

Direct Costs and Benefits of Massachusetts Solar Incentives



Massachusetts Department of Energy Resources

With Consultant Support from
Synapse Energy Economics and Sustainable Energy Advantage

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Consulting Team

Synapse Energy Economics

Pat Knight

Erin Malone

Angela Zeng

Sarah Shenstone-Harris

Sustainable Energy Advantage

Tobin Armstrong

Tom Michelman

Jim Kennerly

Jacob Nichols

Qinyi Ma

Jonas Kaplan-Bucciarelli



Abbreviations

AC	Alternating current
AESC	Avoided energy supply components
AOBC	Alternative on-bill credit
BTM	Behind the meter
CPS	Clean Peak Energy Standard
DC	Direct current
DOER	Department of Energy Resources
DRIPe	Demand reduction induced price effect
EDC	Electric distribution company
ISO-NE	ISO New England
kW, MW, GW, TW	kilowatt, megawatt, gigawatt, terawatt
kWh, MWh, GWh, TWh	Kilowatt-hour, megawatt-hour, gigawatt-hour, terawatt-hour
MassACA	Massachusetts System of Assurance of Net Metering Eligibility
REC	Renewable Energy Certificate
REMO	Renewable Energy Market Outlook
RPS	Renewable Energy Portfolio Standard
SEA	Sustainable Energy Advantage
SCO/SCO II	Solar Carve-Out Program, Solar Carve-Out II Program
SMART	Solar Massachusetts Renewable Target
SREC	Solar Renewable Energy Certificate
VOE	Value of energy



Note on Study Results

The Department of Energy Resources (DOER) commissioned this study to quantify the direct economic costs and benefits of statewide solar programs for nonprogram participants. Direct costs and benefits are those that affect electricity rates but do not include broader socioeconomic impacts, such as avoided greenhouse gas emissions, public health benefits, tax revenues generated, or jobs created. This report is not intended to serve as a comprehensive cost-effective analysis of solar programs, as DOER intentionally focused on the narrow set of key drivers of direct ratepayer costs and benefits.



Executive Summary

Massachusetts has implemented several incentive programs to promote solar development within the Commonwealth to diversify its energy portfolio and achieve statutory climate commitments. The Department of Energy Resources (DOER) oversees the Commonwealth's primary solar incentive programs. DOER hired Synapse Energy Economics and Sustainable Energy Advantage (the "Consulting Team") to perform a thorough accounting of the direct utility system costs and benefits those programs provided from 2018 through 2025. Direct costs and benefits affect electricity rates; they do not include broader socioeconomic impacts such as avoided greenhouse gas emissions, public health benefits, tax revenues generated, or jobs created.¹

This analysis focuses on solar installations under DOER's Solar Massachusetts Renewable Target (SMART) program and post-2018 systems compensated through net metering. The SMART program provides a fixed per-kWh payment for up to 20 years to facilities. Net metering is a billing arrangement, under the statutory oversight of the Department of Public Utilities (DPU), that provides customers with credits for excess solar energy sent back to the electric grid.

The Consulting Team evaluated those incentives from 2018 through the associated system lifetime, up to 2050.² The costs considered were the incentive payments to projects for renewable energy credits (REC) and the different energy compensation mechanisms, including net metering. The benefits covered were the avoided costs of electricity and generation capacity.

The key findings from the analysis are the following:

- **The SMART program provides \$1.49 in benefits to all ratepayers for every \$1 spent.** It provided \$11.5 billion in direct lifetime benefits at a cost of \$7.7 billion and provided almost \$600 million in benefits in 2025 alone (see Figure 1 and Figure 2).
- **Energy costs, including net metering, make up about 79 percent of the total cost** of solar compensation and represent the largest opportunity to further improve cost-effectiveness.

¹ For the purposes of this analysis, ratepayers are customers of the Electric Distribution Companies and do not include customers of municipal light plants.

² The study assumed projects have a life of 25 years.



- **Solar installations deployed since 2018 have provided an average of \$9 in annual savings** per residential household, even those households with no direct connection to solar.
- **Solar provides energy independence for Massachusetts consumers** and helps insulate them from energy price spikes associated with the fuel supply costs of gas-fired generation. This is particularly true for the SMART program, for which, in most cases, total program costs per megawatt-hour are set when the solar array is installed.

Figure 1. SMART costs and benefits

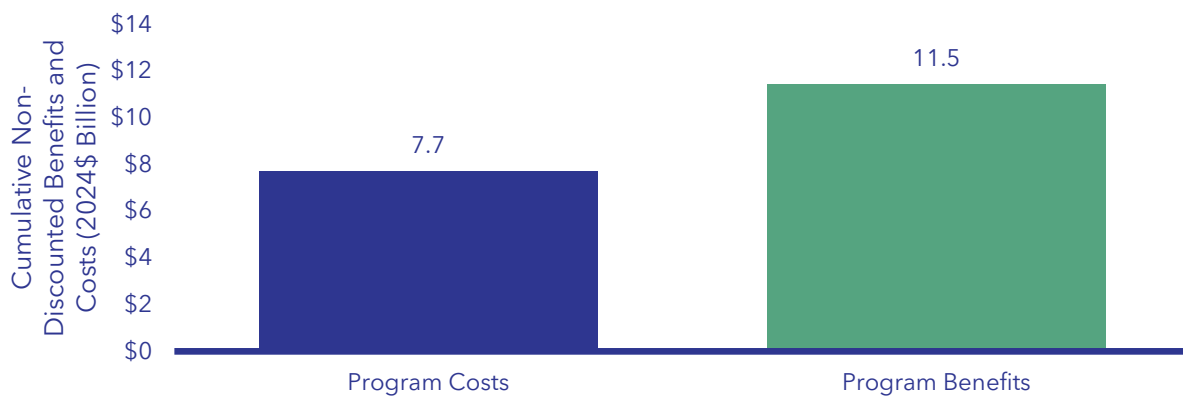
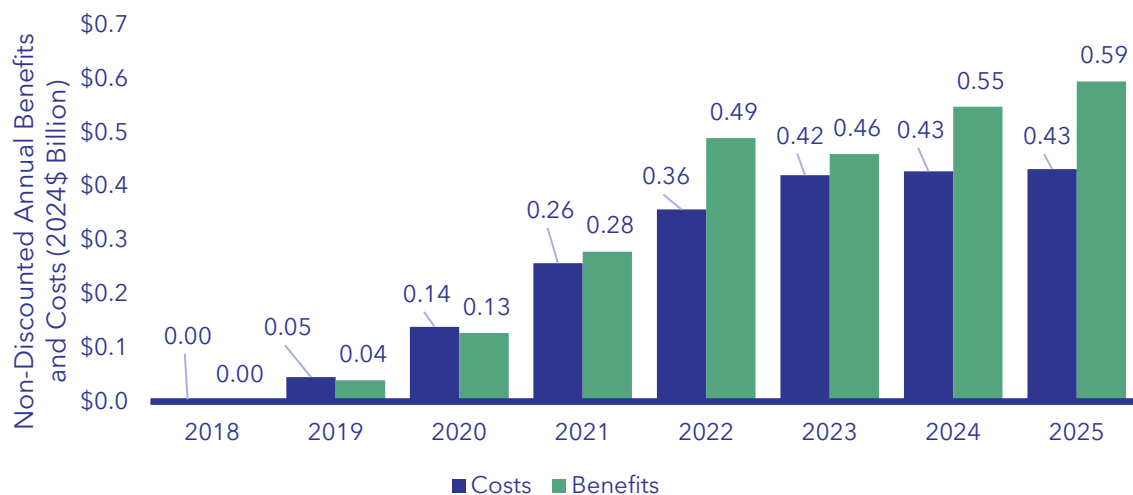


Figure 2. SMART costs and benefits by operating year



Note: Costs and benefits persist after 2025. These are not shown in this figure. See Figure 9 for more.



1. Massachusetts' Solar Incentives

Massachusetts is committed to reducing greenhouse gas emissions to net zero in 2050. To do this, Massachusetts identified renewable energy development, including the addition of 27–34 GW of solar capacity,³ as a crucial pathway.⁴ To this end, the Commonwealth created several solar incentive programs, primarily overseen by the Department of Energy Resources (DOER). This section provides an overview of historical and current solar programs and their impacts on solar capacity and generation.

1.1 Solar renewable energy certificates

Since 2003, Massachusetts' Renewable Energy Portfolio Standard (RPS) has required retail electricity suppliers, including electric utilities or distribution companies (EDC), to obtain a growing share of their electricity from qualified renewable resources.⁵ Suppliers meet their RPS obligations by securing renewable energy certificates (REC). Each REC represents 1 megawatt-hour (MWh) of confirmed renewable generation. To fulfill RPS obligations, suppliers purchase RECs—either through the open market or directly from qualifying generators—and retire them to permanently remove them from circulation.

Policymakers have refined the RPS over time to include different obligation classes, each with different compliance and eligibility requirements. For example, Class I RECs come from qualified renewable facilities that began operations after 1997.

In 2010, Massachusetts established the Solar Carve-Out Program (SCO, also known as "SREC") within the RPS. SCO required a portion of Class I RECs to come from distributed solar projects (capped at 5 megawatts, or MW) within the state. This encouraged solar development by creating demand for these specialized RECs as a subset for general Class I RECs. The first solar REC programs, later known as SCO I/SREC I, stopped taking applications in April 2014, when SCO II/SREC II launched.⁶

³ *Massachusetts Technical Potential of Solar*. Synapse Energy Economics, prepared for Massachusetts Department of Energy Resources. July 2023. Available at <https://www.mass.gov/doc/technical-potential-of-solar-in-massachusetts-report/download>.

⁴ *Clean Energy and Climate Plan for 2050*. Massachusetts Executive Office of Energy and Environmental Affairs. December 2022. <https://www.mass.gov/doc/2050-clean-energy-and-climate-plan>.

⁵ For an overview of the RPS, including more information about different classes of RECs, see <https://www.mass.gov/info-details/program-summaries>.

⁶ As the SREC I and SREC II programs are considered legacy programs, the direct utility system costs and benefits analysis did not include them. However, SREC I and SREC II are commonly cited as the catalyst of the Massachusetts solar industry, contributing to the success of the SMART program.



The latter accepted applications until November 2018, at the inception of the Solar Massachusetts Renewable Target (SMART) program described below.⁷

The SREC I program supported the installation of approximately 525 MW of distributed solar photovoltaics (PV) from 2010 to 2014, and the SREC II program supported the installation of approximately 1,400 MW of solar PV from 2014 to 2020.⁸

Some solar installations in recent years have forgone SREC or SMART incentives and used only the proceeds of Class I REC sales. From 2022 to 2025, the Consulting Team estimates that the total solar capacity using only Class I RECs was 535 MW.⁹

Solar generation is eligible to receive SREC I or SREC II incentives for 10 years, after which qualifying generation generally produce Class I RECs. Other solar compensation mechanisms are also subject to program-specific eligibility periods, as described below.

1.2 SMART

In 2018, the Commonwealth launched the SMART program,¹⁰ which pays eligible solar facilities a per-kWh incentive for a defined term: 10 years for small facilities (up to 25 kW) and 20 years for larger facilities.¹¹ In addition to spurring low-cost solar generation, SMART seeks to promote environmentally-sensitive siting and the equitable distribution of ratepayer benefits. One SMART program requirement is that the EDCs take title to any RECs generated by a solar facility to use for RPS compliance or sell them to help offset the cost of the program.

The SMART program is now in its third iteration, SMART 3.0, with updates informed by a multi-year programmatic review.¹² As 2025 was the first year of SMART 3.0, this analysis did not include the costs and benefits associated with the program. SMART 1.0 and 2.0 supported the installation of 1,385 MW from 2018 to 2025; participating projects will continue to receive incentives for several years.

⁷ For additional information about the SREC I and SREC II programs, see <https://www.mass.gov/guides/solar-carve-out-and-solar-carve-out-ii-program-information>.

⁸ SREC capacity is converted assuming a DC:AC ratio of 1.25. Given this, the values reported are different from those publicly reported by DOER, which are in DC terms.

⁹ Capacity additions in 2025 were forecast based on 2024 actuals.

¹⁰ For more about the SMART program, see <https://www.mass.gov/solar-massachusetts-renewable-target-smart>. Although the latest iteration (SMART 3.0) includes significant revisions, those changes are not reflected in this report, which focuses on projects already interconnected through 2025 (i.e., under SMART 1.0 and 2.0).

¹¹ After these tariff terms end, these facilities are eligible to create and be paid for Class I RECs.

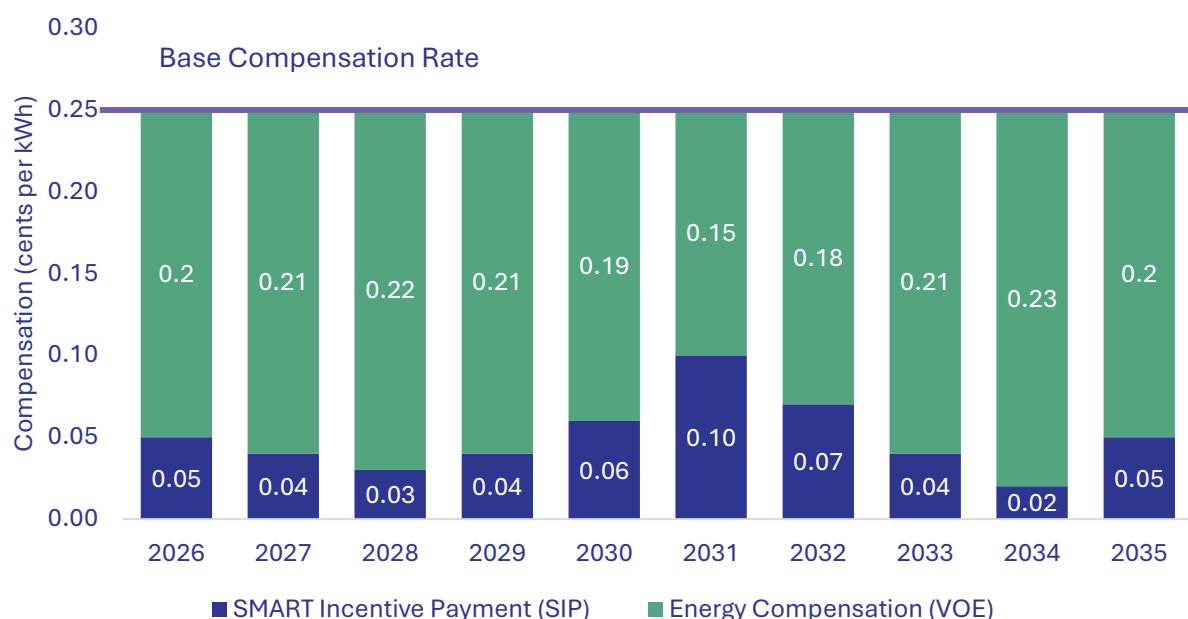
¹² See <https://www.mass.gov/info-details/smart-30-program-details>.



The SMART program has provided program participants—from homeowners to large-scale commercial facilities—a predictable energy revenue. The program pays incentives per kWh to solar facilities based on a total compensation rate that is set when the facility qualifies for SMART. The program established incentive levels in declining capacity blocks that are adjusted based on system size, location, qualifying “adders” (e.g., energy storage, specific off-takers, or specific land-use categories), and subtractions for undesired land uses.

The actual payments depend on whether a facility is standalone—feeding 100 percent of the power generated into the grid—or behind the meter (BTM), with some power consumed by the customer. With standalone facilities, SMART payments vary over time, as they are net of the value of energy (VOE) generated, as seen in Figure 3. For example, if the total compensation rate is 25 cents per kWh, and the customer earns 20 cents through net metering, the incentive is 5 cents; however, there is no claw-back if the VOE increases and exceeds the total compensation rate. If the VOE ends up exceeding the total compensation rate, a facility will receive the VOE, but no additional incentive.¹³ For BTM projects, the incentive rates are fixed based on a VOE set at the outset and are not affected by changes in the VOE.

Figure 3. Illustrative SMART standalone facilities compensation



¹³ This exception was triggered during the 2023 basic service price spikes.



1.3 Net metering and other energy compensation

Net metering allows electric utility customers who generate solar power to receive bill credits in exchange for exporting energy to the grid.¹⁴ Net metering facilities can offset on-site consumption or export 100 percent of their energy to the grid.

Massachusetts law establishes three classes of net metering facilities based principally on generating capacity: Class I (60 kW or less), Class II (60 kW and up to 1 MW), and Class III (greater than 1 MW and up to 2 MW), with different limits applicable to certain governmental facilities. The dollar-per-kWh value of a net metering credit is derived from components of retail rates and varies by facility type (e.g., private vs. public), the year they went into service, their size, and the utility service territory. For certain solar facilities that qualified for Class I, II, or III net metering credits, those credits are available for 25 years, after which the facility receives market net metering credits.¹⁵ SMART program participants can also receive net metering credit.

Other solar facilities may receive compensation for energy by being a “qualifying facility.” Under this arrangement, facilities are paid a price for energy exported to the grid in real time based on ISO New England’s wholesale markets.¹⁶ This contrasts with net-metered facilities, which are generally compensated based on retail rate components and receive credits based off of monthly net energy export (i.e., after on-site energy consumption has been netted out).¹⁷

Finally, some solar facilities participating in the SMART program receive energy compensation through Alternative On-Bill Credits (AOBC), an alternative to net-metering. AOBCs compensate SMART facilities at the applicable basic service rate (i.e., utility default supply service rate).¹⁸

As indicated by the discussion above, Massachusetts’ solar incentives and energy compensation programs can be combined in various ways, producing different sets of costs and benefits. Table 1 summarizes the programs analyzed in this study.

¹⁴ For more on net metering, see <https://www.mass.gov/info-details/net-metering-guide>.

¹⁵ Market net metering credits are equal to 60% of the value of Class I and II net metering credits and 60% of the value of most Class III net metering credits.

¹⁶ For more on qualifying facilities, see <https://www.mass.gov/info-details/qualifying-facilities-and-on-site-generating-facilities>.

¹⁷ Retail rates are generally higher than wholesale market prices, as it includes costs associated with distribution, transmission, and other categories.

¹⁸ For more on AOBCs, see <https://www.mass.gov/doc/alternative-on-bill-credit-faq/download>.



Table 1. Solar programs

REC incentive	Energy compensation
SMART	Net metering
SMART	Qualifying facility
SMART	AOBC
Other¹⁹	Net metering
Other	Qualifying facility*

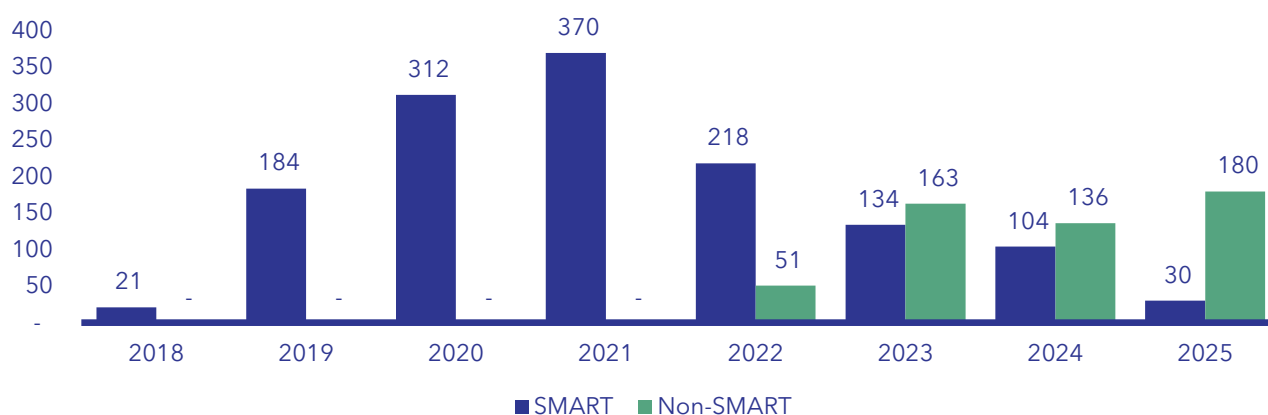
Notes:

* There are zero MW modeled that originate in the category of Non-SMART, Qualifying Facility, but there are some MW that transfer into this category after their SMART tariffs expire.

1.4 Impact of solar incentives

This study estimates that all of Massachusetts' solar incentive programs have supported the deployment of over 3.8 GW of solar generation capacity (including paired solar-and-storage) through 2025 across the Commonwealth (see Figure 4).²⁰ However, this analysis only considers the 1.9 GW of solar capacity deployed after 2018 that is receiving compensation through either SMART or net metering.

Figure 4. Solar capacity (MW) by program and operation date



The 1.9 GW studied resulted in an average of 238 MW installed per year from 2018-2025. Based on this rate of deployment, this study estimated 5.2 TWh in 2025 from all solar programs, and 2.6 TWh in 2025 from solar deployed in 2018-2025 (see Figure

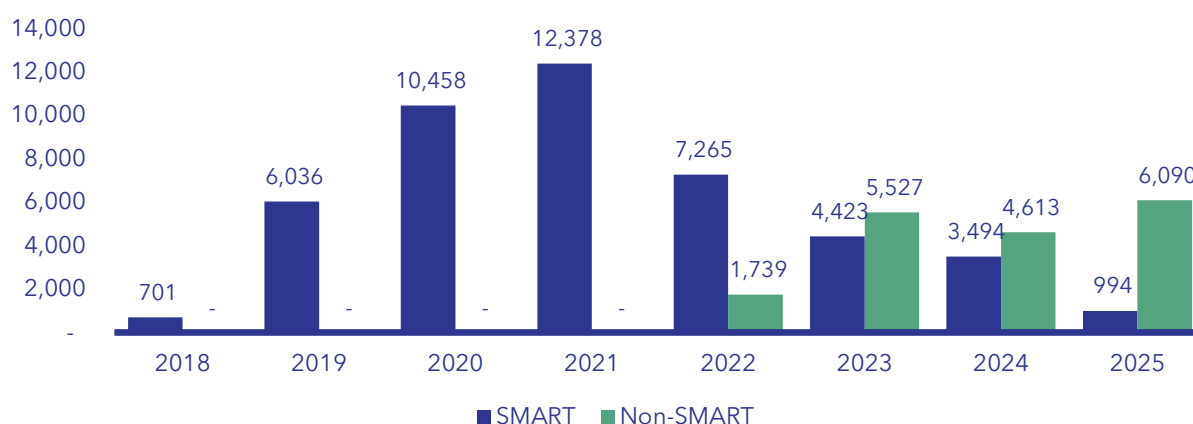
¹⁹ RPS Class I, SREC, or SREC II.

²⁰ All results in this analysis include both standalone solar as well as solar paired with energy storage systems. Results for other (non-SMART) systems for 2025 include forecasted capacity additions. Throughout this report, all capacities are reported in AC terms, rather than DC terms, which are generally larger. Note that this capacity number of 3.8 GW excludes some net metering projects deployed even before the advent of the SREC programs, meaning that actual deployment in the Commonwealth is slightly higher.



5).²¹ For some perspective, Massachusetts households and businesses consumed about 49 TWh of electricity in 2024 (the most recent year for which data are available).²² In other words, the Commonwealth supports enough solar and storage to meet the needs of about 760,000 households, or over one-quarter of all households in the Commonwealth.

Figure 5. Solar generation (GWh) by program and operation date



The Consulting Team calculated the SMART program solar capacity based on project-level qualified unit reports published by DOER. However, development of projects that are not participating in the SMART program has grown in recent years, spurred by declining SMART incentives and rising retail rates in the early 2020s. The Consulting Team relied on each EDC's On-site Generation Facility (OSGF) report, filed in Massachusetts Department of Public Utilities (DPU) docket number 25-DG, to derive the MW quantity of net metering projects built outside of the SMART program.²³

²¹ This study assumed that all systems are in place for 25 years, that projects have capacity factors ranging from 15.6 percent to 17.6 percent (with larger projects receiving a larger capacity factor), and that solar output degrades by 0.7-1 percent per year (assuming less degradation for larger projects). Capacity factors and degradation rates were informed by historical production data, program cost filings, and the Consulting Team's market research.

²² U.S. Energy Information Administration (EIA) Form 861, 2024, available at <https://www.eia.gov/electricity/data/eia861/>.

²³ This study assumed these projects also generate and sell Class I RECs. However, it did not include the costs associated with fulfilling Class I RPS requirements in cost quantification, as Class I is not a program specific to in-state solar. For OSGF data, see EDC's April 1, 2025, filings, available at <https://eeaaonline.eea.state.ma.us/dpu/fileroom/#/dockets/docket/11545>. Capacity additions in 2025 were forecast based on 2024 actuals.



2. Calculating Costs and Benefits

The Consulting Team assessed the cost-effectiveness of resources installed through Massachusetts' solar programs from a utility system perspective. This means the analysis includes all utility system costs incurred to implement the resources, and all benefits that accrue to the utility system. This view helps estimate the impact of solar resources on all ratepayers, not just those who participate in a solar program.

Table 2 shows all cost and benefit categories analyzed in the primary analysis, while Table 3 shows categories quantified but not included in the primary analysis and Table 4 shows categories that were neither quantified nor included.

Table 2. Quantified costs and benefits included in the primary analysis²⁴

Program costs	
Renewable energy certificates (RECs)	Payments made to assign credit for renewable energy generation, including for the purpose of meeting state and local goals.
Energy	Payments for energy that participants feed into the grid and avoided payments to the utility for behind-the-meter energy consumption, most commonly through net metering or AOBC, at rates that vary with the retail price of electricity.
Program benefits	
Electric energy	Solar generation (in MWh) avoids the need to buy electricity from other sources.
Energy demand reduction induced price effect (DRIPE)	Solar resources have \$0 marginal operating costs, so they reduce the wholesale market price for energy, benefiting all consumers. This category also includes knock-on effects on the gas market (i.e., cross-DRIPE effects).
Avoided Renewable Portfolio Standard (RPS) compliance	Behind-the-meter solar generation reduces the overall electricity load, and this reduces the quantity of RECs that utilities must purchase to comply with the RPS.
Capacity	Solar and storage reduce peak demand, reducing the amount of capacity that the regional grid operator must purchase. Paired with storage, solar resources can better coincide with peak demand and avoid even more costs.
Capacity DRIPE	Just as with energy markets, additional solar and storage can reduce the price paid for capacity, which is then passed on to all consumers.
Transmission	BTM solar and paired-solar-and-storage reduce demand during peak hours, reducing the need to build and maintain transmission capacity.
Distribution	BTM solar and paired-solar-and-storage reduce demand during peak hours, reducing the need to build and maintain distribution capacity.

²⁴ When included, all reported values are in undiscounted 2024 dollars.



Reliability	Solar and storage provide reliability benefits within the context of ISO New England's Forward Capacity Market.
REC resale	Solar facilities participating in the SMART program transfer the RECs they produce to utilities, which may use them for RPS compliance, reducing the need to buy RECs, or sell them, generating revenue.

Table 3. Costs and benefits quantified, but not included in the primary analysis

Program costs	
Tax impacts	Installed residential solar and storage are eligible for a sales tax exemption, and some residential solar systems are eligible for tax credits. This is forgone state tax revenue.
Program benefits	
Out-of-state DRIPE from MA resources	Solar and storage facilities in Massachusetts reduce energy and capacity prices for the entire region. These benefits are passed on to consumers in other New England states.
Greenhouse gas emission reductions	Solar generation and storage avoid emissions of carbon dioxide (CO ₂) and other greenhouse gases associated with gas-fired generation. These reductions can be quantified using the social cost of carbon and are estimated at \$34-171/MWh, depending on the year and discount rate used.
Public health benefits	Solar generation and storage also avoid emissions of air pollutants from power plants, such as nitrogen oxides (NO _x), sulfur dioxide (SO ₂), and particulate matter, which contribute to illness and premature mortality. Analysis from U.S. Environmental Protection Agency (EPA) estimates the public health benefits of these reduced emissions at \$12-22 per MWh.

Table 4. Costs and benefits not quantified or included in the analysis

Program Benefits	
Out-of-state DRIPE from non-MA resources	Other states in New England are also supporting solar and/or storage. When these resources generate power, they also reduce regional energy and capacity prices, which are passed on to consumers in Massachusetts. We have not quantified these benefits, but they are likely similar in size to the benefits of out-of-state DRIPE from Massachusetts resources (see above), as Massachusetts makes up roughly half of both regional load and regional solar generation.
Participant benefits	Under net metering outside of SMART, owners of solar facilities retain ownership of the RECs they produce and can sell them to generate income. Utility customers who generate solar power also save on their bills through BTM consumption, net metering, and similar compensation structures.
Tax and municipal benefits	Owners of most solar and storage facilities pay taxes on their property or enter into payment in lieu of taxes (PILOT) agreements, which contribute to municipal budgets. Participant benefits accruing to municipal or state-owned solar also contribute to reducing municipal and state budgetary costs. The sale of RECs also generates income for participants, which may result in increased state tax revenues.
Other	Still other costs and benefits may exist, such as the non-program costs participants incur when installing solar, benefits to local jobs and the economy, property tax exemption costs, and property value benefits.



To quantify the costs and benefits, the Consulting Team assumed that all solar installations have a lifetime of 25 years and identified the lifetime set of costs and benefits listed in Table 2 for each category of solar, based on the installed year.²⁵ For example, a large-scale facility installed in 2019 could receive SMART incentives for 20 years. It could also receive Class I, II, or III net metering credits for 25 years, and market net metering credits thereafter. The Consulting Team grouped the costs and benefits for the last five years of the resource's operating life into the SMART program's total costs and benefits, even though the resource no longer receives SMART incentives in those years.

2.1 Costs

SMART

The Consulting Team estimated the SMART compensation cost using public project-level SMART data included in DOER's Solar Tariff Generation Units (STGU) report in combination with the EDCs' SMART tariffs.²⁶ Next, the Consulting Team derived yearly costs specific to each project, considering the EDC involved and each project's tariff structure, size category, applicable adders and/or subtractors, and program block under SMART 2.0.

As noted in Section 1.2, under SMART, participating facilities receive the difference between the VOE generated and a total compensation rate set at the start of the project. This is called the "net incentive over VOE." A project's VOE can be a function of net metering, AOBC, or qualifying facility rates. Under SMART, BTM projects generally participate through net metering, standalone community shared solar projects participate through AOBCs, and standalone non-community shared solar projects participate through AOBCs or as a qualifying facility.²⁷

²⁵ As stated by U.S. Department of Energy's Integrated Energy Systems Office at <https://www.energy.gov/eere/solar/end-life-management-solar-photovoltaics> "...the average operational lifespan of a solar panel has increased from around 20 years in 2007 to 25-35 years in 2025." Given the span of this analysis covers projects installed from 2018-2025, a 25-year project life was chosen as reasonable simplifying assumption spanning all yearly vintages.

²⁶ See National Grid: <https://www.nationalgridus.com/media/pdfs/billing-payments/tariffs/mae/2026/mpdu-1622-smart-provision-1.1.26..pdf>, Eversource: https://www.eversource.com/docs/default-source/rates-tariffs/74-renewable-credits.pdf?sfvrsn=d8e93072_4, Unitil: https://unitil.com/sites/default/files/2024-11/e_MA_SP.pdf.

²⁷ Some standalone projects, particularly those installed in the early years of the SMART program when net metering cap space was still more widely available, also participate through net metering.



As noted above, for standalone projects, the SMART incentive payments vary depending on the VOE.²⁸ If the VOE for a project rises, for instance, the difference with the total compensation narrows and the incentive payment decreases.

In contrast, for BTM projects, the SMART incentive payments per kWh are determined at project qualification based on an assigned proxy VOE. This means that incentive payments remain fixed for the full 10- or 20-year term. Given this, as the actual VOE goes up or down with electricity rates, so does the total compensation paid for energy from the project. To capture this effect, the Consulting Team estimated each project's proxy VOE assigned at qualification and modeled the actual VOE based on historical and/or forecasted net metering rates (discussed below). The Consulting Team assigned project-specific proxy VOEs using DOER's BTM VOE workbooks in combination with an assumed rate class for each project.²⁹ The Consulting Team assumed rate classes based on an analysis of the dominant rate class by project size category, leveraging the EDCs' OSGF report.³⁰ Lastly, for BTM projects, the Consulting Team removed energy costs associated with the basic service charge for the portion of energy consumed on-site. Avoiding basic service charges does not produce material cost shifts on the scale of those associated with avoided delivery charges. Although avoiding basic service presents value to the customer under SMART, it does not introduce a direct cost to non-participating customers. The Consulting Team benchmarked total costs of implementing the SMART program to SMART Factor filings, verifying their reasonableness.

Net metering and other energy compensation

The Consulting Team quantified net metering costs by producing representative rates for each utility's major rate classes.³¹ The Consulting Team reconstructed historical retail electrical rates from 2018 through 2025, forecast rates through 2050, and weighted rates based on the share of projects under varying rate classes and net

²⁸ There is an exception, when the aggregate compensation level exceeds the VOE, the STGU receives the VOE and there is no claw-back to the aggregate total compensation level as determined by regulation. This exception was triggered during the 2023 basic service price spikes.

²⁹ See 2026 BTM VOE workbook: <https://www.mass.gov/doc/program-year-2026-btm-value-of-energy-workbook/download>.

³⁰ Specifically, we assumed that projects under 25 kW would take service under the residential rate class for their EDC, while projects over 25 kW would take service under the following rates: G-2 for Eversource, G-1, for National Grid, and GD-2 for Unitil. As the BTM VOE workbooks prior to 2020 were not available, SMART projects from 2018 and 2019 were assumed to have the 2020 VOE for their rate class.

³¹ While net metering is available to other technologies (e.g., wind, small hydro, etc.), it has predominantly leveraged by solar projects and thus net metering benefits and costs associated with solar projects are included in this analysis of solar programs.



metering tariffs. The Consulting Team considered utility rates for Eversource East (Greater Boston), Eversource West, Eversource South Shore, National Grid, and Unitil.

For historical rates, the Consulting Team assumed fixed-price basic service for residential and small commercial rates, and variable-price basic service for medium and large commercial rates. The Consulting Team retrieved monthly rates between 2018 and 2025 from a third-party database.³²

To forecast rates through 2050, the Consulting Team applied a 1.4 percent annual inflator to supply charges, a 2.5 percent inflator to distribution charges, and a 2.7 percent inflator to all other charges. The Consulting Team derived the inflators from a separate Eversource East G-1 rate³³ forecast prepared recently, which used wholesale capacity and energy price forecasts to derive a basic service forecast, with delivery charges forecast based on historical trends and public filings on planned transmission and distribution investments.

For each combination of utility and rate class, we reconstructed the possible net metering compensation rates for exported energy based on the corresponding EDC's net metering tariffs (see Table 5).

Table 5. Assumed net metering rate by MW class

Net Metering Class	Assumed Net Metering rate
Class I (< 60 kW)	60% Net Metering Rate
Class II (60-1,000 kW)	60% Net Metering Rate
Class III (1-10 MW)	60% Net Metering Rate
Public	Net Metering Rate (Full)

** This "partial" rate excludes distribution charges.*

For on-site usage, retail net metering participants are effectively compensated at the full retail rate, because the usage avoids metered energy consumption. From a utility system perspective, however, we assume only the avoided delivery charges produce a material cost shift. As such, basic service charges are not included in cost calculations for the portion of solar production assumed to be consumed on site. It is

³² For the Unitil medium and large commercial basic service rates, which shifted to a market pass-through around 2018, the Consulting Team estimated monthly supply rates using historical ISO-NE NEMA locational marginal prices weighted by a solar PV production profile from NREL's PVWatts tool, and it annualized monthly rates using the same production profile.

³³ This rate forecast was created by Consulting Team member Sustainable Energy Advantage as a proprietary product and is not publicly available.



important to note that such costs do not represent a net increase in society-wide costs, just a cost shift from participating customers to non-participating customers.

The Consulting Team then used these rates to derive weighted average rates for each market segment and each year that facilities went online. The OSGF and net metering project-level data are largely customer-reported and were missing certain cost determinants (e.g., metering configuration, on-site usage, public vs. private off-taker). Therefore, the Consulting Team developed assumptions for each class by leveraging SMART STGU data, a BTM load curve analysis, and net metering data provided by the Massachusetts System of Assurance of Net Metering Eligibility (MassACA).³⁴ The Consulting Team combined these assumptions with actual data regarding the share of capacity by utility and net metering class to derive the final per-MWh cost estimates used in modeling.

The SMART program establishes a fixed total per-MWh compensation for standalone projects, allowing the compensation associated with energy to be distinguished from the incremental SMART incentive. Because the allocation between these components does not affect total program costs, the Consulting Team took a simplified approach to estimate the energy component based on historical and forecasted retail rates. For post-tariff SMART projects (i.e., SMART projects continuing to operate past the 10- or 20-year incentive payments), the Consulting Team assumed that AOBC projects will become qualifying facilities, and that qualifying facility costs are equal to the avoided energy rates used to derive electrical energy benefits.

2.2 Benefits

To estimate total dollar benefits, this analysis relied on two primary sources:

- Actual, reported data on historical energy prices and capacity prices
- Estimates of avoided costs based on those used by utilities in Massachusetts to develop cost-benefit tests for the deployment of energy efficiency and electrification measures

Each of these data sources provide time-series of benefits in dollars-per-MW or dollars-per-MWh terms. The Consulting Team multiplied these values by a resource's capacity or generation. The resulting benefits are then summed over the lifetime of a resource.

³⁴ MassACA data is available at <https://app.massaca.org/allocationreport/report.aspx>.



Wherever possible, the Consulting Team used actual historical data to estimate historical benefits. Where actual data was unavailable, the Consulting Team estimated benefits using avoided costs. The analysis generated all future benefits using the latest avoided costs approved by the Massachusetts DPU in early 2025 for energy efficiency and electrification programs.³⁵

A summary of the sources used to estimate avoided costs is shown in Figure 6.

³⁵ D.P.U. 24-140 through D.P.U. 24-149. Massachusetts Department of Public Utilities. February 28, 2025. available at <https://ma-eeac.org/wp-content/uploads/DPU-24-140-through-DPU-24-149-2025-2027-Three-Year-Plans-Order-FINAL-2.28.25.pdf>.



Figure 6. Data sources used to calculate assumed benefits

	Electric Energy	Energy DRIPE	Cross DRIPE	Avoided RPS Compliance	Electric Capacity	Capacity DRIPE	Transmission	Distribution	Reliability	REC Resale
2018	Actuals Data from ISO SMD Reports	AESC 2018	AESC 2018	AESC 2018	Actual FCA prices	AESC 2021 (held constant for previous years)	Regional transmission: AESC 2024 (assuming \$0/kW-yr for local transmission due to a lack of available data)	Estimates from EDCs' energy efficiency modeling	AESC 2018	SEA REMO Model
2019										
2020										
2021										
2022										
2023										
2024	AESC 2024	AESC 2024	AESC 2024	AESC 2024	AESC 2024	AESC 2024	Regional transmission: AESC 2024 (assuming \$0/kW-yr for local transmission due to a lack of available data)	Estimates from EDCs' energy efficiency modeling	AESC 2021	SEA REMO Model
2025										
2026										
2027										
2028 -										
2050										

Notes and sources:

ISO SMD reports are hourly datasets of loads and locational marginal pricing, available at <https://www.iso-ne.com/isoexpress/web/reports/load-and-demand/-/tree/zone-info>.

All AESC (Avoided Energy Supply Cost/Component) studies are available at <https://www.synapse-energy.com/avoided-energy-supply-costs-new-england-aesc>.

Results of ISO New England's capacity market auction can be found at <https://www.iso-ne.com/about/key-stats/markets#fcaresults>. In the AESC 2024 counterfactual approved for use by the DPU in D.P.U. 24-140 through D.P.U. 24-149, the New England region is assumed to be summer-peaking through 2050. In a situation where the region switches to winter-peaking in the mid-2030s (i.e., in line with state goals to electrify space and water heating end uses), standalone solar resources would contribute fewer MW during on-peak times. This would likely produce fewer benefits for programs other than SMART, which is less likely to see smaller aggregate benefits as a result of the large quantity of paired solar-and-storage resources.

REC resale values are generated using Sustainable Energy Advantage's REMO model. The values for Class I RECs estimated in this model are more up-to-date relative to the Class I REC prices assumed in the Avoided RPS compliance benefit category (which were almost all estimated using the REMO model as a part of the AESC studies). However, these differences are small and unlikely to have a material impact on this analysis' findings.

The analysis generated the benefits using several assumptions:

- **Annual load shapes:** Energy load shapes for standalone solar were developed using data from PVWatts. Energy load shapes for solar paired with storage were developed using ISO New England solar generation profiles combined with a 4-hour storage dispatch algorithm based on modeled loads and electricity prices.³⁶

³⁶ The Consulting Team modeled a four-hour dispatch for purposes of simplicity although the average duration for batteries deployed in SMART is 2.9 hours. The four-hour assumption has little impact on the results: it merely changes the weighting of avoided costs between seasonal and on-peak periods (e.g., summer on-peak, winter off-peak) that tend to have similar overall cost streams.



- **Peak coincident factors:** For standalone solar, the Consulting Team developed the coincident factors for each historical year—that is, the extent to which solar output coincides with system peaks—by analyzing hourly data published by ISO New England to compare actual solar output and system peaks (defined as the top 0.5 percent of hours in each year).³⁷ For solar paired with storage, the coincident factors were developed by mapping the Clean Peak Energy Standard (CPS) definitions of peak to actual system peaks as defined above, assuming that storage is likely to discharge during these windows.³⁸ For both standalone solar and solar paired with storage, historical trends were carried forward to develop future values.
- **Capacity bid into market:** The Consulting Team assumed that none of the resources analyzed in this study are bid into ISO New England’s capacity market. Instead, these resources create capacity benefits indirectly via “uncleared” capacity benefits.³⁹
- **Other avoided cost factors:** The Consulting Team assumed values for parameters including line losses and wholesale risk premiums consistent with default values published in AESC 2024.⁴⁰

2.3 Other impacts

This analysis includes four other sets of costs and benefits. The impacts of these categories are generally not included in the aggregate estimates of costs or benefits, unless explicitly noted.

- **Sales tax exemption and the residential tax credit:** The Consulting Team quantified the costs associated with two state policies designed to incentivize solar. Both policies represent forgone state tax revenue, rather than costs borne by electric ratepayers. Under the sales tax exemption, all equipment related to the installation of solar is exempted from the state’s 6.25 percent sales tax.⁴¹ Furthermore, residential solar installations that are owned directly

³⁷ For more on this dataset, see ISO New England’s web page on variable energy resource data, available at <https://www.iso-ne.com/system-planning/planning-models-and-data/variable-energy-resource-data>.

³⁸ The CPS definition of peak only includes business days. This analysis included weekends and holidays in the peak definition and assumed that the CPS Actual Monthly System Peak Multiplier is likely to capture peak hours that fall outside business days. <https://www.mass.gov/info-details/clean-peak-energy-standard-guidelines>.

³⁹ For more on this topic, see AESC 2024, Chapter 5, available at <https://www.synapse-energy.com/sites/default/files/inline-images/AESC%202024%20May%202024.pdf>.

⁴⁰ For more on this topic, see AESC 2024, Appendix B, available at <https://www.synapse-energy.com/sites/default/files/inline-images/AESC%202024%20May%202024.pdf>.

⁴¹ For more on this sales tax exemption, see MGL Chapter 64H, Section(dd) at <https://malegislature.gov/Laws/GeneralLaws/PartI/TitleX/Chapter64H/Section6>.



by a resident for use at their primary residence are eligible to receive a state tax credit of 15 percent, up to a maximum of \$1,000.⁴² For this analysis, the costs associated with these programs were estimated based on an analysis of total installed cost subject to sales tax and total residential installations (assuming all installs were subject to the maximum credit), as provided by DOER's project-level qualified unit reports. Tax-based incentives represent an opportunity to reduce costs borne by ratepayers.

- **Out-of-state impacts on energy and capacity prices:** When producing electricity, standalone and storage-paired solar has a \$0 marginal operating cost. This means that it “shifts” the market supply curves for energy and capacity, effectively lowering the price paid for these commodities. This lower price benefit accrues to consumers throughout New England. Under cost-effectiveness testing methods approved by the DPU, Massachusetts typically only considers the benefits of lower prices within its own borders. This study estimates both the in-state benefits as well as the benefits that accrue to all other customers in New England.⁴³ These benefits were generated using the same sources for Energy DRIPE and Capacity DRIPE described above in Section 2.2.
- **Avoided greenhouse gas emissions:** Solar generation and storage avoid emissions of carbon dioxide (CO₂) and other greenhouse gases associated with gas-fired generation. These reductions can be quantified using the social cost of carbon at a range of discount rates from AESC 2024.⁴⁴
- **Public health benefits:** Solar generation solar and storage also avoid emissions of air pollutants such as nitrogen oxides (NO_x), sulfur dioxide (SO₂), and particulate matter, which contribute to illness and premature mortality. The

⁴² For more on residential tax credits for solar, see <https://www.mass.gov/regulations/830-CMR-6261-residential-energy-credit>.

⁴³ Another category of benefits (not calculated in this analysis) relates to the price-reducing benefits that accrue to Massachusetts customers from solar programs initiated outside the state. Because Massachusetts is both roughly half the region's electricity load and home to roughly half of all distributed solar resources, those energy and capacity pricing benefits are likely similar in quantity to the pricing benefits created for non-Massachusetts customers from Massachusetts-based solar.

⁴⁴ Note that these values include discount rates that are implicit in the use of a social cost of greenhouse gas time-series, meaning that these values are discounted in a way that other costs and benefits in this analysis are not. For more, see AESC 2024, Chapter 8, available at <https://www.synapse-energy.com/sites/default/files/inline-images/AESC%202024%20May%202024.pdf>.

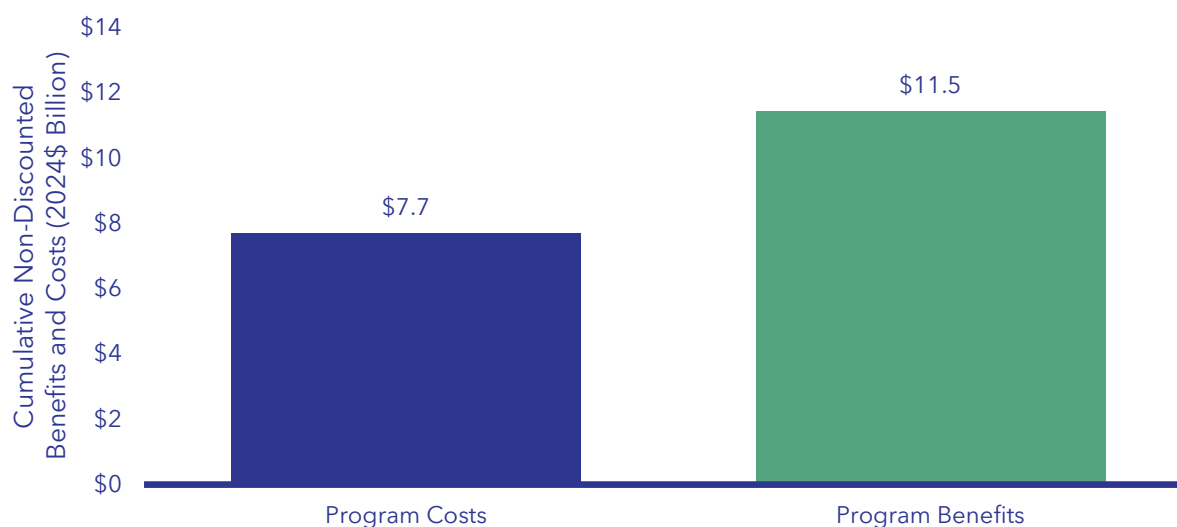


benefits resulting from avoiding these emissions were estimated using data published by U.S. Environmental Protection Agency.⁴⁵

3. Results and Findings

SMART is a cost-effective program for ratepayers. It generates \$1.49 in direct ratepayer benefits for every \$1 spent on program costs, driven by the \$11.5 billion in benefits outweighing the \$7.7 billion in costs (see Figure 7, Figure 8, and Figure 9). In 2025 alone, the program generated nearly \$600 million in benefits, and deployed resources generated more lifetime benefits than costs in every year of the study.

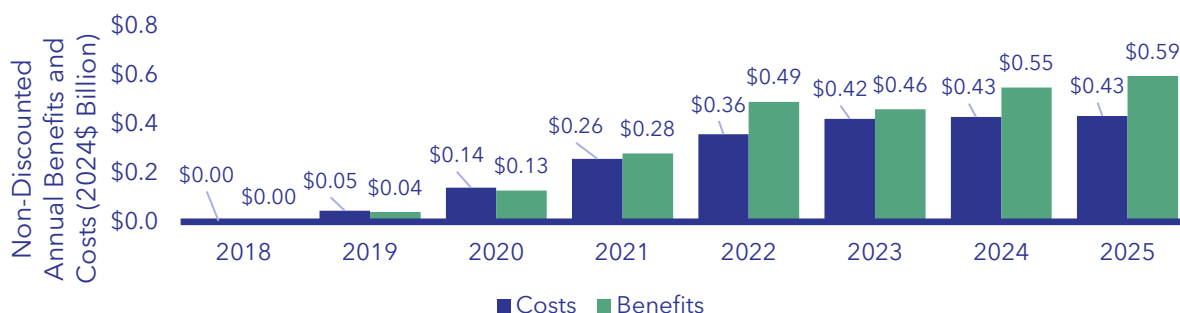
Figure 7. SMART costs and benefits



⁴⁵ *Public Health Benefits per Kilowatt-Hour of Energy Efficiency and Renewable Energy in the United States: A Technical Report*. December 2024. U.S. EPA. Available at https://www.epa.gov/system/files/documents/2024-12/bpk_report_third_edition.pdf. As with social cost of greenhouse gas values, these public health values embed a discount rate.

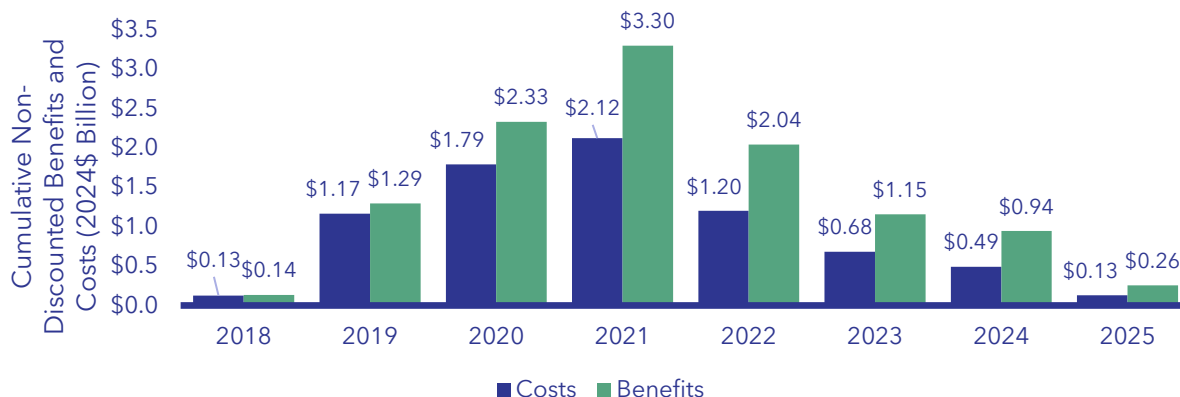


Figure 8. SMART costs and benefits by operating year



Note: Costs and benefits persist after 2025. These are not shown in this figure but are shown in Figure 9.

Figure 9. SMART costs and benefits by date of commercial operation



This analysis found that, across all the solar programs considered, total lifetime costs (including estimated future costs) are \$11.1 billion, and total lifetime benefits to ratepayers are \$14.4 billion (see Figure 10). Starting in 2022, projects participating in Net Metering but not SMART are close to cost-neutral for ratepayers, with \$0.9 in ratepayer benefits generated from every \$1 spent on the program.⁴⁶

⁴⁶ This corresponds to the other (non-SMART) category which is primary projects participating in Net Metering and either RPS Class I or no incentive programs. Again, this analysis assumes the existence of Class I RPS program, which can be complied with via non-solar or storage resources (e.g., wind, biomass, etc.). Therefore, the analysis excludes costs associated with the compliance of that program.



Figure 10. Quantified costs and benefits by initial solar program, 2018-2050

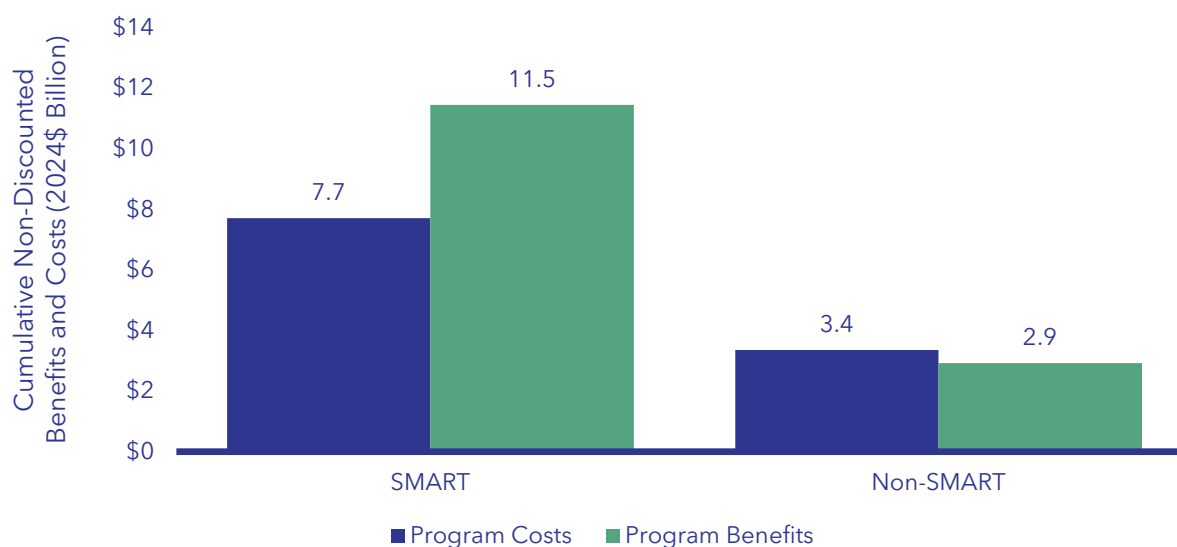
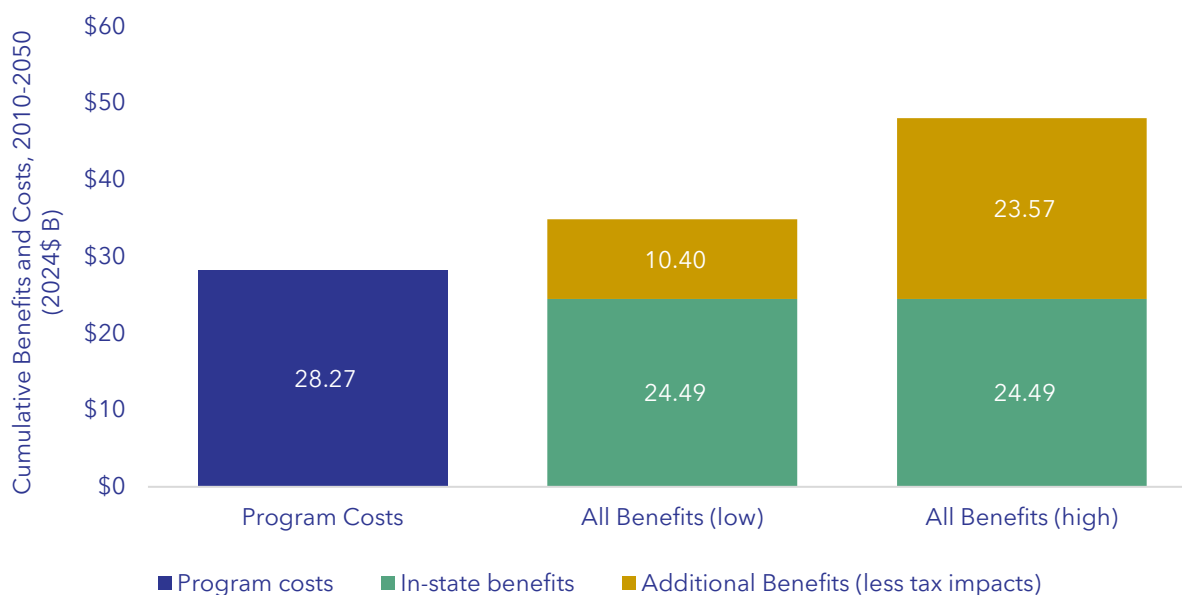


Figure 10 summarizes these costs and benefits and compares them with other quantified benefits, identified in Table 3. As mentioned previously, the Consulting Team Note did not include societal benefits or participant benefits in its primary analysis. If societal benefits were included, each program would be cost-effective (see Figure 11). For additional detail on costs and benefits, see this document's Appendix.



Figure 11. Costs, benefits, and other impacts, all programs, 2018-2050



Notes: "Additional Benefits" include benefits related to avoided greenhouse gases, improved public health, and out-of-state DRIPE effects, net of tax impacts. This analysis provide a range of benefits in line with a range of greenhouse gas benefits at different discount rates, and a range of public health benefits at different monetization levels.

On the cost side, energy costs—mainly from net metering— make up about 79 percent of total costs. Massachusetts has historically included different combinations or percentages of volumetric basic service, distribution, transmission, and transition rates in the net metering credit rate that net-metered facilities receive for monthly net excess generation. These rates vary by utility service territory, customer rate class, cap allocation reservation dates, and project size. Net metering credit values have also significantly increased over time and represent an opportunity to reduce costs from solar programs while maintaining the same level of benefits for ratepayers. This can be accomplished by evaluating how to properly compensate eligible generators for their net excess generation and adopting regulatory and/or statutory reforms to lower costs to ratepayers at large.⁴⁷

⁴⁷ For one example of a current effort to identify and reduce ratepayer costs, see MA DPU's December 15, 2025, opening of 25-200, An Investigation by the Department of Public Utilities on Its Own Motion into Gas and Electric Delivery Charges and Bill Redesign. Available at <https://fileservice.eea.comacloud.net/V3.1.0/FileService.Api/file/aehghabij?HGpQ/JXpoS8hz2B4LtVetGeQrh7dXR/Utfj5zj+lw7CPcSxI+blU344Khxm+qpOeq0hKFj9M9I/xQR8+/8GqPvdGgrFe6XR6nglfa80wd3rxFD8G4j981M2Rna9aVTXA>.



On the benefit side, the two largest categories of benefits are avoided distribution and avoided energy, which together make up 49 percent of total benefits. This represents an opportunity to further reduce ratepayer delivery charges by deploying resources to strategically mitigate necessary infrastructure upgrades.

The SMART program features a REC resale benefit, which allows EDCs to take title to RECs and resell them into the regional Class I marketplace to reduce the cost of the program for ratepayers. This category makes up 9 percent of the total direct benefits associated with SMART.

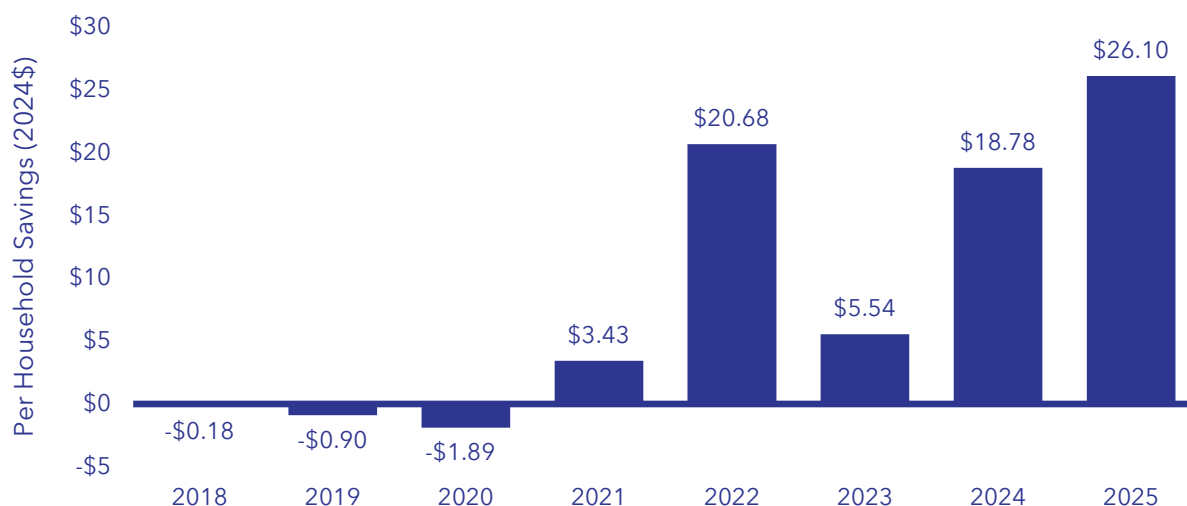
In addition, the SMART program has substantial paired-battery storage capacity: 40 percent of the total capacity deployed under this program includes a paired battery. Paired-solar-and-storage systems are estimated to have higher coincidence with peak demand than standalone solar systems. This higher coincidence factor boosts the benefits associated with reducing peak demand: capacity, capacity DRIPE, distribution, transmission, and reliability.

The net benefits of these programs can be converted into residential household impacts by dividing the total net benefits in each year by the number of kWh sold by the utilities participating in the SMART program (i.e., the three EDCs, Eversource, National Grid, and Unitil) and the net metering program (i.e., all utilities, including municipal utilities). This produces a dollar-per-kWh-consumed metric that can then be multiplied by a typical household's electricity consumption, or 545 kWh per month or 6,543 kWh per year.⁴⁸ Figure 12 illustrates how these residential bill impacts change over time. For the typical residential household located in one of the EDCs, DOER's Commonwealth's solar programs provided an average of \$9 in annual savings from 2018-2025.

⁴⁸ Derived using EIA Form 861, 2024, available at <https://www.eia.gov/electricity/data/eia861/>. For the purposes of this analysis (and all analysis in this report), "households" refers to residential customers in the EDC service territories (i.e., Eversource, National Grid, and Unitil). Customers in municipal utility service territories are not included.



Figure 12. Annual Household electric bill savings, 2018-2025



Bill savings tend to be highest in years with higher avoided costs. Notably, energy prices in 2022, 2024, and 2025 were higher than in other historical years due to global geopolitical impacts on the energy sector. Likewise, capacity and avoided capacity DRIPE avoided costs were exceptionally high in 2024 and 2025. As a result, solar MW and MWh active in these years produced greater-than-average levels of savings.

Conversely, all forward-going costs and benefits are estimated using “typical year” projections. In other words, they do not include the effects of atypical price changes, such as unexpected increases in natural gas prices driven by extreme weather or geopolitical events (unlike the estimates of historical benefits, which do include these impacts). As shown by historical data, solar facilities, particularly those that are compensated at a fixed rate (as with many facilities in the SMART program) help to insulate customers against volatile energy and capacity prices. The AESC 2024 study showed that in a future with high gas prices, net benefits could be 10 percent higher than those modeled in this study.⁴⁹

⁴⁹ See AESC 2024, Chapter 12, available at <https://www.synapse-energy.com/sites/default/files/inline-images/AESC%202024%20May%202024.pdf>.



4. Conclusions

This assessment of lifetime costs and benefits from solar programs deployed in Massachusetts finds the following:

- The SMART program provides \$1.49 in direct benefits to all ratepayers for every \$1 spent. It has provided \$11.5 billion in direct lifetime benefits at a cost of \$7.7 billion, and it provided almost \$600 million in benefits in 2025 alone.⁵⁰
- Including other indirect benefits in the analysis, such as public health and economic impacts, results in all evaluated Massachusetts solar programs providing benefits that exceed ratepayer costs.
- Energy costs, including net metering, make up about 79 percent of the total cost of solar compensation and represent the largest opportunity to further improve cost-effectiveness.
- Solar installations deployed since 2018 have provided an average of \$9 in annual savings per residential household, which increase when accounting for other indirect benefits.
- Solar provides energy independence for Massachusetts consumers and helps insulate them from energy price spikes associated with gas-fired generation. This is particularly true for the SMART program, for which, in most cases, total program costs per MWh are set when the solar array is installed.

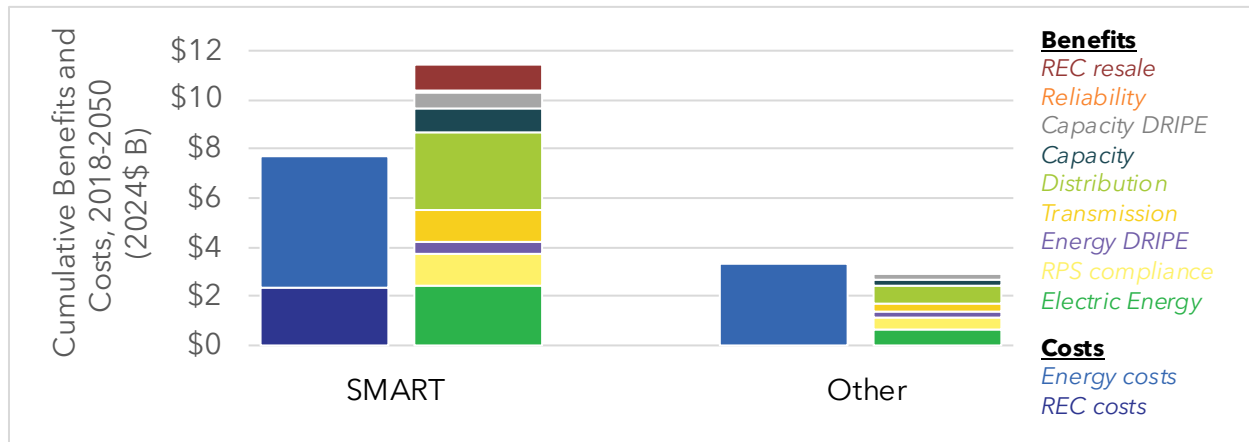
⁵⁰ Findings are based on the utility-system cost perspective and do not include societal benefits (e.g., avoided greenhouse gas emissions or improved public health) or participant benefits.



5. Appendix

Figure 13 and Figure 14 provide additional information on costs and benefits.

Figure 13. Costs and benefits by program, 2018-2050



Note: Costs and benefits in this figure do not include the tax impacts and out-of-state benefits shown in Figure 14.

Figure 14. Costs and benefits including additional impacts, 2018-2050

