Near-Term Rate Design to Align with the Commonwealth's Decarbonization Goals

Prepared for the Massachusetts Interagency Rates Working Group

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Energy+Environmental Economics

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MASSACHUSETTS CLEAN ENERGY CENTER

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Table of Contents

Table of Figures

Table of Tables

Executive Summary

Study Background

Guided by the Massachusetts Clean Energy and Climate Plan (CECP) for 2050 and catalyzed by the Global Warming Solutions Act, the Commonwealth of Massachusetts has embarked on a path towards the rapid evolution of its energy economy. The portfolio of generators that supply electricity is shifting away from fuel-based fossil resources towards clean and renewable resources. Concurrently, the CECP calls for widespread electrification as a core strategy to reduce greenhouse gas (GHG) emissions in the building and transportation sectors. However, customers seeking to adopt clean electric technologies, especially those transitioning away from natural gas heating, risk bill increases due to the existing electric rate structure. The drive to decarbonize the energy system in Massachusetts is occurring against the backdrop of a broader affordability crisis for low-income customers. As the energy economy undergoes this transformation, electric rate designs must evolve to better support electrification as well as energy affordability for low-income customers in the Commonwealth.

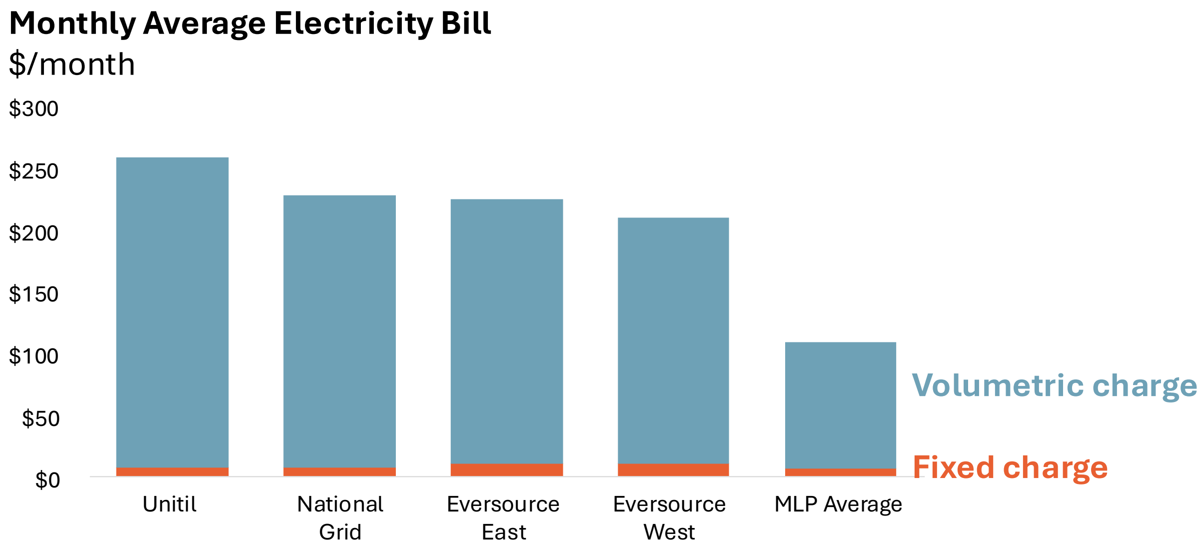
The Massachusetts Interagency Rates Working Group (IRWG), comprised of representatives from the Executive Office of Energy & Environmental Affairs (EEA), the Department of Energy Resources (DOER), the Massachusetts Clean Energy Center (MassCEC), and the Attorney General's Office (AGO), was formed to advance near- and long-term electric rate design and ratemaking that aligns with the Commonwealth's decarbonization goals. To support the IRWG, Energy & Environmental Economics (E3) authored this report, along with the Long-Term Ratemaking Study, which will be released in January 2025. These reports have supported the IRWG in developing Near- and Long-Term Recommendations.

Electric Rates Today

For decades, residential electric rates in the Commonwealth have relied on volumetric per-kWh charges to recover the majority of electric system costs. This approach to rate design, still in use today, reflects a policy choice that was broadly intended to create price signals that encourage conservation and efficiency. However, this fails to reflect that a large share of collected utility costs does not vary based on volumetric customer electricity usage, such as the costs of existing infrastructure and the costs of programs and policies currently collected through electric rates. In the Long-Term Ratemaking Study, we examine the opportunities to avoid forward-looking utility costs through reductions in peak demand and volumetric consumption.

ES Figure 1 illustrates the existing design of electric rates by showing an average monthly electricity bill for residential customers of different electric utilities, broken out by volumetric charges (¢/kWh) and monthly fixed charges ($/mo). This figure shows average bills for the state's three investor-owned electric distribution companies as well as an average for the state's Municipal Light Plants (MLPs). Depending on the utility, volumetric charges make up between 95% and 97% of customer bills.

ES Figure 1: Monthly Average Electricity Bill in 2023 for MA Household Under Existing Rates for Different Utilities (600 kWh/mo.)[1]



The CECP calls for rapid adoption of building and electrification technologies, including the installation of heat pumps in 500,000 residential homes by 2030.[2] However, the current approach of recovering nearly all electric system costs through a flat volumetric rate has important negative impacts for electrification. Under this rate design approach, adoption of electric technologies like electric heat pumps and electric vehicles (EVs) may not result in favorable bill impacts for customers, especially for customers with gas heating. Other rate design approaches are needed to support greater and more reliable cost savings for customers who adopt building and vehicle electrification technologies. In addition, any changes to rate design must also consider energy affordability for low-income customers, regardless of electrification status.

Study Approach

In this report, we evaluate customer bills for a wide range of residential building and customer types in Massachusetts to explore the following research questions:

1. What are key drivers of energy bills and affordability for residential customers today, including those in low-income and moderate-income households?
2. Under today's electricity rates, what are the anticipated energy cost impacts for customers looking to adopt building and vehicle electrification technologies?

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[1] The analysis presented here takes a simple average of monthly electricity consumption per household in Massachusetts today, ~600 kWh per month, and applies each electric service provider's rates to that amount to provide indicative bill comparisons. The analysis presented later in this report uses simulated building energy data to capture nuances in energy usage by building type, heating fuel and technology, vintage, and other characteristics, as well as seasonal variation in energy demand.

[2] Massachusetts Clean Energy and Climate Metrics. https://www.mass.gov/info-details/massachusetts-clean-energy-and-climate-metrics.

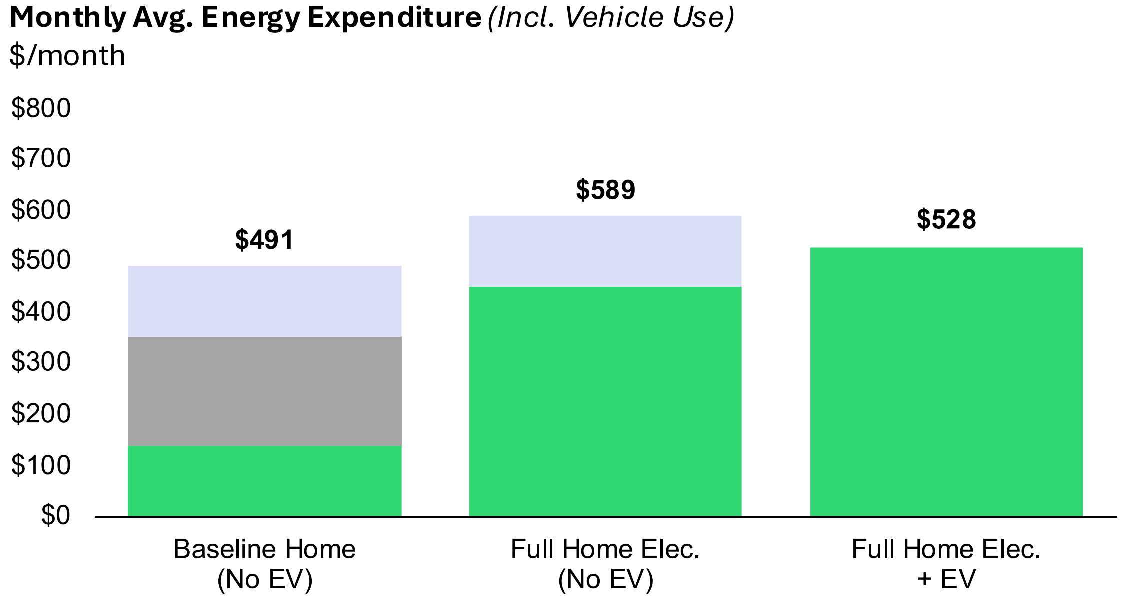
3. How could alternate rate design options help support greater and more reliable bill reductions from electrification, while also supporting energy affordability for both electrifying and non-electrifying households?

This report is focused on near-term rate options that could be implemented before the widespread deployment of advanced metering infrastructure and while the New England grid remains "summer-peaking," *i.e.*, sized to meet peak electric load in the summer. Longer-term rate design options, including time-varying rates, as well as regulatory and ratemaking reforms, are explored in the companion report to this study, **Long Term Ratemaking to Align with the Commonwealth's Decarbonization Goals**, which also considers the potential for the grid shifting to become winter-peaking in the 2030s. The Long-Term Ratemaking Study will be released in January 2025.

Key Findings: Current Rates and Affordability

- **Under existing electric rates, electrification generally increases customer energy bills for homes with natural gas heating, which are the majority of homes in Massachusetts.** Today, customers in the Commonwealth pay for electricity through high volumetric rates, low fixed charges, and no seasonal differentiation of delivery costs. This rate structure, combined with relatively inexpensive gas rates, often leads to bill increases for customers looking to electrify homes with natural gas heating. ES Figure 2 illustrates these dynamics. In contrast, homes heated with electric resistance are expected to see bill savings from heat pump adoption under today's rates. Considering heating fuel types in Massachusetts, electric heat pumps are expected to have similar operating costs to fuel oil boilers, despite high fuel oil costs, while heat pumps are generally cheaper to operate than propane boilers under today's rates and fuel costs.
- **Vehicle electrification generally leads to energy cost savings under today's rates for customers with access to home charging.** EVs reduce fueling costs due to the high efficiency of EVs and the relatively high cost of gasoline. However, as shown in ES Figure 2, these savings may not be enough to offset bill increases from building electrification, nor would EV savings necessarily factor into a customer's decision regarding home electrification. In addition, residents in multifamily buildings may have limited access to home charging, and reliance on higher-cost public charging will reduce expected savings from vehicle electrification.

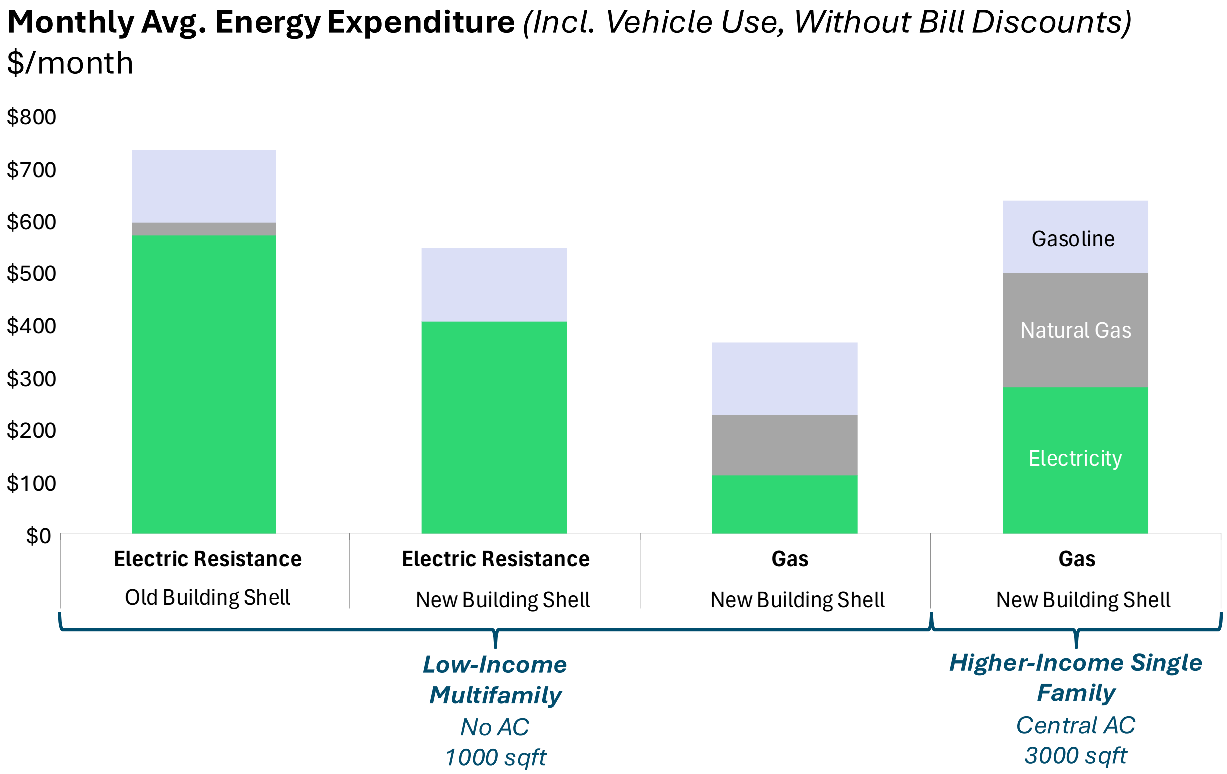
ES Figure 2: Monthly Average Energy Expenditure with Existing Rates, Natural Gas Heated Home[3]



- **Low-income households in Massachusetts may face high energy use and costs due in part to poor insulation and limited weatherization in older homes and a high reliance on costly electric resistance heating.** ES Figure 3 illustrates how, due to these factors, low-income customers without air conditioning (AC) may face similar or even greater energy costs relative to higher-income customers who do have AC. Utility bill discount programs help reduce the energy burden for customers at or below the eligibility threshold of 60% of state median income, but we find that energy burdens are unacceptably high for very low-income households, especially those relying on electric resistance heating. Additional important considerations include the possibility of heating cost shifts for renters in multifamily homes who do not currently pay directly for heating, as well as the prevalence of "hidden energy poverty," or customers curtailing heating or cooling service to unsafe levels to avoid utility bill increases. These important considerations are outside the scope of this analysis but are discussed qualitatively to provide additional context on the energy affordability challenges for low-income households.

[3] Pre-1970 vintage, 1700 square foot home in multifamily housing in Central Massachusetts, with baseline room AC (60% coverage) and gas heating

ES Figure 3: Monthly Average Energy Expenditure across Fuel and Vintage



- **Because heat pumps provide AC service, heat pump adoption is expected to increase the share of customers with access to AC. This will provide important comfort benefits to customers who adopt heat pumps, though it will put upward pressure on customer bills, which is reflected in our analysis**. Today, roughly 33% of Massachusetts households have room AC (i.e., window units), and about 18% of households have no AC at all.[4] Thus, heat pump adoption may dramatically increase space cooling availability for residents of the Commonwealth, with important impacts for comfort, utility costs, and customer bills. These impacts may be especially relevant for low-income households, who are less likely to have central AC today.

Key Findings: Near-Term Rate Designs

- **This report considers four new rate designs that would better align electric system costs with the prices customers pay for electricity and would provide lower volumetric rates that better support electrification.** All four can be implemented in the near term, before the widespread deployment of advanced metering infrastructure. The first two designs would be open to all residential customers, while the third and fourth designs would be restricted to

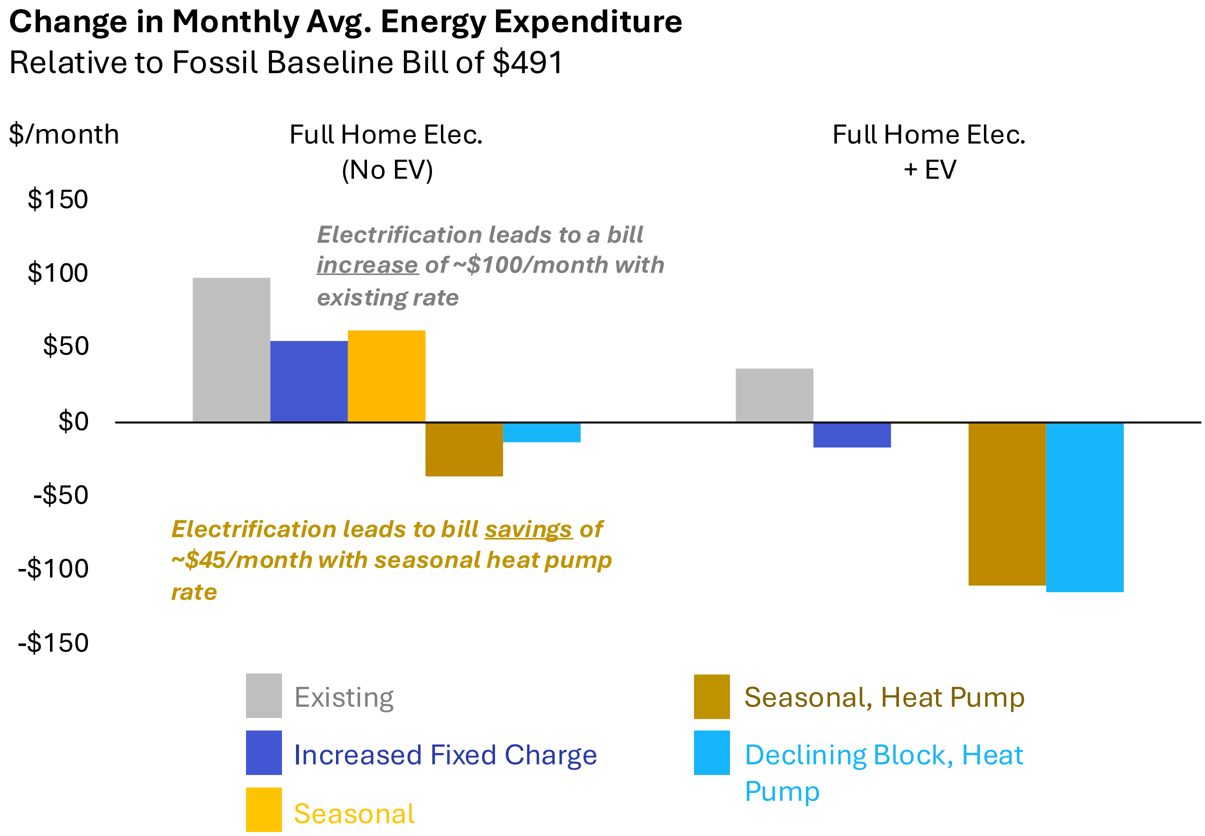
[4] Brossman, Jes, Lixi Liu, Ben Polly, Elaina Present, Jenny Erwin. 2023. "State Level Residential Building Stock and Energy Efficiency & Electrification Packages Analysis". Tableau Dashboard.

customers with heat pump technologies. EV-specific rates were not evaluated because EV adoption is generally found to result in energy cost savings under existing rates.

1. **Increased Fixed Charge**: increased monthly fixed charges to a level that recovers the majority of policy and program costs, with a corresponding reduction in volumetric rates.
2. **Seasonal**: increased share of annual costs recovered through summer volumetric rates, providing a discount on winter volumetric rates. This design reflects that, in the near-term, the grid is summer-peaking and increasing winter loads does not typically require large new electric system investments.
3. **Seasonal (heat pump customers only):** technology-specific rate offered only to heat pump customers, offering a more significant discount in winter volumetric rates, with further increased summer volumetric rates.
4. **Declining Block (heat pump customers only):** technology-specific rate offered only to heat pump customers, offering a significant discount for electric consumption beyond a specified monthly usage amount.

- **The heat pump-specific rate designs can deliver bill reductions for electrifying customers while limiting risks of adverse bill impacts to non-electrifying customers in the near term.** Of the four rate designs considered, we find the two technology-specific rates result in larger improvements in the cost-effectiveness of electrification. ES Figure 4 shows the bill impacts from electrification under each of the four rate options modeled as well as under existing rates. Note that, although these rates are modeled independently, these rate design elements could be combined in a future rate offering.

ES Figure 4: Bill Impacts of Electrification with Alternate Rates – Natural Gas Baseline[5]



- **Each of the four rate design options has advantages and disadvantages, as discussed here and in ES Table 1.** All four rate options are designed to reduce volumetric rates to support electrification.
  1. **Increased fixed charges would reduce volumetric rates, improving electrification affordability and overall cost-reflectiveness, while impacts on low-income customers can be mitigated through progressive designs.** This rate design approach could be combined with any of the other design strategies. One important concern is that larger fixed charges can cause bill increases for non-electrifying customers with below average usage. However, these impacts could be mitigated for low-income customers through the use of progressive designs, such as the tiered discount recently approved for use by National Grid.[6] In addition, this rate design change could be durable in the long term, whereas seasonal rate options may need to be re-evaluated when a winter peak develops.

[5] Pre-1970 vintage, 1700 square foot home in multifamily housing in Central Massachusetts, with baseline room AC (60% coverage) and gas heating. Home consumes ~1300 kWh/month with full home electrification, weatherization, and no EV, and ~1550 kWh/month with full home electrification, weatherization and an EV. Baseline assumed 40 gallons of gasoline/month and 120 therms of natural gas usage/month.

[6] Tiered discount rate approved in D.P.U. 23-150 Order (2024).

2. **Seasonal rates with winter discounts would increase bill savings for electrifying customers but may no longer reflect underlying system costs once the system becomes winter peaking, which is forecast to occur in the 2030s.**[7] As more households and businesses electrify to meet state climate goals, winter peak electricity demand is expected to eclipse summer peak demand and drive future electric system costs. After this point, seasonal rates with a winter discount would need to be discontinued, which could lead to potential price shocks for customers. Two additional concerns are: 1) seasonal rates would not provide significant improvements for the cost-effectiveness of vehicle electrification, and 2) by increasing summer pricing, seasonal rates may encourage low-income customers to curtail AC usage that may be needed for comfort and health.
3. **Heat pump-specific seasonal rate designs could provide a greater reduction in winter volumetric charges, at least in the near-term, while limiting impacts on customers who do not electrify.** However, these rates will face the same challenges described above for class-wide seasonal rates, including the need to discontinue these rates when a winter peak emerges on the grid.
4. **Declining block rates present bill savings for electrifying customers, including for vehicle electrification. However, these rates weaken the price signal for conservation at the margin**. This could have the unintended impact of increasing customer usage during summer peaks, which would increase system costs. Like the seasonal rates, this option would no longer be cost-reflective for heat pump customers in a winter-peaking system, given that the hours of winter electric heating demand will coincide with those of system peak demand.

- **The most effective near-term design will likely combine elements from multiple rate options and layer on top of programs that promote affordability, demand flexibility, and clean technology adoption.** Technology-specific rates and/or opt-in rates available to all households may help allay concerns regarding bill impacts for non-electrifying customers.

[7] https://www.iso-ne.com/about/key-stats/electricity-use.

ES Table 1: Summary of Considerations of Alternative Rate Designs

	Increased Fixed Charge	Seasonal	Seasonal (Heat Pump)	Declining Block (Heat Pump)
Electrifying Customer Affordability	Modest improvement over today's rates (assuming modest fixed charge)	Modest improvement over today's rates	Bill savings for most archetypes studied; minimal improvement for EV affordability	Bill savings for most archetypes studied
Low-Income Customer Affordability	Bill increases for low-usage customers; mitigated through progressive designs like tiered discounts	Higher cost for summer cooling Bill savings for electric resistance customers	N/A (Technology-specific)	N/A (Technology-specific)
Alignment with Cost of Service	Collects some non-volumetric costs with fixed charge	In the near term, better aligns rates with seasonality of system costs On a winter-peaking grid, would no longer reflect seasonality of system costs	In the near term, better aligns rates with seasonality of system costs On a winter-peaking grid, would no longer reflect seasonality of system costs	In the near term, more reflective of cost of service for heat pump customers than existing rates On a winter-peaking grid, would no longer reflect cost of service for heat pump customers
Implementation Challenges	Class-wide rate change would require greater outreach and regulatory process	Class-wide rate change would require greater outreach and regulatory process	Reduced concerns for impacts to non-electrifying customers	Reduced concerns for impacts to non-electrifying customers
Technical Challenges	Implementation of progressive fixed charges can utilize tiered discount approach currently under development	Minimal billing system change required	Minimal billing system change required	Change required to EDC billing systems to accommodate block structure
Stakeholder Perspectives			**Appears to have the greatest acceptance across stakeholder groups**	

Introduction and Study Scope

The Massachusetts Clean Energy and Climate Plan (CECP) for 2050 identifies electrification as a core strategy to reduce greenhouse gas (GHG) emissions in the building and transportation sectors. However, customers seeking to adopt clean electric technologies, especially those transitioning away from natural gas heating, risk potential bill increases due to the existing electric rate structure. The Massachusetts Commission on Clean Heat Final Report recommended evaluation of alternate electric rate designs (i.e., the way in which consumers are charged for electric service) to help consumers lower energy costs for efficient electric heating. A distinct, yet related, policy goal for rate reform is to improve energy affordability for households, as specified in the 2023 Recommendations of the Massachusetts Climate Chief: "As the Commonwealth accelerates building electrification, the [Department of Public Utilities (DPU)] should prioritize any rate reform necessary to ensure that electric bills will be affordable for all households, particularly those with low and moderate incomes."[8]

Accordingly, the Interagency Rates Working Group (IRWG) was formed to advance near- and long-term electric rate structures that align with the Commonwealth's decarbonization and energy affordability goals. The IRWG includes representatives from the Executive Office of Energy & Environmental Affairs (EEA), the Department of Energy Resources (DOER), the Massachusetts Clean Energy Center (MassCEC), and the Attorney General's Office (AGO). Energy & Environmental Economics (E3) is supporting the IRWG in developing three research products for this study:

- **Residential Electric Rates Assessment** to explore the current state of residential electric rates in Massachusetts and describe the policy and regulatory landscape that shapes ratemaking.
- **Near-Term Rates Strategy** to address barriers to near-term electrification by residential customers through rate design offerings available before electric customers receive advanced metering infrastructure (AMI) meters.
- **Long-Term Ratemaking Study** to present a vision and recommendations for advancing ratemaking mechanisms and residential rates for a decarbonized energy system and the associated technologies and capabilities available.

Accompanying this study, the IRWG independently developed a report detailing final recommendations, with the goal of informing a potential DPU inquiry into rate structures and ratemaking reforms necessary to achieve the Commonwealth's decarbonization goals.

This study process was guided by extensive stakeholder engagement, including presentations of interim findings to the public, solicitations of feedback from stakeholders, and focused discussions with representatives from different stakeholder groups including:

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[8] Recommendations of the Climate Chief, October 2023. https://www.mass.gov/files/documents/2023/10/24/CLIMATE%20REPORT.pdf.

- Consumer and advocacy organizations,
- Electric distribution companies (EDCs), municipal light plants (MLPs), and suppliers, and
- Distributed generation (DG) and distributed energy resources (DER) organizations.

The scope of this study is limited to the residential customer class and does not address cost challenges faced by commercial and industrial customers, who display a much wider spectrum of energy usage profiles and building technology configurations compared to residential customers. Commercial and industrial customers can access a wide range of electric rate designs today, with more advanced billing elements such as time-of-use rates and demand charges.

For customers in the Commonwealth, electric rates are split into two categories: *supply,* the cost of procuring electricity, and *delivery*, which includes the costs of electric transmission, distribution, programs, and other utility charges. This report focuses on rate design for *delivery rates*, as customers already have access to different supply rate options, including through competitive suppliers, MLPs (depending on location), and a monthly supply rate through the EDCs. Supply rates are considered in greater detail in the Long-Term Ratemaking Study.

The analysis presented throughout this study uses the National Renewable Energy Laboratory's ResStock database of household energy profiles to develop energy usage data for a wide set of Massachusetts-specific customer types and to explore the bill impacts of existing and alternate rate structures on monthly energy costs. The set of prototypes reflects energy consumption for a diverse set of homes in the Commonwealth but should not be treated as a statistical sample of the population of buildings in the state. The modeling framework uses EDC billing determinants to inform revenue-neutral rate options. The analysis does not capture the induced effects of alternate rate designs on future electric demand and the subsequent rate implications of increased or reduced class-wide electricity demand. The modeling framework is detailed in the Appendix.

Customer economics for electrification will also depend on important considerations such as upfront equipment costs, available incentives, maintenance costs, customer and installer education, and other factors. These considerations are outside the scope of this study.

Energy affordability can be defined as the ability of households to access reliable and sufficient energy services and maintain comfortable living conditions without compromising their financial well-being, influenced by energy costs, energy usage, efficiency, and access to modern energy technologies.[9] Understanding the energy burden implications of existing and alternative rate designs on low- and moderate-income households is an explicit goal of this study, as well as understanding the impact of different state and utility energy affordability assistance programs currently offered. As shown in Figure 5, while this study addresses the way electric utilities recover their annual revenue requirement through rates, the analysis does not explore ways to mitigate the total level of electric revenue requirement, the impact of participation in new rates on total electric system costs, or alternatives to existing energy affordability programs.

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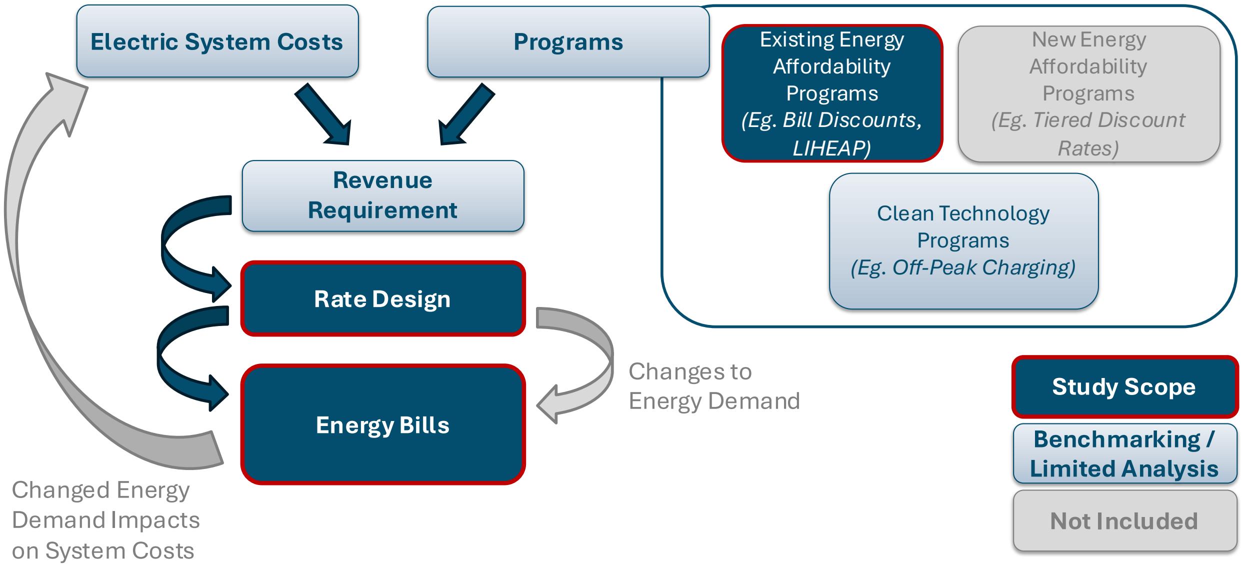
[9] Near-Term Rate Strategy Report Affordability Feedback for the Interagency Rates Working Group and Appendix: Defining Energy Affordability, December 2024, https://www.mass.gov/doc/irwg-near-term-rate-strategy-recommendations/download.

Figure 5: Study Scope



Section I: Electric Rates in Massachusetts Today

An important objective of this study is to shed light on how electric rates are reflected in customer bills, and how the current ratemaking approach in the Commonwealth may be at odds with the state's climate policy and energy affordability mandates and objectives. Understanding today's rates is a crucial first step towards exploring alternative rates in the near and long term that are better suited for a changing electric system, changing policy goals, and new customer technologies. This section covers the following topics:

- The structure of residential electric rates in Massachusetts today.
- The policy, technology, and regulatory considerations relevant to ratemaking in Massachusetts.
- Energy expenditure and bill impacts of electrification today across different household types and customer profiles.
- Energy burden in low- and moderate-income households.

1.1 Residential Electric Rate Components

Residential customers in Massachusetts receive their electric service (i.e., physical delivery of electricity) either from an investor-owned EDC or from a publicly owned MLP. There are fifty municipalities served by MLPs in Massachusetts, while all other Massachusetts residents have their electricity delivered by one of three EDCs: National Grid, Eversource, or Unitil. Table 2 shows the number of residential customers served by each utility in December 2023. The default residential rate structure for EDC customers in Massachusetts is a high-volumetric, low-fixed charge "R-1" rate, with an income-qualified "R-2" alternative rate, offering a utility-specific bill discount on the total electric bill for low-income customers. Secton 1.5 Energy Burden in Low- and Moderate-Income Households Today details the income thresholds, state bill assistance programs, and utility bill discounts offered to low-income residents.

Table 2: Residential Customers Served by MA EDCs as of December 2023[10]

Utility	Customer Class	Number of Customers
National Grid	Residential	999,513
	Residential: Low-Income	153,748
Eversource-East	Residential	146,742
	Residential: Low-Income	44,033
Eversource-West	Residential	967,685
	Residential: Low-Income	108,844
Unitil	Residential	21,493

[10] Latest available annual data at time of report development.

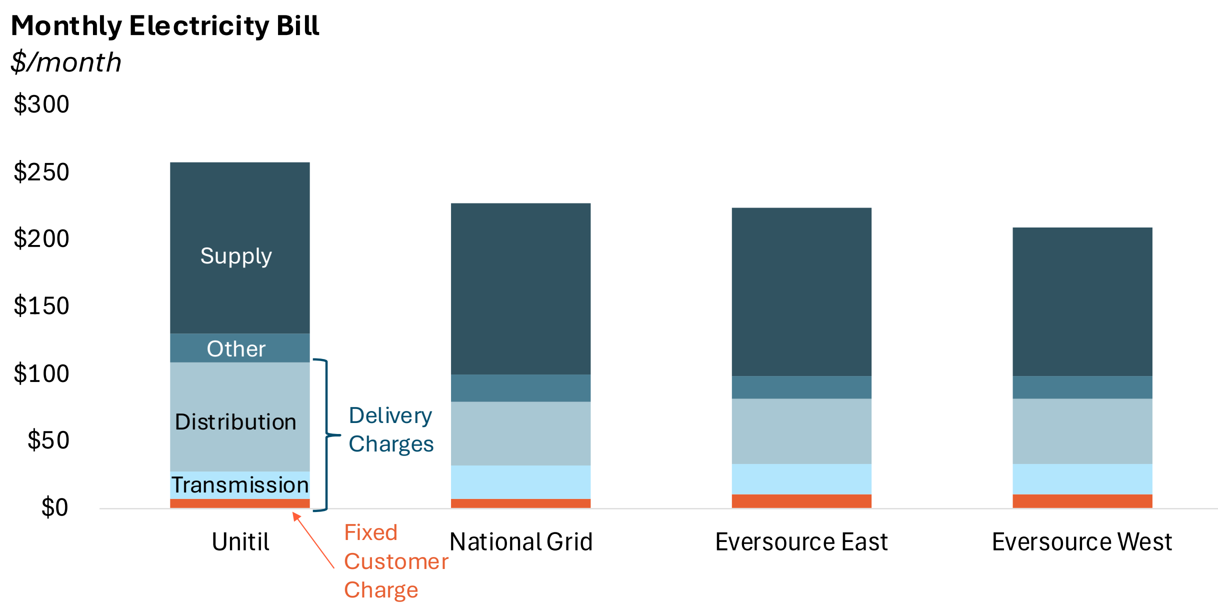
	Residential – Low Income	5,258
MLPs	Total	431,600

We present the costs recovered on an electricity bill in three separate categories: supply costs, delivery costs, and "other" costs:

- **Supply**: This covers the energy supply procured in one of three ways: (1) by the utility from electricity generators and is passed through directly (i.e., without utilities collecting a margin) to customers; (2) though a municipal aggregation; or (3) through a competitive supplier.
- **Delivery (T&D)**: This covers the utility's costs of building, operating, and maintaining the distribution system, as well as the utility's share of costs for the transmission network.
- **Other**: These charges fund energy efficiency programs, solar-incentive programs, low-income bill discount programs, and other programs reflecting state policy priorities such as electric vehicle incentives.

Figure 6 provides a bill breakdown into these categories for a customer consuming 600 kWh per month, the statewide household average, for each EDC service territory. Delivery costs are broken out into transmission and distribution, both of which are billed on a volumetric $/kWh basis, and fixed customer charges, which are billed by $/customer/month.

Figure 6: Electricity Bill Breakdown for 600 kWh/mo. customer



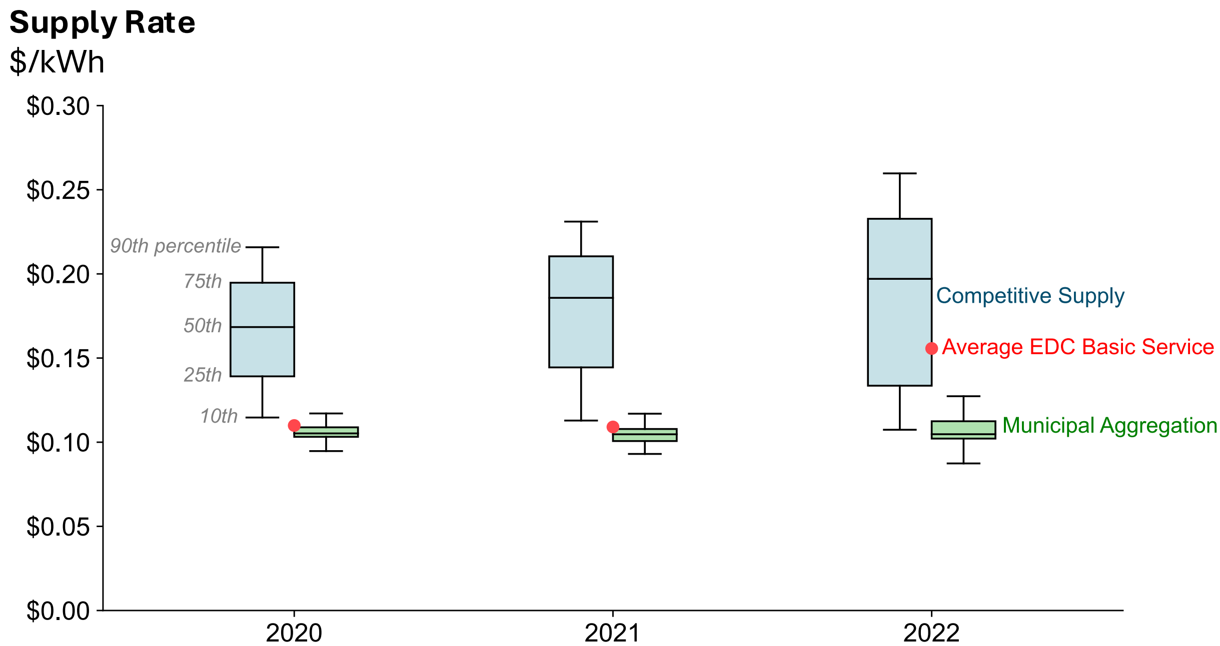
1.1.1 Supply

Massachusetts has a competitive retail supply market, which provides EDC customers with three choices for purchasing their supply: procurement via the utility itself ("basic service"), selecting a third-party competitive supplier, or enrolling in a municipal aggregation, which is available in many but not all municipalities. For basic service, EDCs offer fixed and monthly-varying supply options, with most customers opting for the fixed rate.[11] Competitive suppliers are third-party providers that offer a contract to customers.[12] Competitive supply rates are structured in different ways, including the fixed and monthly variable options similar to basic service rates. Municipal aggregation rates enable municipalities to purchase electricity supply on behalf of customers living in that city or town, who then have the option to choose between EDC basic service and municipal supply rate options.[13]

According to the Massachusetts Department of Energy Resources, about 36% of residential customers as of June 2024 defaulted to their EDC basic service option, while 45% participated in a municipal aggregation and 19% selected a competitive supplier.[14] Figure 7 shows that while most competitive supply rates are more expensive than an average EDC basic service rate, municipal aggregations tend to offer supply rates at or below average EDC basic service rates. From 2019 to 2022, on average 76% of customers on competitive supply rates paid more for energy supply than the EDC basic service rate offered in their area.[15] While competitive supply and basic service rates saw rate increases from 2020 to 2022, especially in 2022, increases in municipal aggregation rates were more moderate.

[11] https://www.eversource.com/content/residential/account-billing/manage-bill/about-your-bill/rates-tariffs/electric-supply-rates and https://www.nationalgridus.com/MA-Home/Rates/Supply-Costs.
[12] https://www.mass.gov/info-details/competitive-electric-supply-product-overview.
[13] https://www.mass.gov/info-details/municipal-aggregation Municipal aggregation is typically the default rate for customers within the municipality, with an option to opt-out of the rate.
[14] Massachusetts Department of Energy Resource, Electric & Gas Customer Choice Data, https://www.mass.gov/info-details/electric-gas-customer-choice-data.
[15] "A Predatory and Broken Market: the 2024 Update Analysis of the Individual Residential Electric Supply Market in Massachusetts", Massachusetts Attorney General's Office, 2024.

Figure 7: Distribution of Electric Supply Rates Offered to Massachusetts Consumers



Supply charges tend to be the most volatile component of a customer bill, linked to market-driven variability in wholesale energy costs, which are influenced factors including fuel prices, customer demand, weather patterns, regional electricity policy, and others. This volatility can be seen in Figure 8, which shows electric bills from 2019 through 2023 for a Massachusetts household using a statewide average of 600 kWh per month.[16] From January 2022 to January 2023 alone, a 600 kWh monthly bill under an EDC basic service rate increased by 47% from $183 to $259. The main driver of the increase in electricity costs in the last two years has been an increase in energy supply rates: EDC basic service rates went from an average of 11¢/kWh in 2021 to 16¢/kWh in 2022 to 20¢/kWh in 2023 – an 88% increase over two years. Increased energy supply costs were largely caused by an increase in natural gas prices, which went from an average of $2.03/MMBtu in 2020 to $6.41/MMBtu in 2022,[17] driven partly by increased demand in 2021 as the economy recovered from the COVID-19 pandemic and partly by the shock to the global natural gas market from the Russo-Ukrainian War. As stated above, this study does not analyze alternative ways to structure electric supply cost recovery, given the limited regulatory authority of regulators in Massachusetts over this portion of electric costs since electric utilities were restructured in 1997,[18] allowing consumers to choose electric suppliers besides the utility delivering electricity to them.

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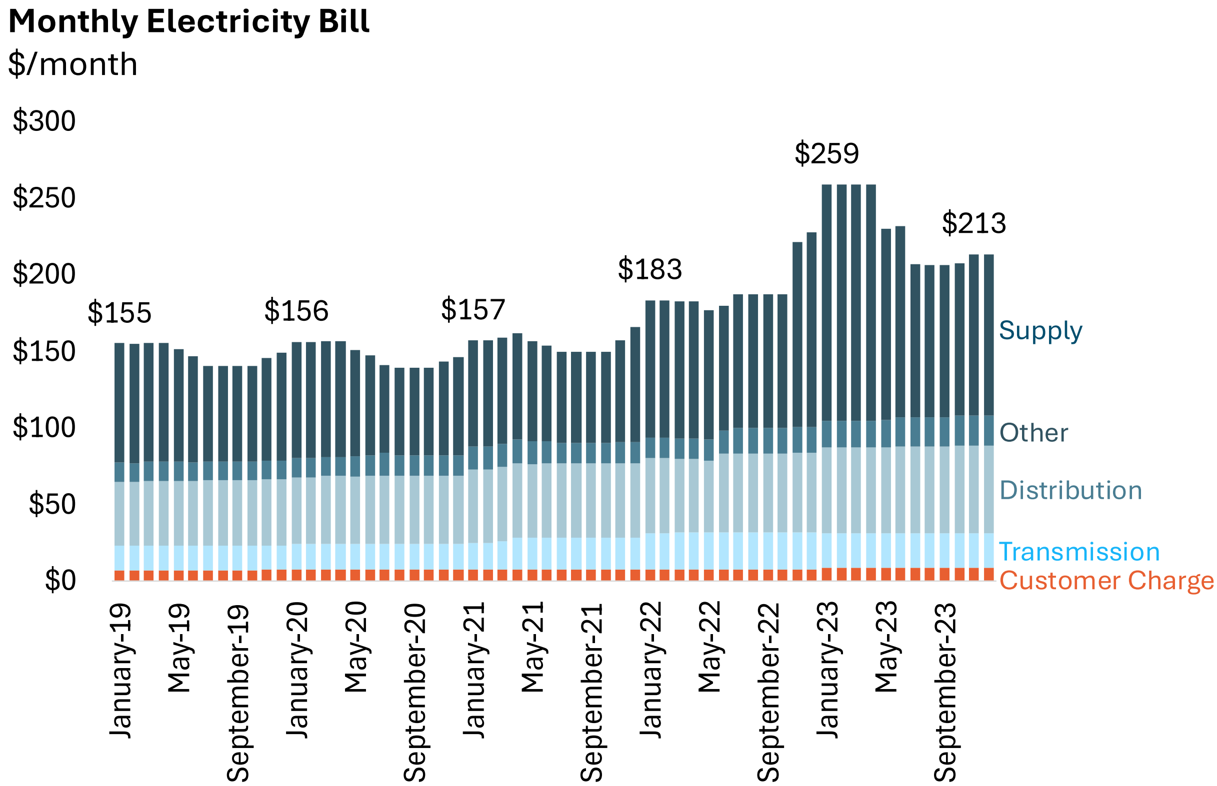
[16] According to the US Energy Information Agency's 2020 Residential Energy Consumption Survey, the average Massachusetts household consumed about 600 kWh per month in 2020. See State Data, CE4.1EL.ST – Electricity by end use by state – totals, https://www.eia.gov/consumption/residential/data/2020/index.php?view=state#ce.
[17] Federal Reserve Economic Data, https://fred.stlouisfed.org/graph/?g=1bBW.
[18] Electric Industry Restructuring Act, 1997.

Figure 8: Historical 600 kWh Electricity Bills from an Average of EDC Rates



1.1.2 Delivery

Unlike with supply charges, customers have no choice over the provider of their delivery service. Electricity delivery is considered to be a "natural monopoly," where increased competition in transmission and distribution infrastructure is unlikely to yield lower prices for customers. Thus, electricity infrastructure in each location is owned and operated by a single utility. Accordingly, customers pay delivery rates to their local utility service provider (i.e., the EDC or MLP) based on their location. Delivery rates can be simplified into two broad categories:

- Distribution: costs associated with building, maintaining, and operating a low-voltage system of transformers, poles, and wires to deliver electricity to end users — owned and managed by EDCs and overseen by the DPU, or by an MLP. Distribution costs also include the costs of operating the utility itself. These costs are recovered via volumetric charges as well as a fixed customer charge.
- Transmission: costs associated with the higher-voltage bulk power grid, which transmits power from generators to the local distribution grid — owned by transmission utilities, managed by Independent System Operator New England (ISO-NE), and overseen by the Federal Energy Regulatory Commission (FERC). These costs are recovered via a volumetric charge.

1.1.3 Other Costs

Beyond supply and delivery, EDCs also collect costs to support programs and policies approved by state regulators or the Massachusetts Legislature. These other costs are recovered through volumetric rate adders. Table 3 below provides a detailed list of these line items; the complete list of electric rate components by utility can be accessed in the Massachusetts Electricity Rates Database, which was developed earlier on in this study's timeline.

Table 3: "Other" Costs (Program and Policy Costs) in EDC Delivery Rates (2023)

Component	Definition	2023 EDC Average Value (¢/kWh)
Energy Efficiency Reconciliation Factor (EERF)	Along with the System Benefits Charge, covers the costs of energy efficiency included in the energy efficiency plan approved by the DPU.	¢2.2
Residential Assistance Adjustment Factor (RAAF)	Covers the cost of the low-income discount rate and incremental expenses of the Residential Arrearage Management Program.	¢1.6
Distributed Solar (SMART)	Covers the cost of DOER's Solar Massachusetts Renewable Target (SMART) program to incentive the development of solar in Massachusetts. This helps to build out the solar industry in the Commonwealth.	¢0.6
Energy Efficiency System Benefits Charge (EESBC)	Covers the costs of energy efficiency included in the energy efficiency plan approved by the DPU (pursuant to M.G.L. Ch. 25 section 19).	¢0.3
Storm Cost Recovery Adjustment (SCRAF)	Covers the costs of exogenous storm events outside a certain threshold.	¢0.2
Revenue Decoupling Adjustment Factor (RDAF)	Covers the rate adjustment as a result of the reconciliation of target revenues from actual revenues; designed to reduce utilities' incentive to increase sales and to align with policy goals of reducing energy consumption and increasing distributed generation.	¢0.2
Vegetation Management Factor (VMF)	Covers the costs of incremental vegetation-management costs associated with the EDC programs.	< ¢0.1
Renewable Energy	Provides funding to the Massachusetts Renewable Energy Trust Fund, administered by the Massachusetts Clean Energy Center, a quasi-public research and development agency (pursuant to M.G.L. Ch. 25 section 20).	< ¢0.1
Electric Vehicle Program Factor (EVPF)	Covers costs (across categories incl. capital, R&D, marketing, evaluation, etc.) associated with utility EV programs. This funds rebates for chargers and for infrastructure to support EV charging.	< ¢0.1
Transition Charge Adjustment Factor (TCAF)	Costs collected from utility restructuring, i.e., utilities shifting to delivery-only and divesting from generation. This charge includes the costs of generation-related assets, investments, and obligations (pursuant to M.G.L. Ch. 164 section 1G).	< ¢0.1
Base Transition	Similar to TCAF, covers stranded or transition costs associated with utility deregulation, i.e., utility cost recovery of generation-related assets.	¢ (0.2)

1.2 High Volumetric Rates

In Massachusetts and the rest of the country, electric service providers commonly rely on per-kWh volumetric charges to recover costs from residential customers, with limited recovery through fixed monthly per-customer charges. This approach reflects efforts to promote energy efficiency and conservation and dates back to a historical grid with costs driven primarily by high fuel costs for oil generation. However, electric system costs look dramatically different today. First, the costs of *delivery* have grown to become an increasingly large share of total utility costs. Second, the costs of *supply* have shifted toward natural gas, a much less expensive fuel than oil, and continue to shift toward renewables with little to no variable cost. The balance of cost recovery through fixed and volumetric charges in existing rates does not reflect this new cost structure.

Figure 9 illustrates the current balance of cost recovery from volumetric and fixed charges, showing average monthly bills for a hypothetical 600 kWh per month customer in each EDC and MLP.[19] For this usage level, the volumetric rate accounts for 95-97% of the bill across EDCs and MLPs. Municipal utilities typically charge their customers lower volumetric rates than EDCs, for varied reasons including municipal utilities' access to lower costs of capital, exemptions from taxes, smaller (and often denser) service territories, and different programs and initiatives funded through rates.[20] The latter sections of this report focus on EDC rates due to (1) availability of EDC billing determinant data, (2) EDC customers comprising the majority of total households and total electricity consumption in the state, and (3) higher EDC electricity rates presenting a greater challenge for electrification today. However, the principles of rate design and the suggestions within this report are relevant and applicable for MLP rate design as well.

[19] According to the US Energy Information Agency's 2020 Residential Energy Consumption Survey, the average Massachusetts household consumed about 600 kWh per month in 2020. See State Data, CE4.1EL.ST – Electricity by end use by state – totals, https://www.eia.gov/consumption/residential/data/2020/index.php?view=state#ce.

[20] Connecticut Office of Legislative Research, Municipal vs. Investor-Owned Utility Electric Rates, https://www.cga.ct.gov/2007/rpt/2007-R-0014.htm.

Figure 9: Distribution of Monthly Electricity Bills in 2023 for Average MA Household (600 kWh/mo.)

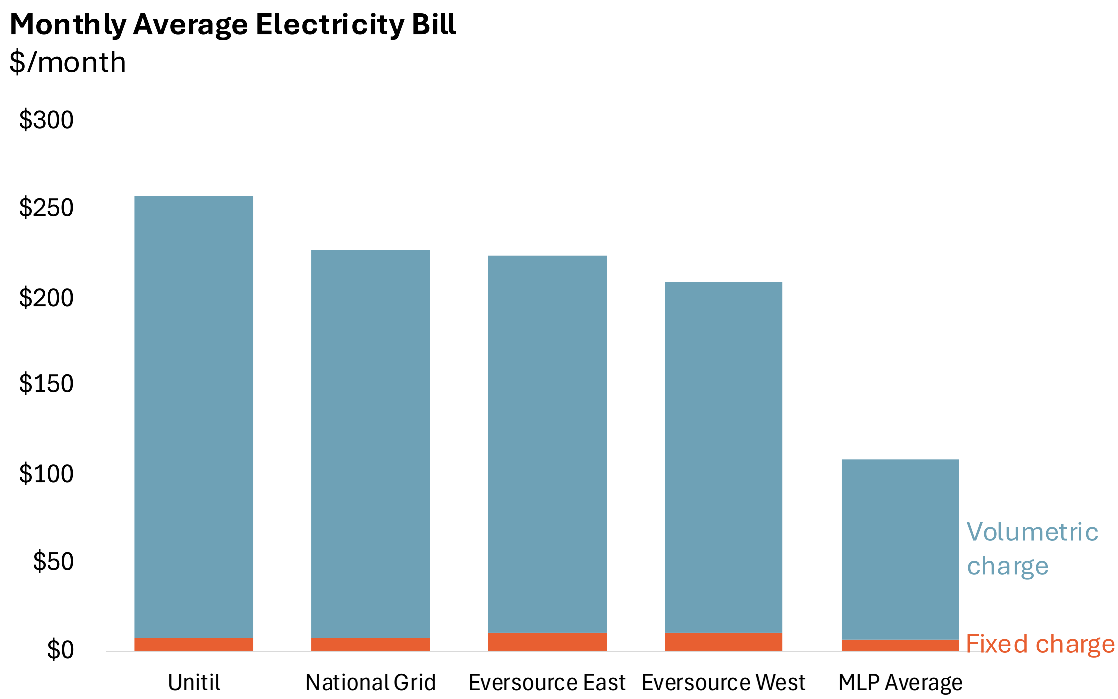
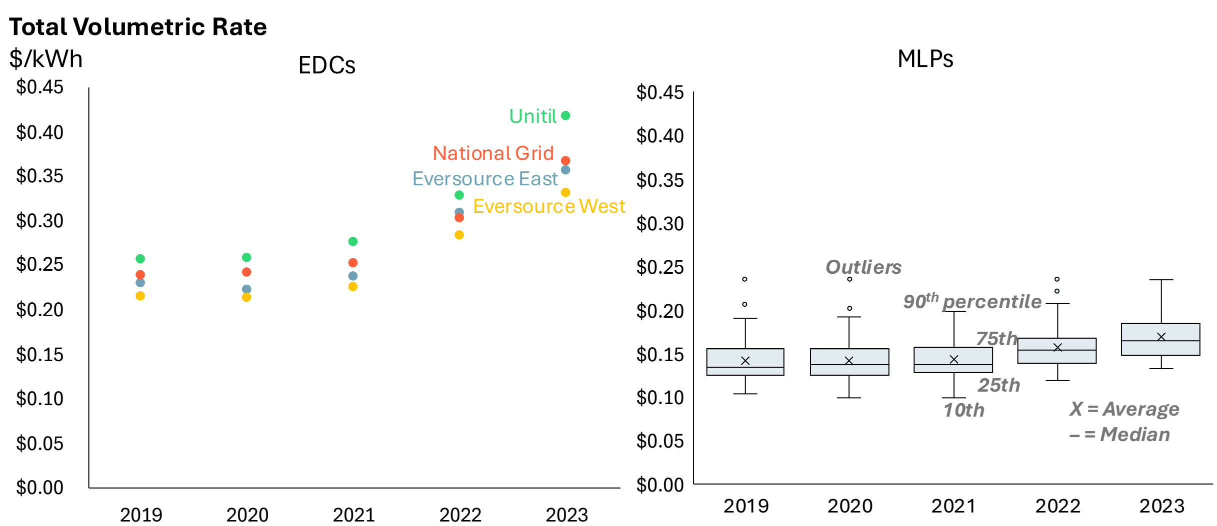


Figure 10 shows how electricity rates have increased significantly over the past five years for EDC customers, with a more muted increase for MLP residential customers. This increase has been driven by a steady increase in delivery costs as well as volatile electricity supply costs, as noted in Section 1.1 Residential Electric Rate Components.

Figure 10: Volumetric Charge Distribution across Utilities (2019-2023)



1.3 Alternative Rate Structures in the Commonwealth Today

While most residential customers are enrolled in R-1 high-volumetric electricity rates, some MLPs and EDCs offer alternative rate structures that customers can choose to opt into. For example, Eversource offers a "residential heating" rate (R-3) to customers that use electricity for space heating, which includes a 3.7% discount on the delivery cost and no change to other bill components. Several MLPs use inclining block tiered rates, which charge higher volumetric rates for electricity usage above specified thresholds.[21] Unitil offers a special rate for households with electric vehicles (EV-RES), offering an additional meter to customers to enable a time-varying rate (TVR) that includes different volumetric rates across "off-peak", "mid-peak", and "on-peak" periods, incentivizing vehicle charging during off-peak periods when costs are low. The DPU also recently approved Unitil's proposed heat pump rate (HP-RES),[22] and directed National Grid to prepare a similar rate,[23] which offers a discounted volumetric rate during the winter to households adopting heat pumps, reflecting the limited contribution of winter loads to incremental system costs in the near term given the current summer-peaking nature of the New England grid. Since existing rates would over-collect costs from high winter usage customers relative to the cost of serving them, lower volumetric rates could help ensure that bills for these customers more closely align with costs of service. This concept is explored in greater detail in Section II: Exploring New Rate Designs.

1.4 Drivers of Differentiation Among Energy Bills Today

The nearly 2.5 million residential electric households served by EDCs across the Commonwealth present wide variation in household characteristics and associated energy costs. This section discusses differentiating characteristics of these customers and the impacts of this differentiation on customer bills. By better understanding the wide variety of customer experiences and the building characteristics driving these experiences, future rate designs can consider or even prioritize the bill impacts of customers who are not well represented by customer class averages.

The modeling framework described in the Appendix outlines the process of identifying representative building types to characterize energy use across different building characteristics. Capturing the variation in energy bills across households is an important step in understanding which building characteristics lead to high energy bills today and in exploring the varying bill impacts of adopting efficient electric heating technologies and electric vehicles.

Some notable factors explored in this analysis include:

- **Heating Technology:** Heating technology and fuel play an important role in determining total energy use for residential households. Most Massachusetts homes are heated with natural gas

[21] Town of Concord Electricity Rates, Residential Rate (PDF), https://concordma.gov/528/Rates.
[22] D.P.U. 23-80 Order (2024).
[23] D.P.U. 23-150 (2024).

(54%), followed by fuel oil (26%) and electric resistance (13%), with the remaining 7% split among other sources such as propane and wood.[24] In addition to fuel costs, the efficiency of a heating technology has important impacts on customer bills, with electric heat pumps operating at significantly higher efficiencies than electric resistance heating or fossil fuel furnaces or boilers. Both total energy use and associated emissions will decrease by transitioning households to electric heat pumps.

- **Space Cooling:** Approximately 18% of Massachusetts households do not have any AC;[25] for those that do, the cost of space cooling is a major component of their energy costs. AC systems run on electricity, and they can take the form of central AC (~46% of households), which circulates cold air throughout a building, or window or portable AC units (~33% of households), which are smaller in size and generally less efficient than central AC but are easier and cheaper to install. Window units typically cool only the rooms where they are installed, unlike central AC systems that cool the entire home. The building prototypes modeled in this study include housing units without AC, with different levels of AC coverage with room AC units, and with 100% of the home covered by central AC.
- **Building Size**: Larger buildings have greater air volume and thus require more energy for space heating and space cooling.
- **Building Vintage and Weatherization**: The effectiveness of a household's building envelope, i.e., its ability to keep heat in or out, plays a crucial role in determining household energy use. Given the typical correlation between building age and envelope quality, we regard building age as a proxy for envelope quality in this work. Older buildings were built under less stringent building codes, and thus tend to have lower-quality building envelopes than newer buildings erected under more modern codes. Lower-quality building envelopes will increase the burden on space heating and cooling devices, and therefore the amount of energy used by them.
- **Regional Variation:** Buildings across the state vary in terms of heating and cooling energy demand due to variation in climate as well as average building vintage and size. When combined with varying heating technologies and retail energy prices, this leads to a wide distribution of energy expenses for households in different regions of the state.
- **Single-Family vs. Multifamily Buildings:** Single family homes tend to be larger in area than apartments in multifamily building complexes and have more surface area exposed to outside air, and subsequently have higher energy demands and energy expenses. Homes in multifamily buildings may not have individual unit metering for natural gas, meaning the costs of heating are included in rent. These households face the risk of significant bill increases if they adopt in-unit heat pumps and are forced to bear individual sub-metered electricity costs for heat without corresponding decreases in rent.
- **Personal Transportation**: Internal combustion engine vehicles (ICEVs) and EVs rely on different energy sources. Gasoline prices are influenced by the price volatility of crude oil,

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[24] National Renewable Energy Laboratory, ResStock 2024.2

[25] Brossman, Jes, Lixi Liu, Ben Polly, Elaina Present, Jenny Erwin. 2023. "State Level Residential Building Stock and Energy Efficiency & Electrification Packages Analysis". Tableau Dashboard.

meaning that the price at the pump can vary dramatically and create unexpected spikes in household expenses. EV home charging can be a significant electric load, although expenses are not as volatile compared to ICEV operational expenses due to the relative stability of electricity rates. The improved efficiency of an EV, seen in the transition from Figure 11 to Figure 12, can drive operational cost savings compared to ICEVs, despite high volumetric electricity rates today.

The following subsections explore each of these factors in greater detail.

1.4.1 Heating Technology

To understand the impacts of different heating technologies on household usage and bills, we first note the large share of annual household energy use driven by space heating in the Commonwealth, seen in Figure 11. This figure also highlights the seasonality of energy consumption for a ~1200 square foot multifamily home in Boston with natural gas heating and a window AC unit. For this example home, space heating and personal vehicle use (internal combustion engine assumed) dominate the total energy consumption.

Figure 11: Energy Consumption for Home with Natural Gas Heating and ICEV, by End Use[26]

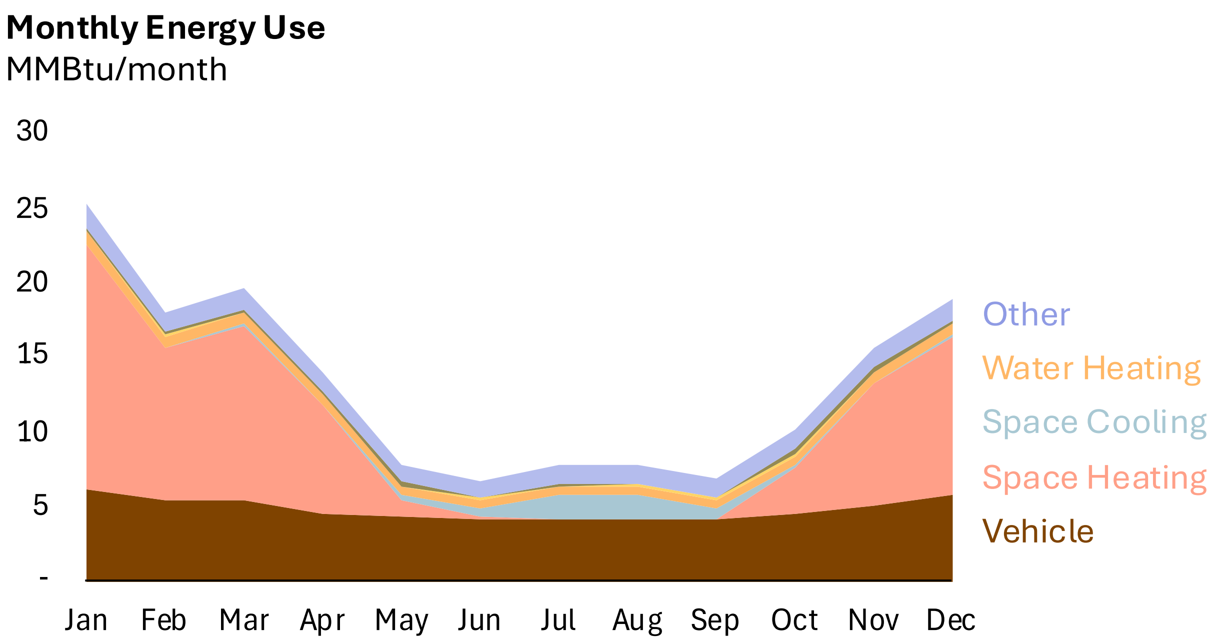
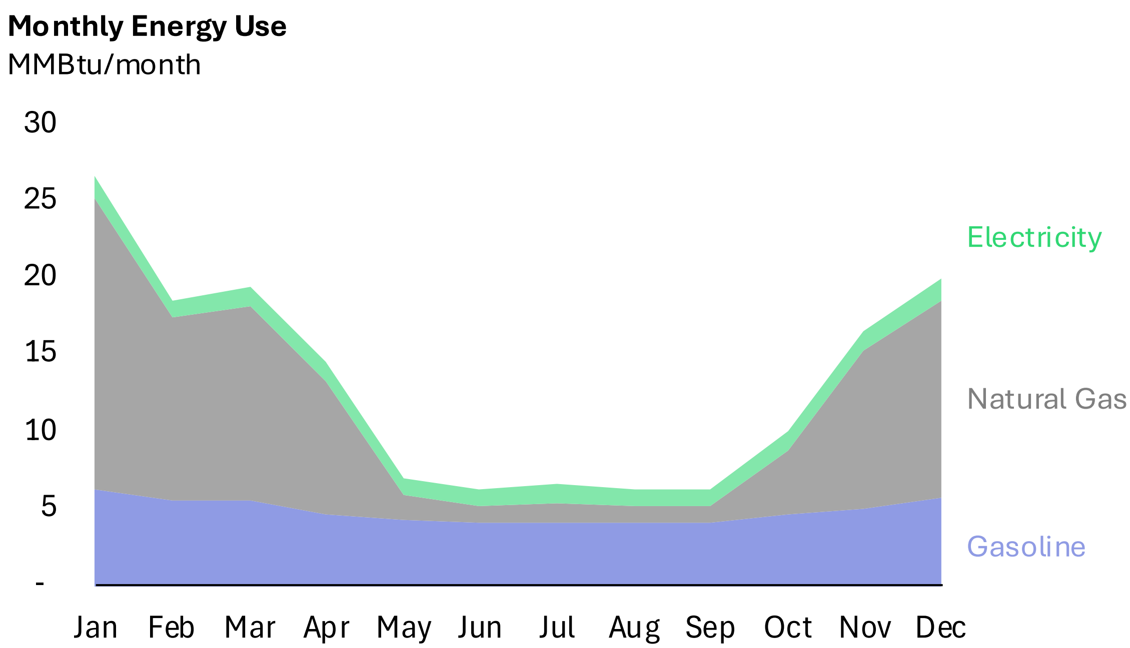


Figure 12 shows the same energy consumption broken down by fuel type: gasoline, natural gas, and electricity. As a result of energy consumption patterns, homes heated with natural gas, fuel oil, or

[26] Pre-1970 vintage, 1700 square foot home in multifamily housing in Central Massachusetts, with baseline room AC (60% coverage) and gas heating

propane all end up using significant amounts of heating fuel in the winter season, with much lower electricity consumption in comparison. The figure also shows an increase in electricity consumed in the summer, reflecting increased space cooling energy demand during hotter months.

Figure 12: Energy Consumption for Home with Natural Gas Heating and ICEV, by Fuel[27]

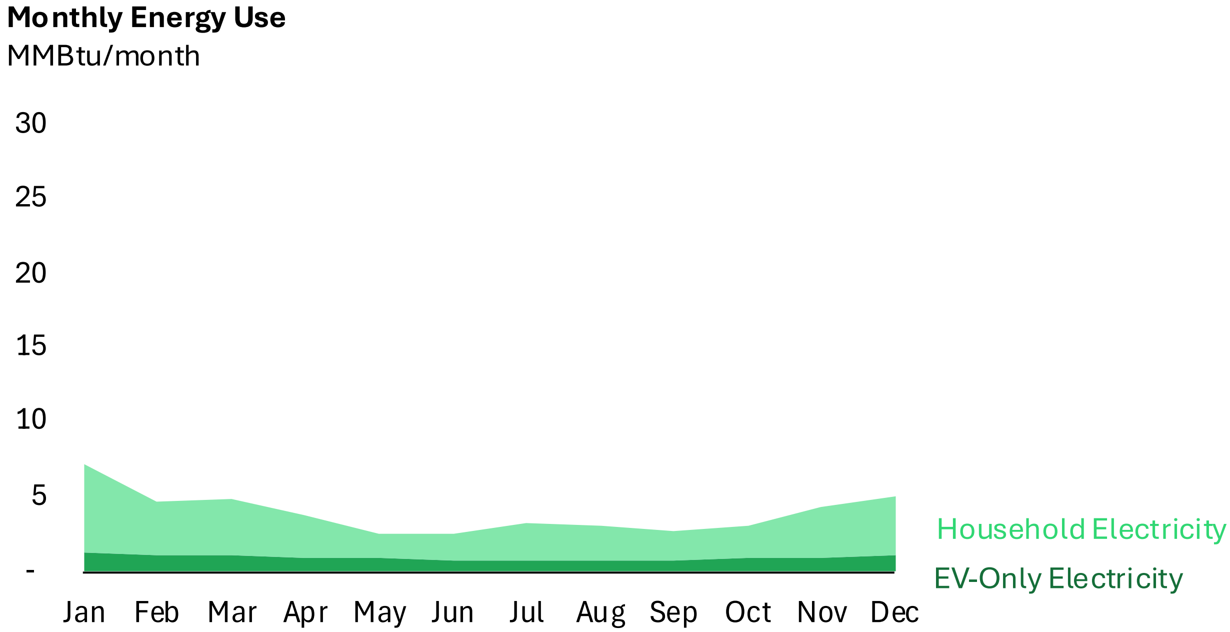


Homes that adopt efficient electric devices and invest in building weatherization measures see significant reductions in overall energy use, as shown in comparing the same households across Figure 12 and Figure 13. Personal transportation energy consumption is reduced by ~72% in shifting from an ICEV to an EV.[28] Household energy consumption falls by ~60%, driven by the superior efficiency of heat pumps for space heating and cooling, heat pump water heaters, and energy demand reductions from building insulation improvements. The seasonality of energy consumption persists, meaning that winter space heating energy demand remains more than twice summer space cooling energy demand, though has been muted relative to the prior example in Figure 12, where energy use was nearly four times higher in the winter.

[27] Pre-1970 vintage, 1700 square foot home in multifamily housing in Central Massachusetts, with baseline room AC (60% coverage) and gas heating

[28] EV efficiency varies significantly from model to model. The highest selling EV models till date in Massachusetts have been higher efficiency models. This study assumes EV energy consumption of 0.33 kWh/mile – see the appendix for more details on EV assumptions in this study. Sources: https://mor-ev.org/statistics and https://ev-database.org/compare/efficiency-electric-vehicle-most-efficient.

Figure 13: Energy Consumption for All-Electric Home with EV, by Fuel[29]



Although electrification leads to a significant reduction in overall energy usage, many households still face bill increases due to Massachusetts having among the highest volumetric rates in the nation. Thus, switching to an electric heat pump leads to varying bill impacts depending on the existing heating energy source and technology, as shown in Table 4. Based on this table, under current rates, bill savings from heat pump adoption would be most significant for households switching from electric resistance heating due to the efficiency improvement of heat pumps, and savings would be limited (or breakeven) for homes switching from fuel oil heating due to fuel oil being an expensive fuel. Bills would most likely increase for residents switching from natural gas heating, due to natural gas being a relatively inexpensive fuel today. The information presented in this table can be used to approximate the range of volumetric electricity rates required for heat pumps to achieve the same operational costs as natural gas furnaces. On the conservative end, the volumetric component of electricity rates would need to be 11-14¢/kWh cheaper than today's rates for relatively less efficient cold-climate heat pump operational costs to reach cost parity with that of highly efficient furnaces.[30] Conversely, highly efficient heat pumps break even with low efficiency gas furnaces at today's electricity rates. Additional energy efficiency improvements through weatherization would further reduce the need for rate reductions to achieve cost parity.

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[29] Pre-1970 vintage, 1700 square foot home in multifamily housing in Central Massachusetts, with baseline room AC (60% coverage) and gas heating.

[30] To calculate the breakeven rate, the natural gas volumetric rate is converted from $/therm to $/kWh and is then multiplied by the relative heating efficiencies of heat pumps to furnaces. This heuristic is sensitive to the assumed rates and efficiencies but provides an estimate of the level of volumetric rate reductions to reach cost parity.

Table 4: Estimated Cost of Heat Delivered by Fuel in Winter 2024-25

Fuel	Retail Cost	Cost of Heat Delivered[31] *(Range reflects device efficiencies)*
Natural Gas[32]		
National Grid	$2.49 per therm	$26-$31 per MMBtu
Eversource	$2.37 per therm	$25-$30 per MMBtu
Unitil	$3.32 per therm	$35-$42 per MMBtu
Electricity (Electric Resistance)[33]		
National Grid	$0.34 per kWh	$100 per MMBtu
Eversource	$0.32 per kWh	$93 per MMBtu
Unitil	$0.45 per kWh	$132 per MMBtu
Electricity (Cold-Climate Heat Pump)[34]		
National Grid	$0.34 per kWh	$31-$39 per MMBtu
Eversource	$0.32 per kWh	$29-$36 per MMBtu
Unitil	$0.45 per kWh	$41-$51 per MMBtu
Fuel Oil[35]	$3.43 per gallon	$28-$31 per MMBtu
Propane[36]	$3.33 per gallon	$43-$48 per MMBtu

To help contextualize bill amounts and to shine a light on affordability, we report energy burden alongside monthly bills throughout much of this section. Household energy burden is defined here as the fraction of a household's gross annual income that is spent on energy bills. We note that the methods for calculating energy burden vary, including in the scope of energy costs included (e.g., whether to include personal vehicle costs). Several states use 6% of household income as the threshold for defining "high energy burden,"[37] with the DPU recognizing a 6% goal for Massachusetts in the D.P.U. 24-15 affordability proceeding,[38] but these approaches do not include energy expense

[31] Gas local distribution company rate filings, residential heating rates, for natural gas rates, EDC R-1 filings for electric rates, Massachusetts Home Heating Fuel Prices for other fuels: https://www.mass.gov/info-details/massachusetts-home-heating-fuels-prices.
[32] Assuming 80% to 95% heating annual fuel utilization efficiency for natural gas furnace.
[33] Assuming 1.0 heating coefficient of performance for electric resistance heating.
[34] Assuming 2.6 to 3.2 range of heating coefficient of performance for heat pump.
[35] Assuming 80% to 86% heating annual fuel utilization efficiency for fuel oil boiler.
[36] Assuming 75% to 84% heating annual fuel utilization efficiency for propane boiler.
[37] For example, New York's Energy Affordability Program sets an energy burden target level of 6% of household income.
[38] https://www.mass.gov/doc/dpu-24-15-interlocutory-order-english/download.

from personal vehicle use. The energy burden calculation method used in this report *does* include the costs of personal vehicle transportation alongside the costs of household energy use to better characterize the electricity bill impacts of vehicle electrification.

As described in the Methodology and Data Sources section, the bills and energy burden estimates presented in this report represent the energy consumption of representative households. Specific energy profiles were selected from a library of building energy simulations to best represent the different characteristics specified (heating fuel, vintage, building type, etc.). For each building, energy costs are calculated for the home assuming baseline technologies as well as for the home after electrification and weatherization. The costs of both cases vary significantly in the real world due to the heterogeneity of the building stock, but the profiles used in this study are selected to communicate patterns that emerge for specified characteristics. Energy burden calculations are then determined for different income levels, i.e., for a given energy profile, different energy burden snapshots are presented for different income levels. Not captured in this study, income levels may directly influence energy consumption through differing responses to weather patterns and energy prices, as discussed in Section 1.5 Energy Burden in Low- and Moderate-Income Households Today.

Figure 14 shows the average monthly energy expenditures under current rates for a baseline electric resistance home, the same home with full home electrification and weatherization, and finally the same home with full home electrification, weatherization, and transportation electrification. The household shown is a pre-1970s, 850 square foot home with room AC (covering 20% of the home), electric resistance heating, and no bill discount, although the findings are broadly indicative of other electric resistance heated buildings as well. The figure also includes the corresponding energy burdens for a household earning 60% of the state median income (SMI),[39] the eligibility threshold for both the Home Energy Assistance Program (HEAP)[40] and utility bill discounts (detailed in the following section), as well as for a household earning 80% SMI, representing energy burden for a moderate-income household that is not currently eligible for the bill discount program.[41]

Heat pump adoption and insulation improvements result in $150/month savings (without a low-income discount rate) due to the efficiency gains of switching from electric resistance heating (efficiency of 100%) to a heat pump (efficiency range of 200% to 400%), and to a lesser degree the reduction in heating and cooling demand enabled by the insulation improvements. These bill savings are realized despite the home shifting from a room AC unit to a whole home heat pump (AC coverage increases from 20% to 100% of floor space in this example), meaning that the household enjoys significant improvements in comfort in addition to bill savings. The household sees an additional

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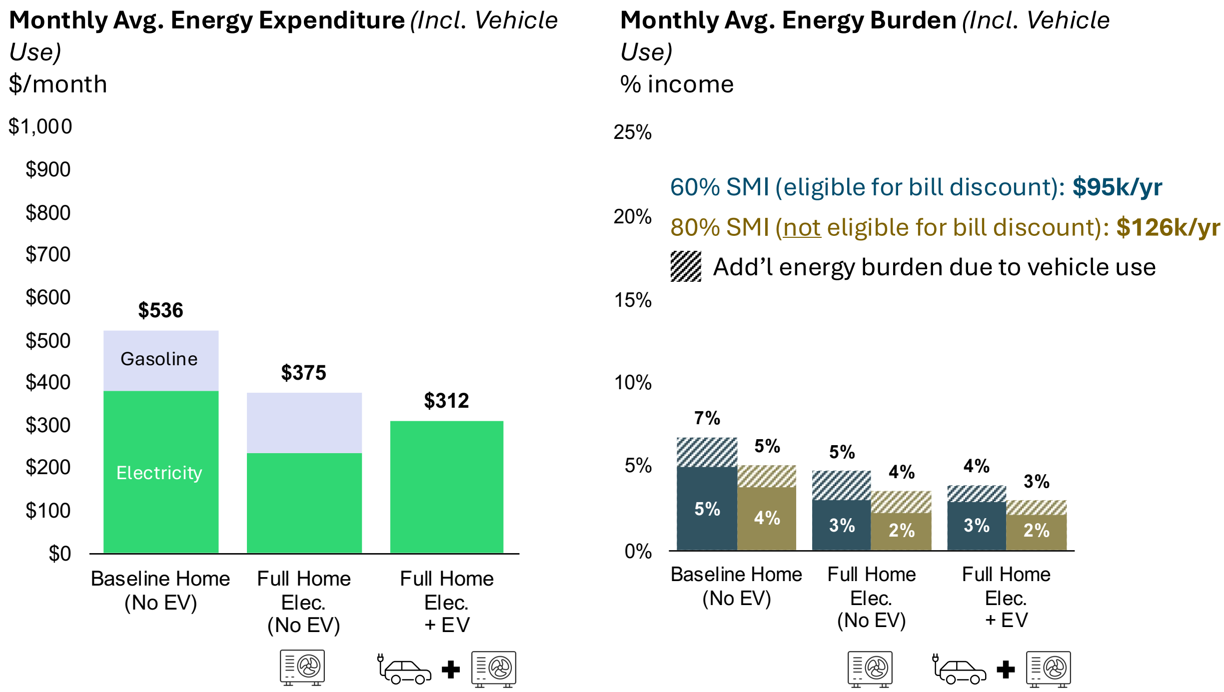
[39] SMI for a 4-person household (size assumed in this study) in FY 2025 was $157,680: https://liheapch.acf.hhs.gov/profiles/povertytables/FY2025/masmi.htm.

[40] LIHEAP (Low-Income Home Energy Assistance Program) was recently retitled HEAP in Massachusetts but the federal name continues to be LIHEAP.

[41] St. 2024, c. 239 recently granted the D.P.U. authority to investigate moderate-income discounts and promulgate regulations to implement this discount.

$60/month in savings from shifting from an ICEV to an EV, due to the high efficiency of battery electric vehicles mentioned above and high avoided gasoline costs.

Figure 14: Energy Bills and Burden for an Example Electric Resistance Heated Home[42]



In a household with fuel oil heating, the bill savings from switching to heat pumps for heating are driven by high avoided fuel oil costs. In the example shown in Figure 15, the total bill savings from building electrification are limited by the additional energy costs of shifting to whole home AC via heat pump (60% additional cooling service provided compared to the baseline case, which uses room AC to cool 40% of the space). This figure shows the energy expenditures and energy burden of a pre-1970, 1,100 square foot home with room AC and fuel oil heating before and after electrification. The average monthly bill savings from shifting from fuel oil to a heat pump are limited, and the same $60 per month benefit of switching from an ICEV to an EV is realized, as in the prior example.

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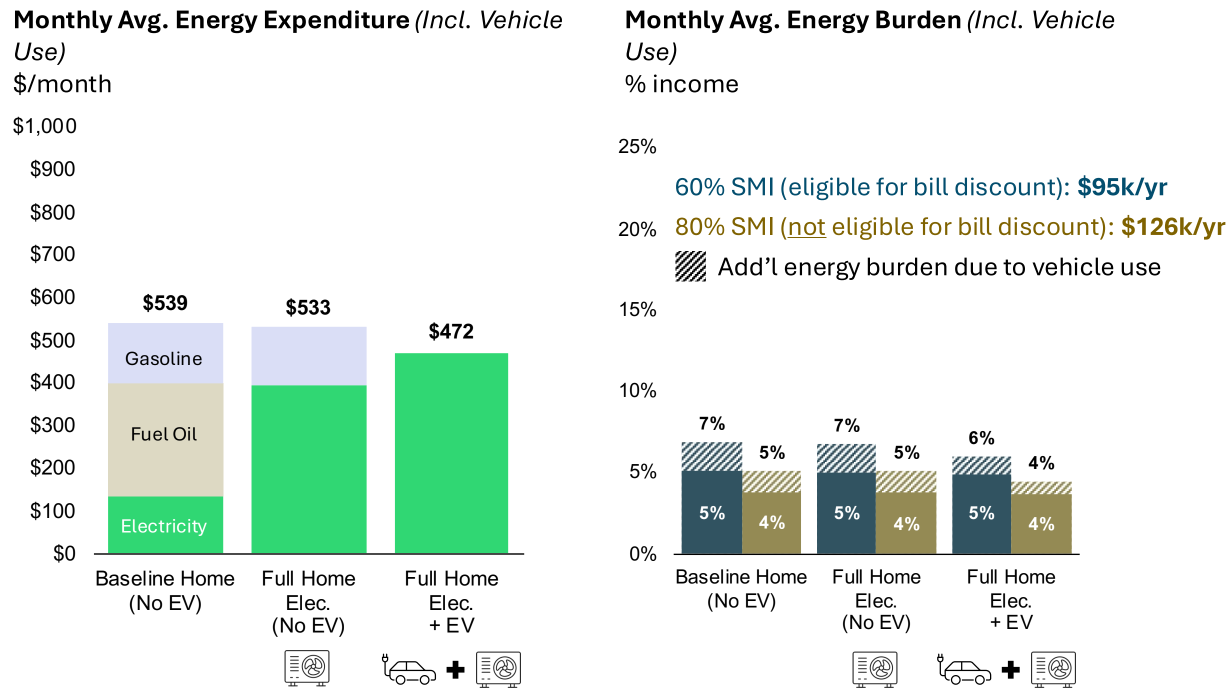
42 Pre-1970 vintage, 623 square foot home in multifamily housing in Boston Massachusetts, with baseline room AC (20% coverage) and electric resistance heating.

Figure 15: Energy Bills and Burden for Fuel Oil Heated Homes[43]



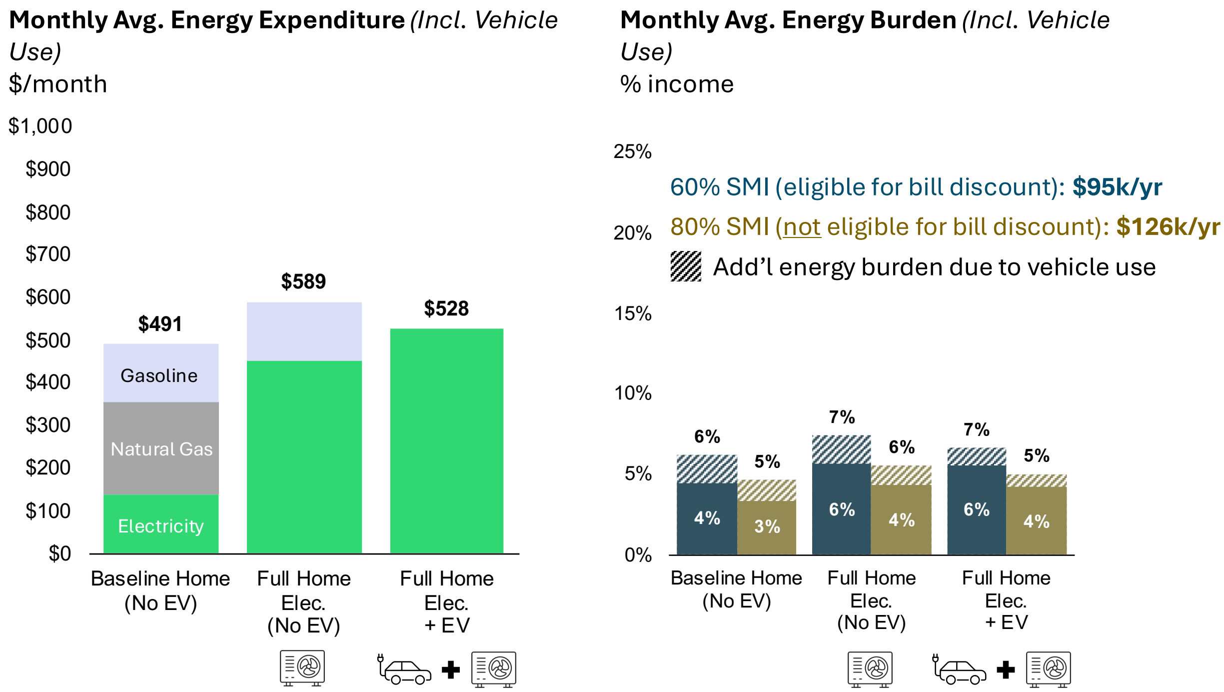
For most homes with natural gas heating, electrification under today's gas and electric rates would cause an increase in energy expenditures, as illustrated in Figure 16. Although air-source heat pumps are far more efficient heating devices than natural gas furnaces or boilers, natural gas rates are inexpensive relative to volumetric electricity rates. Figure 16 shows that, despite the $60/month benefit of adopting an EV, overall energy costs increase compared to the baseline home today, which uses room AC to cool 60% of the space. Since over 50% of homes in Massachusetts are heated with natural gas today, the bill increases gas heating customers may see from building electrification present a major obstacle to the achievement of the Commonwealth's building decarbonization goals.

While the multifamily home shown in the above figure is assumed to be directly metered, and thus paying for its entire natural gas energy demand today, 34% of multifamily households in the Commonwealth[44] have shared heating, ventilation, and air conditioning (HVAC) systems and may not directly pay a utility bill for heat, which may lead to lower natural gas bills than the individually-metered unit snapshot shown above, as well as varying electrification bill impacts that depend on whether the heat pump installed is centralized or per-unit. This dynamic is discussed further in Section 1.4.5 Single-Family vs. Multifamily Buildings.

[43] Pre-1970 vintage, 1100 square foot home in multifamily housing in Central Massachusetts, with baseline room AC (40% coverage) and fuel oil heating.

[44] Reyna, Janet, Eric Wilson, Andrew Parker, Aven Satre-Meloy, Amy Egerter, Carlo Bianchi, Marlena Praprost, Andrew Speake, et al. 2022. U.S. Building Stock Characterization Study: A National Typology for Decarbonizing U.S. Buildings.

Figure 16: Energy Bills and Burden for Natural Gas Heated Homes[45]



1.4.2 Space Cooling

Space cooling is an important part of energy costs and energy burden for Massachusetts households. Roughly 46% of Massachusetts households have central AC, 33% have room AC, 3% use heat pumps, and about 18% of households have no AC at all.[46] Depending on the existing cooling technology of a household, transitioning to a heat pump for cooling can result in a change in cooling energy provided, electricity consumption, and energy bills. That is, for households transitioning from room AC (or no AC) to a heat pump, the installation of the heat pump will allow those customers to cool their entire homes, increasing the cooling energy provided. While this may increase cooling energy costs, improved access to cooling is a clear benefit in terms of health and comfort, especially in a warming climate. Heat pumps also have significantly higher cooling efficiency than room AC and may have higher efficiency than central AC. The improved cooling efficiency of heat pumps is shown in Figure 17, where heat pump energy demand is lower than that of room or central AC providing cooling to an entire home.

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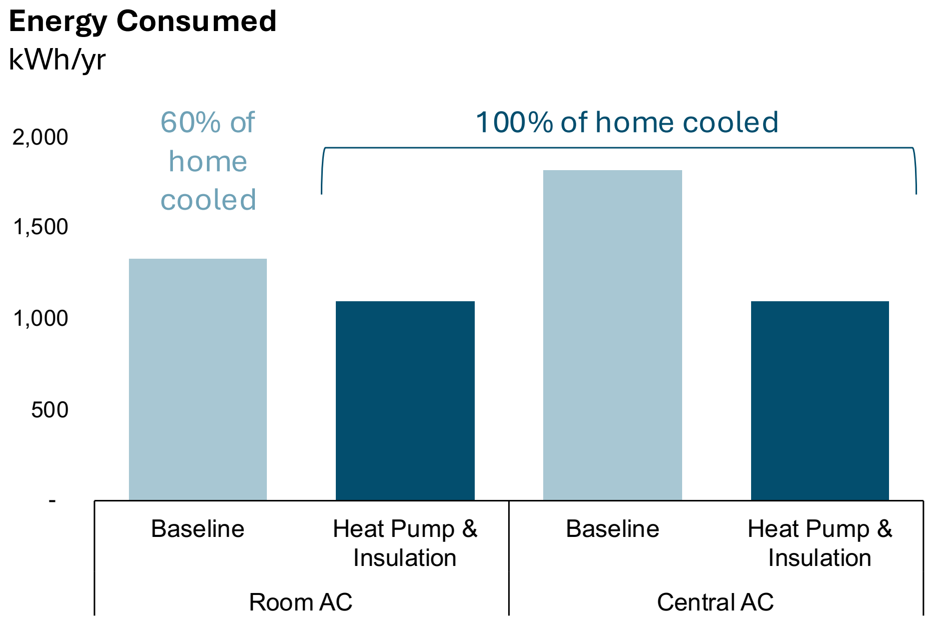
[45] Pre-1970 vintage, 1700 square foot home in multifamily housing in Central Massachusetts, with baseline room AC (60% coverage) and gas heating.

[46] Brossman, Jes, Lixi Liu, Ben Polly, Elaina Present, Jenny Erwin. 2023. "State Level Residential Building Stock and Energy Efficiency & Electrification Packages Analysis". Tableau Dashboard.

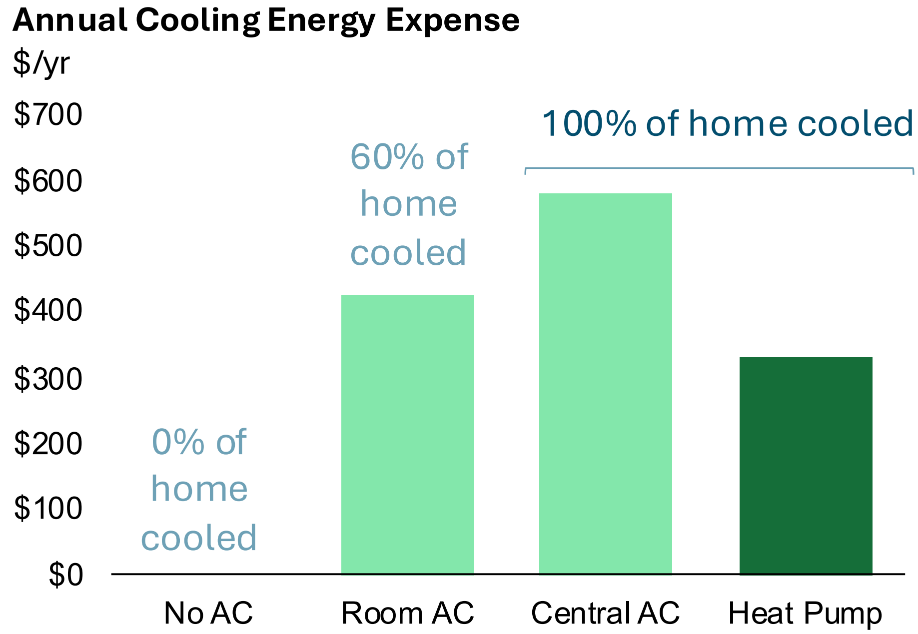
Figure 17: Annual Cooling Energy Demand by Technology[47]



In summary, heat pump adoption would provide improved access to cooling, but would yield bill increases for homes without AC, would likely lead to bill savings for homes with central AC, and may yield increases or savings for homes with room AC, depending on the baseline share of the home cooled. Figure 18 illustrates this outcome, looking at multifamily households in Boston and assuming that room AC provides 60% coverage while central AC and heat pump options provide 100% coverage for space cooling.

[47] Multi-family Boston homes with natural gas heating.

Figure 18: Annual Cooling Expenditure by Technology[48]

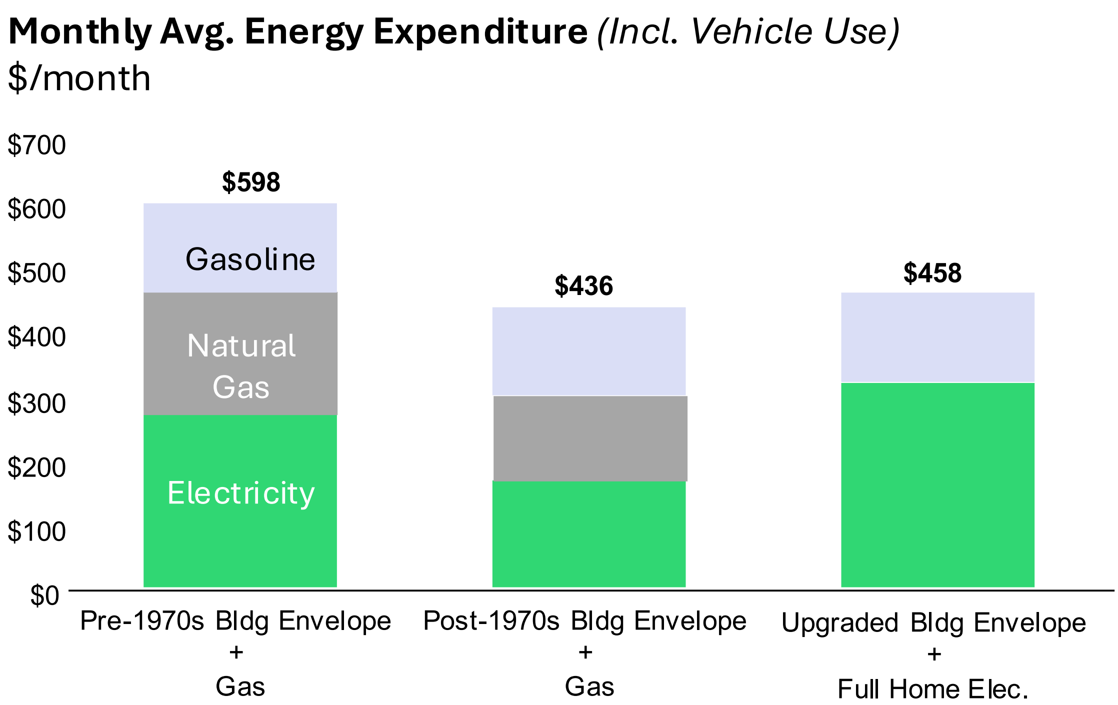


1.4.3 Building Vintage and Weatherization

For two households with the same heating and cooling technologies, differences in the building envelope can have an impact on their respective energy expenses. Older buildings tend to be more poorly insulated and thus less energy efficient than newer buildings. Poorly insulated buildings allow more heat to escape to the outside environment in winter and allow more heat into the building during summer, driving up energy demand and expense. For Massachusetts households that currently use natural gas to heat their homes and live in older buildings, weatherization efforts to improve building insulation, provide air sealing, improve windows, and provide other heat retention measures can mitigate the adverse bill impacts of electrification on those customers, as demonstrated in Figure 19. For example, older homes (built pre-1970) tend to have ceilings that are either uninsulated or have insulation with low R-values[49] between 7 and 19, while newer homes (built post-1970) tend to have insulation with higher R-values between 30 and 49. The building envelope upgrades applied in the electrification measure packages in this study further improve insulation and home efficiency, including upgrades of attic floor insulation to R-60 and a 30% improvement to general air sealing. Among the representative buildings selected in this study, these shell improvements alone can lead to heating demand reductions of approximately 10-25% for most households, and more limited cooling demand reductions of up to approximately 7%.

[48] Multifamily Boston homes with natural gas heating.
[49] "R-Value" is a metric conveying how well a layer of insulation resists the flow of heat; lower values translate to easier passage of heat and worse heat retention on either side of the layer.

Figure 19: Monthly Average Energy Expenditures of Old and New Buildings with Natural Gas Heating After Electrification and Weatherization[50]

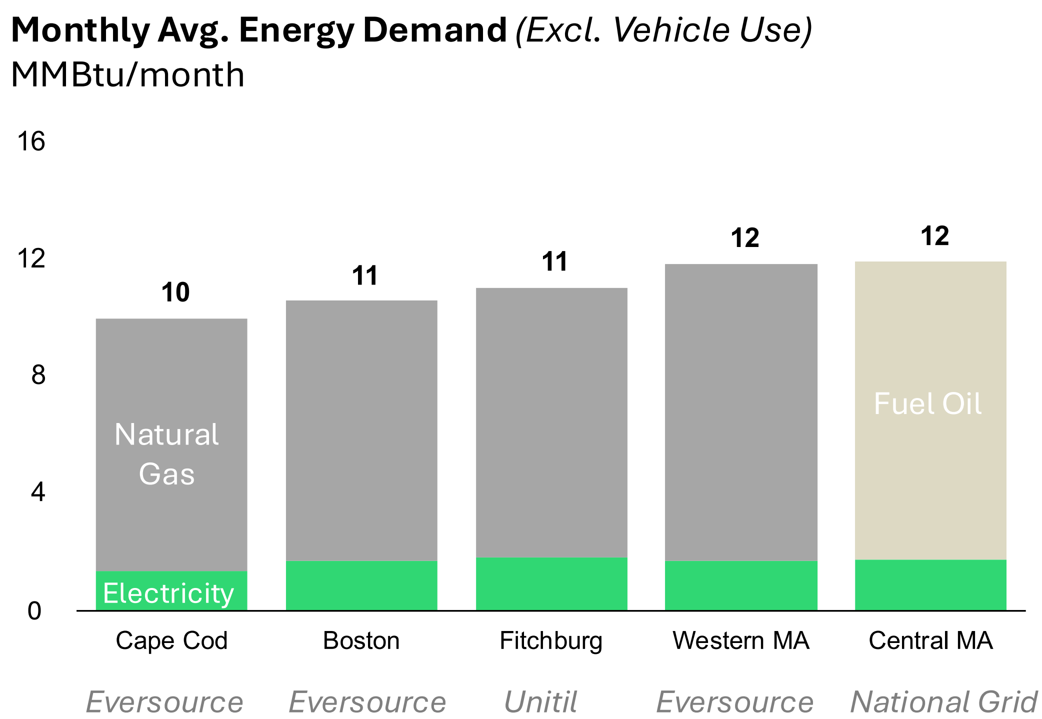


1.4.4 Regional Variation

There are also regional variations in energy consumption patterns across Massachusetts. Figure 20 demonstrates a few key differences across the state. Boston homes tend to be smaller, and as a result have a lower space heating demand. Homes in Western Massachusetts tend to be older than in other regions and tend to face colder winters, which increases the region's monthly average energy usage due to older and less well-insulated building shells. Finally, in Central Massachusetts, heating with fuel oil is more common (47% have fuel oil heating in Central Massachusetts, whereas only 28% of households use it in the rest of the Commonwealth).

[50] Single family Boston homes with natural gas heating.

Figure 20: Monthly Average Energy Use Across Regions for Representative Households[51]



Regional variations in home types and heating technologies also drive differences in average monthly energy expenditures. Different utilities serve customers in different parts of the Commonwealth,[52] so differences in electricity and gas rates add to regional energy bill variation. For example, Figure 21 highlights the higher electric and gas rates offered in Unitil's service territory, compared to those of other utilities,[53] driving higher energy expenditures for Fitchburg residents. On the other hand, lower residential electric and gas rates for Eversource customers in Western Massachusetts help to limit energy expense despite higher energy consumption patterns seen in Figure 20.

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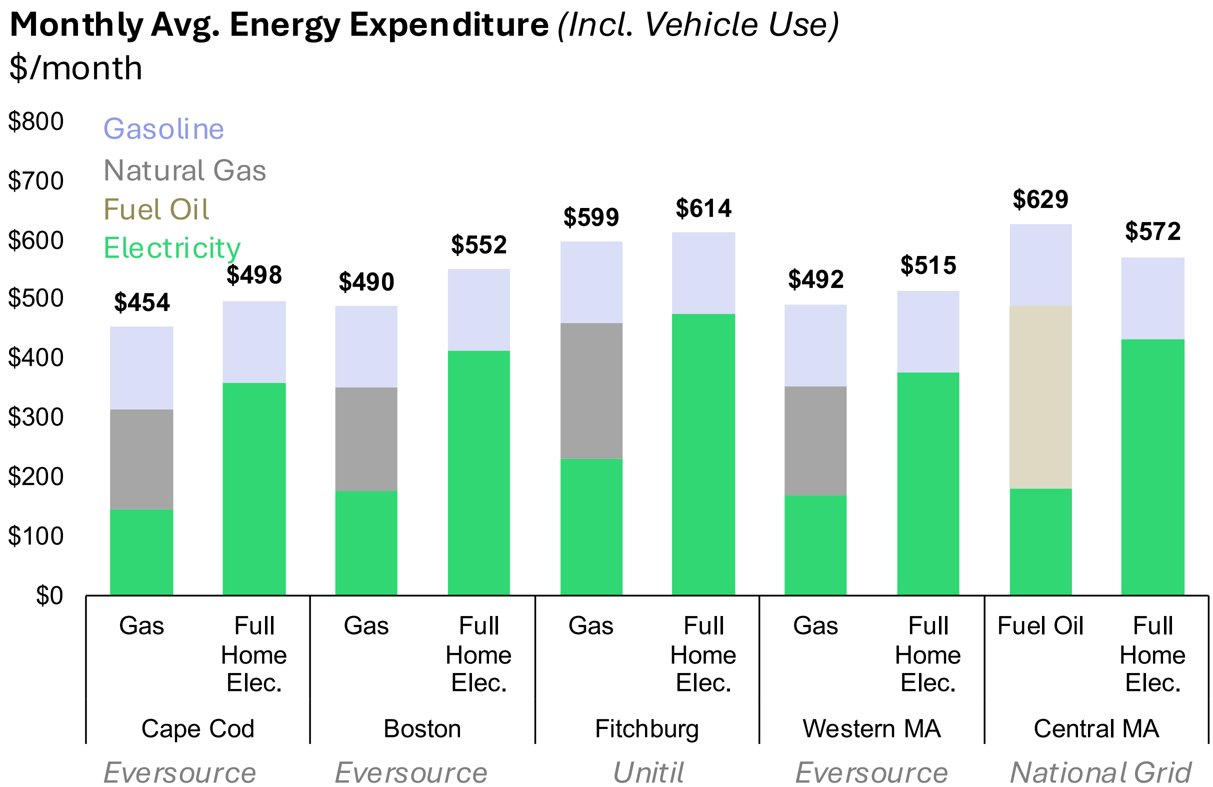
[51] Pre-1970 vintage 1200 square foot homes in single family housing.

[52] Gas utility service territory map: https://www.mass.gov/doc/natural-gas-providers/download, electric utility service territory map: https://www.mass.gov/doc/electricity-providers/download.

[53] National Grid and Unitil gas and electric rates approved in D.P.U. 23-150 and 23-80 respectively not used as report analysis was conducted before these rates were approved.

Figure 21: Monthly Average Energy Expenditures Across Regions for Representative Households[54]



1.4.5 Single-Family vs. Multifamily Buildings

As single-family homes are generally larger than multifamily homes, single-family homes tend to have higher overall energy demands and greater bill impacts from electrification, relative to multifamily homes. This is demonstrated in Figure 22, which shows 1700 and 3300 square foot pre-1970s multifamily and single-family homes, respectively, in the Boston area.

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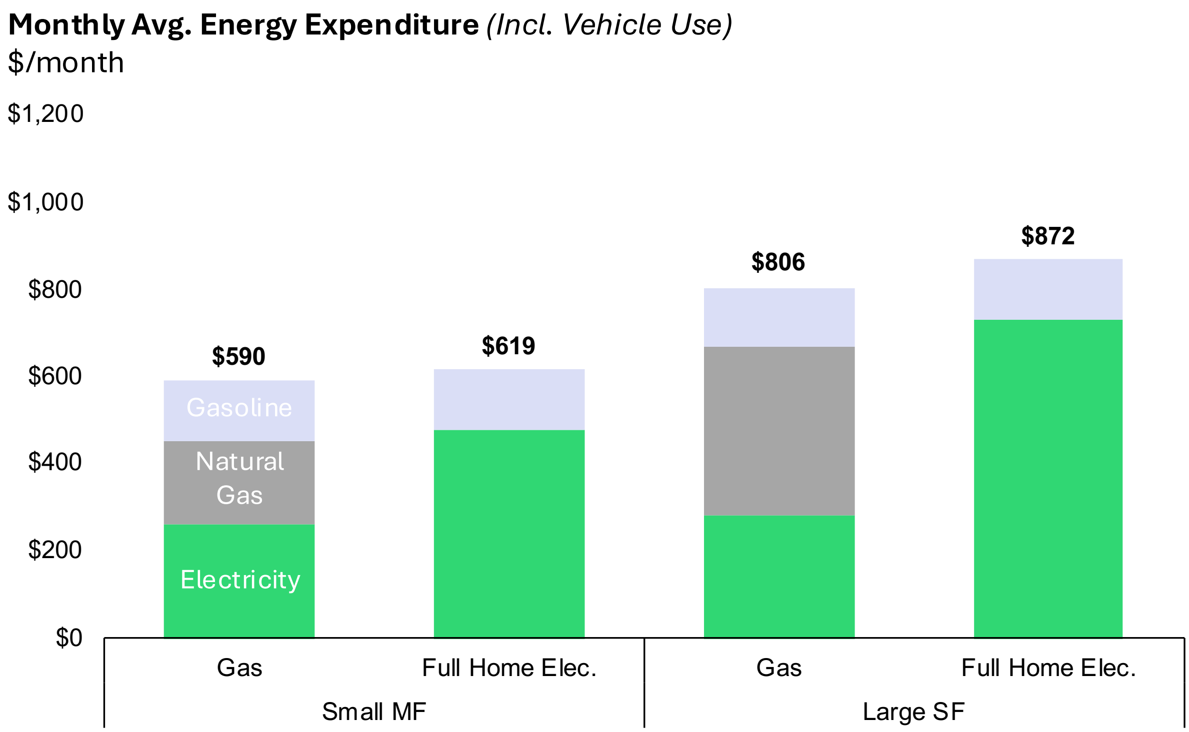
[54] Pre-1970 vintage 1200 square foot homes in single family housing.

Figure 22: Bill Impacts of Electrification for Large Single-Family and Small Multifamily Homes Under Current Rates[55]

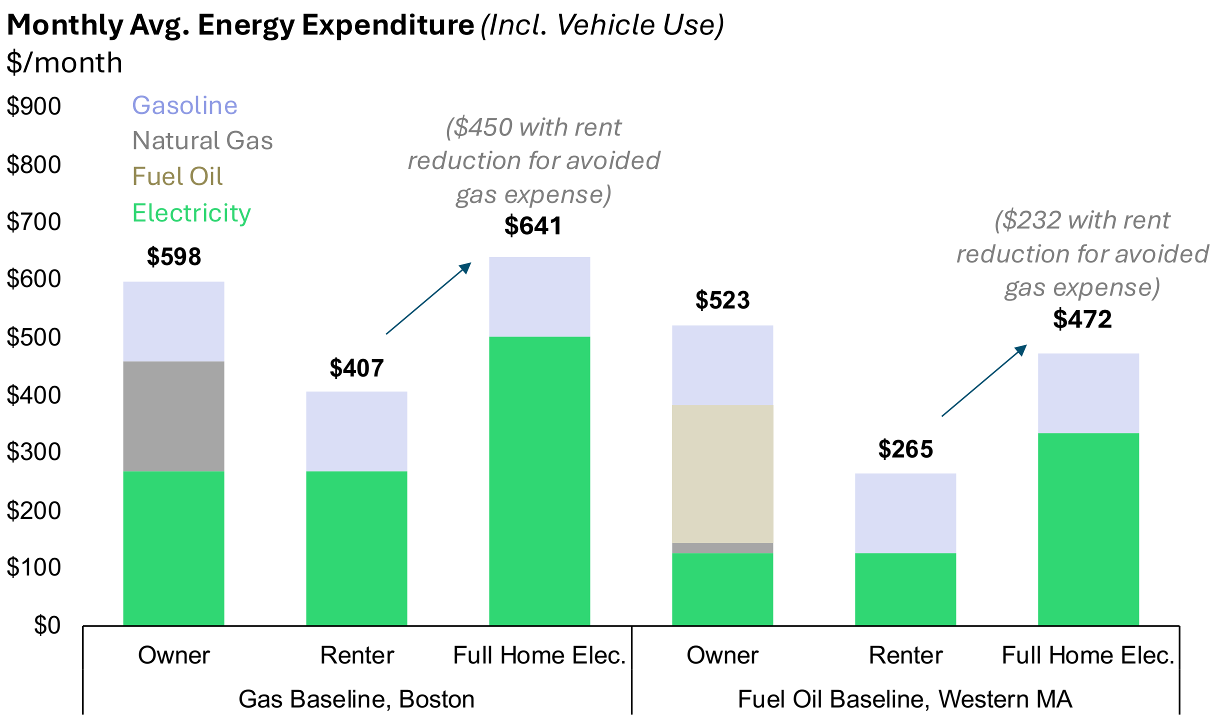


Beyond size differences, multifamily homes are often occupied by renters, and electrification of multifamily buildings with central boilers or furnaces may shift heating costs from landlords to renters. Today, it is estimated that 34% of multifamily households in the Commonwealth have shared heating systems, of which some share of residents does not directly pay for heating through utility bills. [56] Rather, they pay toward the cost of a central building heating system through their rent. With electrification, heat pumps can be installed in either a centralized or decentralized configuration in a multifamily building. If individual heat pumps are installed in customer units, tenants would subsequently pay for heating on their electricity bills, possibly without a corresponding decrease in rent. Figure 23 illustrates this dynamic and includes estimates of bills if rent is decreased to reflect avoided gas expense for the building owner.

[55] Pre-1970 vintage homes in Boston, Massachusetts with baseline natural gas heating.

[56] Reyna, Janet, Eric Wilson, Andrew Parker, Aven Satre-Meloy, Amy Egerter, Carlo Bianchi, Marlena Praprost, Andrew Speake, et al. 2022. U.S. Building Stock Characterization Study: A National Typology for Decarbonizing U.S. Buildings, https://public.tableau.com/app/profile/nrel.buildingstock/viz/StateLevelResidentialBuildingStockandEnergyEfficiencyElectrificationPackagesAnalysis/Introduction.

Figure 23: Potential Heating Cost Shift to Renters[57]

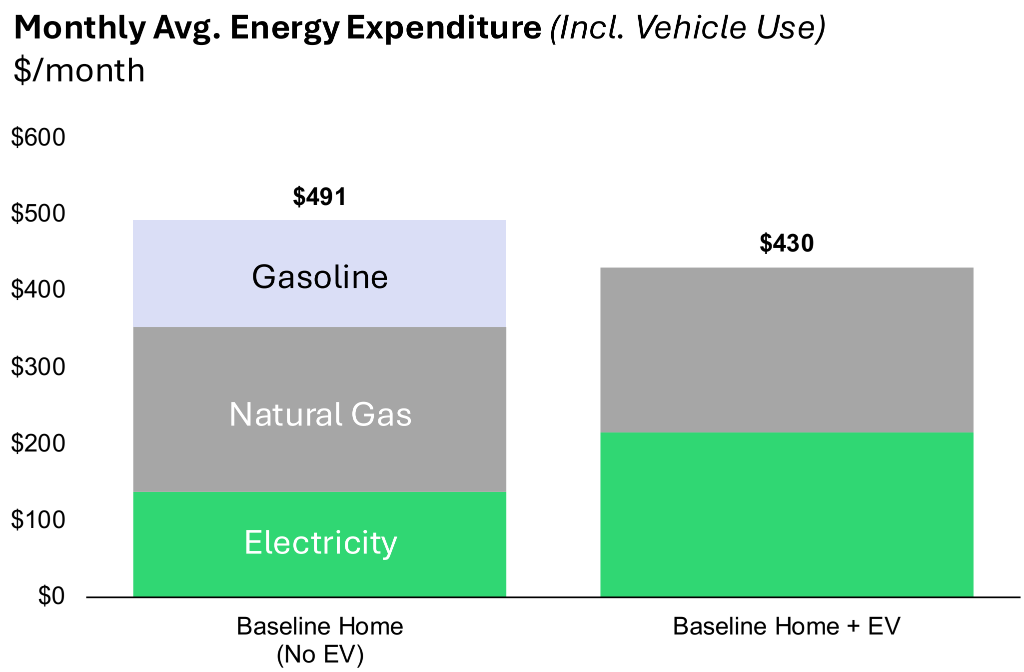


1.4.6 Personal Transportation

Favorable cost-effectiveness for electric vehicles is driven by the high efficiency of EVs relative to ICEVs. While the average mileage for an ICEV on the road in the Commonwealth today is about 21.5 miles per gallon,[58] EVs can travel up to 140 miles per gallon of gasoline equivalent.[59] Figure 24 highlights the bill savings for a home transitioning from an ICEV to an EV, seeing a monthly average of approximately $60 in reduced expenses. These savings are on a per-vehicle basis, so households transitioning multiple vehicles to EVs would see even greater savings. This study models a single set of EV and ICEV efficiency values; in reality, the bill savings from vehicle electrification would vary depending on the relative efficiencies of the specific vehicles, as well as the share of vehicle charging conducted at home and at public charging stations. The latter can be more expensive for customers and is often the only option available to households in multifamily buildings without home charging infrastructure.

[57] Pre-1970 vintage home in Boston, Massachusetts in multifamily housing.
[58] Environmental Protection Agency, Automotive Trends Data. https://www.epa.gov/automotive-trends/explore-automotive-trends-data#SummaryData.
[59] US Department of Energy, https://www.fueleconomy.gov, GGE = energy content of one liquid gallon of gasoline.

Figure 24: Monthly Average Bill Impacts of EV Adoption[60]



1.5 Energy Burden in Low- and Moderate-Income Households Today

Outside of the different drivers of household energy discussed in the prior section, customer energy bills are impacted by affordability programs, rate levels, and rate design. While rate design alone cannot fully resolve customer affordability issues, it remains an important tool to help promote affordability. In this section, we focus on 2024 bills and bill impacts of electrification for low- and moderate-income households and show that existing electric rate design endangers affordability for the Commonwealth's most-burdened populations regardless of electrification status.

To analytically capture affordability at today's rates, we include impacts of key affordability programs in the results below and assume that low-income households that qualify for their utility's low-income discount rate are participating in that rate. An important consideration to include here is the low enrollment of customers in bill discount programs. While more than 28% of households have an income of less than $50,000, low-income discount rate enrollment for the largest utilities (i.e., Eversource and National Grid) does not exceed 16%.[61] We do not discuss potential alterations to these programs and how these alterations could impact affordability — the currently active D.P.U. 24-15 proceeding explores these issues, with the aim of addressing the high cost of energy bills for

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[60] Single family home in Boston, Massachusetts with baseline natural gas heating.
[61] D.P.U. 24-15, DOER Initial Comments at 4 (2024).

Massachusetts residents. Instead, we assume that existing programs would complement new rate designs.

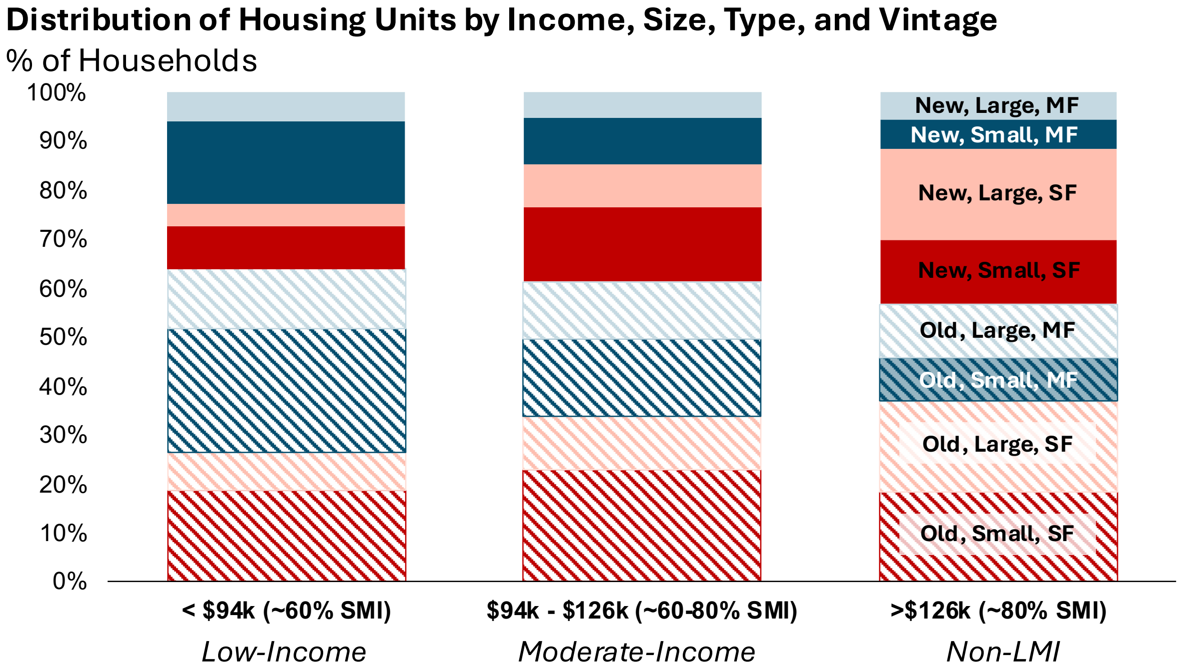
1.5.1 Housing Types of Low-Income Households

Figure 25 explores the differences in building characteristics between low-, moderate-, and higher-income households. The threshold used for low-income homes here is 60% SMI, in keeping with the bill discount eligibility described in Section 1.5.2 Energy Expenditures and Burdens of Low-Income Households. Moderate-income households are also included in this figure, defined as households earning between 60% and 80% SMI.[62] The housing characteristics shown here are broken down along three dimensions:

- Building type:
  - Single-family ("SF") housing
  - Multifamily ("MF") housing
- Size:
  - "Small" homes: less than 1,750 square feet for a SF home and less than 900 square feet for a MF home
  - "Large" homes: greater than 1,750 square feet for a SF home and greater than 900 square feet for a MF home
- Vintage:
  - "Old" homes: built or renovated before 1970
  - "New" homes: built or renovated in 1970 or later

[62] General Law - Part I, Title XVII, Chapter 121B, Section 38D(a)(1) defines "low or moderate income household" as "a household with gross income at or less than 80 per cent of area median household income"; while area median household income varies significantly across the Commonwealth, state median income is used as an average here.

Figure 25: Proportion of Housing Units by Income Level, Vintage, and Size



Looking at different housing types across these three dimensions reveals a few key takeaways:

- **Low-income households are associated with multifamily housing:** 60% of low-income households correspond with multifamily housing, compared to 33% of higher-income households.
- **Low-income households are associated with smaller homes:** 70% of low-income households correspond with small homes, compared to 49% of higher-income customers.
- **Low-income households are associated with older homes**: 64% of low-income households correspond with homes built before 1970, compared to 57% of higher-income households.

The distribution of moderate-income households across size, vintage, and building type is similar to that of low-income households.

This study does not explicitly include income as a direct determinant of energy use, and instead relies on commonly occurring building prototypes among low-income households as a proxy for energy usage in both low-income homes and moderate-income homes. In reality, low-income households are observed to exhibit different energy demands in response to weather patterns and energy prices compared to moderate- or high-income households.[63] While this study does not capture energy-limiting behavior nor price responsiveness, different snapshots of energy burden

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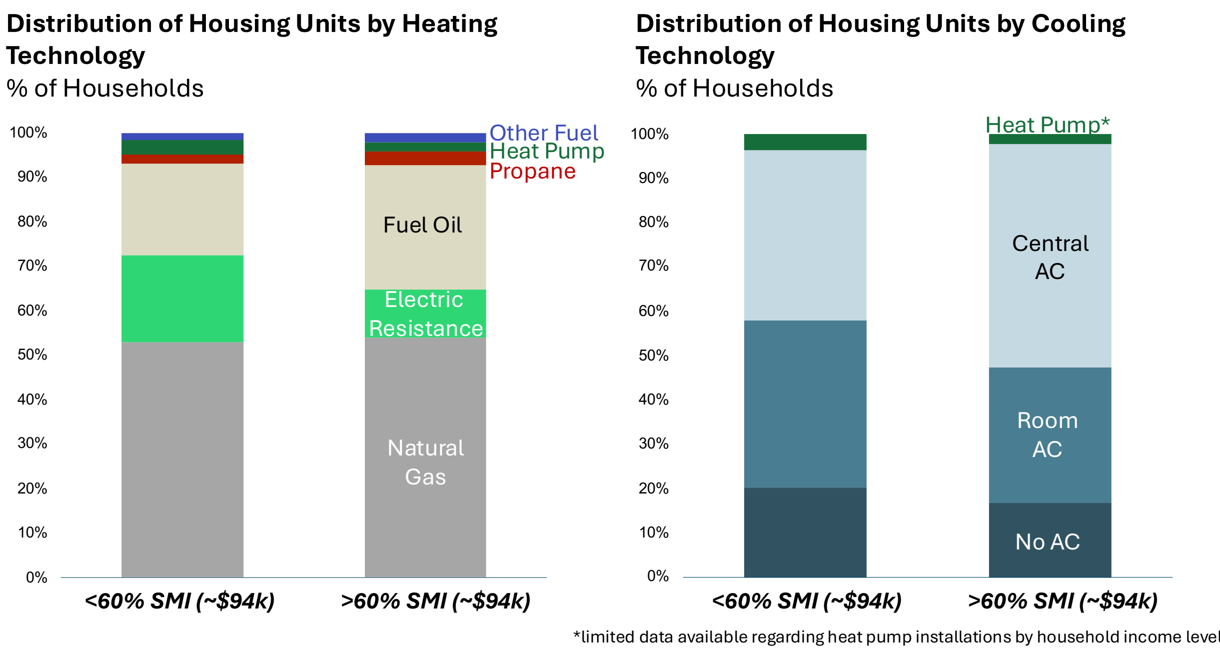
[63] Cong, S., Nock, D., Qiu, Y.L. et al. Unveiling hidden energy poverty using the energy equity gap. Nat Commun 13, 2456 (2022). https://doi.org/10.1038/s41467-022-30146-5.

are presented for different income levels (as shown in 1.4.1 Heating Technology), with bill discount eligibility income levels used for reference (described in the next section).

Figure 26 explores the distribution of heating fuels (left), and the type and presence of AC (right), for lower- and higher-income four-person households. Electric resistance heating and a lack of central AC are more common for low-income homes compared to their higher-income counterparts. These characteristics have important implications for energy bills today (i.e., high bills from electric resistance) and energy bills under electrification as explored in Section 1.4 Drivers of Differentiation Among Energy Bills Today. For lower-income customers, heat pump adoption is expected to lead to bill savings when converting from electric resistance, coupled with bill increases from added AC energy consumption.

Figure 26: Heating & Cooling Technology Distribution by Income Level

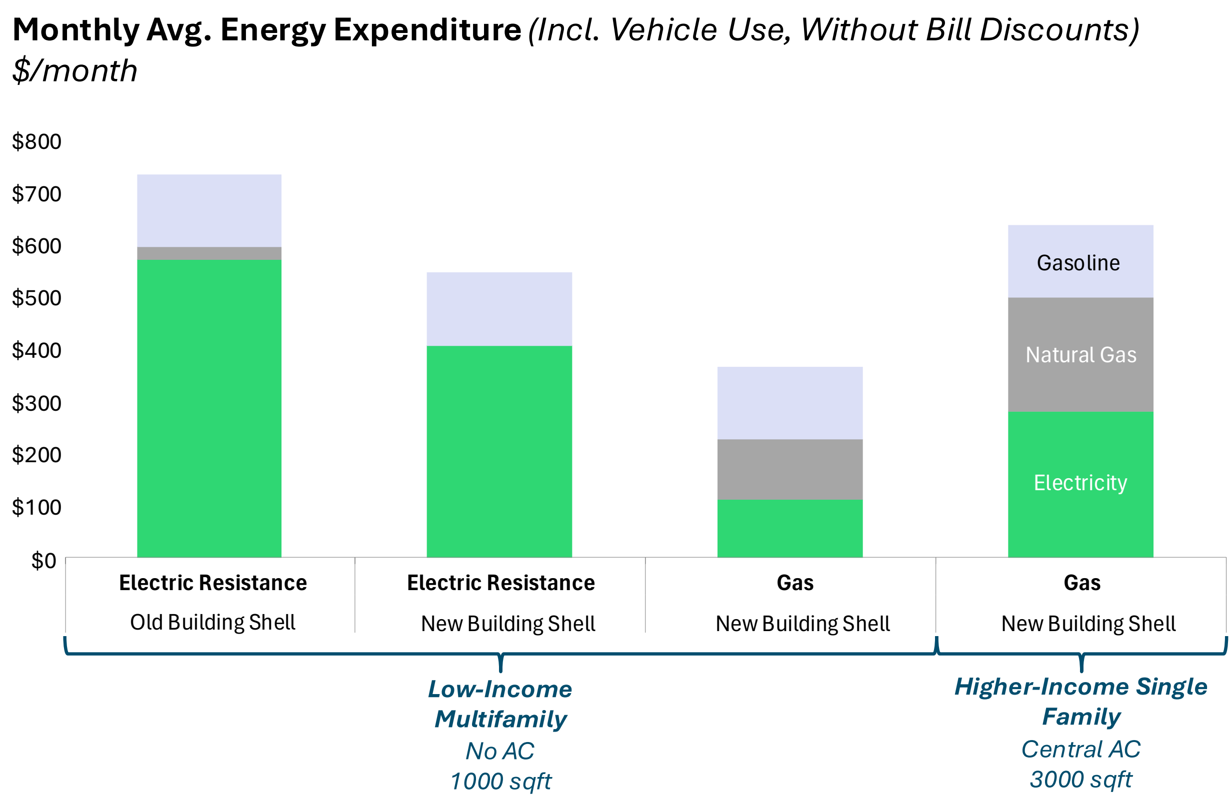


1.5.2 Energy Expenditures and Burdens of Low-Income Households

Figure 27 illustrates the bill consequences of the housing characteristics common among low-income residents. For a representative customer with an old building envelope and electric resistance heating, bills today would be more than $700 per month in energy costs for a 1,000 square foot home. Equivalent multifamily electric resistance homes with newer building envelopes pay $200 less in energy costs, and bills for households with natural gas heating would be reduced by $150. To frame the bill impacts of electric resistance and old building envelopes differently, a new 3,000 square foot single family home with central AC and gas heating may still have lower energy bills than an old, poorly insulated 1,000 square foot multifamily home with electric resistance heating.

Customers with electric resistance heating (20% of low-income customers) have higher electricity usage than those with fossil fuel heating, and therefore pay more toward utility system costs, programs, and policy-driven costs. Even when low-income customers are enrolled in the discount rate, they may still pay the same or more than higher-income counterparts.[64] This is because low-income customers may have poor insulation or older housing stock, which drives up energy use. Beyond having access to higher quality housing stock with improved insulation, higher-income households are more likely to be able to further reduce or avoid energy use by implementing energy efficiency solutions or deploying distributed generation (e.g., customer solar).

Figure 27: Monthly Average Energy Expenditures of Different Household Types



1.5.3 Energy Bill Assistance Eligibility and Discounts in Massachusetts

In Massachusetts, households at or under a certain income level are eligible for payments toward their utility bills through the federally-funded Low-Income Home Energy Assistance Program (LIHEAP, called HEAP in Massachusetts). For Fiscal Year 2025, a family of four in Massachusetts with a gross income no greater than $94,608 (60% SMI, or roughly 300% of the Federal Poverty Level) is

[64] Huang, L., Nock, D., Cong, S., & Qiu, Y. L. (2023). Inequalities across cooling and heating in households: Energy equity gaps. Energy Policy, 182, 113748.

eligible for the program.[65] Households that qualify for LIHEAP receive assistance for heating costs (Table 5) and are also eligible to receive ratepayer-funded bill discounts on their total gas and electric bills (Table 6).

Table 5: LIHEAP Benefits Information ($/year)

Occupant Status	Income Level*	Deliverable Fuel (Oil, Propane, etc.)	Utility and Heat-included-in-Rent
Homeowner / Non-Subsidized Housing Tenant	100% FPL	$600	$500
	60% SMI	$430	$355
Subsidized Housing Tenant	100% FPL	$420	$350
	60% SMI	$300	$250

Table 6: Utility Bill Discounts Offered to Low Income Customers (% of bill)

Utility	Electric Discount	Gas Discount
Eversource	42%	25%
National Grid	32%-71%	25%
Unitil	40%	25%

In November 2023, National Grid proposed a multi-tiered low-income discount rate in D.P.U. 23-150, which was approved in October of 2024, with discounts between 32% and 71% depending on household income levels. Since this approach had not yet been approved by the DPU at the time of this study, the previous fixed low-income discount level and approach was assumed (32%). The DPU also expressed a preference for tiered discount rates as a topic of focus of the D.P.U. 24-15 docket affordability inquiry: "We should pursue a [tiered discount rate] framework that targets certain levels of household energy burdens for electric and gas customers, with possible variances depending on primary heating fuel".[66]

1.5.4 Impact of Bill Discount Programs and LIHEAP

Figure 28 compares the energy burdens of households with and without EDC bill discounts and LIHEAP support at income levels of 30% of SMI and 60% of SMI. While bill discounts help reduce customer energy burdens for those close to the discount eligibility cutoff (60% of SMI), for the

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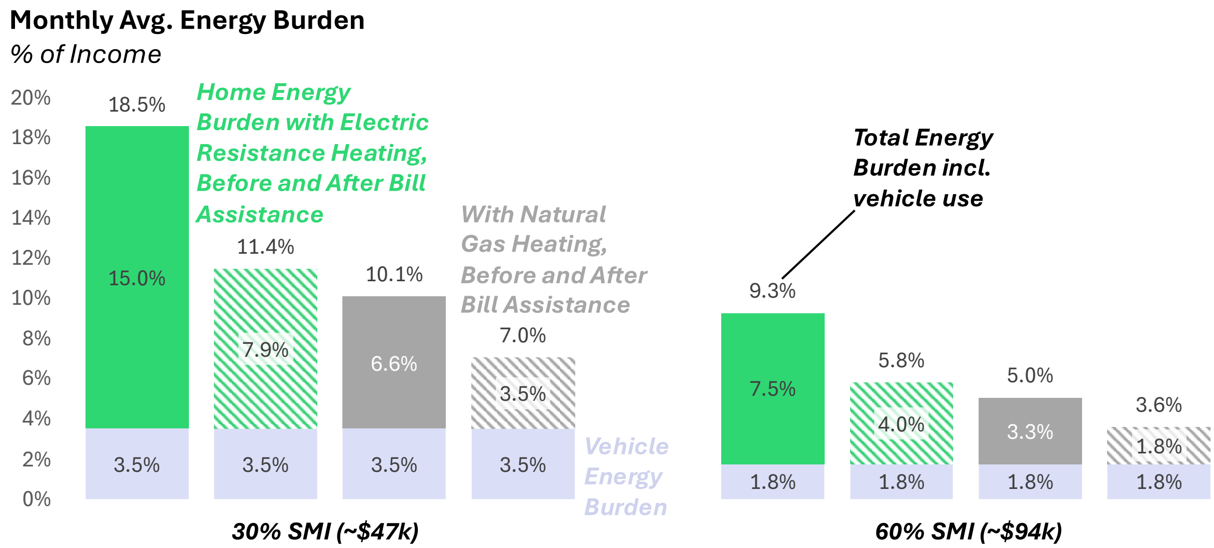
[65] Massachusetts Department of Energy Resources. *Learn about Home Energy Assistance – HEAP*. https://www.mass.gov/info-details/learn-about-home-energy-assistance-heap#program-eligibility-information-.
[66] Interlocutory Order on Next Steps in Investigation of Energy Affordability, D.P.U. 24-15-A, https://www.mass.gov/doc/dpu-24-15-interlocutory-order-english/download.

poorest households (25% of households in the Commonwealth earn less than 30% of SMI), especially those living in the least energy efficient homes and using electric resistance heating, these discounts do not adequately mitigate high energy burden. The current low enrollment of customers in bill discount programs further exacerbates the problem of low-income households facing severe energy burden.

Figure 28: Energy Burden with Energy Affordability Measures[67]



1.5.5 Other Policy Considerations for Low-Income Homes

Existing research documents low-income, Black, Hispanic, Native American, and older adult households having disproportionately high energy burdens both in the Boston metro area and nationally.[68] Systemic inequities cause these demographic characteristics to influence the likelihood of living in older, inefficient homes, as well as relying on electric resistance heating, both of which lead to high energy burdens. Additionally, these residents are more likely to rent rather than own their homes, and landlords may have limited incentives to invest in energy efficiency.

In addition to rate design considerations and utility affordability programs, improving access to weatherization, energy efficiency, and housing opportunities could help to mitigate these disproportionately high energy burdens. Low enrollment in bill discount programs and higher participation in third party electric supply contracts, which on average is more expensive than utility basic service,[69] also exacerbate energy burden among low-income households.

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[67] Both low-income discount rates and HEAP assistance assumed.
[68] ACEEE. *"How High Are Household Energy Burdens? An Assessment of National and Metropolitan Energy Burdens across the U.S.?"*, *Sept. 2020.*
[69] https://www.mass.gov/doc/competitive-electric-supply-report-2024/download.

Hidden energy poverty is another important concern, referring to when households curtail energy services (e.g., maintaining a low thermostat setpoint in the winter) due to concerns of high energy costs. For example, Black households experience a greater need for health services caused by low indoor temperatures.[70] Hotter summers and colder winters would exacerbate the comfort and health impacts of low-income households restricting cooling or heating energy use.

[70] D.P.U. 24-15 Initial Joint Comments of Environmental and Consumer Advocates (2024).

Section II: Exploring New Rate Designs

Section I showed that most customers in the Commonwealth today see high per-kWh volumetric charges on their electricity bills. These high volumetric charges do not reflect the underlying cost structure of the electric grid. Many costs to build and maintain the grid do not scale on a volumetric basis, nor do the costs to support programs and public policies funded by electric ratepayers. Historically, this rate design supported simple rates with a strong signal for conservation. Today, this picture is complicated by policy objectives to electrify end-use loads and the steady growth of delivery costs as a share of total costs. The long-standing flat volumetric rate design now contributes to high bills for electrifying customers in many households, thus discouraging electrification and exacerbating affordability concerns when homes do electrify.

There are a number of mechanisms that can reduce volumetric rates to support electrification without endangering customer energy affordability. We base this claim on both the analysis shown in this section and on studies that indicate that reducing volumetric prices would cause a meaningful increase in customer willingness to adopt EVs and electric heating.[71] In this section, we identify different rate design mechanisms that reduce the bill impacts of electrification. We detail the rationale behind each mechanism, examples of each mechanism from peer jurisdictions, and compare the bill impacts of electrification under existing rates and under rate designs that employ these mechanisms. We also explore the likely impacts of these rate mechanisms on non-electrifying customers, and on electrifying and non-electrifying low-income customers before discussing implementation challenges and considerations associated with each rate mechanism.

As previously noted, rate design is only one lever to improve energy affordability overall and affordability of electrification. Revenue requirement levels themselves play a critical role as well; lower total electric system costs result in lower electric bills and improved affordability. However, this study only focuses on rate design, and changes to overall rate levels remain outside of the scope of this study. For more context on the study scope, we direct the reader to the Introduction and Study Scope section.

2.1 Rate Levers to Explore in the Near Term

The range of possible rate designs to consider in the near term will be limited until greater rollout of Advanced Metering Infrastructure (AMI) and associated information systems is completed. This section accounts for that constraint by exploring key rate designs that could be implemented without AMI, highlighting the merits and challenges of these options. Similarly, we do not include any rates that use demand charges due to potential technological limitations of metering technology in

[71] Bushnell, J., Muehlegger, E., & Rapson, D. (2021). Do Electricity Prices Affect Electric Vehicle Adoption? UC Office of the President: University of California Institute of Transportation Studies. http://dx.doi.org/10.7922/G2DJ5CX3 Retrieved from https://escholarship.org/uc/item/7p19k8c6, and https://energyathaas.wordpress.com/2021/01/04/what-matters-for-electrification/.

capturing peak energy demand during a billing period, and the challenge of introducing demand charges to the residential class without substantial time for customer education.

The rate design elements considered in this study are:

- Rates with increased fixed charges to enable reduced volumetric charges;
- Seasonal rates, with different per-kWh volumetric charges for different seasons to better reflect delivery costs over the year; and
- Tiered rates with declining blocks, which decrease the per-kWh volumetric charge above a certain threshold of monthly usage to reduce bills for high-usage customers.

The designs above can be incorporated into new rate designs individually or in combination. While this study identifies the bill impacts of each lever in isolation to better highlight the considerations of each option, the best approach to near-term rate design may combine multiple rate elements.

As mentioned in Section 1.1.1 Supply, supply costs are usually passed through and directly to customers, who can choose between utility basic service, competitive suppliers, and municipal aggregation. For this reason, the rate designs considered in this report do not consider changes to electric supply rates and instead focus only on the delivery portion of rates. The Long-Term Ratemaking Study will address changes to supply rates as well.

One tension of this task is to balance gradualism, affordability for non-electrifying customers, and rate change that is substantial enough to encourage electrification. To this end, in addition to class-wide rates, we also explore technology-specific rates, which minimize the impact of new rate designs on non-electrifying customers.

2.1.1 Increased Fixed Charges

Increasing the share of delivery costs recovered through the monthly customer charge would help reduce bills for electrifying customers and improve the cost reflectiveness of rate design. If these charges are designed in a progressive manner, they would also support bill reductions for low-income customers.

Increasing fixed charges would allow for a reduction in volumetric rates, thus better aligning with the Commonwealth's building and vehicle decarbonization policy goals compared to today's rates. Increased fixed charges would also allow for better alignment between customer rates and utility costs, as a large share of utility costs do not scale with customer usage. Increased fixed charges could help provide more efficient price signals that better reflect marginal system costs for increasing volumetric consumption through electrification as well as for decreasing volumetric consumption through energy efficiency and DERs.[72]

As described in Section I, several program and public policy costs are currently recovered through volumetric charges. This may be a regressive way to fund these programs, as low-income customers

[72] The impacts of rate design mechanisms on customers with DERs will be included in a forthcoming report.

in buildings with poor energy efficiency, with electric resistance heating, and/or high-occupancy households are all likely to have high electric usage, and thus will pay for a larger share of these programs.[73] While folding some of these costs into a *flat* fixed charge would also be relatively regressive, a *graduated* or *progressive* fixed charge would ensure a more progressive distribution of these costs.

Progressive charges are a promising policy tool that would help improve energy affordability while supporting the goal of improving customer economics for electrification. As stated by the DPU, "Establishing the proper customer charge is a trade-off where the intra-class subsidization of costs between high- and low-consumption customers needs to be balanced against the customer bill impacts, as well as the relevant policy objectives under M.G.L. c. 164, § 141".[74] In California, efforts to implement progressive fixed charges have faced issues with income verification: "A key constraint for designing income-graduated fixed charges is the feasibility of verifying the incomes of moderate- or high-income customers. Parties agreed that, without additional statutory authorization, the Franchise Tax Board cannot share income information or confirm self-reported income information without a taxpayer's written consent."[75] In 2024, balancing these concerns, the California Public Utilities Commission adopted a three-tier system for income graduation, ranging from $6/month for customers enrolled in the "California Alternative Rates for Energy" bill discount program to $24.15/month for customers who do not qualify for the lower charges.

In 2024, the DPU approved National Grid's proposed tiered discount rate, which offers bill discounts that vary from 32% to 71%, depending on customer income levels, and determined that this was an appropriate framework to target household energy burden levels for gas and electric customers.[76] Because the discount rate applies to the entire bill, including any fixed charge, this design effectively incorporates income graduation into fixed charges. While California's system relies on self-attestation, National Grid's approach will rely on "(1) enhanced data sharing, building on auto-enrollment through data sharing with the Department of Transitional Assistance and [Community Action] agencies; and (2) the continuation of direct enrollment for customers who show proof of participation in a qualified means-tested program into the default 32 percent low-income discount rate, unless additional information is provided to demonstrate that a higher discount tier should apply."[77] Thus, Massachusetts may be well equipped to provide low-income homes with tiered discount rates, including graduated customer charges. While this topic is not explored further in this study, income graduation will be an important policy consideration to afford sufficient protections for low-income, low-usage customers under increased fixed charges.

To better illustrate the implications of increased fixed charges for low- and high-usage customers (without accounting for income graduation), Figure 29 highlights the change in electricity bills for a low-usage customer today (small, multifamily home in Western Massachusetts with natural gas heating and room AC) moving to a rate with a $30/month fixed charge, compared to $10/month

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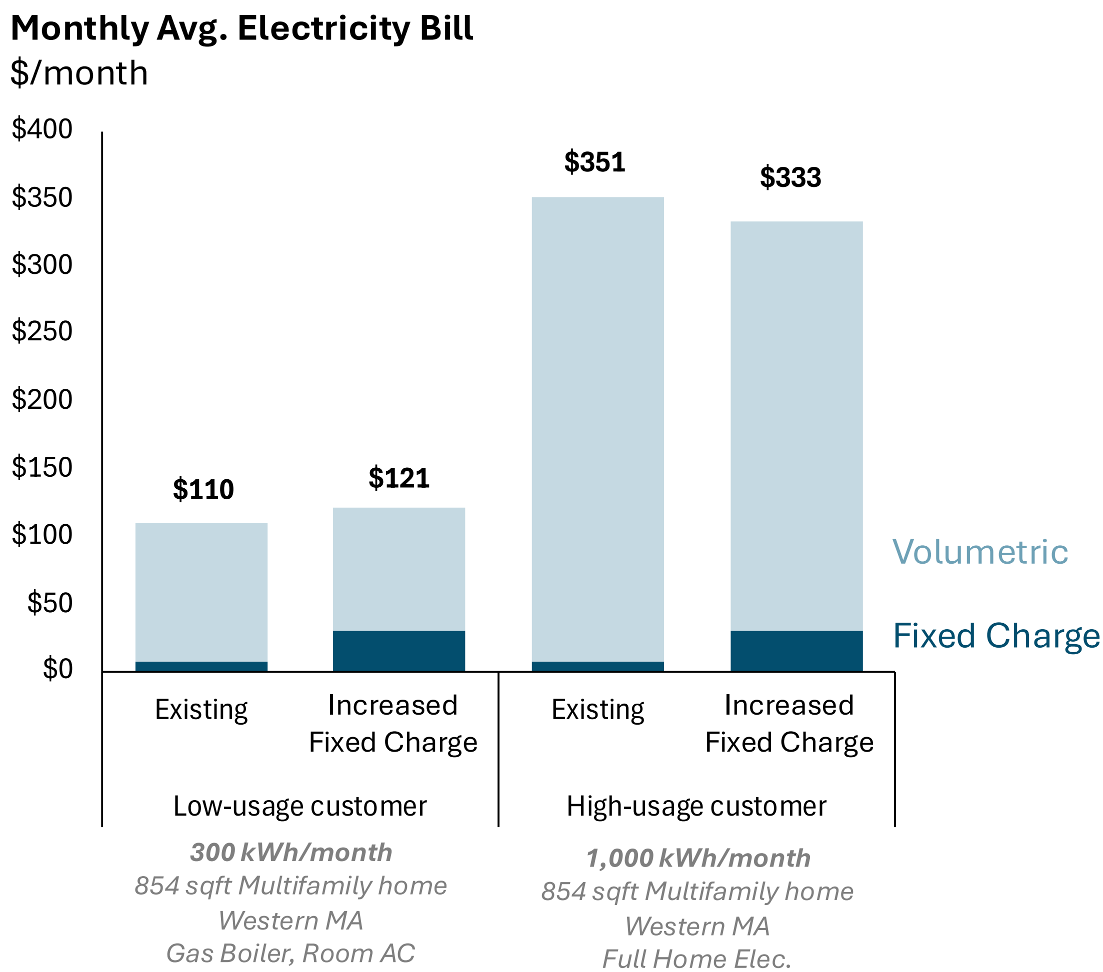
[73] https://energyathaas.wordpress.com/2022/09/26/equitable-decarbonization-requires-rate-reform/
[74] D.P.U. 22-22 Order at 475 (2022).
[75] California Public Utilities Commission, Rulemaking 22-07-005, Proposed Decision at 30 (2024).
[76] D.P.U. 24-15-A at 6 (2024).
[77] D.P.U. 23-150 at 590-591 (2024). National Grid was also ordered to file a proposal for a two-year self-attestation pilot.

charge today. This customer would see an $11 increase in their monthly average bill with a higher fixed charge. By contrast, if this same household were to electrify, their average monthly electricity cost would decrease under the increased fixed charge design, from $351 to $333, due to the reduced volumetric rate enabled by the increased fixed charge.

Figure 29: Electricity Bill Impacts of Increased Fixed Charge by Usage

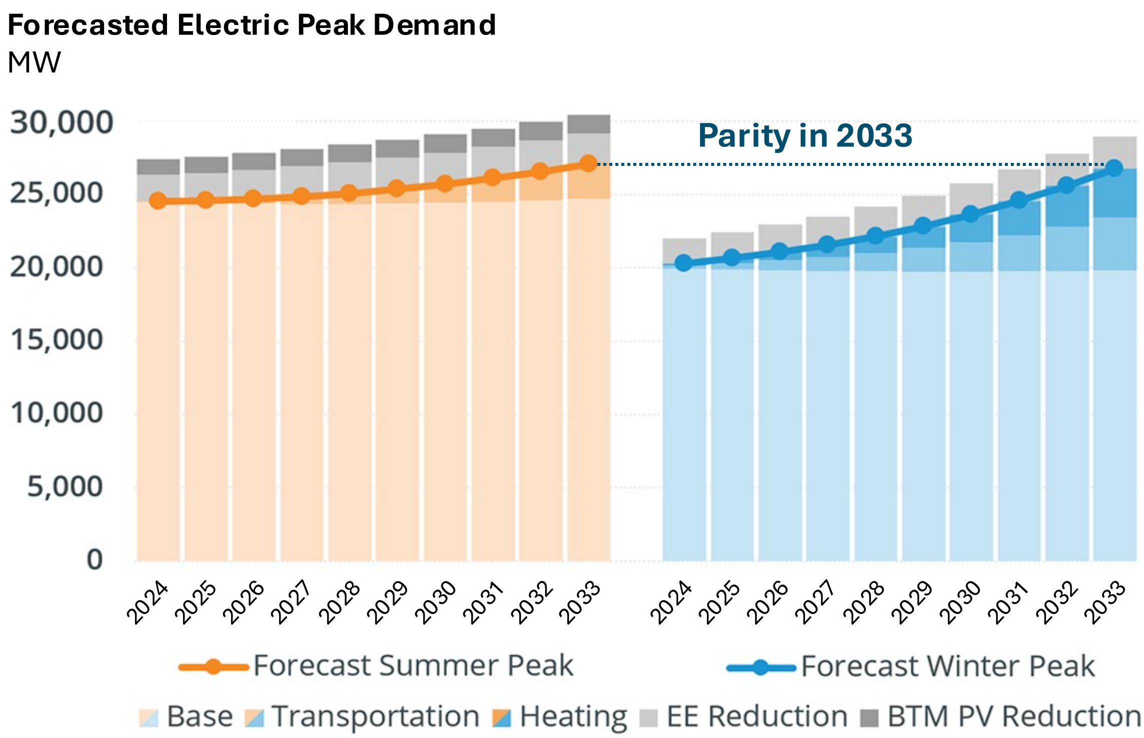


2.1.2 Seasonal Rates

In Massachusetts, customers aiming to adopt heat pumps face the barrier of high electricity prices and cold winters. An option to alleviate winter heating expense is to combine lower winter volumetric rates with higher summer volumetric rates. This option more closely aligns customer rates with costs to serve electric load. As shown in Figure 30, the electricity system in New England today is built to meet high summer peak demand: 25 GW peak in the summer, compared to 20 GW in the winter. Today, additional winter electricity demand does not drive significant costs for additional electric generation capacity, transmission capacity, and distribution capacity compared to summer electricity demand. Accordingly, electricity rates can be aligned to reflect these dynamics, better aligning customer and utility costs and reducing winter heating costs for electrifying customers in the near term.

It is critical to note the impermanence of this dynamic. By 2033-2035,[78] the growth in building electrification is forecast to push the system towards similar winter and summer peaks (27-29 MW depending on weather conditions), with winter peaks increasingly driving system costs as more heating demand transitions to electricity. We note that more rapid heat pump adoption, perhaps spurred in part by favorable rate design, could accelerate this transition to a winter-peaking system, despite concurrent efforts by the state to pursue peak reduction strategies through energy efficiency rebate programs, stringent building codes, demand response programs, and other initiatives. A built-in glide path from seasonal rates to advanced, AMI-enabled rates could ensure that rates remain cost-reflective through periodic re-evaluation and a possible sunset date for the seasonal rate offering as the seasonal system peak shifts. Without cost-reflective rates, customers would face inadequate price signals for load management, thus running the risk of increasing electric system costs for all by driving up winter electric peak demand.

Figure 30: ISO New England's 10-Year Electricity Demand Forecast[79]



[78] There are varying estimates of when this peak flip will occur, within the range of 2033 through 2036, provided by Eversource and National Grid in their ESMP filings, as well as the ISO-NE source mentioned in the next footnote. See https://www.mass.gov/doc/cetwggmac-joint-meeting-presentationnational-grid-10-13-2023/download and https://www.mass.gov/doc/cetwggmac-joint-meeting-presentationeversource-10-13-2023/download.

[79] Adapted from https://www.iso-ne.com/about/key-stats/electricity-use.

An important concern for seasonal rates is that increasing summer pricing would increase the cost of AC. With a seasonal rate as the default rate for the entire residential customer class, bills would likely increase for customers with high AC loads and limited winter electricity demand, which is an especially important consideration as climate change induces greater demands for AC.

One way to mitigate this challenge would be to restrict seasonal rate eligibility to those with electric heating systems. Under this design, we continue to assume that increased winter loads do not significantly add to delivery costs in the near term, which implies that the delivery costs to serve a customer with electric heating are not significantly different from the delivery costs to serve a customer with fuel-based heating. As a result, it is possible to drastically reduce the winter per-kWh rate for electric heating customers and fully recover the delivery costs for serving that customer.

Multiple jurisdictions in New England offer similar electric heating rates with steeply reduced volumetric charges in the winter.[80] Central Maine Power (CMP) offers a "Seasonal Heat Pump rate" pilot program, which increases the default rate's customer charge from $27/month to $41/month and increases the summer delivery rate by 9¢/kWh, enabling an approximately 95% discount on the per-kWh delivery charge from November 1st to April 30th.[81]

Here in the Commonwealth, Unitil's proposed heat pump rate from D.P.U. 23-80 was approved in 2024, offering a 7-cent winter electricity discount (a 64% discount compared to the summer rate), with the same summer rates and fixed charge as their R-1 and R-2 rate offering. As noted earlier, the DPU has also directed National Grid to prepare a heat pump rate consistent with Unitil's approved rate. For a 1,100 square foot gas-heated multifamily home in Unitil's service territory, the new rate still yields a small bill increase when transitioning to all-electric heating system, as shown in the yellow column on the left of Figure 31, despite also including a building insulation upgrade. The two bars on the right show that combining building electrification with replacing an ICEV with an EV would yield overall energy expense savings under both the existing and heat pump rate.

While this is an improvement compared to the bill impacts of heat pump adoption under the existing rate, shown in grey on the left, the bill increase suggests that the Unitil heat pump rate reduces, but does not remove, the barrier to home electrification. Greater reductions in the winter delivery rate could be provided through an increase in the customer charge, an increase in the summer delivery rate, as in the CMP rate offering, or by applying seasonal variation to a larger share of costs in the delivery rate.

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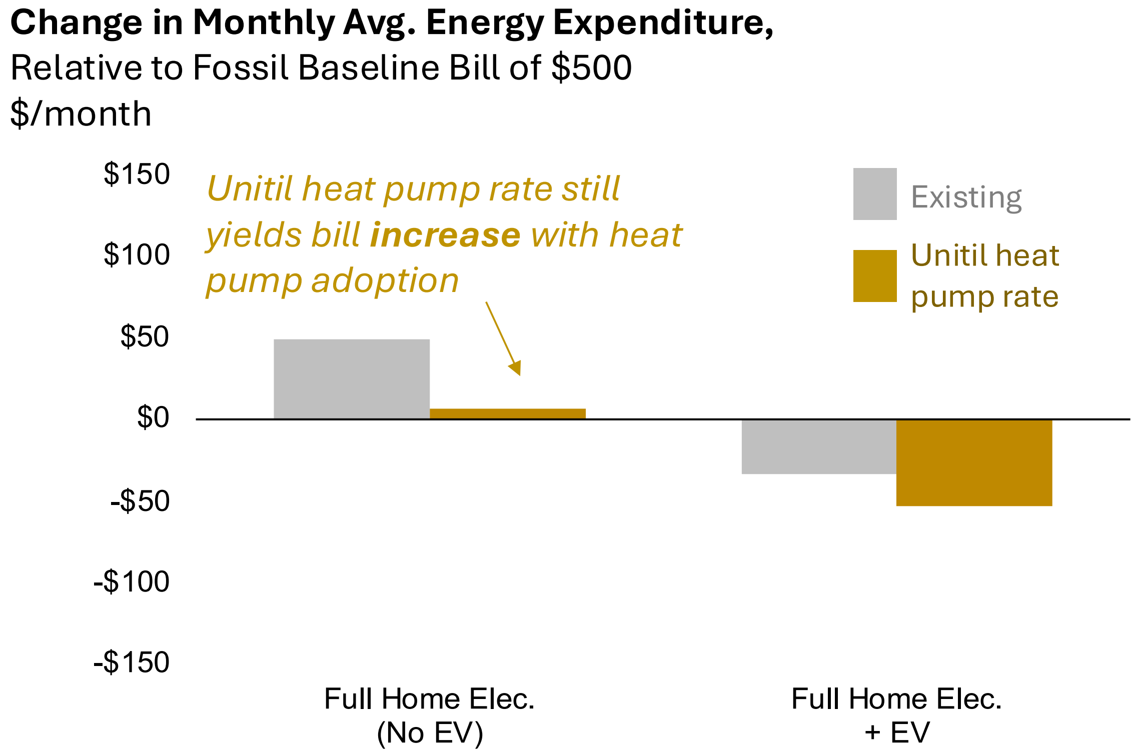
[80] Central Maine Power: https://www.cmpco.com/account/understandyourbill/newseasonalheatpumprate, Versant Power: https://www.versantpower.com/media/49251/Rate_A20_ResHEAT.pdf.

[81] https://www.cmpco.com/account/understandyourbill/newseasonalheatpumprate.

Figure 31: Unitil Heat Pump Rate Bill Impacts of Electrification[82]



Another concern is the potential overcompensation of net energy metering (NEM) customers on seasonal rates. Additional compensation for NEM customers in summer months would not be fully offset by decreased compensation in winter months because rooftop solar generation is far higher in the summer. This additional compensation may create or exacerbate a cost shift from NEM customers to non-participating customers. The customer economics of NEM participants will be explored further in the Long-Term Study.

2.1.3 Declining Block Tiered Rates

Most tiered rates offered today to residential customers have inclining blocks to encourage energy conservation by raising the per-kWh cost of electricity at higher levels of monthly consumption. Conversely, declining tiered rates provide a discounted volumetric rate above specified thresholds to reduce bills for high usage customers. As described, households with electric heating today use more electricity than other households without necessarily adding significantly to delivery costs in the near term, and these customers face disproportionately high bills under today's high-volumetric electricity rates. A declining block structure would allow utilities to recover the delivery cost of service from a roughly average level of consumption and then offer a lower rate for monthly consumption beyond that level to support the addition of new electrification loads.

[82] Unitil service territory multifamily home with baseline natural gas heating, 1100 square feet, room AC (60% coverage).

One example of a declining block rate targeted at electrified homes is Maine's Versant Power Home Heating Eco Rate.[83] The rate has a threshold of 600 kwh, above which the delivery rate is discounted by approximately one-third for the heating season, with no associated change in any of the other charges. To be eligible for the rate, a customer must use a heat pump for 50% or more of their winter heating needs. The average home with a heat pump in their service territory uses approximately 1200-1300 kWh per month during the heating season, meaning that the average customer will see substantial bill savings during the heating season relative to what their cost would be on the default residential rate. PSEG-Long Island is another example of a utility with a similar winter declining block pricing scheme, also limited to homes with electric heating.[84]

As implied by these examples, we note that a declining block rate with significantly reduced pricing above the usage threshold may have challenges for residential class-wide implementation. One key concern is that declining block rates provide a reduced signal for conservation, including for peak summer electricity usage when the marginal costs of incremental electricity consumption are high in the near term. Accordingly, we only consider declining block rates that are limited to electrified customers.

Declining block rates address affordability of electric heating somewhat indirectly, i.e., not by changing the cost of electricity used for heating, but by reducing the costs of being a large consumer. As discussed above, this mutes the desired signal for conservation in the summer, and in a future winter-peaking system, the mechanism would also mute the signal for conservation in the winter. Like the seasonal rates, this option would no longer be cost-reflective for heat pump customers in a winter-peaking system, given that the hours of winter electric heating demand will coincide with those of system peak demand. However, we note that this mechanism is well-suited for improving the affordability of EV charging, since charging demand varies little by season. Still, a more effective long-term approach to improving EV affordability will become available with AMI, given the presence of low-cost hours throughout the year and the flexibility of EV charging. We explore this concept further in the forthcoming Long-Term Ratemaking Study.

2.2 Rate Options Modeled

To explore the customer energy bill impacts, we model four illustrative rate designs for residential delivery rates, two applicable to the entire residential class and two electric-heating-only rates. Supply rates are assumed to be passed on to the customer, as is the case today. The class-wide rate options are revenue-neutral, meaning that the total revenues collected under these rate designs are equal to the revenues collected under existing rates. For the two technology-specific options, the approach to revenue neutrality is driven by the assumption that customers with electric heating add limited delivery costs in the near term beyond the average customer, as detailed in Section 2.1.2 Seasonal Rates. To reflect this rationale, the rates are designed so that delivery revenue per customer for electric-heating customers under *alternative* rates are equal to delivery revenue per

[83] https://www.versantpower.com/media/49251/Rate_A20_ResHEAT.pdf.
[84] https://www.psegliny.com/aboutpseglongisland/ratesandtariffs/-/media/A0FDA80A6FE44A45973922422E86BD9E.ashx.

customer for non-electric-heating customers with *today's* rates. This approach thus ensures that customers with electric heating are not penalized for adding electricity demand during periods of the year when the system is not constrained.

These calculations were replicated for each of the three EDCs using utility-specific billing determinants (monthly number of customers and energy sales). Table 7 highlights the various rate options for Eversource customers as an example, to show the relative magnitude of bill components under different rate options relative to existing rates today. We emphasize that technology-specific rate designs present an opportunity for substantial changes to current design, as the technology-specific nature of the rates remove the need for gradual change to mitigate impacts on non-electrifying customers.

Table 7: Study Rate Designs, Eversource

Rate Design Lever	Rate Level	Notes
Existing Rate	**Fixed charge**: $10/month fixed charge **Volumetric rate**: 34¢/kWh	17¢ delivery + 17¢ supply
Increased Fixed Charge	**Fixed charge**: $30 (+$20/month) **Volumetric rate**: 30¢/kWh (-4¢/kWh)	$30/month fixed charge would collect the majority of program and policy costs currently collected via volumetric rates for an average customer while limiting bill increases for low-usage customers.
Seasonal	**Fixed charge**: $10/month fixed charge **Summer rate**: 37¢/kWh (+3¢/kWh) **Winter rate**: 29¢/kWh (-5¢/kWh)	60% of utility delivery costs recovered in summer rate; supply costs passed on to customers year-round. Limited winter discount aims to mitigate potential bill increases for high-summer-usage customers.
Seasonal (Electric Heating)	**Fixed charge**: $10/month fixed charge **Summer rate**: 42¢/kWh (+8¢/kWh) **Winter rate**: 16¢/kWh (-18¢/kWh)	100% of utility delivery and "other" costs recovered in summer rate; supply costs passed on to customers year-round.
Declining Block (Electric Heating)	**Fixed charge**: $10/month fixed charge **Tier 1 rate**: 34¢/kWh (+ 0 to 1¢/kWh) **Tier 2 rate**: 17¢/kWh (-17¢/kWh)	100% of utility delivery and "other" costs recovered in first tier (500 kWh/mo); supply costs passed on to customers in second tier.

2.3 Energy Costs and Electrification under New Rates

This section explores energy bills for both electrifying and non-electrifying customers under the alternate rate designs outlined in the prior section. Key results include:

- Bill impacts for customers across fuel types;
- Month-to-month variation in energy costs;
- Bill impacts for low-income households, with natural gas or electric resistance heating; and
- Bill impacts for customers with customer solar under net energy metering.

2.3.1 Bill Impacts for Electrifying Homes Across Fuel Types

As identified in Section 1.4.1 Heating Technology, most homes with natural gas heating face bill increases with electrification under existing rates, while homes with electric resistance heating and fuel oil heating would see bill savings or close to operational cost parity from heat pump adoption. Figure 32 shows the change in monthly energy expenditure with electrification under alternative rates for an example home that currently uses natural gas heating.[85] While all rate designs studied improve annual bill impacts from electrification compared to electrification under existing rates, only the two technology-specific rates present absolute bill savings for full home electrification compared to the natural gas baseline. When full home electrification is paired with vehicle electrification, EV-induced bill savings reduce energy costs most significantly for the declining block rate and increased fixed charge rate, with more muted reductions for the other options.

The takeaway from this snapshot is that the greater the reduction in the winter volumetric rate, the greater the bill savings for customers looking to electrify. Rate reform that only achieves limited volumetric rate reduction presents an improvement in the price signal to electrify, but significant reductions are needed to generate bill savings compared to natural gas heating. The impact from the technology-specific rate mechanisms is significant enough that almost all the prototypes modeled in our analysis see a bill decrease from electrification.

[85] 1,700 square foot home in multifamily housing in Worcester.

Figure 32: Bill Impacts of Electrification with Alternate Rates – Natural Gas Baseline[86]

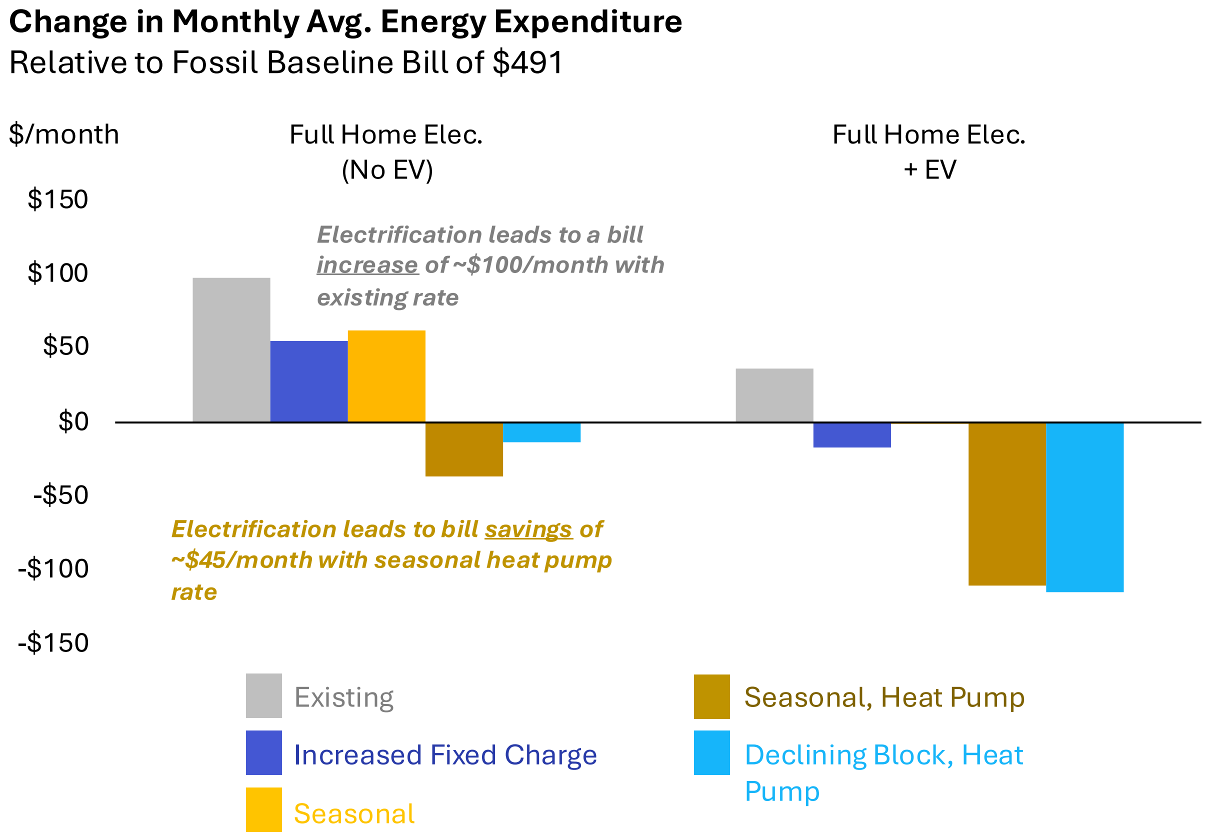


Table 8 shows the range of bill impacts for the households modeled in this study, not including the impacts of bill discounts, which are included in Section 2.3.3 Bill Impacts for Low-Income Households.

- Among customers that do not electrify, low-usage natural gas and fuel oil customers would see small bill increases for the increased fixed charge rate, and customers with high summer usage would see the greatest increases from the seasonal class-wide rate.
- For the two class-wide rates modeled (i.e., offered to all residential customers, not just those adopting heat pumps), natural gas baseline households would see improved economics for building electrification, but would still see an increase in energy bills from full home electrification without EV adoption, as the modest reduction in volumetric rates modeled for these options in this study is insufficient to reduce the costs of increased electric loads.
- In contrast, the heat pump rates show bill savings upon electrification for nearly all modeled customers because the more significant reduction in winter volumetric rates enables lower cost electric winter heating, except for a few natural gas households that

[86] Pre-1970 vintage, 1700 square foot home in multifamily housing in Central Massachusetts, with baseline room AC (60% coverage) and gas heating.

have a relatively high summer AC load and low winter heating load (e.g., summer vacation homes).

- For fuel oil heating customers, electrifying households would see bill decreases under all four modeled rate designs, as even the class-wide rate reduction options modeled provide enough of a reduction to volumetric rates to shift efficient electric heating costs to near cost parity with fuel oil heating today, as shown previously in Table 4.
- Electric resistance heating customers who adopt heat pumps would see bill savings across all rate options due to the efficiency improvements of heat pumps and insulation upgrades.
- Vehicle electrification would yield bill savings across customers and rate designs as modeled, although this outcome is sensitive to the assumed relative efficiencies of ICEVs and EVs, as described in 1.4.6 Personal Transportation.

Table 8: Change in Monthly Average Energy Costs for Households without Bill Discounts relative to Baseline Home and Existing Rates

		High Fixed Charge	Seasonal	Seasonal, Heat Pump	Declining Block, Heat Pump
Baseline Home (No EV)	Natural Gas	-$5 to $5 (-1% to 1%)	-$3 to $1 (0% to 0%)	N/A for households not adopting heat pumps	
	Fuel Oil	-$12 to $6 (-1% to 1%)	-$3 to $0 (-1% to 0%)		
	Electric Resistance	-$83 to -$35 (-9% to -5%)	-$75 to -$27 (-7% to -5%)		
Full Home Elec. (No EV)	Natural Gas	$3 to $61 (0% to 26%)	$8 to $69 (2% to 19%)	-$78 to -$13 (-14% to -4%)	-$103 to $4 (-17% to 1%)
	Fuel Oil	-$139 to -$26 (-17% to -8%)	-$117 to -$30 (-14% to -6%)	-$255 to -$101 (-35% to -19%)	-$257 to -$90 (-35% to -17%)
	Electric Resistance	-$472 to -$217 (-49% to -39%)	-$468 to -$221 (-48% to -40%)	-$545 to -$261 (-54% to -47%)	-$538 to -$244 (-54% to -39%)
Full Home Elec. + EV	Natural Gas	-$56 to $0 (-18% to 0%)	-$45 to $16 (-14% to 7%)	-$137 to -$79 (-29% to -14%)	-$193 to -$88 (-31% to -22%)
	Fuel Oil	-$204 to -$88 (-25% to -20%)	-$173 to -$76 (-21% to -12%)	-$325 to -$166 (-44% to -32%)	-$352 to -$183 (-48% to -34%)
	Electric Resistance	-$535 to -$274 (-55% to -41%)	-$522 to -$263 (-54% to -39%)	-$610 to -$331 (-61% to -60%)	-$631 to -$337 (-64% to -54%)

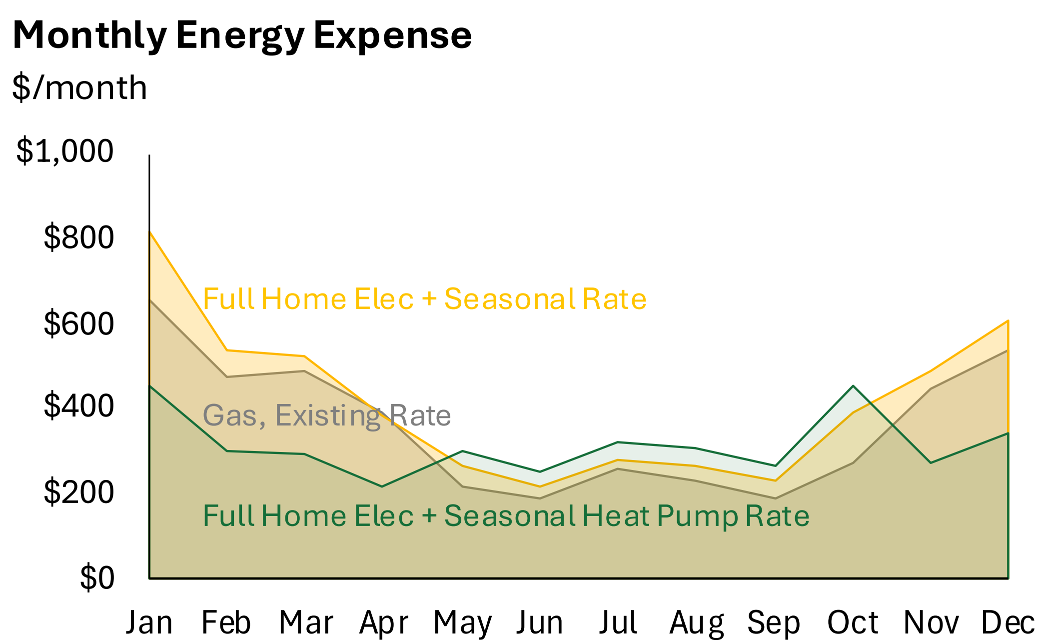
Bill savings
Range crosses 0
Bill increase

Note: Monthly bill impact (and percentage change) is shown for the 10% to 90% range across modeled representative prototypes selected from NREL's ResStock database.

2.3.2 Monthly Bill Variation

While average monthly energy cost is a useful metric to understand the overall cost impacts of the considered rate designs, understanding the impacts on bill volatility over the course of a year is also crucial. Figure 11 illustrated that winter heating energy demand is significantly larger than summer AC energy demand. Figure 33 builds on this, showing monthly bills for a multifamily natural gas heated home with room AC[87] under existing rates compared to a fully-electrified home using the seasonal class-wide rate as well as the seasonal heat pump rate. The increase in energy costs in summer is not fully offset by savings in winter after the switch to a seasonal class-wide rate, resulting in a $640 annual increase in household energy costs. In contrast, the more significant winter discount of the technology-specific seasonal rate is able to provide significantly lower winter bills. These winter savings will be especially important for customers gaining increased AC service from the heat pump and thus seeing larger bills in the summer. The technology-specific seasonal rate modeled would provide deeply discounted winter heating rates to support bill savings compared to a fossil fuel baseline – close to $580 in annual savings in this case. These savings are the result of $200 in monthly savings in peak winter months offsetting the $90 monthly increase in summer electricity costs driven by AC now extending to the whole home. An added benefit compared to the existing baseline case is reduced month-to-month volatility in bills, despite the increase in summer bills.

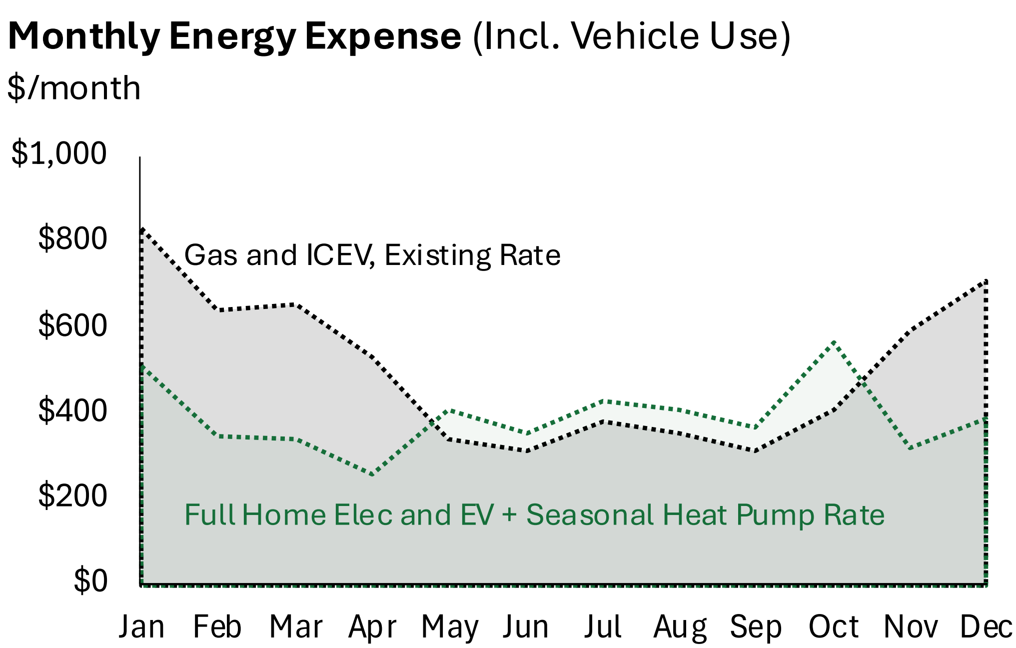
Figure 33: Household Monthly Utility Bills with Seasonal Rates[88]



[87] 1700 square foot home in Central Massachusetts.
[88] Pre-1970 vintage, 1700 square foot home in multifamily housing in Central Massachusetts, with baseline room AC (60% coverage) and gas heating.

To explore concerns about adding EV charging load in addition to AC load in the summer with a technology-specific seasonal heat pump rate, Figure 34 shows total energy expense including EV charging costs. The figure shows that even with a higher summer rate, the highest monthly bills would be below or on par with baseline winter energy costs. It also shows that households would enjoy annual savings compared to the natural gas heating and ICEV baseline. Annual savings in this case total $1,370, with summer monthly expenses increasing by $40 and winter monthly expenses decreasing by $300.

Figure 34: Household Monthly Energy Expense (Incl. Vehicle) with Technology-Specific Seasonal Rates[89]



2.3.3 Bill Impacts for Low-Income Households

As identified in Section 1.5.1 Housing Types of Low-Income Households, the share of low-income households heated with electric resistance is higher than the share among higher-income households. Focusing on a representative low-income household with electric resistance heating, with a baseline bill of $372/month, Figure 35 highlights that electric resistance customers would see bill reductions from heat pump adoption across all rate designs due to the improved efficiency of heat pumps.

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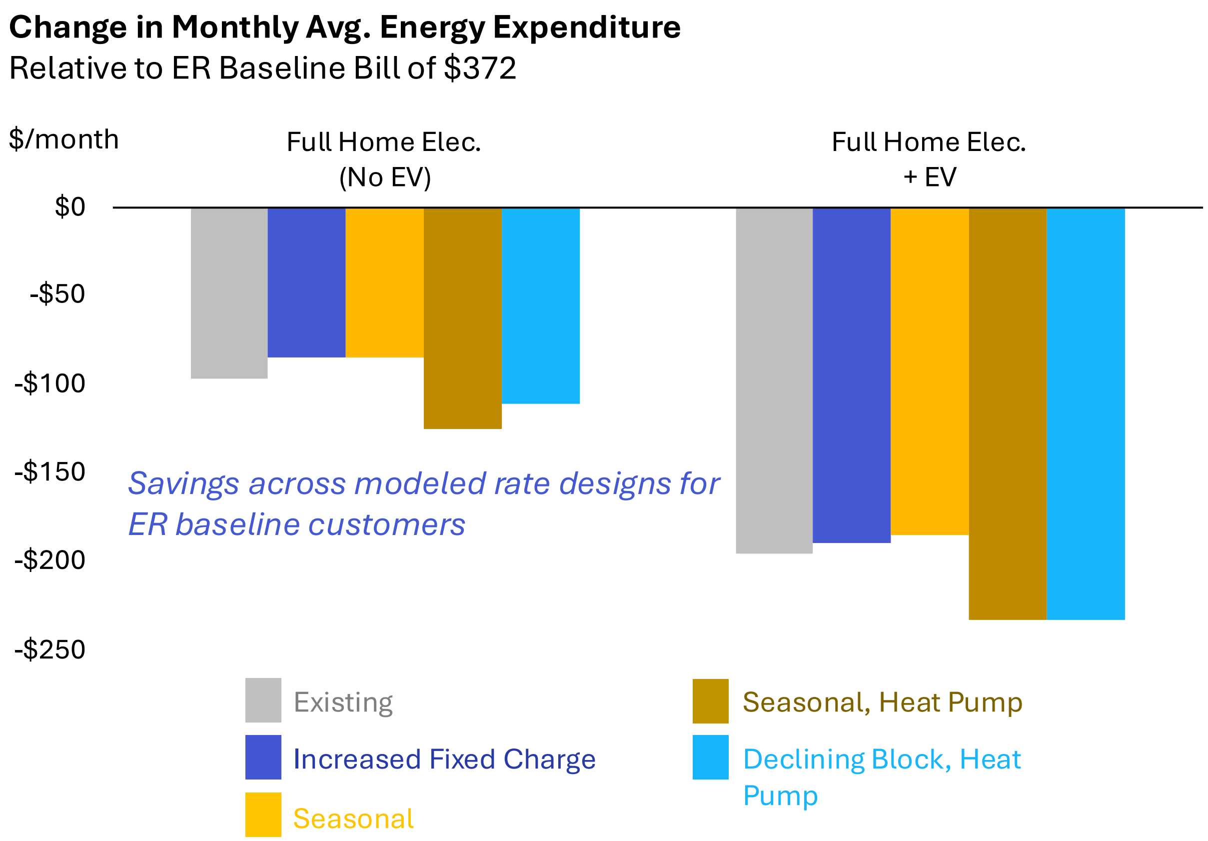
[89] Pre-1970 vintage, 1700 square foot home in multifamily housing in Central Massachusetts, with baseline room AC (60% coverage).

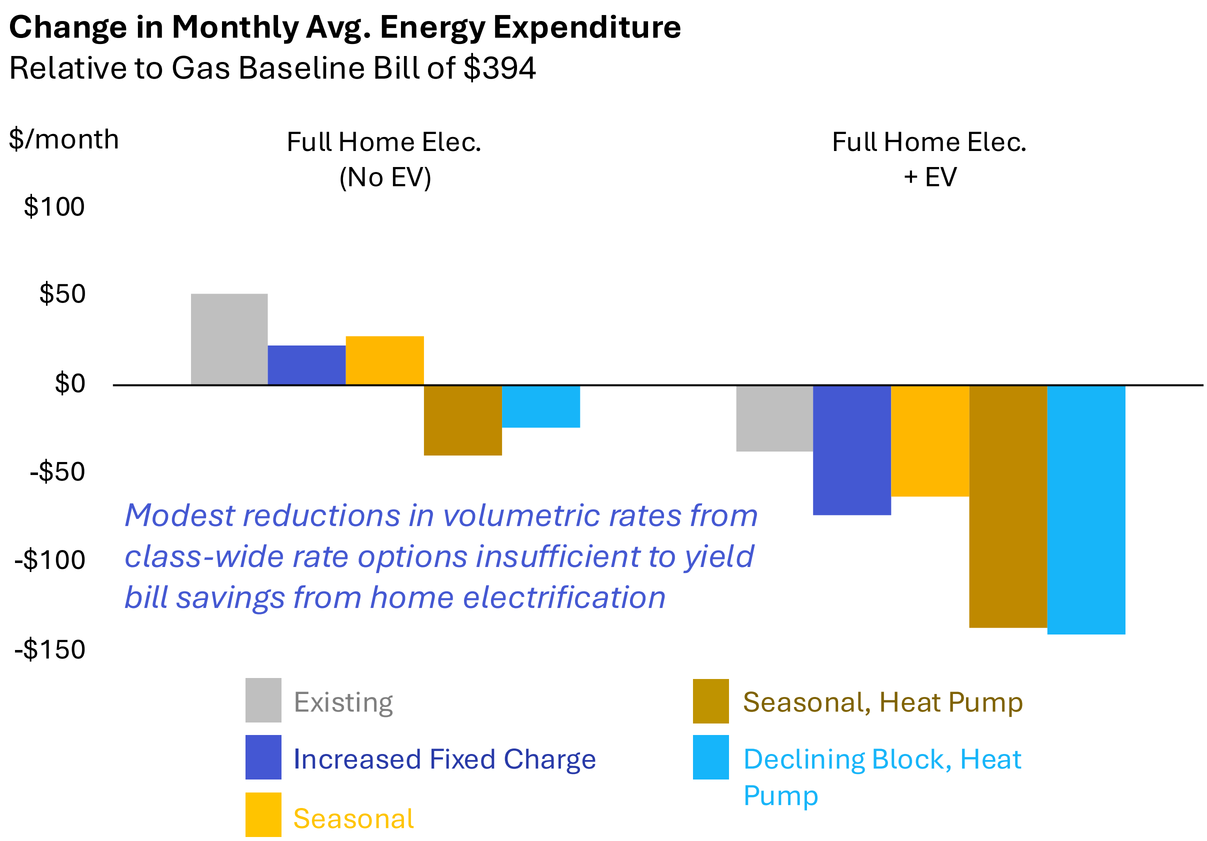
Figure 35: Bill Impacts of Electrification with Alternate Rates – Electric Resistance Baseline[90]



For low-income households with natural gas heating, the results shown in Figure 36 are similar to those for electrifying natural gas baseline heating customers without bill discounts: the two heat pump rates yield more significant bill savings than the class-wide options modeled. Bill savings are larger for customers with bill discounts as a percentage reduction from baseline bills, driven by the comparatively higher bill discounts offered by electric utilities (~32% for the customer shown) compared to that for gas utilities (~25% for the customer shown).

[90] Pre-1970 vintage, 620 square foot home in multifamily housing in Boston Massachusetts, with baseline room AC (20% coverage) and electric resistance heating.

Figure 36: Change in Monthly Energy Expenditures for a Low-Income Home with Natural Gas Heating[91]



In addition to bill impacts, it is also important to consider impacts of electrification and rate design on energy burden, as shown in Figure 37. Here, the monthly average energy burden is calculated as annual energy expenditure divided by 60% of state median income for a family of four ($95k/year), the current threshold for bill discounts. Note that, in this figure, energy burden includes the costs of both building energy consumption and fueling costs for personal vehicles, and that energy burden would vary on a monthly basis, as explored in 2.3.2 Monthly Bill Variation.

For the example natural gas customer we model on existing rates and with a baseline home (no home or vehicle electrification), energy burden is 6.2% without a bill discount and 5.0% with a bill discount, based on an annual income of $95k/year. For this customer fully electrifying the home but without adopting an EV, energy burden increases most under the existing rate structure; in contrast, energy burden decreases under both the seasonal electric heating rate as well as the declining block rate. Adopting an EV on top of home electrification decreases energy burden relative to full home electrification; in all cases, a customer with a bill discount achieves lower energy burden than the baseline customer (driven by higher electric discount rates compared to gas discount rates), and

[91] Pre-1970 vintage, 1700 square foot home in multifamily housing in Central Massachusetts, with baseline room AC (60% coverage) and gas heating.

again the seasonal electric heating and tiered rates provide the greatest savings across the rate options. For the class-wide rate options modeled, energy burden increases with full home electrification despite bill discounts, pointing to the need for greater volumetric rate reductions, as are achieved by the seasonal and declining block heat pump rates, to limit energy burden for low-income electrifying customers. This is especially important given the current levels of under-enrollment in bill discount rates described in 1.5.4 Impact of Bill Discount Programs and LIHEAP.

Figure 37: Household Energy Burden for Electrifying Natural Gas Household Under Alternate Rate Designs[92]

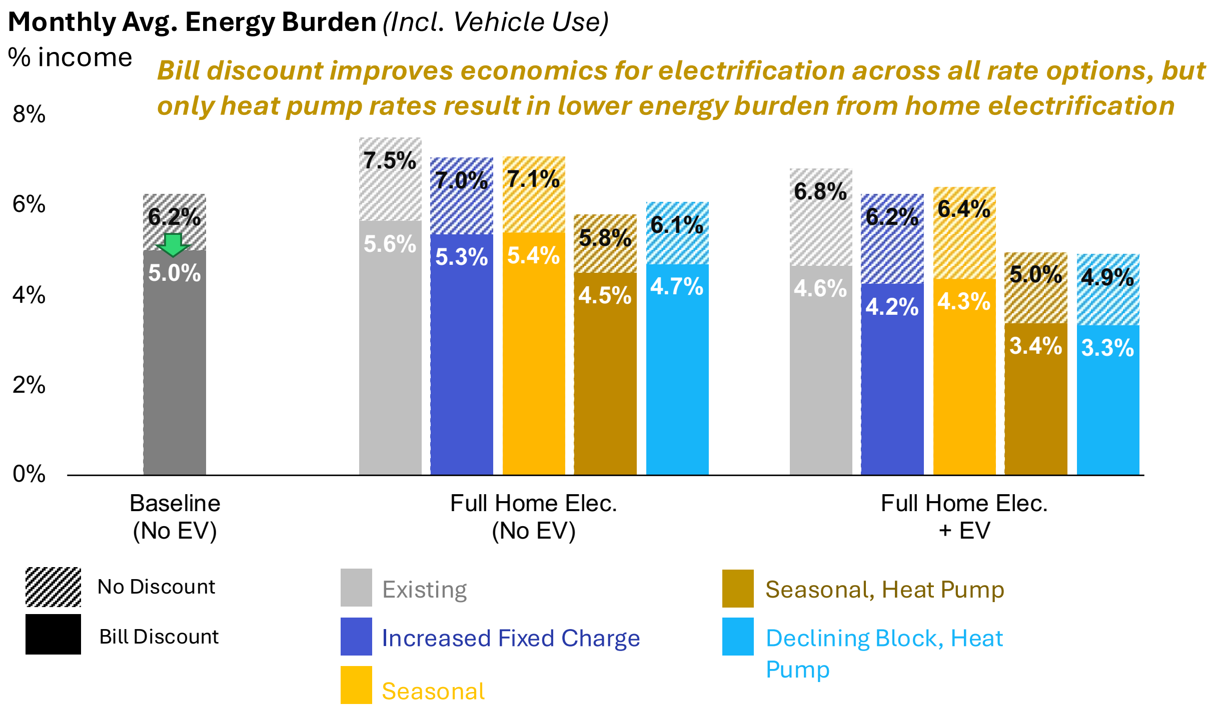


Table 9 shows the range of bill impacts for the households modeled in this study, focused on customers eligible for utility bill discounts. For baseline customers (who do not electrify), low usage customers see bill increases under increased fixed charges, although this modeling does not incorporate the impacts of progressive fixed charges. High AC load customers would see increases under the seasonal class-wide rate. For customers who do electrify, overall bill impacts are improved across all rate options relative to customers who are not eligible for bill discounts, due to the greater bill discounts on electricity than on gas, and no utility bill discounts for other fuels. As shown in the prior figure, electrification still yields bill increases for some gas heating customers on the class-wide rate options despite bill discounts, due to the limited volumetric rate reductions achieved by these modeled options.

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[92] Pre-1970 vintage, 1700 square foot home in multifamily housing in Central Massachusetts, with baseline room AC (60% coverage) and gas heating.

The analysis above demonstrates that low-income customers today face high energy costs and high energy burden, and that electrification, especially under heat pump-specific rate designs, can improve energy affordability.

An all-of-the-above approach would maximize benefits for the Commonwealth's low-income households, combining reformed rate designs with expanded efforts to deploy heat pump technologies to low-income customers, improve enrollment in tiered discount rates, and keep rate levels in check. As discussed in Section in 1.5.5 Other Policy Considerations for Low-Income Homes, improved monitoring of hidden energy poverty with the deployment of AMI would also help ensure that the most at-risk homes are able to continue accessing essential energy services.

Table 9: Monthly Average Energy Expenditure Changes for Households with Bill Discounts relative to Baseline Home and Existing Rates

		High Fixed Charge	Seasonal	Seasonal, Heat Pump	Declining Block, Heat Pump
Baseline Home (No EV)	Natural Gas	-$3 to $3 (-1% to 1%)	-$2 to $1 (-1% to 0%)	N/A for households not adopting heat pumps	
	Fuel Oil	-$7 to $4 (-2% to 1%)	-$2 to $0 (0% to 0%)		
	Electric Resistance	-$57 to -$23 (-8% to -5%)	-$51 to -$17 (-7% to -4%)		
Full Home Elec. (No EV)	Natural Gas	-$21 to $24 (-6% to 4%)	-$17 to $30 (-6% to 10%)	-$79 to -$23 (-18% to -8%)	-$88 to -$11 (-18% to -4%)
	Fuel Oil	-$234 to -$97 (-38% to -20%)	-$227 to -$93 (-36% to -23%)	-$309 to -$148 (-44% to -27%)	-$312 to -$143 (-49% to -31%)
	Electric Resistance	-$321 to -$138 (-46% to -33%)	-$315 to -$136 (-42% to -31%)	-$369 to -$168 (-52% to -41%)	-$358 to -$149 (-51% to -33%)
Full Home Elec. + EV	Natural Gas	-$113 to -$65 (-32% to -14%)	-$105 to -$55 (-21% to -17%)	-$171 to -$116 (-34% to -35%)	-$195 to -$118 (-41% to -37%)
	Fuel Oil	-$329 to -$184 (-54% to -38%)	-$318 to -$177 (-50% to -37%)	-$398 to -$241 (-63% to -63%)	-$425 to -$255 (-67% to -51%)
	Electric Resistance	-$408 to -$226 (-58% to -51%)	-$398 to -$221 (-55% to -58%)	-$458 to -$263 (-64% to -59%)	-$466 to -$255 (-66% to -61%)

Bill savings Range crosses 0 Bill increase	Note: Monthly bill impact (and percentage change) is shown for the 10% to 90% range across modeled representative prototypes selected from NREL's ResStock database.

2.3.4 Bill Impacts for Customers with Distributed Generation

Customers with solar generation may also stand to benefit from the modeled rate designs. NEM currently works in Massachusetts such that a customer pays the normal electricity rate for any monthly net consumption after distributed generation. That is, if a customer consumes 700 kWh and produces 600 kWh over a month, the customer pays their normal rate for 100 kWh. If the customer generates more than 700 kWh in a month, then the customer receives a credit for the excess energy generation, at a rate slightly lower than the retail rate.[93] This means that, for customers with net metering that produce less than what they consume before electrification, the operational costs of heat pump and EV adoption are the same as that of non-NEM households, as the additional electric load would be exposed to the full retail volumetric rate. For a NEM customer producing more than monthly consumption pre-electrification, there may be additional savings.

Figure 38 shows the change in monthly energy expenditures for a customer with gas heating and a rooftop solar system that generates enough electricity to account for 75% of their annual pre-electrified load. For an electrified solar customer, all four proposed rates lead to bill savings compared to existing rates. For the Increased Fixed Charge, savings compared to existing rates are modest compared to the savings a non-solar customer may experience, since the Increased Fixed Charge rate benefits users with higher consumption, and solar generation lowers the customer's net usage. Since solar customers with heat pumps have net usage that is much higher in the winter and lower in the summer, these customers benefit from the Seasonal Heat Pump rate. Finally, under the Declining Block rate, these customers can still experience wintertime net usage in the lower-priced block to see meaningful savings compared to existing volumetric rates.

Solar customers who are electrifying may see additional value from increasing the capacity of their solar systems, especially for customers on seasonal rates that would provide greater savings due to higher avoided retail rates during the summer.

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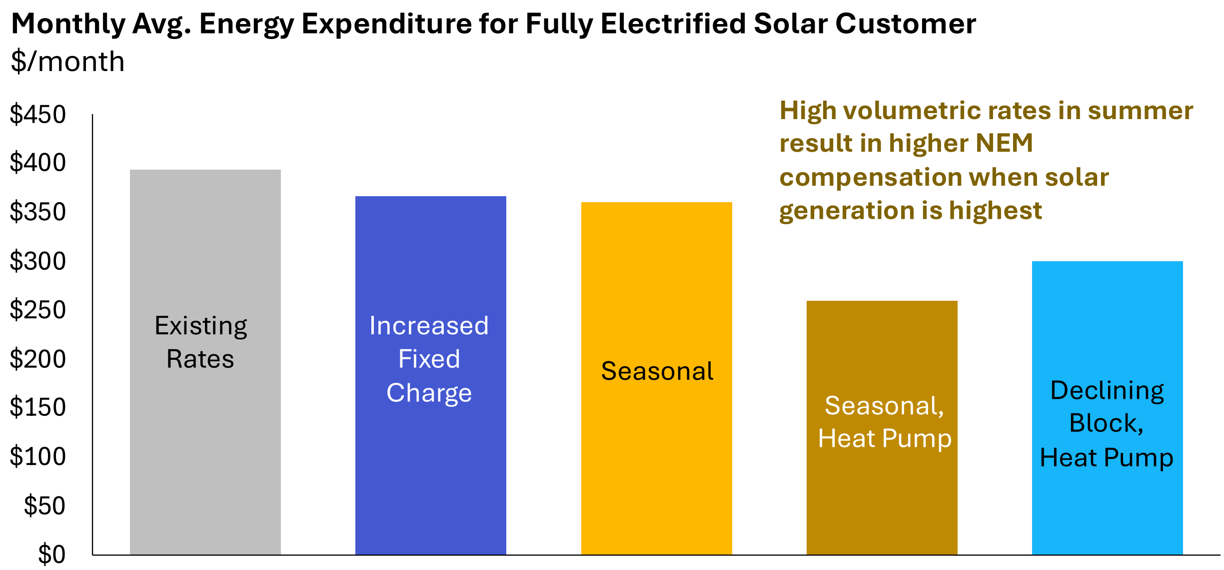
[93] Massachusetts Net Metering Guide, https://www.mass.gov/info-details/net-metering-guide.

Figure 38: Monthly Utility Bills Under Alternate Rates for Electrified Solar Customer with Net Energy Metering, Solar Sized to Pre-Electrification Load[94]



2.3.5 Summary of the Impact of Different Near-Term Rate Levers

Table 10 highlights the strengths and challenges of each of the rate designs modeled in this study, informed by the analysis from this study and feedback from stakeholders.

Increased fixed charges improve the customer economics of electrification by shifting non-volumetric system costs into a fixed charge. This can cause bill increases for non-electrifying customers with below average usage, but these increases could be offset for low-income residents with progressive fixed charges.

Seasonal rates with steep winter discounts present significant bill savings for electrifying customers but require a clear transition plan once winter peaks begin to drive system costs. Increased summer electricity costs are another concern for these rates, especially in a warming climate. This concern could be ameliorated by increasing fixed charges, thus reducing the amount of remaining revenue requirement collected through volumetric rates, as in CMP's heat pump rate. Restricting eligibility to electric heating customers would also insulate non-electrifying customers from cost impacts.

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[94] Post-1970, 1700 square foot home in single family housing in Central Massachusetts with gas heating, 689 kWh average monthly electricity usage before solar, hypothetical 6 kW-DC solar array, SMART incentive not included.

Declining Block rates similarly present bill savings for electrifying customers but weaken the price signal for conservation. This could have the unintended impact of increasing summer electricity peak demand, which would increase system costs.

Table 10: Summary of Considerations of Alternative Rate Designs

<table>
<tr><th></th><th>Increased Fixed Charge</th><th>Seasonal</th><th>Seasonal (Heat Pump)</th><th>Declining Block (Heat Pump)</th></tr>
<tr><td rowspan="2">Low-Income Customer Affordability</td><td rowspan="2">Bill increases for low-usage customers; mitigated through progressive designs like tiered discounts</td><td>Higher cost for summer cooling</td><td rowspan="2">N/A (Technology-specific)</td><td rowspan="2">N/A (Technology-specific)</td></tr>
<tr><td>Bill savings for electric resistance customers</td></tr>
<tr><td rowspan="2">Alignment with Cost of Service</td><td rowspan="2">Collects some non-volumetric costs with fixed charge</td><td>In the near term, better aligns rates with seasonality of system costs</td><td>In the near term, better aligns rates with seasonality of system costs</td><td>In the near term, more reflective of cost of service for heat pump customers than existing rates</td></tr>
<tr><td>On a winter-peaking grid, would no longer reflect seasonality of system costs</td><td>On a winter-peaking grid, would no longer reflect seasonality of system costs</td><td>On a winter-peaking grid, would no longer reflect cost of service for heat pump customers</td></tr>
<tr><td>Implementation Challenges</td><td>Class-wide rate change would require greater outreach and regulatory process</td><td>Class-wide rate change would require greater outreach and regulatory process</td><td>Reduced concerns for impacts to non-electrifying customers</td><td>Reduced concerns for impacts to non-electrifying customers</td></tr>
<tr><td>Technical Challenges</td><td>Implementation of progressive fixed charges can utilize tiered discount approach currently under development</td><td>Minimal billing system change required</td><td>Minimal billing system change required</td><td>Change required to EDC billing systems to accommodate block structure</td></tr>
<tr><td>Stakeholder Perspectives</td><td></td><td></td><td>Appears to have the greatest acceptance across stakeholder groups</td><td></td></tr>
</table>

2.4 Rate Design Implementation Considerations

While the analysis above demonstrates the promise of the different rate design levers modeled, any modifications to electric rate offerings in the Commonwealth will need to draw from the principles outlined in the Regulatory Background appendix, including "simplicity" and "continuity" to ensure that customers are able to understand and adapt to new ways of paying for electricity. Furthermore, as mentioned in the Introduction and Study Scope, rate design is one of several important pieces determining energy affordability and influencing clean technology adoption in the Commonwealth. Newly designed rates will need to integrate smoothly into the existing and planned set of programs to ensure consistent price signals to customers. Building on these points, this section explores the following implementation considerations:

- Benefits and drawbacks of establishing new rates as "opt-in" or "opt-out;" and
- Complementarity of rate design with programs that support demand flexibility, clean technologies, load management, and energy efficiency

2.4.1 Rate Participation

We have discussed in previous sections some of the advantages and disadvantages of class-wide versus technology-specific rate structures for the Commonwealth's near-term goals: technology-specific rates alleviate concerns of bill increases for non-electrifying customers and allow for more aggressive changes to rate designs that take advantage of electric heating usage profiles. Meanwhile, class-wide rates can help to move all customers toward paying more cost-reflective rates.

An important strategic decision in introducing new rates relates to designating new rate offerings as "opt-in," i.e., only applied to customers who elect to enroll in the rate, or "opt-out", i.e., applied by default to all customers and allowing customers to opt out of participation.

Technology-specific rates may need to be opt-in and rely on customers attesting or demonstrating that they have the requisite technology. However, utilities could potentially move eligible customers proactively into a technology-specific rate if they are able to determine that customers have accessed Mass Save and/or other heat pump rebates, or if they can identify these customers through usage patterns. Given that electrified customers only stand to benefit from near-term rate reform, it would be reasonable to move these customers to technology-specific rates by default. This would give electrified customers the benefit of cheaper, more cost-reflective bills without any action from them, an approach likely beneficial for the Commonwealth's lower income residents.

Class-wide rates could be designed as opt-in or opt-out, assuming the legacy rate continues to be offered. Utilities across the country have had to grapple with this question, especially in developing roll-out strategies for time-of-use rates, which require customer acceptance and understanding to effectively induce demand flexibility. Existing research can shine light on the strengths and drawbacks of each option.

- Introducing rates as "opt-in" would likely increase support for new rate offerings, as this would allow for participation from those who would benefit the most from these rates and would minimize impacts to those who benefit less from the new rates. However, limiting new rates to opt-in status would decrease the scale of participation, leaving unaware customers on default rates with a continued disincentive to transition to clean electric devices. This challenge could be addressed by robust EDC customer education and marketing efforts to inform customers of the potential bill savings of combining clean technology adoption with newly available rates, and by linking clean technology program participation (e.g., Mass Save, Net Energy Metering) to automatic enrollment in new rates.
- Introducing new rates as "opt-out" would yield higher enrollment in rates (3-5 times higher, by some estimates),[95] with similar retention to opt-in rates.[96] Expanded customer education efforts such as shadow billing (providing customers with calculations of their bills under multiple rate options, e.g., Central Maine Power's Heat Pump Rate calculator)[97] could help customers identify the rate designs that best fit their needs, as would bill protection mechanisms for rate transition periods. Opt-out rates would also limit the risk of revenue under-collection (and the associated increase in revenue requirement in future years) for the utility due to self-selection into or out of new rates by customers who know they will reduce bills through participation or abstention.[98] The greatest benefit of introducing rates as "opt-out" would be to more widely address the barrier to electrification presented by current rate design.

2.4.2 Complementarity of Rates and Programs

As discussed earlier in the report, rate design is one of many policy levers advancing the state's climate and energy affordability goals. Even before AMI technology is available to all households in the Commonwealth, EDCs can implement programs that encourage demand flexibility, load management, and energy efficiency. An existing example of this is National Grid's Off-Peak Charging Program, which awards rebates for off-peak electric vehicle charging by partnering with a third-party organization to view participant charging behavior. At present, bill savings from this program are limited: $100 average annual savings,[99] shown for an example natural gas heated multifamily home today in Figure 39. However, the model of allowing EDCs access to customer device electricity usage data could be effectively leveraged to encourage whole home demand flexibility, especially if coupled with grid-participation enabling technologies such as smart thermostats.

The ConnectedSolutions program is an example of a technology-enabled program that can help reduce peak demand in the summer in the near term with expanded cooling management and in the

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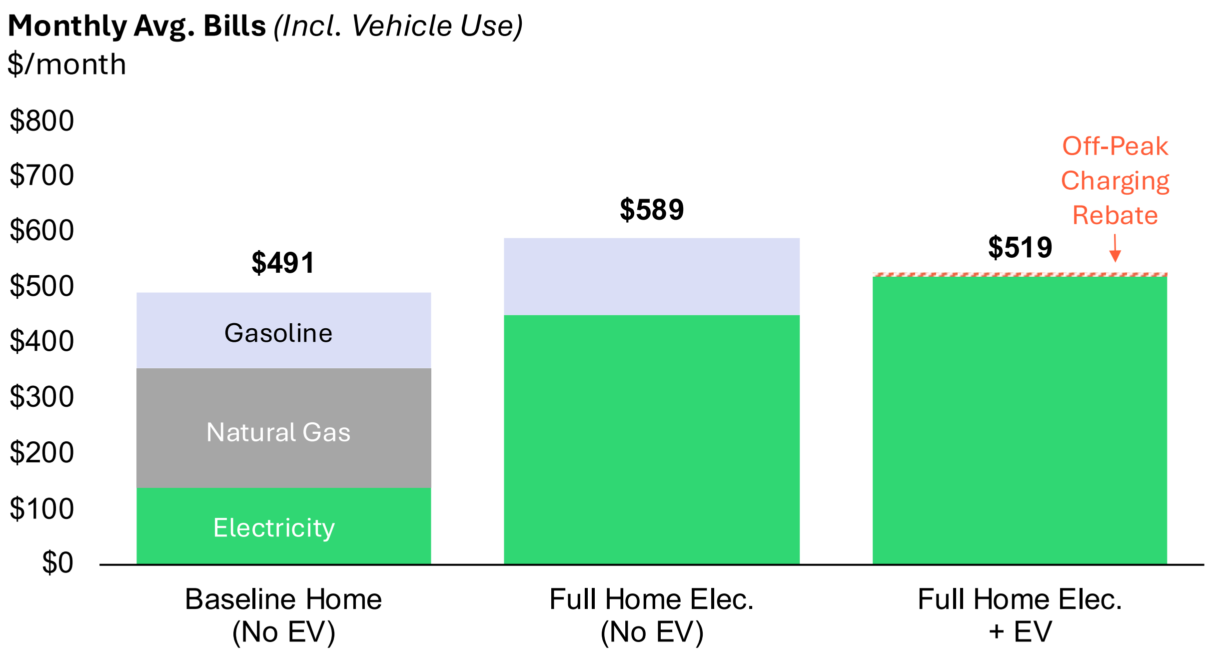
[95] https://rmi.org/wp-content/uploads/2017/04/A-Review-of-Alternative-Rate-Designs-2016.pdf.
[96] https://www.energy.gov/oe/articles/interim-report-customer-acceptance-retention-and-response-time-based-rates-consumer.
[97] https://www.cmpco.com/account/understandyourbill/newseasonalheatpumprate.
[98] https://www.publicpower.org/system/files/documents/Moving-Ahead-Time-of-Use-Rates.pdf.
[99] https://www.nationalgridus.com/electric-vehicle-hub/Programs/Massachusetts/Off-Peak-Charging-Program.

long term with expanded electric heating management. Demand response programs, leveraging smart thermostats and behind-the-meter batteries, can provide valuable cost reduction opportunities for the electric system (and thus ratepayers) when the electric system is most stressed and costs are highest (~15 events per year for smart thermostat customers, 30-60 events per year for battery customers),[100] while compensating participants (up to $70/year).[101] These programs can be layered on top of the proposed rate designs to concurrently support the goals of encouraging demand flexibility, load management, and clean technology adoption, using technology available today.

Similarly, existing efficiency rebate programs such as Mass Save can be effectively combined with proposed rate designs to help participants realize energy savings from both annual and peak demand reduction, especially for rate designs with high summer volumetric charges. Peak demand reduction will play an important role in controlling future electric system cost growth, a key focus of the Long-Term Ratemaking Study.

Figure 39: Bill Savings from Existing Managed Charging Rebates[102]



[100] https://www.nationalgridus.com/MA-Home/Energy-Saving-Programs/ConnectedSolutions.
[101] https://www.thermostatrewards.com/unitil/.
[102] Pre-1970 vintage, 1700 square foot home in multifamily housing in Central Massachusetts, with baseline room AC (60% coverage) and gas heating.

Conclusion

This research effort sought to take stock of household energy expenditure in the Commonwealth today, shine a light on the obstacles posed by current electric rate design to achieving widespread building electrification, and explore alternative electric rate designs that would support a more affordable energy transition in the near term. The insights from this analysis will inform the IRWG's final recommendations, as well as provide data and analysis to enable further discussion of rate design in the Commonwealth.

Energy Expenditure and Electrification with Today's Electric Rates

- EDC customers today pay for electricity through high volumetric rates, low fixed charges, and no seasonal differentiation of delivery costs. This presents a challenge for households that increase their electric consumption through the adoption of EVs and efficient electric heating.
- Existing EDC bill discounts for low-income customers are inadequate for the most vulnerable low-income households, especially those living in older homes heated with electric resistance.
- Customers currently heating with gas (54% of Massachusetts households) tend to see bill increases upon installing a heat pump, driven by relatively inexpensive natural gas today and high volumetric electricity rates.
    - For low-income households with gas heating and old building shells, electrification could increase energy burden by multiple percentage points.
- Customers currently heating with electric resistance (18% of Massachusetts households) are guaranteed to see bill savings upon installing a heat pump, driven by the energy efficiency improvement of heat pumps.
    - For low-income residents with electric resistance heating in multifamily buildings, electrification could reduce energy burden by multiple percentage points.
- Customers currently heating with fuel oil tend to see bills decrease slightly upon installing a heat pump, driven by the high cost of fuel oil.
- Building shell improvements reduce household heating and cooling demand and can offset bill increases for gas customers seeking to electrify older homes as well as reduce AC energy demand and expense.
- Increased access to cooling will benefit residents who adopt heat pumps, though this may contribute to bill increases for homes with room AC or no AC today.
    - This is especially relevant for low-income households, most of which tend to not have central AC today.
- Vehicle electrification tends to reduce customer energy costs due to the efficiency improvement of EVs compared to ICEVs.
    - With more limited access to at-home charging for residents in multifamily buildings, multifamily residents may be more likely to use higher cost public charging options, decreasing the total energy cost savings from vehicle electrification.

    - Existing EDC rebates for managed charging provide relatively limited bill savings (~$100 per year on average).

Energy Expenditure and Electrification with Alternative Electric Rates

- Increased fixed charges, seasonal variation, and declining block structures would better align rates with utility costs compared to existing high-volumetric retail rates.
- Increased fixed charges would benefit electrification by reducing volumetric rates.
    - The risk of bill increases from high fixed charges on low-income, low-usage customers can be mitigated with progressive fixed charges, such as the tiered discounts under development by EDCs.
- A seasonal rate with lower winter prices would be cost-reflective and beneficial to heat pump customers in the near term, while the electric system has winter capacity headroom.
    - This rate offering would need to be sunset as the electric system shifts to winter peaking, potentially leading to price shocks for electrified customers on this rate.
- A declining block rate would similarly improve the economics of electrification but would provide a reduced conservation signal, including during the summer when electric system capacity is currently most constrained. This rate option may need to be re-evaluated once the grid shifts to winter-peaking.
- Changing electric rates for all customers should be balanced by concerns related to gradualism and the desire to minimize bill increases for non-electrifying customers.
- Technology-specific rates could enable more significant changes while limiting impacts to non-electrified customers and thus could be a useful tool to support bill savings for electrification. However, technology-specific rate options come with their own implementation challenges regarding enrollment.
- The rate levers examined could be combined to further improve the bill savings from electrification.
- Increased fixed charges, seasonal rates, and declining block rates are all rate design elements that could be maintained with future time-varying rates. However, the shift to a winter peaking system will require the sunset of the two heat pump rate options that provide a winter discount and a re-evaluation of declining block pricing, while increased fixed charges would be a more durable rate design option.
- For class-wide rates, designating rates as opt-out (default) vs. opt-in will require careful consideration of the benefits and drawbacks of participation, program administration costs, customer education required, and risk of unintended bill impacts; technology-specific rates will be opt-in by default unless utilities are capable of identifying heat pump customers.
- Rate design, demand flexibility and load management, clean technology rebates, and energy efficiency programs will need to act in a complementary manner to ensure households are given adequate incentives to adopt clean devices, consume energy flexibly, and manage load to reduce system costs.

Appendix

Methodology and Data Sources

HEEM Overview

To explore a diversity of bills with and without electrification under current and alternative rate designs, E3 developed the Household Energy Expenditure Model (HEEM). HEEM enables the calculation of household energy costs for pre- and post-electrification households in Massachusetts under different rate options. HEEM models a diverse set of representative households and captures energy expenditures for both home energy demands and vehicle usage. Key output metrics such as monthly bills and energy burden illustrate the impact of different rate designs on electrification cost-effectiveness and on energy affordability. HEEM enables the comparison of pre- and post-electrification customers on a given rate, as well as the comparison of one customer between different rate options.

HEEM Representative Customers

To capture a diverse set of households across Massachusetts, HEEM models representative customers based on combinations of key building, technology, and other characteristics, as shown in Figure 40. Building characteristics include housing type (single-family vs. multifamily homes), size (<1,600 square foot Vs > 1,600 square foot), vintage (pre-1970, post-1970), region, baseline heating source, and AC. Technology characteristics include home and vehicle electrification status. Lastly, other customer characteristics include occupant status (renter vs. owner) and eligibility for bill discount programs. For each combination of customer characteristics, representative households were selected from NREL's public ResStock database version 2024.2.[103] ResStock's baseline package was used for pre-electrification households while ResStocks's measure package 12 was used to represent fully electrified households.[104]

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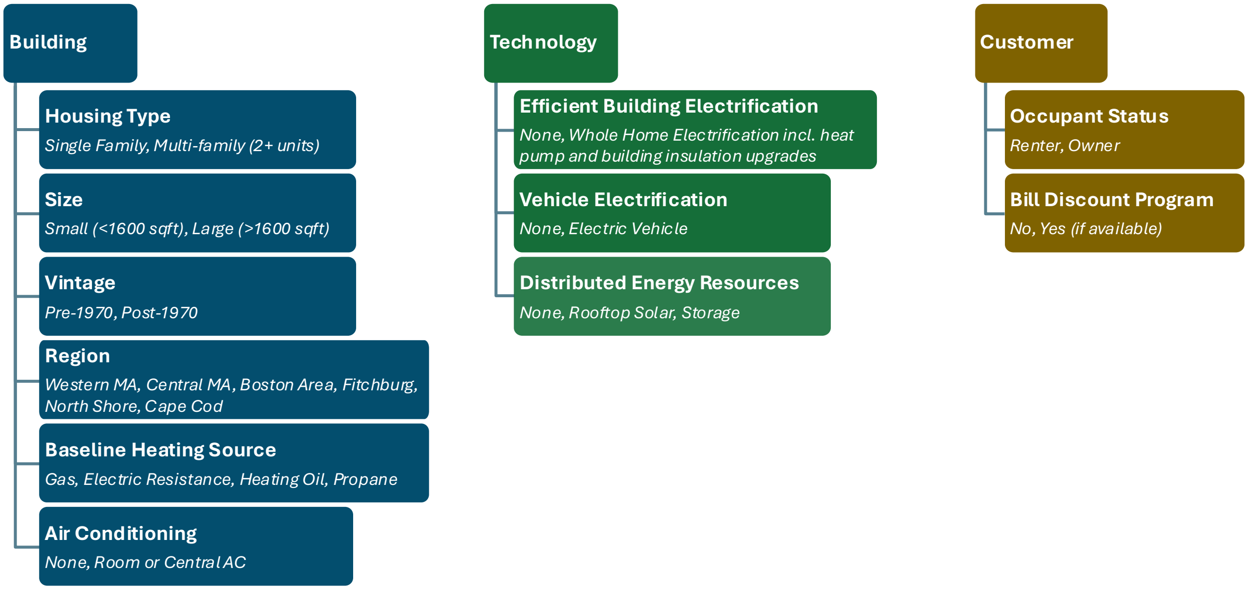
[103] ResStock includes electricity and gas usage data and hourly profiles for thousands of representative residential customers in Massachusetts. More information available at https://www.nrel.gov/buildings/resstock.html.

[104] Measure package 12: "High efficiency cold-climate air-to-air heat pump with electric backup + light touch envelope improvements + HPWH + appliance electrification".

Figure 40: HEEM Customer Prototypes



For each home selected, HEEM aggregates detailed hourly home energy usage profiles from ResStock into monthly load shapes by fuel (electric, natural gas, fuel oil, propane) and end use (space cooling, space heating, water heating, cooking, clothes drying, and other). On top of that, gasoline usage and home electric vehicle charging consumption are estimated assuming one personal vehicle, approximately 10,000 vehicle miles per year,[105] an ICE efficiency of 21.5 miles per gallon (looking at the average on-road fuel efficiency for vehicles in Massachusetts today),[106] and an EV efficiency of 0.3008 kWh per mile, taking the average efficiency of new vehicles sold.[107] While there is significant variation in vehicle efficiency, the majority of EVs sold in Massachusetts to date have tended to be higher efficiency Tesla vehicles, as tracked by the MOR-EV program[108], with efficiencies of up to 0.21-0.26 kWh per mile; this study opted for a more conservative average to account for potential future growth in sales of other vehicle manufacturers as more models at lower price points are made available.

HEEM Rate Design

The core functionality of HEEM is the evaluation of electric bills, heating fuel bills, and gasoline expenditure, based on customer energy usage and rate and pricing information.[109] HEEM is designed to calculate electric bills under various rate designs. Rate designs are *input*s to the model, including both existing rates and proposed future rate designs. The class-wide rate options are revenue-neutral, meaning that the total revenues collected under these rate designs are equal to the

[105] https://www.mass.gov/doc/appendices-to-the-clean-energy-and-climate-plan-for-2025-and-2030/download.
[106] https://publications.anl.gov/anlpubs/2021/01/165141.pdf.
[107] https://ev-database.org/cheatsheet/energy-consumption-electric-car.
[108] https://mor-ev.org/statistics.
[109] In additional to electric rate inputs, historical 2023 gasoline, fuel oil and propane prices are used to calculate associated fuel expenses.

revenues collected under existing rates. For the two technology-specific options, the approach to revenue neutrality is driven by the assumption that customers with electric heating in the near term add limited delivery costs in a summer-peaking system, as detailed in Section 2.1.2 Seasonal Rates. To reflect this rationale, the rates are designed so that delivery revenue per customer for heat pump customers under *alternative* rates are equal to delivery revenue per customer for non-electric-heating customers with *today's* rates. This approach thus ensures that customers with electric heating are not penalized for adding electricity demand during periods of the year when the system is not constrained. These calculations were replicated for each of the three EDCs using utility-specific billing determinants (monthly number of customers and energy sales). Eversource's R-3 customer energy consumption profiles are used to model electric-heating customer energy usage for the modeled seasonal heat pump rate.

HEEM Key Outputs

For a given input electric rate, the HEEM tool can output various metrics for each representative customer. Key metrics include:

- Monthly household energy expenditures ($/month)**:** This metric reflects the monthly household costs for electricity, gas, fuel oil, propane, and gasoline.
- Energy burden (%)**:** This metric reflects energy expenditures as a percent of household income. The term "energy burden" is often used to describe utility bills only, but this does not effectively capture the cost impact of vehicle electrification nor of fuel oil. In HEEM, the energy burden metric reflects electric utility bills, gas utility bills, fuel oil costs, and vehicle gasoline expenditures. Specifically, energy burden is calculated as annual energy expenditure divided by gross income. The income data source is US Census Bureau, American Community Survey 1-Year Estimates (2022).
- Electrification bill impact ($/month)**:** This metric reflects the change in monthly household energy expenditures associated with adoption of vehicle and/or building electrification technologies.

The HEEM tool does not directly consider the *upfront costs* of electrification (capital costs and installation costs). Rate designs can support electrification by enabling lower *operating costs* for electric technologies, which offset upfront costs and improve customer cost-effectiveness. However, rate design does not directly address upfront costs and so these costs do not appear in the HEEM tool.

Ratemaking Context in Massachusetts

Electricity rates today represent a careful balance of many considerations, several of them often in competition. This section describes the ratemaking context in the Commonwealth through three lenses: policy goals that influence goals of rate design, regulatory requirements that dictate utility priorities in rate design, and technological considerations that constrain or enable certain rate design features.

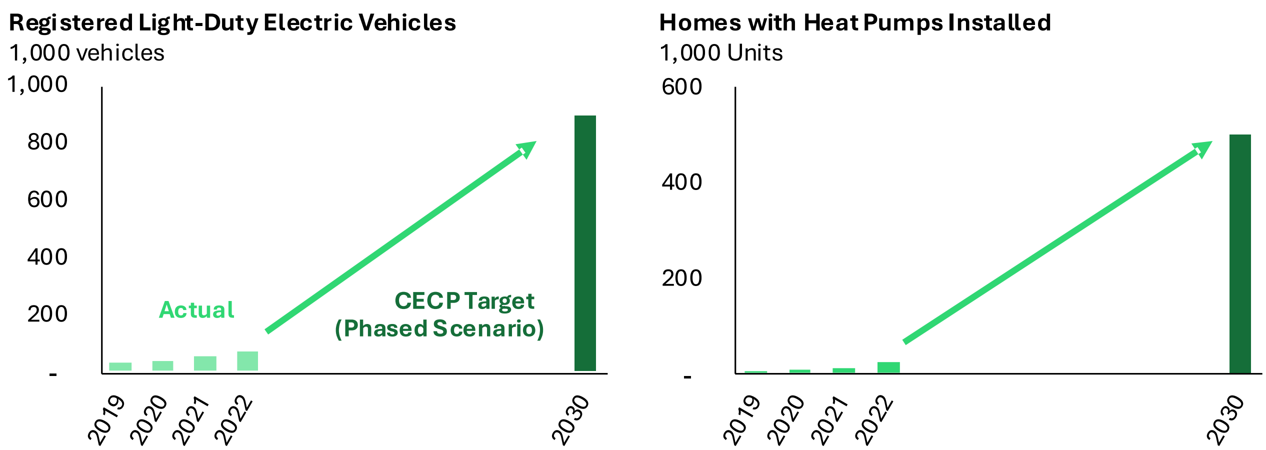
State Policy Goals

Pursuant to the Global Warming Solutions Act, Massachusetts established a mandate to reduce economy-wide emissions by at least 85% relative to 1990 levels by 2050.[110] As required by law, the Executive Office of Energy and Environmental Affairs (EEA) has produced a series of roadmaps outlining strategies for the Commonwealth to meet the decarbonization mandate. The most recent near-term plan is the Clean Energy and Climate Plan (CECP) for 2025 and 2030,[111] which was published in 2022. The CECP notes four key "pillars" of decarbonization:

1. *Transitioning buildings, vehicles, and other end uses away from consuming fossil fuels;*
2. *Aggressively pursuing energy efficiency and flexibility to enable cost-effective decarbonization;*
3. *Producing zero- and low-carbon energy supplies to power our energy system; and*
4. *Balancing remaining emissions by facilitating carbon sequestration.*

CECP's first pillar of "widespread electrification of transportation and building heat"[112] relies on rapid and widespread adoption of efficient electric heat pumps and EVs, as shown in Figure 41.

Figure 41: Historical Adoption of Clean Technologies and 2030 CECP Adoption Targets



Achieving these ambitious technology transformations will require a concerted effort to reduce the upfront equipment cost premium of clean technologies, educate customers and build trust in clean technologies, train a clean energy workforce, and most pertinent to this study, ensure that energy bills provide a price signal to adopt clean technologies. Rate reform will complement the existing programs and initiatives in place in the Commonwealth to support these efforts, including Mass Save and MOR-EV rebates and zero-interest loans for upfront cost reductions, and Mass Save and MassCEC customer education and workforce development efforts.

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[110] M.G.L. c. 21n, § 3(a).
[111] Here, we refer to the 2025-2035 CECP as simply "CECP", not to be confused with the CECP for 2050.
[112] Massachusetts Clean Energy and Climate Plan for 2025 and 2030 at 5.

The second pillar of the CECP emphasizes efficiency and demand flexibility. As the Commonwealth's electricity system continues to increase its reliance on renewable generation, the marginal costs of the system will be low for most hours of the year and very high for a few high-demand, capacity-constrained hours. Accordingly, peak demand reduction and load flexibility will be crucial, and electricity rates and utility load management programs will need to work in tandem to provide clear and aligned price signals to encourage energy efficiency adoption and load shifting – this is one of the central topics of focus of the IRWG Long-Term Ratemaking Study.

Regulatory Background

The DPU oversees investor-owned electric power, natural gas, and water distribution companies in Massachusetts, ensuring that utilities provide reliable service at the lowest possible cost for consumers. All non-supply, retail electricity rates charged by the EDCs are subject to investigation and adjudication by the DPU, to ensure that rates are just and reasonable, and that consumer rights are protected. The DPU also has authority over the procurement of basic service supply, and more limited ratemaking authority over MLPs, competitive suppliers, and municipal aggregations.[113] In addition to its obligation to ensure safe and reliable utility service, the DPU is charged with advancing utility-related policy priorities as directed by the Massachusetts Legislature.

Rate designs in the Commonwealth are shaped by the DPU's application of long-standing ratemaking principles. These principles represent a mix of legislative directives and departmental determinations.

Historically, the ratemaking principles of the DPU have been[114]:

1. **Efficiency**: "the rate structure should allow a company to recover the cost of providing the service and provide an accurate basis for consumers' decisions about how to best fulfill their needs,"
2. **Simplicity**: "a rate structure achieves the goal of simplicity if it is easily understood by consumers,"
3. **Continuity**: "changes to rate structure should be gradual to allow consumers time to adjust their consumption patterns in response to a change in rate structure,"
4. **Fairness**: "no class of consumers should pay more than the costs of serving that class," and
5. **Earnings stability**: "the amount a company earns from its rate should not vary significantly over a period of one or two years."

[113] The DPU has limited regulatory authority over MLPs, which do not have to receive DPU approval to implement changes in rates. The DPU also has limited regulatory oversight of supply rates offered by competitive suppliers: DPU regulates retailer business practices, requires disclosures from suppliers relating to rate structures, and is empowered to license retailers, investigate potential violations and take enforcement actions, but does not have approval discretion over individual retailer rates. See https://www.nclc.org/wp-content/uploads/2022/09/competitive-energy-supply-report.pdf at 10, CMR 11.05 and CMR 11.06.

[114] D.P.U. 17-170 Order at 313-314 (2018).

Recently enacted legislation advances specific policy priorities and will apply to any new rate designs considered by the DPU:

6. **Affordability, equity, and reductions in greenhouse gas emissions***: An Act Creating a Next-Generation Roadmap for Massachusetts Climate Policy* (2021 Climate Act), requires the DPU to prioritize "affordability, equity and reductions in greenhouse gas emissions to meet statewide greenhouse gas emission limits" in its regulatory actions,[115] while *An Act Driving Clean Energy and Offshore Wind (*2022 Clean Energy Act) additionally requires the DPU to consider "efforts to … encourage non-emitting renewable sources of energy" in all rate design decision-making.[116]

Recent and forthcoming proceedings focus specifically on time-varying rates (TVR) that more closely align rates with system costs. DPU has expressed its intention to open a new proceeding to investigate TVR both for basic service supply rates as well as transmission and distribution charges.[117] Decision-making in this future proceeding would likely consider, and potentially amend, DPU's 2014 TVR policy framework that stated a goal for basic service customers to be placed on a default TVR, once one is available.[118] The 2022 Clean Energy Act directed EDCs to propose EV time-of-use rates to the DPU for consideration, with special consideration of the impacts of the proposed rates on "(i) energy conservation; (ii) optimal and efficient use of a distribution company's facilities and resources; (iii) benefits to transmission and distribution systems; (iv) equitable rates for electric consumers; and (v) greenhouse gas emissions reductions."[119] The statute also prohibited the inclusion of demand charges in the proposed rates – pertinent to future rate design efforts that seek to lean on demand charges as a lever to encourage demand flexibility. In December 2022, the DPU approved Unitil's proposed 3-part residential EV time-of-use rate (off-peak, mid-peak, and on-peak pricing), stating that "[the proposed rate] will assist in incentivizing off-peak charging and support the Commonwealth's public policy goals and the Department's grid modernization objective to optimize system demand by facilitating consumer price responsiveness."[120] However, there has been no enrollment in this rate as of May 2024, driven in part by the upfront cost barrier of installing the requisite additional advanced metering infrastructure (AMI) socket. [121]

Another key priority is consideration of customer affordability.[122] The Department has recently directed the EDCs to explore stratified, tiered low-income rates that emphasize assisting the most vulnerable customers, and approved a tiered discount rate for National Grid in 2024.[123]

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[115] M.G.L. c. 25, § 1A.
[116] M.G.L. c. 164, § 141.
[117] D.P.U. 21-80-B/21-81B/21-82-B Order at 327 n.136 (2022).
[118] D.P.U. 14-04 Anticipated Policy Framework for Time Varying Rates (2014).
[119] Session Laws Acts of 2022, Ch 179 Sec. 90
[120] D.P.U. Order 21-90; D.P.U. 21-91; D.P.U. 21-92 at 269 (2022).
[121] Unitil Massachusetts Electric Vehicle Program, 2023 Annual Report (May 2024).
[122] D.P.U. 22-22 at 405 (2022) (Equity, in rate structure, means that the Department considers affordability among customers in establishing rate classes and when establishing discount rates for low-income customers.").
[123] D.P.U. 22-22 at 472 (2022). Unitil did not propose a stratified rate structure in its most recent rate case, D.P.U. 23-80, while National Grid proposed a 5-tier low-income discount rate in D.P.U. 23-150, which was approved.

In January 2024, the DPU opened an investigation to evaluate energy burden and affordability for residential ratepayers, D.P.U. 24-15. By opening this docket, the DPU seeks to "consider improvements to the programs currently offered to address energy affordability, to ensure maximum participation in each of these programs, and to determine whether additional programs may further benefit residential ratepayers of the Commonwealth's electric and gas distribution companies."[124] The DPU seeks to investigate ways to improve upon the design of residential affordability measures, soliciting comments on determining affordability program eligibility, the pros and cons of tiered discount rates and percentage-of-income-based payment plans that would cap bills at a given percentage of a customer's income, and addressing the "cliff" effect experienced by those just above discount rate income eligibility, among other research questions.[125]

In addition to requesting comment on program design, the DPU also seeks to better understand the experience of energy burden for individuals, the decision-making process for paying energy bills, and altering energy consumption to lower bills.[126] Participants in the proceeding highlighted the importance of electric rate design in aligning energy affordability with the state's decarbonization mandate, including the Department of Energy Resources, which stated: "Electric affordability is required to incentivize strategic electrification. With current electric rates, installation of heat pumps can result in increased utility costs, particularly for customers that replace gas heating equipment with heat pumps."[127] In September 2024, the DPU identified areas of consensus based on comments filed in the proceeding and determined: "that this inquiry should focus on the development of [tiered discount rates] rather than [percentage of income payment plans]"[128] and "that recovery of the revenue shortfall from providing discounts [to low-income customers] should continue to be collected through company-specific RAAFs, across all customer classes[.]"[129] The Department also requested additional comments from stakeholders about the energy burden that should be targeted in tiered discount rates, recovery of the revenue shortfall from discount rates, arrearage management plans, disconnection practices, enrollment and verification practices, and outreach strategies.

Technology Considerations

Although the DPU's desire to shift toward TVR is clear, existing Automated Meter Reading (AMR) meters used by the EDCs cannot capture energy consumption data at the level of granularity needed for TVR, commonly an hourly basis. Similarly, the EDCs' existing billing systems are designed to support today's comparatively simple rates. These technology limitations constrain the types of rate structures that can be deployed in the near term.[130] AMI will enable advanced rate structures by measuring electricity consumption on an hourly or sub-hourly basis. EDCs expect to complete AMI

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[124] D.P.U. 24-15 Notice of Inquiry at 1 (2024).
[125] D.P.U. 24-15 Notice of Inquiry at 13 (2024), D.P.U. 20-80-B at 16 (2023).
[126] D.P.U. 24-15 Notice of Inquiry at 16 (2024).
[127] *E.g., see* comments on D.P.U. 24-15 by Massachusetts Department of Energy Resources (DOER) at 1 n. 1 (2024),
[128] D.P.U. 24-15, Interlocutory Order at 5 (2024).
[129] *Id.,* at 7.
[130] Existing metering infrastructure can be used to facilitate seasonal and tiered rate structures, along with net energy metering for distributed generation.

deployment in their service territories in 2025 for Unitil, 2027 for National Grid, and 2028 for Eversource,[131] and contend that TVR should not be offered until a year after the first meters are installed "to ensure a suitable penetration of AMI meter installations[,] [132] although other stakeholders contend that their TVR deployment could be accelerated since "thousands of EVs [will be] added to the Commonwealth's roads in the intervening years."[133]

Aside from metering, billing technology constraints limit rate design options today as well. EDCs will need to update their Meter Data Management Systems (MDMS) to collect and organize the more granular meter data, as well as improve their Customer Information Systems (CIS) to implement billing of any forthcoming TVR options. These investments have been approved by the DPU alongside the approval for AMI meter deployment.[134] EDCs also note that increases in rate complexity such as rate differentiation based on adopted technology or geographic area may prove challenging using today's billing systems.[135]

Customer data availability also constrains which rate options may be feasible in the near term. Technology-specific rates can require verification of specific technology adoption, which may be challenging to do at scale depending on the desired level of technology verification, especially without AMI shedding light on customer energy use and implied technology configurations.

Customer information and control over energy usage is another important factor to consider in electric rate design. Currently, customers receive information about electricity usage primarily in the form of a customer's monthly bill. EDCs' AMI plans include tools to help customers better interface with their electricity usage, such as home area networks that grant customers access to their real-time consumption data and offer alerts related to usage spikes.[136] This type of communication better empowers customers to respond to the more advanced rate signals of TVR. Additional education and outreach will be needed to support implementation of new rates.

[131] https://www.mass.gov/info-details/grid-modernization-and-ami-resources#second-grid-modernization-plans-and-ami-implementation-plans-.
See National Grid initial filing testimony in D.P.U. 23-85 (2023). *See* also Eversource's ESMP at 330. Unitil already has substantial AMI deployment but plans to replace all current meters with more advanced ones by Q2 2025 through its approved 2022-2025 GMP. The new meters will enable interval metering and TVR (Unitil ESMP at 121).

[132] National Grid proposal testimony D.P.U. 23-85 (2023).

[133] Acadia Center comments on D.P.U. 23-84 (2023).

[134] *See* National Grid ESMP Order in D.P.U. 24-11 at 278 (2024).

[135] Stated during interview with EDCs and other parties on 6/13/2024.

[136] *E.g.,* National Grid Testimony (Ex. NG-AMI-1) in D.P.U. 21-81 at 20-23 (2021).