentives for locational grid

¹¹⁸ (1) “The cost of solar panels in Massachusetts (2025),” EnergySage, November 2025, www.energysage.com/local-data/solar-panel-cost/ma/; 2) “How much do storage systems cost in Massachusetts in 2025?” EnergySage, December 2024, www.energysage.com/local-data/energy-storage-cost/ma/.

¹¹⁹ 830 CMR 62.6.1: Residential Energy Credit, Massachusetts Department of Revenue, 2016, www.mass.gov/regulations/830-CMR-6261-residential-energy-credit.

¹²⁰ “Solar Massachusetts Renewable Target (SMART),” Massachusetts DOER, www.mass.gov/solar-massachusetts-renewable-target-smart

¹²¹ 225 CMR 28.00: SOLAR MASSACHUSETTS RENEWABLE TARGET (SMART) PROGRAM 3.0, Massachusetts DOER, www.mass.gov/doc/225-cmr-2800-1/download.

¹²² “MA SMART Solar Incentive Program regulations govern the calculation of incentive rates for typical residential projects (small Behind-the-Meter). This calculation includes the base compensation rate set by the project’s block allocation, adds any project adders, and then subtracts the Value of Energy (distribution kWh charge + transmission kWh charge + transition kWh charge + three-year average of basic service kWh charge). The SMART program is designed so that base compensation rates decline as blocks are filled and retired.” See: *Declining Incentive Rates and Billing/SMART Incentive Payment Effects*, Massachusetts DOER, 2023, www.mass.gov/doc/declining-smart-incentive-rates/download.

¹²³ “SMART Solar Tariff Generation Units” [Workbook], Massachusetts DOER, January 2026.

¹²⁴ Battery Storage,” Mass Save, www.masssave.com/en/residential/rebates-and-incentives/battery-storage-and-eps/batteries.



services, but this revision had not been implemented at the time of this report’s publication.¹²⁵) CPS and Net Metering can also provide performance payments but do not help with the upfront costs of BTM solar and storage systems. (Note: The Mass Save HEAT Loan provides zero percent interest loans up to \$25,000 to residential customers purchasing batteries to be enrolled in ConnectedSolutions, but does not support solar installations, and cannot be accessed by customers served by municipal light plants.¹²⁶)

Expanding the SMART, CPS, and ConnectedSolutions program budgets to include up-front financial incentives for low-income households will improve affordability of solar and storage installations while supporting the Commonwealth in achieving its clean energy and storage goals.

Recommendations:

- A. Set statewide BTM solar and BTM solar paired with storage capacity targets for 2030 and 2050 that are commensurate with 2025/2030 CECP and 2050 CECP goals.
- B. Expand SMART, CPS, and ConnectedSolutions program budgets commensurate with new BTM deployment targets, including up-front financial incentives for low-income households.
- C. Restore the SMART storage adder for solar <25 kW to support residential and small commercial BTM solar paired with storage.

Barrier: Insufficient equity incentives and lack of equity goals and carve-outs

Massachusetts EEA’s 2025/2030 CECP presents the Commonwealth’s plans to achieve its emissions reduction goals for 2025 and 2030, including “strategies to promote equity and reduce emissions in overburdened EJ communities.”¹²⁷ In Massachusetts, EJ neighborhoods are defined by EEA as U.S. census block groups¹²⁸ in which:

- Annual median household income is 65 percent or less of the statewide annual median income (\$99,858 in 2023¹²⁹); **or**,
- At least 40 percent of the population is Black, Indigenous, or people of color (BIPOC); **or**,
- At least 25 percent of households identify as limited English-speaking; **or**,
- At least 25 percent of the population is BIPOC and the median household income of the municipality housing the block group is less than or equal to 150 percent of the statewide

¹²⁵ “ConnectedSolutions: What’s New in 2026,” Mass Save, March 2026, www.youtube.com/watch?v=rRUvh4dblsM.

¹²⁶ “0% Interest Financing,” Mass Save, www.masssave.com/residential/programs-and-services/financing.

¹²⁷ *Massachusetts Clean Energy and Climate Plan for 2025 and 2030*, Massachusetts Executive Office of Energy and Environmental Affairs, 2022, www.mass.gov/doc/clean-energy-and-climate-plan-for-2025-and-2030/download, p. 2.

¹²⁸ The U.S. Census Bureau defines census block groups as divisions of census tract areas containing between 600 and 3,000 people, see: “Glossary,” U.S. Census Bureau, www.census.gov/programs-surveys/geography/about/glossary.html.

¹²⁹ *ACS 5-Year Estimates* [Table ID: B19013], U.S. Census Bureau, 2023, [https://data.census.gov/table/ACSDT5Y2023.B19013?q=B19013:+Median+Household+Income+in+the+Past+12+Months+\(in+2023+Inflation-Adjusted+Dollars\)&g=040XX00US25&moe=false](https://data.census.gov/table/ACSDT5Y2023.B19013?q=B19013:+Median+Household+Income+in+the+Past+12+Months+(in+2023+Inflation-Adjusted+Dollars)&g=040XX00US25&moe=false).



annual median household income.¹³⁰

The 2025/2030 CECP also lays out a commitment to equity that emphasizes the importance that “all Massachusetts residents can fully access and participate in the transition to a low-carbon economy” and that “differences in income-level, location, English proficiency, and previous marginalization” must not prevent anyone from participating in the benefits created by a new, low-carbon economy.¹³¹ Nonetheless AEC’s 2024 report on the Commonwealth’s energy storage programs documents SMART, CPS, and ConnectedSolutions programs’ lack of equity provisions necessary to align with this commitment.¹³²

Neither CPS nor ConnectedSolutions include targeted financial incentives, goals, or requirements to support deployment of storage resources in low income or EJ neighborhoods. In addition, while SMART 3.0 includes a 10 percent set-aside of program year capacity for low-income property generation units and a 15 percent set-aside for community shared solar generation units, there is no budget carveout to ensure there are funds allocated to achieving these targets.¹³³

As a result, SMART has never come close to reaching its equity participation goals; Just 0.1 percent of SMART BTM units brought online from 2018 through 2025 were low-income units, with just one low-income BTM unit paired with storage, suggesting that the per kWh adder is not sufficient to incentivize low-income BTM adoption.¹³⁴ For context, over 47 percent of Massachusetts block groups are designated as EJ neighborhoods (including low-income areas) according to the 2022 EJ map update.¹³⁵ For more detailed discussion and recommendations on improving equity participation in Massachusetts solar and storage programs, see the companion to this report, *Electrification with Equity, Part 2: Scaling Behind-the-Meter Solar and Storage in Massachusetts Environmental Justice Neighborhoods*,¹³⁶ as well as the 2024 report, *Energy Storage Equity: An Assessment of Three Massachusetts Programs*.¹³⁷

The following recommendations build upon SMART 3.0’s new requirements for community solar programs to serve low-income households at meaningful levels with requisite support.

Recommendations:

- A. Establish a 50 percent EJ participation target for statewide programs. EJ participation rates should be available publicly and reviewed annually with incentive rates adjusted accordingly.

¹³⁰ “Environmental Justice Populations in Massachusetts,” Massachusetts Office of Environmental Justice & Equity, www.mass.gov/info-details/environmental-justice-populations-in-massachusetts.

¹³¹ Ibid, p.11.

¹³² Stasio et al., *Energy Storage Equity: An Assessment of Three Massachusetts Programs*.

¹³³ 225 CMR 28.00: Solar Massachusetts Renewable Target (SMART) Program 3.0, Massachusetts DOER, 2025, www.mass.gov/regulations/225-CMR-2800-solar-massachusetts-renewable-target-smart-program-30.

¹³⁴ “SMART Solar Tariff Generation Units,” Massachusetts DOER, January 2025, www.mass.gov/doc/smart-solar-tariff-generation-units.

¹³⁵ *Environmental Justice Maps Update 2022: Frequently Asked Questions*, Massachusetts EEA, 2022, www.mass.gov/doc/environmental-justice-maps-update-2022-frequently-asked-questions/download.

¹³⁶ Stasio et al., *Electrification with Equity, Part 2: Scaling Behind-the-Meter Solar and Storage in Massachusetts Environmental Justice Neighborhoods*.

¹³⁷ Stasio et al., *Energy Storage Equity: An Assessment of Three Massachusetts Programs*.



- B. Implement statewide program budget carve-outs for EJ neighborhoods to ensure financial assistance is available to areas that need it most.
- C. Increase or add low-income incentive adders within existing programs to be adjusted annually if participation targets are not being met.
- D. Develop an online tracking tool to enable residents and businesses to stay up to date on clean energy program participation for low-income and/or EJ neighborhoods and to identify municipalities with lower participation rates.
- E. Require Massachusetts utilities' *Electric Sector Modernization Plans* to include strategies employed to achieve participation targets.
- F. Amend the existing Massachusetts Residential Energy Tax Credit to 1) increase the maximum credit cap for low-income households and 2) establish an additional credit adder for solar paired with storage.

Barrier: Need for electric system or building upgrades

Some buildings, especially older ones, may need electric system or building upgrades to be compatible with BTM resources.¹³⁸ For example, roof load limitations may require structural reinforcement that will increase up-front costs for rooftop solar. This limitation is especially relevant for older buildings that may have experienced a decline in the load-bearing capacity of their roofs over time.¹³⁹ In addition, upgraded electric service panels may be required to bring a building up to code before installing BTM energy resources on-site. Federal tax credits and rebates are available through the Inflation Reduction Act to assist with upgrading residential electric services¹⁴⁰ but the up-front cost for the average 2,000 square foot home is still high (\$3,500 before incentives, down to \$2,900 after incentives).¹⁴¹ (Note: Previous federal tax credits available for energy efficiency home improvements ended on December 31, 2025 under the *One Big Beautiful Bill Act*.¹⁴²)

Older buildings may require additional upgrades to be compatible with BTM resource installations, as they often contain asbestos, lead, and mold which can make home repairs more complicated and result in additional costs to the owner,¹⁴³ making it more costly and time consuming for those living in older homes to prepare their homes for BTM installations. In Massachusetts, 46 percent of homes were built before 1960, with just 15 percent of homes built

¹³⁸ Watson, A., Giudice, L., Lisell, L., Doris, L., Busche, S., *Solar Ready: An Overview of Implementation Practices*, NLR, January 2012, www.NLR.gov/docs/fy12osti/51296.pdf.

¹³⁹ See for example: Fok, R., "What solar installers should know about roof load capacity," Nova Mounting, July 2024, <https://novamounting.com/blog/what-solar-installers-should-know-about-roof-load-capacity/>.

¹⁴⁰ (1) "Home energy tax credits," U.S. Internal Revenue Service, 2023, www.irs.gov/credits-deductions/home-energy-tax-credits; (2) *Inflation Reduction Act of 2022*, U.S.C. 11-169, (2022), www.congress.gov/bill/117th-congress/house-bill/5376.

¹⁴¹ "Electrical Service Upgrade," Mass Save, <https://goclean.masscec.com/clean-energy-solutions/electrical-service-upgrade/>.

¹⁴² *One Big Beautiful Bill Act*, 119th Congress (2025-2026), www.congress.gov/bill/119th-congress/house-bill/1.

¹⁴³ (1) Daigle, J., Jungers, B., *Enhancing the Customer Experience of Upgrading an Electric Service Panel*, Building Decarbonization Coalition, 2023, <https://buildingdecarb.org/wp-content/uploads/BDC-Panel-Upgrade-Report.pdf>; (2) Heeter, J., Sekar, A., Fekete, E., Shah, M., Cook, J.J., *Affordable and Accessible Solar for All: Barriers, Solutions, and On-Site Adoption Potential*, NLR, 2021, www.NLR.gov/docs/fy21osti/80532.pdf.



in 2000 or later.¹⁴⁴ Moreover, low-income families are more likely to live in older homes needing costly electric system upgrades.¹⁴⁵

For new construction, Massachusetts has three levels of building codes: the Base Code (required for all municipalities), Stretch Code (municipality opt-in), and Specialized Code (municipality opt-in).¹⁴⁶ Amending the Stretch and Specialized codes to include solar paired with storage provisions and overall electrification readiness would better align the stretch code policy with the Commonwealth’s decarbonization strategies. Currently, the residential and commercial Stretch code and Specialized opt-in code include solar ready provisions but lack language for solar paired with storage readiness in new construction.¹⁴⁷ The Commonwealth should ensure that funding is available to support this program so that municipalities are not responsible for bearing the brunt of the costs.

Recommendations:

- A. Provide financial incentives for electric system building upgrades on low-income properties
- B. Amend the Stretch and Specialized codes for new construction to include BTM solar and storage readiness

Barrier: Workforce limitations

Solar installations are growing faster than the number of qualified workers needed to design, install, and maintain these systems.¹⁴⁸ According to the Interstate Renewable Energy Council, U.S. solar jobs grew by 6.8 percent from 2022 to 2023, while solar installations grew by 76 percent.¹⁴⁹ In 2023, Massachusetts had:

- 11,674 jobs in the solar industry, a 5.9 percent increase from 2022 jobs, and
- 5,087 jobs in energy storage, a 1.5 percent increase from 2022 jobs (putting Massachusetts fourth on the list of states with the highest number of clean energy jobs behind California (18,062), Nevada (9,181), and Texas (8,519)).¹⁵⁰

¹⁴⁴ American Community Survey: Physical Housing Characteristics for Occupied Housing Units, [Table ID: S2504], U.S. Census, 2023,

<https://data.census.gov/table/ACSST1Y2023.S2504?q=S2504:%20Physical%20Housing%20Characteristics%20for%20Occupied%20Housing%20Units&g=040XX00US25>.

¹⁴⁵ Heeter, J., Sekar, A., Fekete, E., Shah, M., Cook, J.J., *Affordable and Accessible Solar for All: Barriers, Solutions, and On-Site Adoption Potential*, NLR, 2021, www.NLR.gov/docs/fy21osti/80532.pdf.

¹⁴⁶ “2025 Massachusetts Building Energy Codes,” Massachusetts DOER, 2025, www.mass.gov/info-details/2025-massachusetts-building-energy-codes.

¹⁴⁷ (1) *MA 2025 Residential Stretch code and Specialized Opt-in code (IECC2021 with MA amendments)*, Massachusetts DOER, December 2024, www.mass.gov/doc/stretch-specialized-code-residential/download; (2) *MA 2025 Commercial Stretch code and Specialized Opt-in code (IECC2021 with MA amendments)*, Massachusetts DOER, December 2024, www.mass.gov/doc/stretch-specialized-code-commercial/download.

¹⁴⁸ “Workforce Challenges Impact the Solar Industry’s Bright Future,” *Engineering News Record*, November 2024, www.enr.com/articles/59655-workforce-challenges-impact-the-solar-industrys-bright-future.

¹⁴⁹ *14th Annual National Solar Jobs Census 2023*. Interstate Renewable Energy Council (IREC), September 2024, <https://irecusa.org/census-solar-job-trends/>.

¹⁵⁰ (1) “Massachusetts Solar and Clean Energy Jobs,” IREC, 2024, <https://irecusa.org/massachusetts-solar-and-clean-energy-jobs/>; (2) “Jobs in Battery Storage,” IREC, 2024, <https://irecusa.org/census-jobs-in-other-clean-energy-industries/>.



Employers in the clean energy technologies field cite the lack of experience, training, or technical skills as the most common reason for hiring difficulties across all segments of the industry, including electric power generation, transmission, distribution, and storage, and energy efficiency.¹⁵¹ In a 2023 assessment, MassCEC found that lack of information about clean energy careers was a major barrier to workforce development in the area, particularly amongst women and Black populations.¹⁵²

From 2019 to 2022, Massachusetts' total number of employees in the solar photovoltaic installers occupation increased from 330 employees to 950 employees.¹⁵³ But from 2022 to 2023, the number of solar photovoltaic installers fell to 700 employees. In 2023, the median annual wage for these employees was \$50,990,¹⁵⁴ less than the Massachusetts median earnings of \$54,953.¹⁵⁵

Existing workforce training offerings could be strengthened by assessing workforce trends in the context of EJ neighborhoods to identify areas where training is most needed and ensure these areas are benefiting from existing state offerings. In particular, the study should investigate how training efforts could be expanded to see trainees through to gain employment in the clean energy industry. For example, participants in Illinois' *Climate and Equitable Jobs Act* workforce training programs are connected to clean energy employers looking to hire staff or apprentices.¹⁵⁶

Recommendations:

- A. Assess workforce trends and identify opportunities for expanding existing workforce training programs, including follow-through measures to help trainees to secure employment in the field.

Barrier: Solar and storage ownership barriers and split incentives for renters, landlords, and condominium owners

There are two main challenges to BTM adoption for households living in rental units or condos: ownership barriers and split incentives.

- **Ownership barriers:** Renters and condo owners lack the ownership rights to install BTM energy resources, either because they do not own their home (in the case of rental properties) or because some part of the structure is jointly owned (in the case of condominiums with shared walls or roofs).

¹⁵¹ (1) *United States Energy & Employment Report 2024*, U.S. DOE, 2024, www.energy.gov/sites/default/files/2024-10/USEER%202024_COMPLETE_1002.pdf; (2) "Workforce Development," IREC, 2024, <https://irecusa.org/census-workforce-development/>.

¹⁵² *Powering the Future: A Massachusetts Clean Energy Workforce Needs Assessment*, MassCEC, July 2023, www.masscec.com/sites/default/files/documents/powering_the_future_a_massachusetts_clean_energy_workforce_needs_assessment_final.pdf

¹⁵³ "Occupational Employment and Wage Statistics (OEWS) Tables" [Workbook], U.S. BLS, May 2019 - 2023, www.bls.gov/oes/tables.htm.

¹⁵⁴ "Occupational Employment and Wage Statistics (OEWS) Tables" [Workbook], U.S. BLS, May 2023.

¹⁵⁵ "Earnings in the Past 12 Months" [Table ID: S2001], U.S. Census, 2023, <https://data.census.gov/table/ACSST1Y2023.S1903?q=median%20income&g=040XX00US25>.

¹⁵⁶ *DCEO CEJA Programs*, Illinois Department of Commerce and Economic Opportunity, 2024, https://ilworkforceacademy.com/wp-content/uploads/2024/10/climate_and_equitable_jobs_act_a_model_for_equitable_workforce_training.pdf.



- **Split incentives:** Building owners who are not responsible for their tenants' energy costs have no economic incentive to make clean energy investments on their properties, because such upgrades would not directly benefit them.¹⁵⁷

Together, these barriers affect nearly half of all residential units in Massachusetts. In 2023, 37 percent of Massachusetts' units were rented, and an additional 10 percent of housing units were owner-occupied units in buildings with two or more apartments.¹⁵⁸

Community solar and storage resources provide one pathway to improve clean energy resource access for households and businesses that are unable to access BTM solar or storage due to physical or financial reasons. Massachusetts should increase available funds dedicated to community solar deployment in, and for, EJ neighborhoods in concert with the new SMART 3.0 requirements; and the Commonwealth should invest in educational materials, available in multiple languages and formats (handouts, websites, email, etc.), to educate local community organizations and other entities on how to invest in community solar and storage, the benefits of these systems, and what financial incentives exist for Massachusetts residents and businesses. Local events to present these materials in EJ neighborhoods will encourage more equitable adoption of community solar and storage while increasing overall awareness of the Commonwealth's offerings.

SMART provides incentives for community solar adoption, but low-income community shared units make up the minority of community shared systems participating in SMART. The SMART program provides additional per kWh bill savings that are added onto the base compensation rate for participants that meet certain criteria, including for community-shared (\$0.07 per kWh of additional bill savings) and low-income community-shared (\$0.04 per kWh of additional bill savings) solar tariff generating units.¹⁵⁹ (For context, the base compensation rate for a National Grid customer with a SMART generating unit greater than 25 kW ranges from \$0.17 to \$0.28 per kWh.¹⁶⁰) From 2018 to 2025, SMART supported 51,500 solar generating units, just 1 percent of which are community-shared or low-income community shared units (see Figure 9). Since 2019, the number of SMART program community shared units coming online each year has fallen, from 93 in 2021 down to just 35 and 10 in 2024 and 2025 respectively.

If approved by the Massachusetts DPU, the proposed SMART 3.0 program revision will require that all participating community solar projects serve at least 40% low-income households. This would constitute a significant change in how community projects are developed and who benefits from them.

¹⁵⁷ Thoubboron, K., "Community solar pros and cons: An overview," Energy Sage, 2023, www.energysage.com/community-solar/pros-and-cons-of-community-solar/.

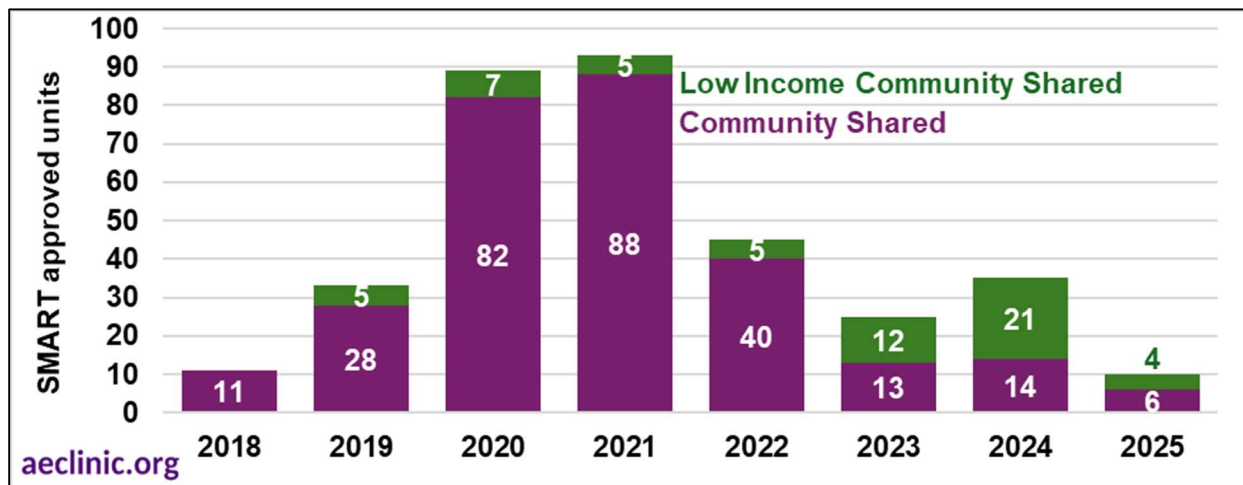
¹⁵⁸ "American Community Survey: Physical Housing Characteristics for Occupied Housing Units" [Table ID: S2504], U.S. Census Bureau, 2023, <https://data.census.gov/table/ACSST5Y2023.S2504?q=S2504:%20Physical%20Housing%20Characteristics%20for%20Occupied%20Housing%20Units&g=040XX00US25&moe=false>.

¹⁵⁹ *Solar Massachusetts Renewable Target 3.0 Annual Program Year Report: Program Year 2025*, Massachusetts DOER, August 2025, www.mass.gov/doc/smart-program-year-2025-annual-report/download, p. 9.

¹⁶⁰ *Ibid*, p. 8.



Figure 9. SMART community solar generating units



Note: Year corresponds to commercial operation date.

Data source: “SMART Solar Tariff Generation Units,” Massachusetts DOER, January 2026, www.mass.gov/doc/smart-solar-tariff-generation-units.

Recommendations:

- A. Investigate incentive mechanisms for multifamily building owners.
- B. Expand budget to support BTM community solar and storage, including budgeting for educational materials and outreach.

Barrier: Program complexity and lack of coordination

Massachusetts energy programs are not offered to customers in a coordinated manner; customers seeking to participate in clean energy, energy efficiency, and electrification programs must sign up for each of these programs separately, making program enrollment inefficient. Furthermore, these programs are separately administered, often by different entities, operate independently, and often interact inefficiently.

An example of a less siloed, better optimized program is the Cape and Vineyard Electrification Offering (CVEO) offered by Cape Light Compact from 2023 to 2025. CVEO offered lower income residential customers a combined suite of clean energy upgrades including heat pumps, solar, and storage systems. Moreover, the program automatically enrolled participating homes in the ConnectedSolutions program, streamlining program enrollment.¹⁶¹

Recommendations:

- A. Integrate and coordinate across state energy programs to improve the ease of enrollment, increase participation, and streamline customer outreach and education. Programs should be offered as a package whereby customers could sign up for energy efficiency upgrades, electrify their home or commercial building, and sign up for SMART, CPS, and/or ConnectedSolutions at the same time. Program implementation should be coordinated for cost-effectiveness and optimum efficiency across programs.

¹⁶¹ Tym, O., *Solar+Storage+Electrification: A Clean Energy Equity Model for Massachusetts*, Clean Energy Group, March 2025, www.cleanegroup.org/publication/solar-storage-electrification-cveo-massachusetts/.



- B. Require Massachusetts utilities to provide information on the suite of available financial incentives to customers with their monthly bills, and send reminders to customers with existing BTM solar or storage to enroll in eligible programs
- C. Replicate CVEO as a statewide offering through ConnectedSolutions.

Barrier: Lack of trust between customers and utilities and solar developers

Customers may be mistrustful of utilities and solar developers and, as a result, may be reluctant to participate in state incentive programs. In Massachusetts, electric customers may lack trust in their utilities due to:

- Billing failures and errors as documented by the Massachusetts DPU,¹⁶²
- Poor customer service according to the *MA Energy Ratings* website,¹⁶³ and
- High rates compared to elsewhere in the country according to data from the U.S. EIA.¹⁶⁴

Negative public opinion may reduce customers' participation in net metering, SMART, ConnectedSolutions, or CPS programs. Massachusetts recently passed legislation, *An Act Promoting a Clean Energy Grid, Advancing Equity and Protecting Ratepayers*, that creates a fund for stakeholders to intervene in the utility siting process to help tackle this lack of trust.¹⁶⁵ This measure is just the start of needed actions to improve trust in utilities, solar and storage developers/installers.

Recommendations:

- A. Establish outreach and transparency requirements for utilities and clean energy developers to ensure customers understand system costs, expected bill impacts, and programs available to offset these costs.
- B. Investigate additional measures to improve transparency and trust between customers and their utilities and clean energy developers.

Barrier: Interconnection and permitting issues

Interconnection—the process of integrating, or connecting, a resource to the larger electric grid—can be a barrier to BTM deployment if it presents a difficult, costly or lengthy application process to customers, requires too much effort for utilities to process applications, or allows BTM interconnections that may cause system issues.¹⁶⁶ Larger projects also face additional interconnection barriers, for example, in a 2023 report prepared on behalf of Clean Energy Group,

¹⁶² *Letter Order - Failure to Issue Timely Bills*, Massachusetts DPU, March 2025, www.mass.gov/doc/dpu-national-grid-letter-order-march-2025/download.

¹⁶³ "Reviews for Eversource," MA Energy Ratings, August 2025, www.maenergyratings.com/read-reviews/eversource.

¹⁶⁴ *2023 Total Electric Industry - Average Retail Price (cents/kWh)*, U.S. EIA, 2023, www.eia.gov/electricity/sales_revenue_price/pdf/table_4.pdf.

¹⁶⁵ (1) *An Act Promoting a Clean Energy Grid, Advancing Equity and Protecting Ratepayers*, Massachusetts General Laws Chapter 239, Section 109 (2024), <https://malegislature.gov/Laws/SessionLaws/Acts/2024/Chapter239>; (2) *Staff Straw Proposal: Intervenor Support Grant Program*, Massachusetts Energy Facilities Siting Board and Department of Public Utilities Division of Public Participation, 2024, www.mass.gov/doc/2024-ca-isgf-proposal/download.

¹⁶⁶ *Behind-The-Meter Battery Energy Storage: Frequently Asked Questions*, NLR, 2021, www.nrel.gov/docs/fy21osti/79393.pdf.



AEC investigated interconnection issues in Massachusetts by interviewing key stakeholders in the energy industry and policy community and found that while there are hundreds of proposed solar paired with storage systems in the interconnection queue each year, very few were authorized to interconnect to the grid.¹⁶⁷

In addition to delays, project owners may be responsible for any costs associated with interconnecting a distributed generation facility, including any necessary upgrades of the electric system, creating an additional barrier to deployment. Massachusetts DPU's Provisional System Planning Program (D.P.U. 20-75-B) begins to address the traditional “cost causation” model, which assigned all grid upgrade costs to the project causing the need for the upgrade. Under the DPU’s provisional system, cost responsibility may be shared more equitably for eligible projects if the utility files a Capital Investment Project (CIP) with MA DPU.¹⁶⁸ However, only projects meeting specific criteria may be included in a CIP. Otherwise, project costs default to the old cost causation model.¹⁶⁹

Massachusetts has also worked towards reforming its siting and permitting processes for clean energy, establishing a new Division of Energy Siting and Permitting within Massachusetts DOER,¹⁷⁰ but it is too soon to know whether these advancements have resulted in faster, easier, or less costly permitting. Moreover, these solutions support large scale clean energy deployment rather than addressing barriers to BTM adoption sited at homes or businesses.

To encourage BTM deployment and reduce costs, the Commonwealth should set strict limits on the maximum interconnection costs that utilities can charge to project developers. According to a 2018 National Renewable Energy Laboratory study, California and Utah have policies in place to increase interconnection cost certainty and limit cost liability for developers.¹⁷¹ Development of these limits should be done in collaboration with developers.

Recommendations:

- A. Design and implement required standards for better ease and speed of BTM interconnection
- B. Set maximum total interconnection costs that can be charged by utilities to project developers

¹⁶⁷ Lala, C., Burt, J., Peddada, S., *The Interconnection Bottleneck: Why Most Energy Storage Projects Never Get Built*, prepared by Applied Economics Clinic for Clean Energy Group, May 2023, www.cleangroup.org/publication/the-interconnection-bottleneck-why-most-energy-storage-projects-never-get-built.

¹⁶⁸ “Provisional System Planning Program Guide,” Massachusetts EEA, www.mass.gov/guides/provisional-system-planning-program-guide.

¹⁶⁹ “Provisional System Planning Program,” Massachusetts DPU, www.mass.gov/doc/provisional-system-planning-summary-0/download.

¹⁷⁰ *Recommendations to Governor Maura Healey on Clean Energy Infrastructure Siting and Permitting Reform*, Massachusetts EEA Commission on Energy Infrastructure Siting and Permitting, April 2024, www.mass.gov/doc/recommendations-to-governor-maura-healey-on-clean-energy-infrastructure-siting-and-permitting-reform.

¹⁷¹ Manning, D., and McAllister, R., *Review of Interconnection Practices and Costs in the Western States*, NLR, 2018, <https://docs.nrel.gov/docs/fy18osti/71232.pdf>.



Barrier: Lack of solar panel and battery recycling and disposal options for customers

Recycling processes for silicone and cadmium telluride PV modules and lithium-ion batteries are available in the United States, but expensive. Recycling technologies for some solar and storage materials (e.g., glass from a solar panel) are well-established, but the recycling industry for other solar components, including the aluminum frame, copper wire and plastic junction box, are less established.¹⁷² In addition, there are serious technical, economic, regulatory and social challenges to recycling lithium-ion batteries.¹⁷³ Customers may be hesitant to invest in BTM solar and storage systems if they are unsure how they will recycle, replace, reuse, or dispose of these materials at end-of-life.

Massachusetts should build on its 2023 discussion draft¹⁷⁴ and conduct an updated study that summarizes current recycling and reuse practices being employed in the Commonwealth and in other states and identifies solutions (e.g., programs or recycling requirements) that will facilitate sustainable end-of-life management for BTM systems in the Commonwealth while keeping consumer costs low. Future programs or recycling requirements should be developed in collaboration with key stakeholders, including solar and storage developers, installers and recycling businesses. In addition, requirements should be developed in line with existing research, policy, and programs in other jurisdictions. For example, according to the U.S. Environmental Protection Agency (EPA), California, Hawaii, New Jersey, North Carolina, and Washington have enacted policies related to solar panel waste.¹⁷⁵ Moreover, in May 2023, the EPA published a memorandum on lithium battery recycling regulations, encouraging recycling of lithium-ion batteries.¹⁷⁶ Currently, the EPA is working on a report to Congress on best practices for battery recycling.¹⁷⁷

Recommendations:

- A. Investigate recycling and reuse solutions for solar and storage systems

Barrier: Lack of internet access to learn about, or participate in, solar and storage programs

Information on the Massachusetts programs that provide financial incentives and technical support to households and businesses interested in installing BTM systems is primarily available online, creating a barrier to BTM deployment for households that lack broadband access. As of 2024, four percent of Massachusetts households (110,476 households) lack internet access.¹⁷⁸

¹⁷² "Solar Panel Recycling," U.S. EPA, www.epa.gov/hw/solar-panel-recycling.

¹⁷³ Chacana-Olivares, J., Peceño, B., Grageda, M. et al., "Lithium-ion battery recycling: a perspective on key challenges and opportunities," *npj Materials. Sustainability*, 3(38), 2025, <https://doi.org/10.1038/s44296-025-00083-7>.

¹⁷⁴ Ibid.

¹⁷⁵ "End-of-Life Solar Panels: Regulations and Management," U.S. EPA, www.epa.gov/hw/end-life-solar-panels-regulations-and-management.

¹⁷⁶ Hoskinson, C., "Lithium Battery Recycling Regulatory Status and Frequently Asked Questions," U.S. EPA, May 2023, <https://rcrapublic.epa.gov/files/14957.pdf>.

¹⁷⁷ Battery Collection Best Practices," U.S. EPA, August 2025, www.epa.gov/electronics-batteries-management/battery-collection-best-practices.

¹⁷⁸ *American Community Survey 1-Year Estimates Detailed Tables* [Table ID: B28011], U.S. Census Bureau, 2024, <https://data.census.gov/table/ACSDT1Y2024.B28011?g=040XX00US25>.



This creates a barrier to BTM deployment for households that lack internet access. In addition, internet access is required for participation in some energy programs, like ConnectedSolutions.¹⁷⁹ There are ongoing efforts to improve internet access for Massachusetts families; the MBI Residential Retrofit Program improves access to the internet for low-income households by providing grants for fiber optic cabling for Internet Service Providers that install, own, and maintain the equipment,¹⁸⁰ while MBI's RANGE Program provides grants to housing operators participating in the Residential Retrofit Program for investment in digital navigation, digital literacy and education, public space improvements, and device distribution for residents. Still, many households remain without internet access. For these households, alternate forms of outreach and education are needed.

Recommendations:

- A. Require utilities to host workshops in EJ neighborhoods for customers to learn about and enroll in existing programs

VII. Conclusion

Massachusetts is working towards electrifying its building and transportation sectors as a key strategy to meet its climate goals. The result will be an increased demand for electricity and a need for substantial additional electric supply. Increased BTM solar and storage resources are a powerful tool to lower peak electric demand and avoid investments in expensive fossil-fueled peaking supply while providing access to household savings, grid resilience, workforce development, and community ownership.¹⁸¹ Moreover, BTM deployment that targets low-income and EJ neighborhoods expands access to the benefits to clean energy to more households while supporting the Commonwealth's equity commitments.

Based on "highly suitable" technical potential estimates for BTM solar from the Massachusetts Department of Energy Resources' 2023 *Technical Potential of Solar Study* and assuming a storage-to-solar capacity of 0.43, AEC estimates that the technical potential of BTM storage paired with solar is 40 GW, or more than one and a half times (165 percent) of Massachusetts peak demand forecasted for 2050 (24 GW). To help realize this potential, this report offers 23 recommendations to address the barriers and preconditions to BTM deployment in Massachusetts.

¹⁷⁹ "ConnectedSolutions Wi-Fi Thermostat Program," Until, <https://unitil.com/rebates/connectedsolutions-wi-fi-thermostat-program-ma>.

¹⁸⁰ "Residential Retrofit Program," Massachusetts Broadband Institute (MBI), 2024, <https://broadband.masstech.org/retrofit>.

¹⁸¹ Waechter, K., O'Shaughnessy, E., Kannan, S., & Burton, R., *Technical Potential and Meaningful Benefits of Community Solar in the United States*, NLR, February 2024, <https://docs.nlr.gov/docs/fy24osti/87524.pdf>.



Electrification With Equity, Part 1

The Opportunity for Behind-the-Meter Solar and Storage in Massachusetts

MAY 2026



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