JOINT RESOLUTION 7617 SUBSTITUTE A

EXECUTIVE CLIMATE CHANGE COORDINATING COUNCIL REPORT ON BUILDING ENERGY BENCHMARKING AND PERFORMANCE STANDARDS

February 10th, 2025

Prepared by the Rhode Island Office of Energy Resources

CONTENTS

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EXECUTIVE SUMMARY

This report, prepared in response to Joint Resolution 7617 Substitute A, summarizes existing data and outlines recommended approaches for implementing energy benchmarking and performance standards for large (at least 25,000 square foot (SF)) public and private buildings in Rhode Island. Building performance standards (BPSs) hold promise to reduce emissions from buildings over 25,000 SF, which could account for 10% of statewide emissions (see Appendix 2), but an effective rollout would hinge on utility data access, staff and budget resources, and a realistic implementation timeline. At present, the requisite automated whole-building energy data infrastructure is not available to building owners statewide. Additionally, there is not enough data known about large municipal and private buildings in the state to properly evaluate the public and private costs of implementing benchmarking and performance standards statewide. As a first step towards statewide energy benchmarking and performance standards, the Office of Energy Resources (OER) should design and implement an energy benchmarking and performance standards program for certain large state-owned and state-occupied buildings that could later be adapted to large municipal and private buildings. Energy benchmarking and performance standards for large buildings are significant undertakings and will require a substantial budget and realistic timeframe for OER to implement with the respective state agencies and other stakeholders.

Understanding existing emissions and energy use of large buildings is a critical foundation for benchmarking and performance standards. While aggregate emissions data for the building sector and large buildings specifically can be estimated, recent granular building-level data are largely not available. Aggregated Portfolio Manager datasets and somewhat outdated reports on municipal and school energy usage provide most of the available data on the Energy Use Intensity (EUI) and fuel usage of large buildings in the state. However, as OER begins reporting on state-property energy usage per Governor McKee's Lead by Example (LBE) Executive Order 23-06 and Providence rolls out their building energy reporting program, more data will become available.

There is no comprehensive database of large buildings or their current energy sources in the state, and creating such a database of covered buildings would be a time-intensive process. At a high-level, a National Renewable Energy Laboratory (NREL) analysis suggests that there are at least 2,320 buildings over 25,000 SF statewide.[1] Creating a detailed list of covered buildings (let alone energy usage data) would require aggregation of municipal tax records, geographic information system (GIS) data, and commercial datasets. New geographically defined unique building identifiers would need to be created to properly link and merge these disparate data sources. Once assembled, this database would require monitoring and updating on a regular basis to reflect accurate ownership and building information.

Utilities' automated provision of aggregated and verified whole-building energy usage data will be foundational for building energy benchmarking and performance standards. The state's largest utility, Rhode Island Energy, is currently building out these services for customers, especially those subject to Providence's ordinance, while smaller utilities would likely use more manual processes to fulfill customer data needs in the future. While the first-year building information verification and energy-reporting setup processes take time, access to automated utility data may ease the burden of reporting. The costs of compliance with performance standards vary substantially by existing conditions, typology, and other factors.

OER is well-positioned to lead a building energy benchmarking and performance standards program given the office's existing experience with managing building energy-efficiency programs, benchmarking state properties, and collaborating with the three utilities in the state. Energy benchmarking and performance standard programs for large private and public buildings could be integrated into OER's portfolio of programs, including LBE Executive Order 23-06, that provide support for state, municipal, and public-school buildings to reduce energy usage. OER would design and manage the program in consultation with relevant state agencies

[1] National Renewable Energy Laboratory, "State and Local Planning for Energy (SLOPE): Building Count."

and parties, including the Department of Environmental Management, Department of Administration, and Department of Business Regulation.

The lack of both data on large buildings and infrastructure for automated energy-use reporting prevents the effective evaluation and implementation of statewide benchmarking and performance standards for large municipal and private buildings. In contrast, a program applying to certain large state-owned and state-occupied buildings does not hinge on the availability of such data and infrastructure. OER finds that such a program applying to only large state-owned and state-occupied buildings could be implemented beginning as soon as FY26 with just one additional full-time employee.

Meanwhile, a statewide benchmarking and performance standard program for large municipal and private buildings would likely require approximately four full-time employees, including a program manager, policy analyst, and two compliance specialists, and an annual budget of approximately $600,000 initially and approximately $1.4 million following the launch of a recommended technical support program. These figures represent a preliminary estimate based on data from precedent programs and cannot be determined with greater precision until specific Rhode Island program details are refined. A timeline for such a program should include a year and a half for program development and regulatory promulgation, a phased rollout of benchmarking over the following two years, target-setting based on the second full year of data at the end of program year five, and enforcement of performance standards beginning in program year 10. This timeline would allow for a realistic program development period that grants owners the right to comment on regulations and allows for target-setting based on accurate data, while still giving owners time to make upgrades.

Given the lack of requisite data and infrastructure to support the rollout of a program for large municipal and private buildings, OER should focus on leading a program for certain large state-owned and state-occupied buildings that would lay the foundation for future expansion to large municipal and private buildings. In support of this recommendation, Governor McKee's FY26 Proposed Budget includes provisions for a state facility benchmarking and performance standard program, including a new OER full-time employee to support these efforts.

INTRODUCTION

During the 2024 legislative session, the General Assembly passed a joint resolution requesting that the Executive Climate Change Coordinating Council (EC4) prepare a report on building benchmarking and performance standards that includes:

- "recommendations for the implementation of benchmarking and building performance standards for large existing buildings in Rhode Island, meaning those with at least 25,000 sq. ft. of gross floor area and including both publicly and privately owned buildings;" and

- "recommended approaches and implementation plans to collect and evaluate" seven key facets of this topic. [2]

The report is structured around these seven requested topic areas:

1. Summary of building sector emissions using the best available data on energy use intensity and emissions of large buildings,
2. Inventory of covered properties, including building type and size,
3. Summary of best available data on current energy sources of large buildings,
4. Estimated costs of retrofits, alterations, and repairs needed to comply with building performance standards,
5. Relevant State agencies for implementation of benchmarking and performance standards,
6. Estimated staff, budget, and resources to develop and implement benchmarking and performance standards, and
7. Recommended timeline for establishment and implementation for large buildings

In addition to addressing these seven topics, OER has included relevant background information in Appendix 3.

OER prepared this report on behalf of the EC4, in collaboration with the Rhode Island Department of Environmental Management (DEM) and the Rhode Island Department of Administration (DOA).

OER solicited feedback on the resolution from the Green Buildings Advisory Committee at a meeting held on November 19th, 2024. Feedback was incorporated into the draft report, which was presented to the EC4 at a meeting held on February 10th, 2025. A public listening session was held on January 27th, 2025.

[2] Rhode Island Legislature, Joint Resolution: Report on Benchmarking and Building Performance Standards, 1.

FINDINGS

1 – Summary of the State's Building Sector Emissions Using the Best Available Data

Our best estimate of emissions from large buildings statewide suggests that buildings larger than 25,000 SF account could account for 10% of emissions statewide, or roughly one-fifth of the estimated emissions from the whole building sector. Meanwhile, we lack sufficient up-to-date emissions and energy-use intensity sample data for large buildings to extrapolate results statewide. Precisely measuring the emissions and energy-use intensity of large buildings in the state would require a building energy benchmarking program for these buildings.

Existing Emissions Data

The operational emissions of a building can be broken into two broad categories: direct on-site emissions (scope 1) and offsite emissions from imported energy resources (scope 2). Scope 1 emissions include greenhouse gases (primarily carbon dioxide) resulting from the on-site combustion of fuels and direct venting of greenhouse gases (primarily refrigerants and methane). For the purposes of building emissions calculations, the direct venting of greenhouse gases (GHGs) is typically ignored; however, a building's scope 2 emissions typically include the offsite emissions associated with producing electricity and steam that are consumed onsite.

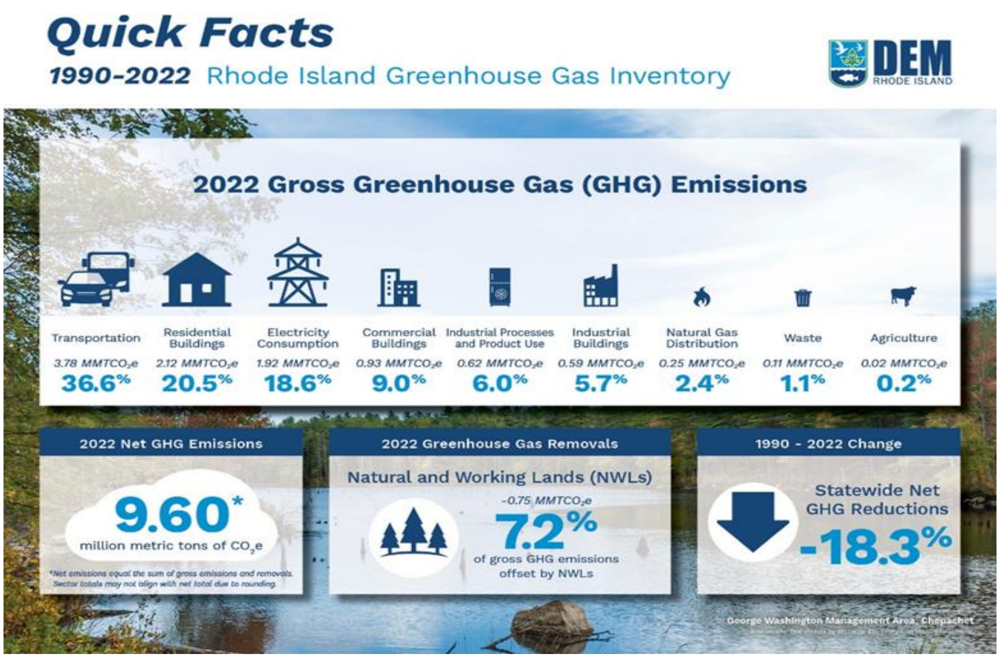

Figure 1: 2022 Rhode Island Greenhouse Gas Inventory

DEM publishes an annual inventory of statewide GHG emissions that serves as the official accounting framework for measuring progress towards the Act on Climate in Rhode Island. The image above, presented at a November 2024 EC4 meeting, illustrates the distribution of emissions by category of generation in Rhode Island.[3] Due to complexities of the state and federal data sources involved, the inventory lags roughly two years behind the covered year. As such, the most recent available data are from 2022. These data come directly from the U.S. Energy Information Administration's (EIA) State Energy Data System (SEDS), which provides a comprehensive view of heating fuel consumption by building sector and fuel type as far back as 1990. However,

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[3] Rhode Island Department of Environmental Management, "2022 Rhode Island Greenhouse Gas Inventory."

electricity-sector emissions are calculated by applying ISO New England grid emissions factors to the net load served to Rhode Island, after subtracting both voluntary and mandatory retirements of Renewable Energy Certificates (RECs) in the state.[4] Therefore, the DEM statewide GHG emissions inventory is not designed to provide a precise disaggregation of the various electricity end-uses (e.g., buildings, streetlights, pump stations, telecom broadcasting, EV chargers, etc.), let alone a breakdown by building size. As such, a precise accounting of emissions from large buildings is not available.

However, it is possible to estimate the total share of emissions attributable to the building sector at large. The National Renewable Energy Laboratory (NREL) estimates that buildings account for 75% of total electricity consumption[5]. Applying this estimate to the 2022 Rhode Island GHG inventory suggests that the buildings sector could account for as much as 49% of statewide gross emissions, as shown in Figure 4 in Appendix 1.[6] However, this estimate does not reflect a bottom-up accounting of emissions from the building sector and is merely an estimate. However, this estimate does not reflect a bottom-up accounting of emissions from the building sector and is merely an estimate.

While it is possible to estimate the emissions attributable to large buildings in the state, there is no Rhode-Island specific data to construct this estimate. As such, the results should be taken under advisement and not treated as a bottom-up accounting. To estimate the emissions attributable to large buildings over 25,000 SF in the state, we first estimate the aggregate fuel usage per square foot for large commercial buildings in Rhode Island and then apply emissions intensities to find the average emissions per square foot for the aggregate of these buildings. Lastly, we multiply this aggregate emissions intensity by the total floor area of Rhode Island buildings over 25,000 SF that were included in a 2020 CoStar commercial real-estate database provided by NREL, as discussed below in section 2. For more details on these calculations, see Appendix 2. Using this method, we estimate that the 2,320 buildings included in the aggregate CoStar floor area data[7] account for 1.04 million metric tons (MMT) CO2e in scope 1 and 2 emissions annually. These estimated emissions amount to 10.1% of the 2022 gross GHG emissions statewide, and 20.6% of emissions from the total building sector, using the 49% estimate from above.

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[4] Rhode Island Department of Environmental Management, "Updates to Electricity Sector GHG Accounting"; RI Executive Climate Change Coordinating Council, "May 11, 2016 EC4 Meeting Minutes"; Rhode Island Public Utilities Commission, "Voluntary Renewable Energy Certificates and the Renewable Energy Standard," 9.

[5] National Renewable Energy Laboratory, "NREL Researchers Reveal How Buildings Across United States Do—and Could—Use Energy."

[6] Rhode Island Department of Environmental Management, "2022 Rhode Island Greenhouse Gas Inventory."

[7] National Renewable Energy Laboratory, "State and Local Planning for Energy (SLOPE): Building Count."

Existing Energy-Use Intensity Data

The availability of existing energy-use intensity (EUI) data for large buildings in the state is summarized in Table 2 in Appendix 1. There is generally a lack of recent EUI data for large buildings in the state, but some 2023 data from Providence's benchmarking of municipal buildings is available and reported in Table 4 in Appendix 1. For reference, Table 3 in Appendix 1 contains the 25th percentile (more efficient than 75% of buildings) site EUIs for selected property types, based on data from the 2012 RECS and 2015 CBECS for ASHRAE 2021 climate zone 4A (most of Rhode Island).[8] These site EUIs represent model BPS targets and are reported by ASHRAE in 2022 Addendum C to their model BPS materials, ASHRAE Standard 100.[9] While Providence's municipal reporting is not reflective of buildings statewide, it shows that at least Providence's median school and municipal office have not yet achieved their targets. The median school was still 50% over its target, while the average office was still 19% over its target (averaging between the admin, courthouse, government, medical, and mixed-use office-type targets). Meanwhile, other data sources offering either aggregated or older data are detailed below.

DOE's Building Performance Database offers anonymized data ranging from 2003-2022 for large public and private buildings in Rhode Island over 20,498 SF, reported in Table 5 and Table 7 in Appendix 1 (the database did not permit a 25,000+ SF filter threshold, and instead defaulted to 20,498 SF).[10] Furthermore, while it is possible to subset data from the most recent five years (2019-2024), the low number of data prevents disaggregation by property type.

In 2016, the University of Rhode Island (URI), under direction of OER, benchmarked over 400 properties across 28 Rhode Island municipalities, using energy data obtained from National Grid and the municipalities directly. URI transmitted a final report to OER in 2017.[11] Of the over 400 buildings benchmarked, only 74 are larger than 25,000 SF, and of these only 45 have EUIs that are above 10 and below 500 kBtu/SF/yr.[12] These data, ranging from 2011-2015, are summarized and reported in Table 6 and Table 8 in Appendix 1.

Lastly, the School Building Authority at the Rhode Island Department of Education published in 2017 a Schoolhouse Energy Report Card that reports average site EUI for all school districts in the state, based on 2014 data.[13] However, the reported EUIs are converted values based on energy cost, rather than usage data. Additionally, these data are for school campuses, which may be composed of multiple buildings smaller than 25,000 SF. The data reported in Table 9 excludes 28 campuses for which site EUI data was not available or less than 10 kBtu/SF/yr.

Additional data sources were consulted but did not offer EUI data for large buildings in Rhode Island, including multifamily buildings. Specifically, EIA's Commercial Building Energy Consumption Survey (CBECs) does not subset data by state, while the EIA Residential Energy Consumption Survey (RECS) provides data for multifamily buildings on a dwelling-unit rather than building basis. Meanwhile, Rhode Island Energy's databases and Energy Efficiency Program Evaluation Studies lacked the comprehensive data necessary to compute EUI (e.g., property type, gross floor area, total energy consumption (including electricity, gas, delivered fuels, etc.)).

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[8] ASHRAE, "ANSI/ASHRAE Addendum a to ANSI/ASHRAE Standard 169-2020: Climatic Data for Building Design Standards," 113.
[9] ASHRAE, "ANSI/ASHRAE/IES Addendum c to ANSI/ASHRAE/IES Standard 100-2018: Energy Efficiency in Existing Buildings," 4–7.
[10] Lawrence Berkeley National Laboratory, "Building Performance Database."
[11] Trandafir, "Municipal Energy Trends in Rhode Island Final Report."
[12] Trandafir, "Municipal Energy Trends in RI Dataset."
[13] RIDE School Building Authority, "Schoolhouse Energy Report Card."

2 – Inventory of Properties Subject to Benchmarking and Performance Standards

Municipal and Private Buildings

Building benchmarking and performance standards programs typically focus on large buildings because they account for the majority of the built floor area and thus the majority of emissions from buildings. While granular building emissions data are not available for Rhode Island specifically, sub-setting a National Renewable Energy Laboratory (NREL) model representative of 62% of the commercial floor area[14] and all multifamily buildings over 10,000 SF nationwide to Southern New England provides some insight into what the building segmentation could look like in Rhode Island. Among the commercial and multifamily buildings represented by the sub-set model (which excludes single-family homes, small multifamily buildings, and at least 38% of the commercial floor area), the buildings larger than 25,000 SF account for 75% of the emissions yet only 35% of the structures. Meanwhile, the results indicate that such buildings between 10,000 and 25,000 SF in size account for 35% of buildings represented by the model, yet only an additional 17% share of emissions.[15] Therefore, a 25,000 SF applicability threshold is a practical target that recognizes limited resources for benchmarking and performance standards programs while still addressing the majority of building emissions from such commercial and multifamily buildings. See Figure 5 in Appendix 1 for more details on this segmentation analysis.

The State does not have a repository of large buildings statewide. To achieve this list would require access to a consolidated inventory of all buildings – public and private – statewide, that also included the necessary building information (owner, size, address, etc.), tied to energy use and emissions. Municipal governments have the closest proxy for this information (except energy use or emissions) in the form of tax assessor databases. While those databases can be inaccurate or out-of-date subject to revaluations, this would be the best starting point. Building this database from municipal records would be resource-intensive and compliance at the city or town level would be predicated on available financial and human capital. Due to the technical nature of these tasks, it would be best to task a third party with these tasks rather than benchmarking/performance standard program staff. Once the data infrastructure was completed, continuous updating would require ongoing management and funding.

While a comprehensive, granular database of all buildings in the state does not exist, the National Renewable Energy Laboratory (NREL) has published some high-level data sourced from a 2020 CoStar commercial real-estate transaction dataset. This dataset does not include all buildings larger than 25,000 SF, but it is likely to be at least somewhat representative of the statewide stock of large buildings. Of the estimated 2,320 Rhode Island buildings included in this dataset, 2,301 fall into standardized categories. Of these 2,301 buildings, the majority (53%) of buildings over 25,000 are very large – at least 50,000 SF. Additionally, just four building types (industrial, multifamily, office, and retail) account for 81% of all large buildings. These data are reported in Figure 6. Meanwhile, Figure 7 demonstrates how the largest buildings (over 50,000 SF) account for the vast majority (81%) of all the floor area among large buildings in the dataset.[16]

Some of these large buildings are a part of campuses, which are often served by a central utility plant that generates electricity and steam (for heating) for buildings. Such systems are often referred to as combined heat and power plants, while the steam heating component is commonly called district heating. Because one entity typically owns all buildings served by such systems, there has historically been little need to meter building-level electricity or steam usage. Therefore, such campuses tend to lack submetering and thus the ability to report building-level energy usage data for the purpose of building energy benchmarking. Short of installing

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[14] National Renewable Energy Laboratory, "ComStock Reference Documentation: Version 1," 15.
[15] National Renewable Energy Laboratory, "Understanding Building Energy Use in Southern New England: Basic Building Stock Characterization," fig. 2.
[16] National Renewable Energy Laboratory, "State and Local Planning for Energy (SLOPE): Building Count."

submetering in every building, which is no small undertaking, benchmarking policies typically allow campuses to compute energy and emissions intensity metrics in aggregate for all buildings served by such systems.

Industrial buildings may also require special treatment if they have significant process loads. For instance, buildings with energy-intensive processes subject to New York City's Local Law 97 building performance standard can apply for an adjustment to their emissions standard.[17]

State Buildings

The State maintains a list of all State-owned properties, which can help identify buildings larger than 25,000 square feet. A significant portion of these buildings are located on either the Pastore or Zambarano campuses, which do not have submetering capabilities due to their use of central utility plants that provide both electricity and steam to most buildings. At Pastore, some buildings are also tied to Rhode Island Energy for electricity use. A current consulting project is examining the feasibility of sub-metering at Pastore in the next several years. At present, however, there is no way to extract precise measures of energy use or emissions for some individual State buildings on those two campuses. Instead, emissions and energy use at the central utility plant would need to be collected. Setting performance standards for campuses that lack submetering yet have multiple property types requires calculating a blended energy or emissions intensity standard for the campus.

[17] NYC Department of Buildings, "Adjustments Application Filing Guide," 6.

3 – Summary of the Best Available Data on Current Energy Sources for Large Buildings

Statewide

There is no comprehensive database of energy sources for large buildings statewide. With the exception of the limited data reported in Table 10, Table 11, and Table 12 in Appendix 1 from the URI Municipal Energy Trends report and the International District Energy Association, we found that data that would be useful do not exist at the building, but rather an account level. For instance, Rhode Island Energy has both electricity and gas customer account data at the meter level but would not be able to report building-level data without first matching meters and accounts to buildings. A similar issue exists with data on onsite renewables. Likewise, OER has access to all electricity and gas billing and usage data for all state-owned facilities but does not track this information on a per-building basis.

However, it is possible to estimate the energy sources of large buildings in the state. As the Commercial Building Energy Consumption Survey (CBECS) subsets only by region, we further subset 2018 results from New England to buildings over 25,000 SF that fell into one of Rhode Island's two climate zones at the time of the study (see Appendix 2). For this subset of 122 large buildings, electricity accounted for the majority (54%) of aggregate total annual energy use, while gas accounted for 31% of usage, oil 8%, and steam 6% (Figure 8).

The URI Municipal Energy Trends report offers acceptable fuel use data from 2011-2015 for 45 buildings over 25,000 SF, reported in Table 10 and Table 11.[18] Row totals may sum to greater than 100% due to rounding. As expected, almost all the energy consumed by large buildings comes from electricity (49% of total energy) and gas (51% of total energy), while oil accounts for less than 1% of total energy usage.

Unfortunately, the Rhode Island buildings larger than 20,498* SF contained in the Building Performance Database do not have data on fuel usage (*the database does not allow for a filter threshold of 25,000 SF, and instead defaults to 20,498 SF). Additionally, because Rhode Island Energy's databases and Energy Efficiency Program Evaluation Studies do not contain information on building size, they cannot offer fuel usage or on-site renewables data for large buildings specifically. However, on-site renewable energy generation is typically explicitly excluded from calculations of site EUI for the purposes of building benchmarking.

Relatively few buildings in the state use district heating, based on data reported in Table 12 in Appendix 1 principally from the International District Energy Association unless otherwise noted.

State-Owned and State-Occupied Buildings

While consumption-based energy-source information for every large state-owned facility is not available, a preliminary inventory of state-owned and state-occupied facilities shows that the majority may have natural gas as the primary energy source. This is because many of the large buildings are located on the Pastore Campus, where the central utility plant uses natural gas to generate both electricity for power and steam for heating. Such systems are often referred to as combined heat and power plants, for which the steam heating component is commonly called district heating. Half of large (over 25,000 SF) state agency buildings use district heating. Most such buildings are located on the district-heated John O. Pastore campus in Cranston, which alone accounts for 34% of the floor area of large state buildings.

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[18] Trandafir, "Municipal Energy Trends in RI Dataset."

4 – Estimated Costs Pertaining to Retrofits, Alterations, and Repairs to Comply with Benchmarking Program

Energy Benchmarking

The time required to benchmark a single building will vary based on an owner's existing record-keeping system and ability to gather necessary data. While utility-provided whole-building energy data (for electricity and gas) would reduce the total time required for compliance, staff would still need to verify these data and submit information in advance of deadlines. Moreover, owners of multiple buildings will need to manage compliance for multiple facilities, and thus may need to hire additional employees if existing staff are constrained. Notably, the State and its municipalities may lack the administrative capacities for compliance that commercial real estate companies may have. As such, compliance staff (who would track individual buildings' reporting and alignment with performance standards) could look to provide additional assistance to these parties during the first year of benchmarking, which tends to be the most challenging.

BPS: Hard Costs

The per-building cost of complying with a performance standard varies widely by a building's existing EUI, size, form (high/low-rise), aesthetic requirements, age, location, existing conditions, and existing infrastructure. At present, there is no single repository of building information available for private or public buildings statewide that would facilitate a comprehensive assessment of total retrofit costs to comply with a performance standard.

However, in the absence of such comprehensive data for Rhode Island, we have selected representative retrofit projects to demonstrate the wide range of costs associated with different scopes of work. The costs of these upgrades are representative and likely to vary somewhat between different buildings due their unique characteristics, as discussed above.

Some low-cost, medium-impact upgrades, like LED lighting and retro-commissioning or replacement of building management systems, tend to be more similar in scope and cost intensity across building types and conditions. For instance, a LED retrofit project in state prison buildings cost $4/SF with an estimated payback period of 5 years (

Table 13). Meanwhile, controls replacement projects at the Powers Office building (constructed 1989) and Arrigan rehab center (constructed 1900) have similarly low costs ($4 and $9/SF respectively yet longer payback periods of 18 and 10 years, respectively (Table 13).

While these upgrades are a great first step towards reducing energy use, they will only reduce a building's EUI on the margin. Larger projects that replace core building systems (e.g., envelope and HVAC distribution systems) and electrify heating systems would be required to meet performance standards in-line with net-zero emissions by 2050. For instance, the Powers office building was constructed in 1989 and hosts multiple State agency operations plus public-facing operations for the Division of Taxation, among other public uses. The building's efficiency was compromised by windows with permeable borders, and the State conducted a project to replace the windows to improve temperature control and heat retention. The total cost of the project was approximately $4.8 million, or $19 per square foot. This project was completed in early 2025.

Moreover, when buildings require gut renovation and complete replacement of all building systems, costs can increase substantially. Eleanor Slater/Regan State Hospital was constructed in 1979 and hosts hospital functions operated by the Department of Behavioral Healthcare, Developmental Disabilities & Hospitals. This project was made possible because patients and staff were temporarily relocated to another building to conduct construction necessary for compliance. The State decided to leverage the building's vacancy and open interiors to install new MEP systems (including HVAC, plumbing, controls, lighting, and some electrical systems, plus associated architectural modifications)), as existing systems at the ends of their useful lives were compromising the continued operation of the hospital. The total project cost is projected to be $28.1M, or $227 per square foot. The cost is lower than a typical full MEP replacement project because the building was already gutted for other work. Furthermore, this interior project would not have been possible without the prior refurbishment of the roof and envelope. This project is ongoing.

BPS: Soft Costs

Beyond the construction costs of retrofit projects, additional soft costs associated with compliance with a BPS should be evaluated to properly compare building performance standards to other energy-efficiency and emissions-reduction policies. Note that the budget detailed in section six is in addition to these costs.

- Financing: Access to capital, interest rates, and other administrative costs related to financing projects. Additionally, there is an opportunity cost of funding these projects instead of other initiatives. Upgrades of State-owned buildings are funded primarily through the Rhode Island Capital Plan (RICAP), which is finite and distributed across all State-owned properties and other assets based on timing and need across five-year programmatic periods. To adequately fund the State portion of energy efficiency upgrades, more or different funding may be required. Additionally, construction costs may increase in the future, further constraining the use of funds.
- Operational Interruptions: Relocating operations (staff, clients, etc.), procuring temporary space, and any resultant productivity loss. Additionally, some operations (like hospitals or grocery stores) may not tolerate even temporary closures for major upgrades. Construction may also result in the short-term increase in utility costs if portions of the building are exposed.
- Permitting of Retrofits: Building code requirements and other permitting, etc. Additionally, the existing conditions and infrastructure of historic buildings may cause additional challenges, compounded by comportment with Rhode Island Historical Preservation & Heritage Commission as appropriate.
- Future Maintenance: Staff training to manage updated systems or contracted vendor costs as required by the new systems.
- Loss of Competitiveness: Private industry may internalize performance standards as additional costs of doing business in Rhode Island, making the state less competitive for location and expansion for large commercial enterprises. For example, Connecticut does not have a comparable program while Massachusetts is pursuing only a benchmarking program. Such a loss of competitiveness could adversely impact employment, productivity, and tax collections.

- Housing: Large landlords may pass on the costs of these upgrades to residents, further increasing the cost of rent or occupancy for eligible buildings.

In addition to these costs, other constraints include the availability of qualified contractors and vendors to conduct the design, engineering, construction, and maintenance work. Furthermore, electrification will put more demands on the state's energy grid that will need to be evaluated. Coordination with the three utilities will be necessary to make sure the grid infrastructure can support increasing demand.

5 – Identification of State Agencies with Relevant Roles and Responsibilities to Develop and Implement Benchmarking and Performance Standards for Large Buildings

Rhode Island Office of Energy Resources

OER is the state's energy office and is responsible for developing and implementing "plans and programs to promote, encourage and assist the efficient and productive use of energy resources in Rhode Island, and to coordinate energy programs for natural gas, electricity, and heating oil to maximize the aggregate benefits of conservation and efficiency of investments"[19]

OER is currently tasked with implementing Executive Order 23-06, which sets specific targets for reducing both emissions from onsite fossil fuel consumption and overall site energy use intensity in state properties:

- Reduce emissions from fossil fuels used onsite by buildings and vehicles from a 2014 baseline: 40% by 2030, 70% by 2040, and 95% by 2050.
- Reduce overall site energy use intensity (EUI), defined as weather-normalized Btu per square foot, from a 2014 baseline at state-owned buildings 20% by 2030, 30% by 2040, and 40% by 2050.[20]

As part of the reporting process under Executive Order 23-06, OER is already tracking building emissions and site EUI in-aggregate for the portfolio of State-owned buildings, in addition to building-level benchmarking for 16 properties. This experience in implementing building benchmarking and performance standards (BPS) for state properties provides OER with relevant experience to implement statewide energy benchmarking and performance standard programs. In recognition of the need to report on and likely implement building benchmarking and performance standards in the near future, OER has brought on a DOE Energy Innovator Fellow with expertise in benchmarking and performance standards to support this evolving policy space. However, at least one additional staff would be required to support benchmarking and/or performance standards for all large state-owned buildings individually, and more staff and funding to support programs for private buildings. Additionally, while OER has the expertise to design and implement energy benchmarking and performance standard programs, it lacks some of the required statutory authorities to provide oversight and regulate building energy usage. OER's statutory authority would need to be expanded to include the ability to regulate building energy use, including promulgating and enforcing regulations.

Furthermore, OER's substantial experience with administering energy-efficiency and renewable energy programs and implementing multiple energy projects with state agencies, municipalities, and public schools additionally gives OER the contextual knowledge to develop building decarbonization regulations that work in concert with existing state and federal energy incentive programs, helping reduce the regulatory burden on constituents. OER already manages the Lead by Example program, Clean Heat Rhode Island program, and Home Electrification and Appliance Rebates program, and is expecting to soon administer the Home Efficiency Rebates program and multi-state New England Heat Pump Accelerator program. The programs listed below reflect current offerings; these are likely to change in both availability and scope from year-to-year.

- **Lead by Example (LBE) Program - Administered by OER**
  - The LBE Program offers technical assistance, financial support, and procurement and implementation management for public sector entities (e.g., State Agencies, Municipalities, and Public Schools) for a variety of energy technologies.
  - State Agencies can receive grants from OER to support the installation of: LED Lighting, Building Automation Systems, HVAC equipment, heat pump water heaters, EV charging stations, solar PV, and energy storage systems.

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[19] The State of Rhode Island, Rhode Island Energy Resources Act, sec. 3.

[20] McKee, "EO 23-06: State Agencies To Lead By Example And Act On Climate."

  - Public Schools can receive grants from OER to support: LED lighting, heat pump water heaters, Building Automation Systems, and some HVAC equipment.
  - Municipalities can take advantage of the Energy Efficiency & Conservation Block Grant formula funding program to support a wide variety of energy efficiency and/or energy planning activities.
- **Federal Energy Programs - Administered by OER, DHS**
  - Administered by OER, the Clean Heat Rhode Island Program offers incentives for nonprofit and commercial customers with annual gross revenue under $30 million to install heat pumps. Incentives range from $2,000/ton for air-source heat pumps to $4,500/ton for closed-loop ground-source heat pumps. Rebates up to $2,500/ton are also available for heat pump water heaters.[21]
  - OER is expected to receive approximately $35 million for mid-stream heat pump incentives as part of the multi-state New England Heat Pump Accelerator initiative funded by the EPA's Climate Pollution Reduction Grant program.
  - The 179D tax deduction provides $.50/SF for 25% modeled savings, plus $.02/SF/additional modeled percentage saving, up to $1/SF, or up to five times the savings per SF if local prevailing wage and apprenticeship requirements are met.[22] This deduction can be allocated to the "person primarily responsible for designing the property" in the case of non-taxable entities.[23]

It is important to note that recent changes at the federal level have introduced uncertainty around the availability and consistency of energy-related grants, making it challenging to predict current and future funding opportunities.

Additionally, OER supports the work of the Energy Efficiency Council (formerly the Energy Efficiency and Resource Management Council), which oversees Rhode Island Energy's Energy Efficiency programs that Rhode Island Energy administers.

- **State Energy Efficiency Program - Administered by Rhode Island Energy**
  - The Small Business Direct Install program offers free audits and savings on heating systems, building controls, air-sealing, insulation, refrigeration, and lighting upgrades, with an option for on-bill repayment.[24] Based on the average national electricity and gas EUIs from the Building Performance Database, the consumption-based eligibility thresholds for this program translate to a square-footage threshold on the order of 195,000 SF, making many covered building eligible.[25]
  - The Commercial Heating and Cooling provides rebates for high-efficiency heating, cooling, and combined heat and power (CHP) equipment.[26]
  - The Instant Commercial Rebate program offers discounts on LED lighting, heat pumps, gas water heaters, and kitchen and refrigeration equipment.[27]
  - The Retrofit program offers incentives for lighting upgrades, efficient motors and pumps, and building system optimization (e.g., tuning, monitoring-based commissioning).[28]

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[21] Rhode Island Office of Energy Resources, "Clean Heat Rhode Island Program Incentives," 4.
[22] Internal Revenue Service, "Energy Efficient Commercial Buildings Deduction."
[23] Internal Revenue Service, "Notice 2008-40," 2.
[24] Rhode Island Energy, "Small Business Program."
[25] Rhode Island Energy, "Small Business Program Mailer"; Lawrence Berkeley National Laboratory, "Building Performance Database."
[26] Rhode Island Energy, "Commercial Heating and Cooling Programs."
[27] Rhode Island Energy, "Instant Commercial Rebate Programs."
[28] Rhode Island Energy, "Retrofit Program."

- The Multifamily Program provides bonus incentives for affordable multifamily housing.[29]
- Custom multifamily and commercial incentives are also available for larger or more complex projects.

OER would implement the energy benchmarking and performance standards program in consultation and coordination with the relevant state agencies and parties below.

Department of Environmental Management (DEM)

DEM works to protect, restore, and promote our environment to ensure Rhode Island remains a wonderful place to live, visit, and raise a family. DEM manages the official GHG accounting for compliance with the Act on Climate and would be the subject matter expert for the calculation of the effective emissions intensity of electricity in Rhode Island.

Department of Administration (DOA)

DOA provides supportive services to all Rhode Island departments and agencies for the effective coordination and direction of state programs within a changing administrative and fiscal environment, while ensuring accountability of and value for public dollars. DOA's Division of Capital Asset Management and Maintenance oversees all state-owned buildings and would be an essential partner in implementing benchmarking and/or performance standards for state-owned buildings.

State Building Office (SBO)

The Building Code Commission (BCC) at the State Building Office is tasked with protecting public health, safety, and welfare by establishing minimum standards of construction. If a BPS were enacted, OER would work with the Building Codes Standards Committee to ensure alignment and coordination between the energy code for new buildings and the performance standard for existing buildings.

Department of Business Regulation (DBR)

DBR is the regulator for a wide variety of businesses in the state and performs benefit-cost analyses of proposed changes to the state building code. OER could work with DBR to set performance standards that are feasible and do not place an undue burden on property owners.

Rhode Island Infrastructure Bank (RIIB)

Additionally, OER may seek to work with the Rhode Island Infrastructure Bank (RIIB) to establish low-interest loan programs to support high capital-cost building energy retrofits. Such a program could complement the existing Commercial Property Assessed Clean Energy (C-PACE) program that provides long-term, fixed-rate financing for commercial and industrial property owners to invest in energy-efficiency technologies.[30]

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[29] Rhode Island Energy, "Multifamily Properties."
[30] Rhode Island Infrastructure Bank, "Commercial Property Assessed Clean Energy."

6 – Estimation of Staff and Other Resources Needed to Develop and Implement Benchmarking and Performance Standards for Large Buildings

At the outset, it is critical to acknowledge that Rhode Island does not currently have access to the building inventory, data, and defined scope of work needed to provide a more precise estimate of what staffing capacity and budget might be needed to implement statewide benchmarking and performance standards for large buildings. To understand the resource requirements of a benchmarking and performance standard program, OER researched and consulted with other jurisdictions engaged in similar programs. Providence and Massachusetts are still in the process of staffing up and building out their programs, both of which include only benchmarking, and thus are not as informative as programs in Boston, Washington State, Washington D.C., and New York City.

Staffing

Table 14 in Appendix 1 reports the staffing needs of building performance standard programs in Boston, Washington State, Washington D.C., and New York City. These programs were selected because of their relevance to Rhode Island's potential benchmarking and performance standards initiative. Washington, D.C., and New York City have begun implementation of their performance standard programs, while Boston and Washington State plan to begin enforcing their standards next year. Rhode Island can look to Washington State for guidance and valuable reference points in program development and implementation. While Washington is not a regional peer, it was the first state to enact and implement a benchmarking and performance standards program. Although not an exact comparison, Washington's program is a useful reference in evaluating a potential statewide program for Rhode Island.

Based on the NREL estimate of 2,320 covered buildings and the average number of covered buildings per staff of 570, four staff could be sufficient to design and implement a statewide benchmarking and performance standards. These staff would be in the roles proposed below within the Building Energy Performance Program:

- (1) Chief: Program Manager
  - » Oversee program, hire staff, apply for funding, manage contracts,
  - » Develop and revise rules and regulations.
- (1) Programming Services Officer: Policy Analyst *(Strong Data Analysis Skills Required)*
  - » Develop and administer covered building list,
  - » Manage software platforms,
  - » Develop communications materials.
- (2) Programming Services Officer: Compliance Specialist (*Only One Required Initially)*
  - » Conduct initial outreach to building owners; update covered buildings list,
  - » Manage building data and compliance tracking,
  - » Assess fees for noncompliance.

While some full-time state employees dedicated exclusively to the building energy performance program are preferred, consultants may be considered as a supplementary resource. Benchmarking and performance standards programs are complex and require significant collaboration and teamwork across roles. Full-time staff can provide continuity and deeper program integration, enabling effective regulatory work and long-term planning.

Some jurisdictions choose to outsource portions of the compliance workload to individual contractors or consulting firms. This approach offers flexibility, allowing resources to be adjusted as the program evolves. While full-time state employees are essential for long-term program stability and implementation, consultants can also play a valuable role in providing targeted support and addressing specific needs as they arise.

OER's Lead By Example (LBE) team of two full-time employees and one contractor has already begun developing an energy benchmarking and performance standards program for large state-owned and state-occupied buildings pursuant to Governor McKee's LBE Executive Order 23-06. While OER's LBE team has made significant progress on benchmarking sixteen (16) large state buildings with the assistance of a consultant, they currently lack the staff capacity to complete these existing tasks in-house, let alone expand their benchmarking efforts to more buildings. To expand the LBE program scope to include additional state-owned and-occupied properties, OER would require one additional full-time staff member to assist with design and implementation of the program. Governor McKee's FY26 Proposed Budget includes an allocation for a new LBE full-time employee.[31]

Budget

To effectively design and administer a program for certain large state-owned and state-occupied properties, OER would require only one additional dedicated full-time employee to focus on energy benchmarking and performance standards efforts, which, as noted above, is provided by Governor McKee's FY26 Proposed Budget.

Meanwhile, the staff and budget resources required for a program applying to both public and private buildings would be substantial. OER created an estimated budget for administering a statewide benchmarking and performance standards program applying to public and private buildings, reported in Table 15 within Appendix 1. While costs are estimated at $600,000 during the first program year, data from other states suggests that implementing an accelerator technical assistance program immediately prior to the start of the improvement period may be beneficial, which would increase the annual budget to just over $1 million, eventually reaching $1.4 million following the full rollout of the accelerator. These figures represent a preliminary estimate and may be determined with greater precision as program details are refined.

OER has included an accelerator in the program budget because all four peer programs studied provide free "concierge" technical assistance to at least some building owners – New York City and Washington State offer accelerators to all covered buildings, while Boston and D.C. target under-resourced properties.[32] These programs are designed to decrease transaction costs associated with upgrades and increase project follow-through by assisting building owners with understanding and acting on regulations, energy assessments, financing, incentives, and quotes. A typical scope of work for an accelerator includes a few hours each of technical and non-technical consultations, estimated at roughly $1,000 per building on average. The budget in Table 15 assumes that all buildings are eligible for the accelerator, but that only 25% of covered buildings use it each year. Rhode Island Energy currently provides technical assistance to building owners looking to make building energy efficiency upgrades, including long-term, tailored, accelerator-like support for very large customers through their Strategic Energy Management Program.[33] While Rhode Island Energy funds this technical assistance, they work with third parties to deliver the support programs. Leveraging Rhode Island Energy's existing experience with administering technical assistance programs could assist with the smooth launch of an effective accelerator program.

Beyond program administration costs, a critical budgetary consideration in the implementation of this program for state-owned and -occupied buildings is the uncertainty surrounding the escalation of capital costs in the state budget for state properties over time. These costs, which are funded through the Rhode Island Capital Plan (RICAP), are inherently volatile, influenced by a range of factors including inflation, market conditions, and shifts in regulatory requirements. Given that RICAP is a finite funding source distributed across

[31] State of Rhode Island Office of the Governor, "FY26 Budget Article 3: Relating to Government Reform and Reorganization," 33–35.
[32] NYC Accelerator, "Technical Assistance"; Smart Buildings Center, "Clean Buildings Performance Standard Helpdesk"; City of Boston, "Application for BERDO Building Decarbonization Advisor Services"; DC Sustainable Energy Utility, "Affordable Housing Retrofit Accelerator."
[33] American Council for an Energy-Efficient Economy, "Leaders of the Pack 2024: Commercial."

all State-owned properties and other assets based on timing and need, the aging of state-owned buildings and the increasing demand for maintenance and upgrades further strain these limited resources. This unpredictable rise in capital expenditures places added pressure on the state budget, and it is essential to factor in these potential escalations when planning for long-term sustainability and program implementation. The success of the benchmarking and performance standards program for state properties will depend on careful coordination with the state's evolving budgetary constraints and the capacity to manage unforeseen capital expenditures.

7 – Recommended Timeline for Establishing and Implementing Benchmarking and Performance Standards for Large Buildings

Broadly, the EC4 recognizes that building performance standards hold promise as a tool for meeting the goals of the Act on Climate, which set a 2030 emissions reduction goal of 45% below 1990 levels. To meet the Act on Climate's 2030 mandate of 6.47 MMTCO2e, Rhode Island 2022 net emissions (9.6 MMTCO2e) will need to be reduced by 32.6%.[34] Therefore, further action is needed this decade. However, the EC4 also recognizes that building benchmarking and performance standards programs are complex and take time, staff, and financial resources to be effectively implemented.

Establishing a definitive start date for the design and implementation of a statewide building benchmarking and performance standards program for all large public and private buildings is currently untenable due to significant uncertainties regarding economic impacts and the absence of the requisite data infrastructure to support municipal and private buildings. In particular, the success of a program for municipal and private buildings is contingent upon the availability of automated whole-building utility data, a critical component that remains unavailable at this time. Advancing prematurely without these prerequisites would jeopardize the program's efficacy and is not feasible.

Large State-Owned and State-Occupied Buildings

Meanwhile, OER's access to state-facility energy billing and usage data for large state-owned and occupied facilities simplifies the process of benchmarking and has enabled the Lead by Example team to begin benchmarking select buildings already. Given the internal availability of these data, OER has prepared two recommended timelines, the first of which is detailed in Figure 2 and applies to only large state-owned and state-occupied buildings over 25,000 square feet. Starting with these buildings would allow OER to establish and refine the program framework, develop consistent and reliable data reporting infrastructure, and better assess the program's economic and operational impacts. By focusing first on state-controlled properties, a program for state facilities could ensure that data collection and analysis methods are robust, accurate, and capable of supporting broader expansion. This strategy and timeline are aligned with Governor McKee's FY26 proposed budget article pertaining a State Facilities Benchmarking and Performance Standards Program.[35] If OER receives its requested new full-time employee in the FY26 State Budget, it would be prepared to advance this program effort. .

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[34] Rhode Island Department of Environmental Management, "2022 Rhode Island Greenhouse Gas Inventory."

[35] State of Rhode Island Office of the Governor, "FY26 Budget Article 3: Relating to Government Reform and Reorganization," 33–35.

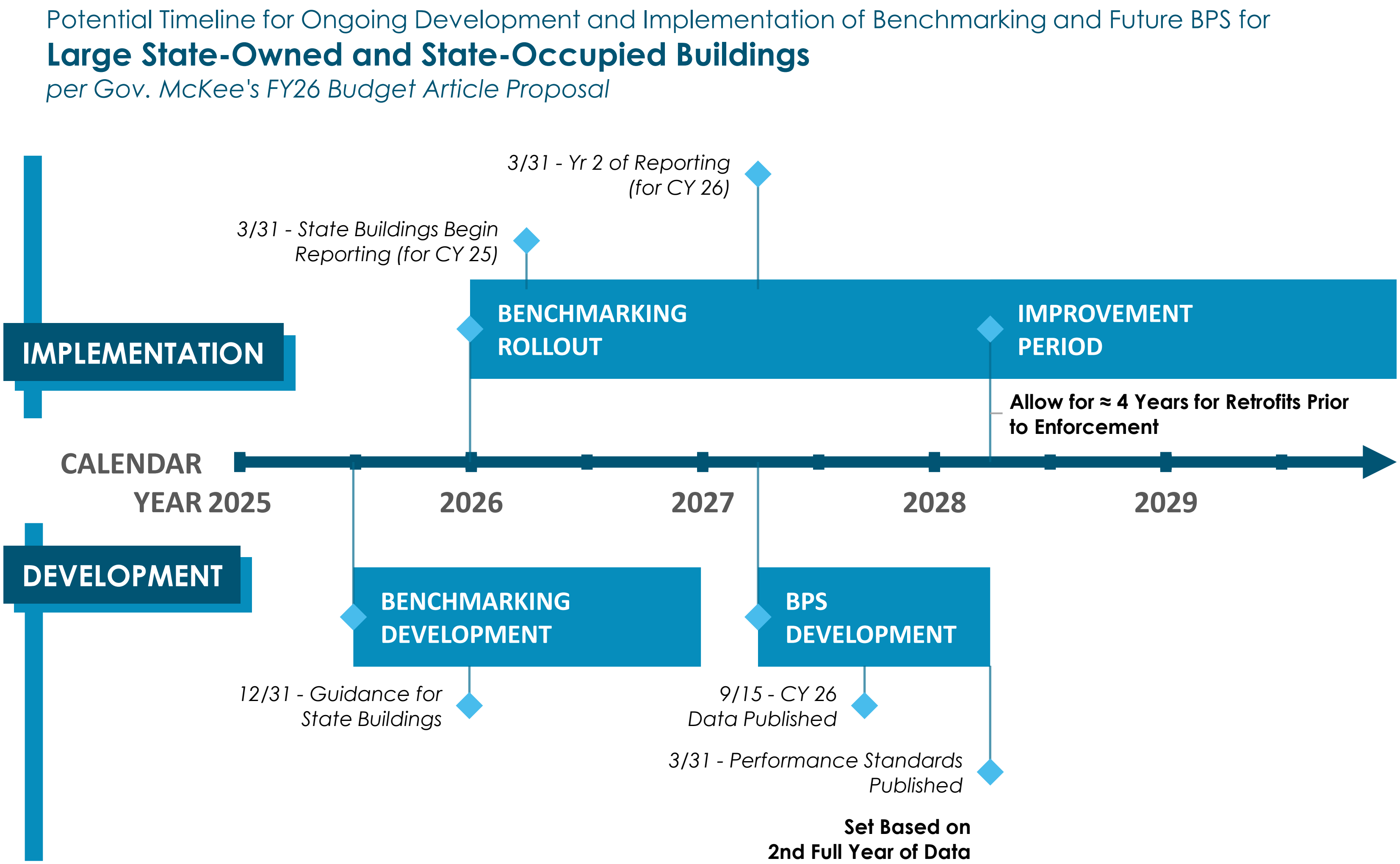

Figure 2: Potential Timeline for Large State-Owned and State-Occupied Buildings

Large Municipal and Private Buildings

Once automated whole-building energy data becomes available and the state properties program validates a reliable and effective program methodology, OER would be poised to execute a fast and effective rollout of an expanded program for large municipal and private-sector buildings, leveraging the lessons learned and data insights from the state program. Table 1, below, reports some of the key research findings and their applications to the potential timeline for municipal and private buildings reported later in Figure 3. Because the infrastructure to provide building owners with automated whole-building energy data is not available, yet a prerequisite for the operation of a benchmarking program, OER has constructed this timeline based on program, rather than calendar years.

Table 1: Timeline Recommendations for a Large Municipal and Private Buildings

Topic	Research Finding	Application to Potential Timeline
Prerequisites	Automated provision of aggregated building-level utility data is essential to set-up, manage, and monitor the program. Providence has faced numerous issues with trying to roll out their benchmarking program for private buildings before this data functionality became available.	Delay of program start is necessary until automated whole-building data access can be assured by relevant utilities.
Program Development	It typically takes at least a year to develop rules and regulations, create a covered buildings list, and implement software solutions for compliance tracking. The time required to build out a benchmarking program is made much shorter today thanks to new off-the-shelf software and services that were not available for jurisdictions that were developing their programs just five years ago.	1.5 years to staff up, develop the program, and promulgate regulations should be sufficient if using existing software solutions and purchasing covered buildings list from consultant to free up staff time for program development.
Regulatory Fairness	Private and municipal building owners should have an opportunity to comment on the regulations to which they will be subject.	Final regulations are in place before private and municipal buildings need to report for the first time, allowing owners time to comment on draft regulations and understand the final ones prior to being regulated.
Target Setting	The first year of benchmarking data is almost invariably inaccurate and missing many buildings.	Delays target setting until the second full year of benchmarking is published to avoid setting targets based on inaccurate data.
Building Improvements	Meeting the first performance standard can be challenging for building owners, especially if they need to make large building improvements on a tight timeframe.	Allow four years for building improvements. Provide accelerator and mandate audits for over-target buildings*.

** It can take years to plan and undertake upgrades on large buildings due to tenant, financial, and technical complications. Requiring that all building owners over the performance standard at the beginning of the five-year compliance cycle undertake ASHRAE Level II audits or similar assessments prior to the close of that first year within the compliance cycle could help ensure that building owners proactively address energy use.*

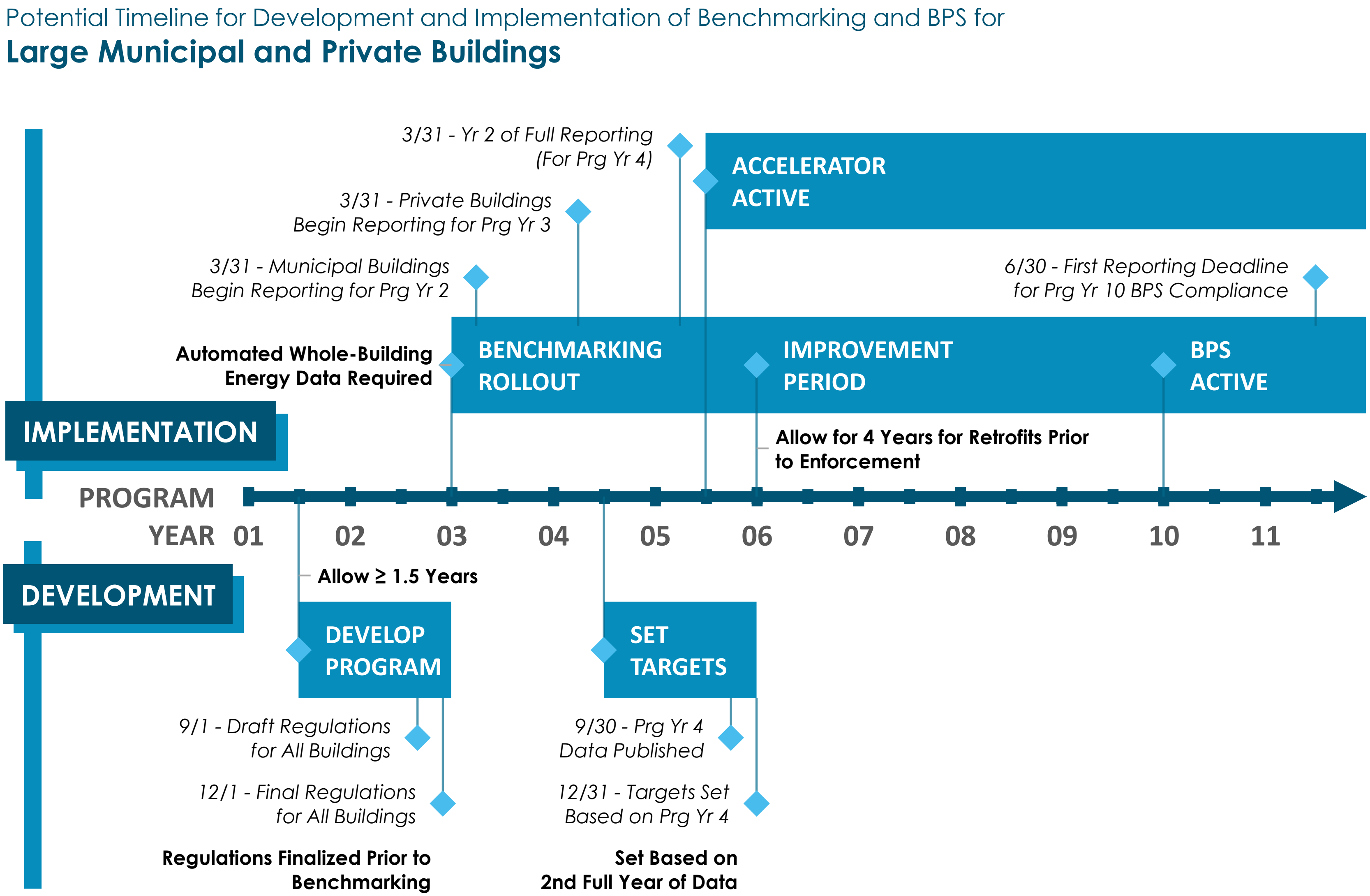

Figure 3: Potential Timeline for Large Municipal and Private Buildings

RECOMMENDATION FOR THE 2025 LEGISLATIVE SESSION

At this time, there is not enough data known about municipal and private-sector large buildings in the state to properly evaluate the costs of implementing benchmarking and performance standards for large buildings statewide. Additionally, key infrastructure components including automated utility data access, regulatory software, and a list of large buildings statewide have not yet been developed. Although EC4 believes that a program could be implemented per the potential timeline reported above in Figure 3 if the requisite data and resources were available, such a feat would still rely on the timely completion of infrastructure by third parties like Rhode Island Energy and the Division of Statewide Planning. As Providence has learned through their own implementation, complications with these resources can delay program rollout and cause confusion among building owners.

Therefore, as a first step towards benchmarking and performance standards in Rhode Island, OER should lead a public-sector program for a select range of large state-owned and state-occupied properties that could serve as the basis for expanded programming for municipal and private buildings in the future. While OER is already benchmarking some state properties and tracking emissions in aggregate per Executive Order 23-06, OER should expand the scope of these efforts to a formal state benchmarking and performance standards program for individual large state buildings. Launching such a state-buildings benchmarking program would give OER a runway to develop the experience and processes that would be invaluable for potential future municipal and private benchmarking and performance standard programs. However, the Lead by Example team is currently only two full-time employees and one contractor, who do not have the capacity as is to complete current benchmarking tasks without consultant assistance. To properly design and implement a formal state-property benchmarking and performance standards program, the OER LBE team would require one additional full-time staff member who would be dedicated to developing a program that could later be adapted to a program for municipal and private buildings. Governor McKee's FY26 State Budget includes a dedicated new OER full-time employee to focus on the energy benchmarking and performance standards efforts.[36]

[36] State of Rhode Island Office of the Governor, 33–35.

APPENDIX 1: SUPPLEMENTAL TABLES AND FIGURES

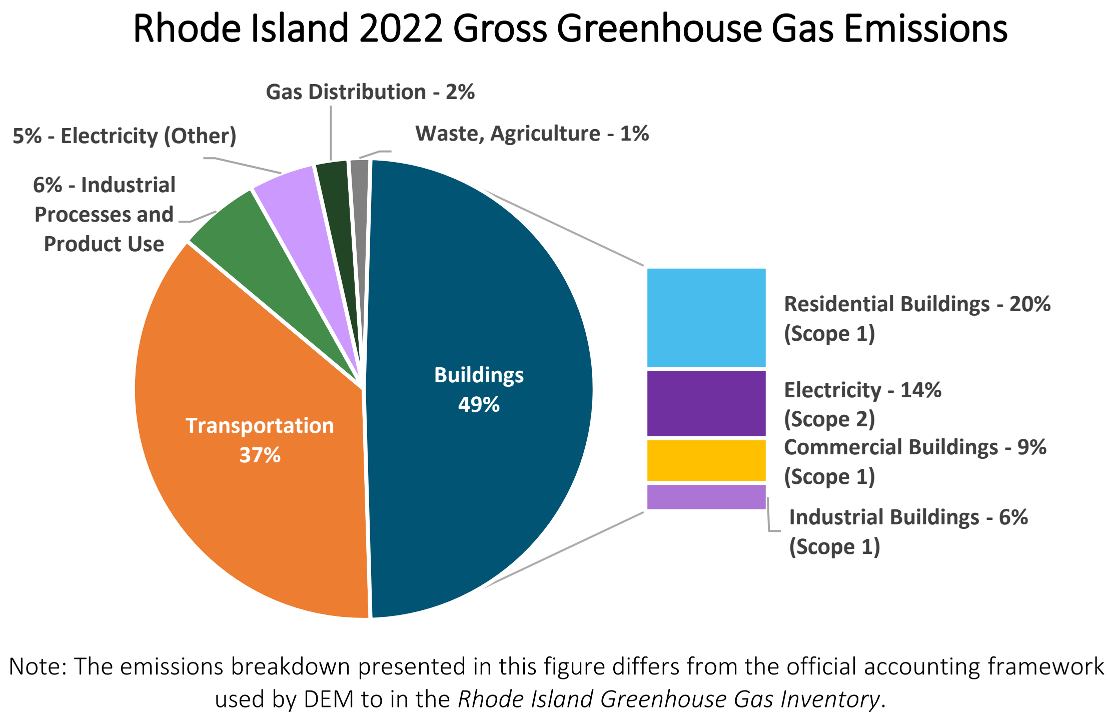

Figure 4: Rhode Island Gross Greenhouse Gas Emissions Breakdown, 2022[37]

[37] Rhode Island Department of Environmental Management, "2022 Rhode Island Greenhouse Gas Inventory."

Table 2: Energy Data Availability for Rhode Island's Large Buildings

Report	Principal Investigator	Partial Sample or All	Relevance for RI Statewide Benchmarking	Property Ownership	Building Size (SF)	N	Data Vintage	Energy Data Available
2017 URI Municipal Energy Trends in RI	URI/OER	Sample	Relevant	Municipal	>25k	74	2011-2015	Yes
2017 Schoolhouse Energy Report Card[38]	RIDE	All	N/A – Not Energy Data	Municipal	Campuses	308	2014	Yes
2024 Building Energy Reporting[39]	City of Providence	All	Excluded	Municipal	<10k	48	2023	Yes
		All	Relevant	Municipal	>10k	72	2023	Yes
2024 OER Lead By Example EO23-06 Reporting	OER	Sample	Relevant	State	>25k SF		2014-2023	2/2025
2025 Building Energy Reporting	City of Providence	All	Relevant	Private	>50k	369	2024	10/15/2025
2025 Schoolhouse Energy Report Card	RIDE	All	N/A – Not Energy Data	Municipal	Campuses			2025
2026 Building Energy Reporting	City of Providence	All	Partially Relevant	Private	20k-50k	515	2025	10/15/2026

[38] RIDE School Building Authority, "Schoolhouse Energy Report Card."
[39] City of Providence, "Setting the Baseline for Carbon Neutrality: City of Providence 2024 Building Energy Report."

Table 3: ASHRAE Standard 100-2018, 2022 Addendum C Site EUI Targets, Climate Zone 4A

Property Type	Target
Admin/professional office	39
Courthouse/probation office	74
Elementary/middle school	36
Fire station/police station	43
Government office	43
High school	51
Library	53
Medical office (diagnostic)	40
Medical office (nondiagnostic)	39
Mixed-use office	35
Multifamily (5+ units)	33
Nursing home/assisted living	94
Recreation	39

Table 4: Providence BERO Benchmarking – Site EUI for Municipal Buildings >10,000 SF, 2023[40]

Property Type	Count	Median EUI
K-12 School	35	54.1
Misc. Building Types	15	67.5
Office	5	53.6
Public Safety Buildings	8	89.7
Zoo	1	114.7

Table 5: Building Performance Database – Site EUI for Buildings > 20,498 SF by Property Type, 2003-2022

Property Type	Count	Mean EUI	Standard Deviation EUI	Median EUI
Office - Uncategorized	33	59	22	57
Education - Elementary or middle school	24	45	18	50
Retail - Uncategorized	20	54	14	56
Nursing Home	10	68	5	68

[40] City of Providence.

Table 6: URI Municipal Energy Trends – Site EUI for Buildings > 25,000 SF by Property Type, 2011-2015

Property Type	Count	Mean EUI
Library	9	61
Office	14	62
Public Safety	8	82
Public Works	7	128
Recreation	5	193
Senior Centers	2	94
Total	**45**	**92**

Table 7: Building Performance Database – Site EUI for Buildings > 20,498 SF by Floor Area, 2003-2022

Floor Area (SF)	Count	Mean EUI	Standard Deviation EUI	Median EUI
20,000 – 50,000	41	57	25	54
50,000 – 100,000	29	62	46	56
100,000 – 200,000	44	62	26	58
20,0000 – 500,000	22	62	17	60

Table 8: URI Municipal Energy Trends – Site EUI for Buildings > 25,000 SF by Floor Area, 2011-2015

Floor Area (SF)	Count	Mean EUI
25,000 – 49,999	33	74
50,000 – 74,999	7	180
75,000 – 99,999	2	97
100,000 – 124,999	2	62
125,000 – 150,000	1	96
Total	**45**	**92**

Table 9: Schoolhouse Energy Report Card – Cost-Derived Site EUI for Campuses, 2014

District	Campuses	Mean
Barrington	6	71
Bristol Warren	6	64
Burrillville	5	50
Central Falls	6	64
Chariho	8	65
Charter	14	57
Coventry	7	45
Cranston	24	61
Cumberland	8	71
East Greenwich	6	90
East Providence	12	78
Exeter-West Greenwich	3	53
Foster	1	59
Foster-Glocester	2	31
Glocester	2	58
Jamestown	2	55
Johnston	7	59
Lincoln	6	57
Little Compton	1	25
Middletown	4	64
Narragansett	3	46
New Shoreham	1	87
Newport	3	54
North Kingstown	8	57
North Providence	9	69
North Smithfield	4	66
Pawtucket	14	62
Portsmouth	4	73
Providence	36	64
Scituate	4	59
Smithfield	6	76
South Kingstown	9	45
Tiverton	5	73
Warwick	22	79
West Warwick	6	60
Westerly	6	73
Woonsocket	10	125
Total	**280**	**66**

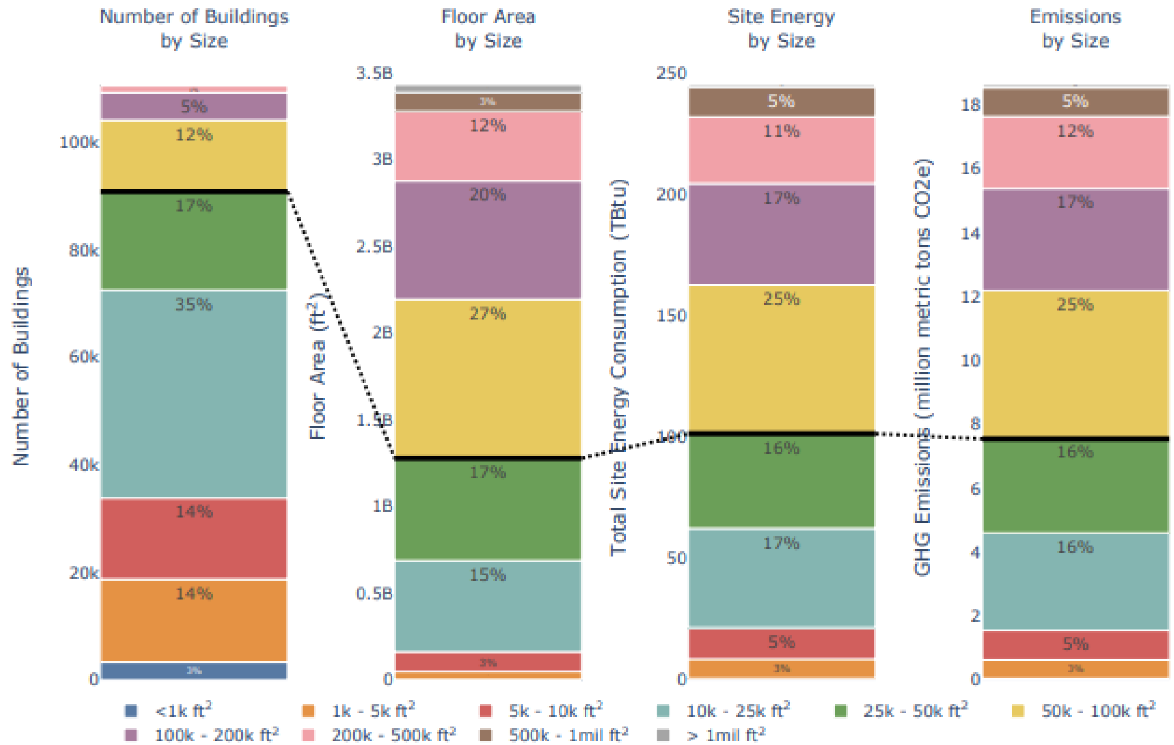

Figure 5: Southern New England Building Stock Segmentation by Size[41]

Reproduced from National Renewable Energy Laboratory (NREL) report. Note that the black line is at 50,000 SF, not 25,000 SF.

[41] National Renewable Energy Laboratory, "Understanding Building Energy Use in Southern New England: Basic Building Stock Characterization," fig. 2.

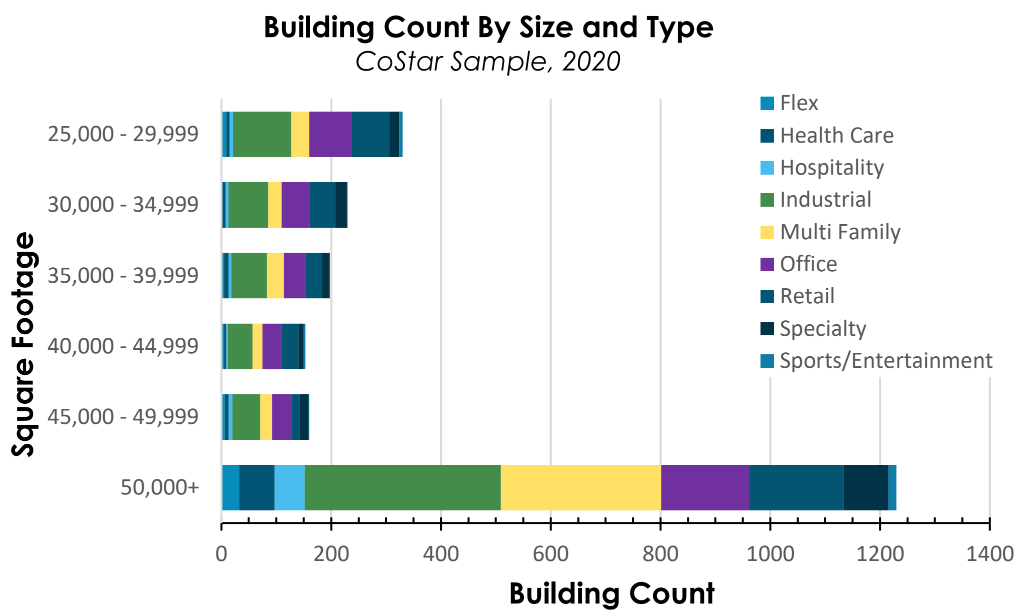

Figure 6: RI Commercial Building Count by Size and Type, 2020 CoStar Sample

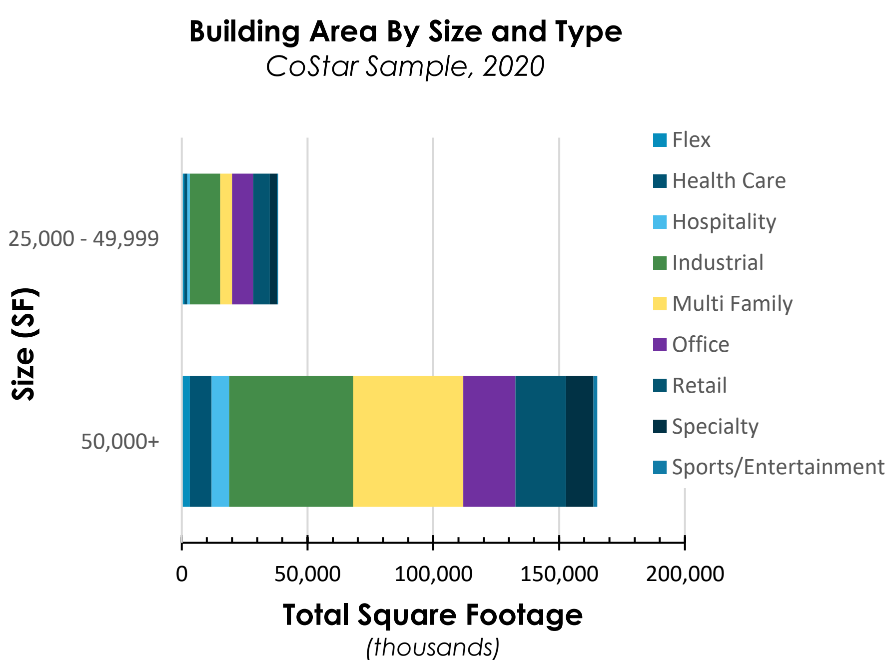

Figure 7: RI Commercial Building Area by Size and Type, 2020 CoStar Sample

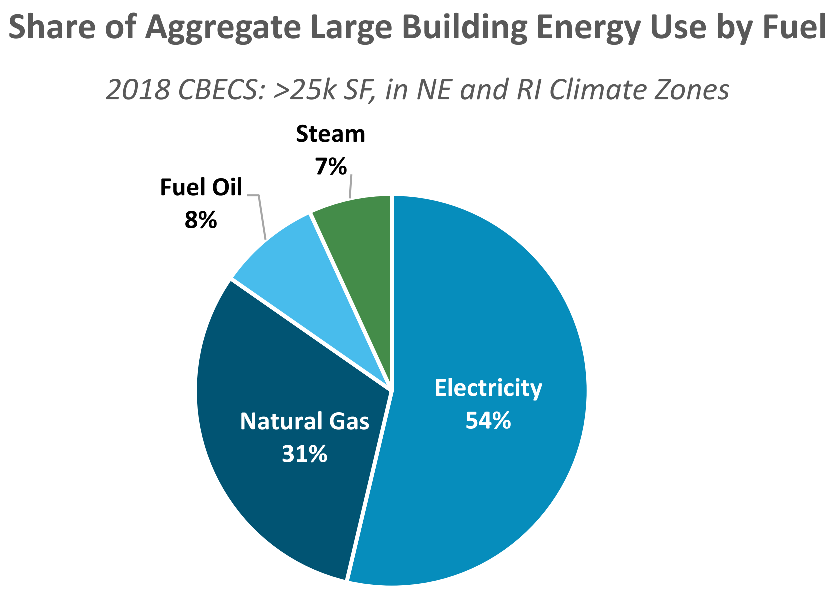

Figure 8: Share of Aggregate Large Building Energy Use by Fuel, 2018

Table 10: URI Municipal Energy Trends – Energy Sources for Buildings > 25,000 SF by Property Type, 2011-2015

Property Type	Count	Mean Annual Energy Use (kBtu)	Mean Share Elec.	Mean Share Gas	Mean Share Oil
Library	9	2,556,631	43%	57%	0%
Office	14	2,629,670	53%	45%	3%
Public Safety	8	3,939,417	50%	50%	0%
Public Works	7	6,105,902	59%	41%	0%
Recreation	5	6,960,117	34%	66%	0%
Senior Centers	2	2,868,068	32%	68%	0%
Grand Total	**45**	**3,880,410**	**48%**	**51%**	**1%**

Table 11: URI Municipal Energy Trends – Energy Sources for Buildings > 25,000 SF by Floor Area, 2011-2015

Floor Area (SF)	Count	Mean Total Energy Use (kBtu)	Mean Share Elec.	Mean Share Gas	Mean Share Oil
25,000 – 49,999	33	2,283,833	49%	50%	1%
50,000 – 74,999	7	8,536,166	54%	46%	0%
75,000 – 99,999	2	7,075,232	37%	63%	0%
100,000 – 124,999	2	6,963,674	12%	88%	0%
125,000 – 150,000	1	11,420,955	83%	17%	0%
Grand Total	**45**	**3,880,410**	**48%**	**51%**	**1%**

Table 12: Combined Heat and Power/District Heating Systems in Rhode Island[42]

System	Capacity (pounds per hour (pph))
Toray Plastics America, Inc	41,553 (based on annual generation)[43]
Rhode Island School of Design	64,000
Rhode Island College	81,500
Rhode Island Hospital	86,636
Brown University	275,458
University of Rhode Island	232,301*
John O. Pastore Campus	570,980

* Provided by URI, assuming 150 psig sat.

[42] International District Energy Association, "Map of District Energy in North America."
[43] US DOE New England CHP Technical Assistance Partnership, "Toray Plastics America: 7.5 MW and 12.5 MW CHP Systems."

Table 13: State Project Retrofit Costs

Building	Scope of Work	Square Footage	Capital Cost ($)	Cost Per SF ($)	Payback Period (yrs)
Maximum Security Prison and Admin Buildings	LED lighting retrofit with new controls systems	189,760	$815,285	$4	5
Powers Office Building	Replacement of pneumatic controls with electronic systems; refurbishment of auxiliary HVAC distribution system	250,708	$1,081,603	$4	18
Arrigan Rehab Center	Building energy management systems and controls improvements	35,400	$311,547	$9	10
Powers Office Building	Window replacement	250,708	$4,800,000	$19	
Eleanor Slater/Regan State Hospital	HVAC, plumbing, controls, lighting, some electrical systems, and accompanying architectural work	123,619	$28,100,000	$227	

Table 14: Staffing Needs of Precedent Building Performance Standard Programs

Jurisdiction	Policy	Status	Buildings Currently Subject to Benchmarking	Count Currently Subject to Benchmarking	Buildings Currently Subject to BPS	Count Currently Subject to BPS	Staff	Buildings per Staff
Boston, MA	BPS: Building Emissions Reduction and Disclosure Ordinance (BERDO)	Benchmarking Complete; BPS takes effect 2025 for >35 units or >35k SF[44]	Non-res 20k+ SF, MF 15+DU[45]	5,647 [46]			5	807
Washington State	BPS: Clean Buildings Performance Standard (CBPS)	Benchmarking Tier 1, BPS takes effect 2025 for >220k SF[47]	Tier 1: Non-res 50k+ SF[48]	8,452 [49]			15	563
District of Columbia	BPS: Building Energy Performance Standard (BEPS)	BPS Rollout in Progress – First Covered Year was 2021[50]	Public and Private 10k+ SF[51]	2,995 [52] (Public 10k+ SF and Private 25k+ SF only)	BPS Tier 1: Public 10k+ SF, Private 50k+ SF[53]	1,864 [54]	7	428
New York, NY	BPS: Local Law 97 (LL97)	BPS Rollout in Progress – First Covered Year is 2024	Private 25k+ SF	27,976 [55]	Private 25k+ SF Excluding Income Restricted and Rent Regulated	22,256 [56]	58 [57] (planned)	482
AVERAGE								**570**

[44] City of Boston, "Building Emissions Reduction and Disclosure."
[45] City of Boston.
[46] City of Boston, "BERDO Covered Buildings List."
[47] Washington State Department of Commerce, "CBPS Tier 1 Compliance."
[48] Washington State Department of Commerce.
[49] Washington State Department of Commerce, "Tier 1 Covered Buildings Dashboard."
[50] District of Columbia Department of Energy and the Environment, "What Is the Timeline of the BEPS Program?"
[51] District of Columbia Department of Energy and the Environment, "Is My Building Required to Benchmark?"
[52] DC Department of Energy and Environment, "Current Covered Buildings List."
[53] District of Columbia Department of Energy and the Environment, "Is My Building Subject to BEPS?"
[54] City of Washington, DC, "Building Energy Performance Dataset."
[55] City of New York, "LL97 All Properties CBL."
[56] City of New York, "LL97 2035 Income Restricted (§ 28-320.3.9) CBL"; City of New York, "LL97 2026 Rent Regulated (§ 28-320.3.10) CBL"; City of New York, "LL97 All Properties CBL."
[57] "City Triples Staff to Enforce Local Law 97 as First Deadline Looms."

Table 15: Estimated Yearly Budgets for Municipal and Private Program Development and Implementation Per Potential Timeline

			- STAFF -				- OTHER -	
Year	**Summary**	**Total**	**Manager**	**Analyst**	**Compliance**	**Compliance**	**Software**	**Accelerator**
1	Enacted; Hiring	$75,000	$37,500	$37,500				
2	Program development; Utility data access coordination; Municipal buildings begin tracking; Purchase covered buildings list*; Onboard compliance specialists; Notify private buildings; Regs drafted and finalized	$619,375	$153,750	$153,750	$153,750	$76,875	$81,250*	
3	Municipal reporting deadline; Private begin tracking	$682,906	$157,594	$157,594	$157,594	$157,594	$52,531	
4	All Buildings Reporting Yr 1	$699,979	$161,534	$161,534	$161,534	$161,534	$53,845	
5	All buildings reporting Yr 2; Accelerator launch; Targets set	$1,037,584	$165,572	$165,572	$165,572	$165,572	$55,191	$320,106
6	Improvement Yr 1	$1,391,632	$169,711	$169,711	$169,711	$169,711	$56,570	$656,217
7	Improvement Yr 2	$1,426,423	$173,954	$173,954	$173,954	$173,954	$57,985	$672,622
8	Improvement Yr 3	$1,462,083	$178,303	$178,303	$178,303	$178,303	$59,434	$689,438
9	Improvement Yr 4	$1,498,636	$182,760	$182,760	$182,760	$182,760	$60,920	$706,674
10	Targets take effect	$1,536,101	$187,329	$187,329	$187,329	$187,329	$62,443	$724,341
11	All buildings report Program Year 10 data; Compliance determined; Fines assessed	$1,574,504	$192,013	$192,013	$192,013	$192,013	$64,004	$742,449

Assumptions: 2.5% annual cost inflator after program year 1. Accelerator available to all buildings but used by only 25% each year ($1,000/building/year on average).

APPENDIX 2: EMISSIONS FROM LARGE BUILDINGS

Narrative: To estimate the emissions attributable to commercial buildings over 25,000 SF, we first estimate the aggregate fuel usage per square foot for large commercial buildings in Rhode Island and then apply emissions intensities to find the average emissions per square foot for the aggregate of these buildings. Lastly, we multiply this aggregate emissions intensity by the total floor area.

The CBECS does not provide state level data, so we instead subset to New England buildings that fell into one of Rhode Island's two climate zones at the time of the study (n = 122). Rhode Island included both "mixed mild" and "cool" areas under the climate zone map used by the 2018 CBECS.[58] For this subset of buildings, we sum the total site energy usage by fuel and divide by the total square footage to find the aggregate energy usage per square foot, by fuel, reported below in Table 16. We then apply the emissions factors by fuel to find the total average annual emissions intensity (per square foot) for the aggregate of the subset buildings.

Table 16: Aggregate Energy and Emissions Intensities by Fuel for 25,000+ SF New England Buildings in Rhode Island's Climate Zones, 2018 CBECS

	Average Annual Energy Intensity, Aggregate (kBtu/SF/Yr)[59]	**Emissions factor (kg CO2e/MBtu*)**	**Average Annual Emissions Intensity, Aggregate (CO2e/SF/Yr)**
RI Electricity, 2022	42.57	69.74**	2.97
Natural Gas	24.58	53.11[60]	1.31
Fuel Oil (No. 2)	6.71	74.2[61]	0.50
Steam	5.43	66.4[62]	0.36
Propane	N/A	66.4[63]	N/A
TOTAL	79.28		5.13

* Unless otherwise noted, MBtu = Million British Thermal Units

** DEM Calculation. Based on RI DEM 2022 non-biogenic electricity consumption emissions (including mandatory and voluntary purchases of Renewable Energy Certificates (RECS))[64] and 2022 NEPOOL GIS RI net energy for load, including behind-the-meter generation.

The total floor area of commercial buildings over 25,000 SF in the CoStar data set is 203,476,970 SF.[65] Therefore, the total CO2e emissions from these buildings is estimated to be 1.04 MMTCO2e/yr. The 2022 gross emissions were 10.35 MMTCO2e[66], so these buildings account for 10.09% of this total. Meanwhile, we previously estimated in section 1 that the building sector accounted for 49% of statewide gross emissions in

[58] ANSI/ASHRAE, "U.S. Climate Zones for 2018 CBECS."
[59] US Energy Information Administration, "Commercial Building Energy Consumption Survey Public Use Microdata."
[60] Energy Star, "Energy Star Portfolio Manager Technical Reference: Greenhouse Gas Emissions," fig. 1.
[61] Energy Star, fig. 1.
[62] Energy Star, fig. 3.
[63] Energy Star, fig. 1.
[64] Rhode Island Department of Environmental Management, "2022 Rhode Island Greenhouse Gas Inventory"; Rhode Island Public Utilities Commission, "Voluntary Renewable Energy Certificates and the Renewable Energy Standard," 9.
[65] National Renewable Energy Laboratory, "State and Local Planning for Energy (SLOPE): Building Area."
[66] Rhode Island Department of Environmental Management, "2022 Rhode Island Greenhouse Gas Inventory."

2022, or 5.08 MMTCO2e. Therefore, we estimate that these large buildings account for 20.56% of emissions from the building sector.

APPENDIX 3: BACKGROUND

Energy Benchmarking

Building energy benchmarking requires buildings over a certain size threshold to annually report their energy usage, which can include electricity, gas, delivered fuels, and steam. While benchmarking is a simple task in theory, the process of aggregating and reporting whole-building energy data can be burdensome, especially without assistance from electric and gas utilities. Utilities can assist in two respects: aggregating meter data to the building level for multi-tenant buildings, and automatically pushing monthly energy data to reporting software for all buildings. While this automated data push is extremely helpful to owners, the availability of aggregated building data is primary due to the time and effort required to manually collect tenant energy bills in accordance with tenant data-privacy protections. It would be essential for Rhode Island Energy to provide both aggregation and automation services to covered customers, while it could be helpful if Clear River Electric and Water District (formerly Pascoag Utility District) and Block Island Utility District could at least manually provide aggregated whole-building energy data in a usable format to the few covered buildings among their combined 7,000 electric customers.[67]

Providing building owners with the ability to aggregate meters while excluding some other (e.g., separately metered EV chargers, on-site parking garages, etc.) and update this meter-to-building mapping over time is essential. However, regulator verification of the accuracy of the meter-to-building rollup process through "itemized receipts" of both the included and excluded meters will be necessary to ensure that bad-actors cannot inappropriately exclude meters from their aggregate consumption. While Rhode Island Energy currently provides aggregated whole-building electricity and gas usage data upon request to commercial, industrial, and multifamily building owners, including for multi-tenant buildings with at least four tenants, building out meter-to-building mapping for over 2,000 estimated covered buildings would be a time-intensive process.[68] Though there may be some multitenant buildings over 25,000 ft with fewer than four tenants, the effort of collecting data in accordance with privacy requirements for just three units is relatively small. Because Rhode Island Energy is currently in the process of building out their data access capabilities, there is an opportunity to collaborate on building a system that would support the need for verifiable and updatable meter-to-building mapping. It is important to note that building energy benchmarking should not be conflated with Advanced Metering Infrastructure, which has already been adopted by Block Island Utility District and will soon be adopted by Rhode Island Energy and Clear River Electric and Water District. These new meters and associated software provide utilities real-time insight into electricity usage and outages and thus usage data on a fine timescale, which could enable time-of-use rates in the future. However, the availability of more precise energy usage data does not necessarily assist with building benchmarking efforts, as benchmarking can be completed with monthly data. However, the metadata collected during the meter replacement process (including information on meter location and loads served) as well as the software systems associated with them could greatly assist with meter-to-building mapping.

As for automating the data linkage, Rhode Island Energy previously relied on National Grid's systems to push data to Energy Star Portfolio Manager and is now in the process of creating their own backend linkage. Until the new automated solution comes online (likely in 2025), Rhode Island Energy will continue to manually provide customers with aggregate building data. This manual process is inconvenient and makes it more difficult for building owners to easily and accurately report building energy usage data. Benchmarking is almost universally carried out through the U.S. Environmental Protection Agency's (EPA) free online software, Energy Star Portfolio Manager (PM). This tool allows building owners to input non-energy characteristics about their building, import data manually or via integrations with utilities, and share data with other software and partners. Once a property owner has gathered whole-building aggregated energy data and accurate building meta-data, it

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[67] Block Island Power Company, "About"; Pascoag Utility District, "Homepage."

[68] Energy Star, "Utilities Providing Energy Data for Benchmarking in ENERGY STAR Portfolio Manager (Map)."

should take no more than a couple hours to initially set up a building in Portfolio Manager. In practice, this initial reporting process tends to be time-consuming, especially for owners of many buildings. Owners must first verify their buildings' square footage to determine regulatory applicability, and then develop a list of associated meters for each covered building for input into Portfolio Manager. They would then need to either manually or digitally through Portfolio Manager request these data from utilities, while also collecting any bills for delivered fuels and/or steam. As there are many opportunities for error during this process (e.g., incorrect building square footage, missing a meter, forgetting about a backup generator), some jurisdictions require owners to obtain third-party verification of their benchmarking data at regular intervals. Once this initial setup is complete, manually inputting energy usage monthly should take no more than 20 minutes per building, while utility integration can either reduce or fully eliminate this process. The Portfolio Manager system is currently being overhauled to better support building owners in their compliance with benchmarking and performance standard programs.

Building Performance Standards

Benchmarking can inform the design of a building performance standard (BPS) program, which regulates building energy usage through mandatory EUI or emissions targets for large buildings. BPS programs typically set performance targets by property type that become more stringent every five years, sometimes in alignment with goals to reach net-zero by 2050 (e.g., US Federal BPS, Seattle, Boston, and New Yok City).[69] While performance standards require substantial investments of staff and budgetary resources to implement effectively, they have become an increasingly utilized policy tool for reducing the GHG emissions of existing building stocks in-line with climate goals.

To support jurisdictions in their implementation of Performance Standards, the U.S. Department of Energy (DOE) developed the Standard Energy Efficiency Data (SEED) platform that allows for streamlined administration of both benchmarking and performance standards. This software is designed to manage multiple data sources and types (including Portfolio Manager and spreadsheets), track compliance, and report on program key performance indicators. Jurisdictions can choose to self-host their own instance of SEED or contract with a third-party that handles hosting. Unlike Portfolio Manager, SEED is an open-source software. A more expensive software offering called Building Energy Analysis Manager (BEAM) is based on the open-source SEED platform, but offers additional functionality, especially for customer relationship management and external reporting. While neither SEED nor BEAM are as much of an industry standard for performance standards as Portfolio Manager is for benchmarking, at least 16 jurisdictions were using either SEED or BEAM as of 2023. Many benchmarking-only programs use SEED, while jurisdictions implementing building performance standards are increasingly using BEAM because of its superior compliance-management functionality over SEED and price favorability over custom-built software.

Nationally, Washington, Colorado, Oregon, and Maryland have enacted statewide performance standards, while Boston, New York, and Washington DC offer local case studies of municipal/district performance standard programs. As of October 2024, no municipality in the state has a performance standard program.

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[69] Hinge and Nadel, "Mandatory Building Performance Standards: A Key Policy for Achieving Climate Goals," 49, 54, 65; City of New York, "LL97 Greenhouse Gas Emissions Reduction."

Linking Energy to Emissions

A typical building uses a fossil fuel for both space and water heating, and electricity for cooling, appliances, and plug loads. While electricity usage by buildings does account for an estimated 14% of statewide emissions, these emissions can be reduced on the supply side through cleaner electricity generation. Notably, Rhode Island's Renewable Energy Standard (RES) requires that "one hundred percent (100%) of Rhode Island's electricity demand is from renewable energy by 2033 and each year thereafter."[70] As such, the challenge with buildings is to reduce or eliminate the emissions from the onsite combustion of fossil fuels for space and water heating by electrifying these end-uses of energy.

Total emissions are based on both the amount of each fuel used and its emissions intensity (the emissions associated with using a unit of energy on site).

Holding a fuel type constant, building owners can reduce their emissions by upgrading to more efficient heating equipment that uses the same fuel. Because they are still using the same fuel after the upgrade, their emissions reduction is directly proportional to their energy savings from the more efficient equipment. Table 17 reports illustrative space heating equipment efficiencies.

Table 17: Efficiencies of Illustrative Space Heating Equipment

Equipment	Less Efficient	More Efficient
Electric Resistance	100%	
Electric Air-Source Heat Pump	230%	300%
Fossil-Fuel Boiler/Furnace	80%	90%

Building owners can also reduce their emissions by switching to a lower-emissions fuel. While the emissions intensities of natural gas, oil, and propane are constants, the emissions intensity of electricity depends on how it was generated. 100% renewable electricity has zero associated emissions, while electricity generated by fossil fuel plants have substantial associated emissions. The annual emissions intensity of electricity in Rhode Island varies based on the mix of generating resources on the ISO-NE (Independent System Operator – New England) grid, Rhode Island energy suppliers' compliance with the state's Renewable Energy Standard (RES), and generation from behind-the-meter clean energy (like rooftop solar). As shown in Table 16 in Appendix 2, holding the efficiency of a fossil-fuel boiler or furnace constant, using natural gas will result in lower emissions than either propane or oil. Alternatively, switching from grid electricity to 50% renewable electricity while using a heat pump will reduce emissions.

However, to evaluate the emissions implications of switching from fossil-fuel heating to electric heating, both the relative efficiencies of the heating equipment and the relative emissions factors of the fuels must be considered. As of 2022, the average emissions intensity of electricity in Rhode Island was 31% higher than that of natural gas and 13% higher than propane, but 6% lower than oil.[71] Yet at the same time, even an illustrative lower-efficiency electric heat pump is 156% more efficient than an illustrative higher efficiency boiler. Therefore, the overall emissions from using a heat pump with grid electricity are lower than using a fossil-fuel boiler furnace. While these numbers are purely illustrative, Figure 9 reports the annual space

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[70] The State of Rhode Island, Renewable Energy Standard, sec. 4.

[71] *Although the RES in 2022 required that 20.5% of electricity retail sales to be met with renewable electricity, the overall emissions intensity of electricity was still higher than natural gas (the primary fuel used to generate electricity) due to the substantial heat losses that occur during electricity generation. For instance, even the newest combined cycle power plants built between 2010 and 2022 still have an average efficiency of just 49%, while new natural gas boilers and furnaces have efficiencies over 90%. Morey and Aramayo, "Natural Gas Combined-Cycle Power Plants Increased Utilization with Improved Technology."*

heating emissions associated with the average Rhode Island residential heating load, subset by heating system type (fuel and equipment).

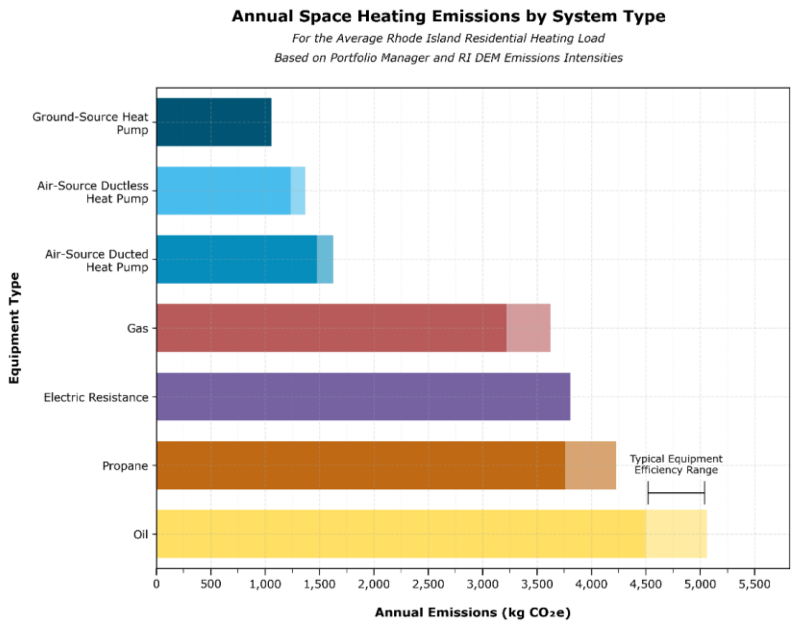

Figure 9: Annual Space Heating Emissions by System Type

While using inefficient electric resistance heating results in comparable emissions to fossil-fuel based heating systems, the average Energy-Star listed standard (not cold climate) ducted heat pump results in half the emissions of an efficient gas boiler. Moreover, the average Energy-Star listed cold-climate ductless heat pump results in just 38% of the emissions of an efficient gas boiler and merely 24% of the emissions from an inefficient oil boiler. For an explanation of these calculations and a detailed table, see Appendix 2.

While these data are for residential space-heating systems, the underlying physics and emissions results generally apply to commercial buildings and water-heating systems as well.

Metrics

As discussed above, emissions are determined both by amount of fuel used and its emissions intensity. While the emissions intensity of fossil fuels are constants, the emissions intensity of electricity varies by source (e.g., rooftop solar vs grid purchases) and can change over time as the grid decarbonizes. Therefore, calculating scope 1 and 2 building energy emissions requires data on the emissions intensity of the building's electricity supply. As such building-specific data are largely not available, this report deals principally with energy usage data. Site Energy Use Intensity (EUI) is the most common unit for building energy reporting, in part because it is a relatively simply and relevant unit of account for building owners. Site EUI includes only the energy that was consumed onsite – including fuels, electricity, steam, and more. In contrast, Source EUI includes the energy lost through the generation and distribution of electricity and/or steam and is used in calculating Energy Star scores.[72] Typically, site EUI is weather-normalized to account for year-to-year variations in average temperatures that would otherwise confound timeseries results.

[72] US Environmental Protection Agency, "Understanding and Choosing Metrics for Building Performance Standards," 35.

However, performance standards (and benchmarking in support of performance standards) often are based on emissions. Because the effective emissions intensity of electricity in Rhode Island will change over time as the grid decarbonizes, pre-determining the maximum electricity emissions factors for each year or compliance period would allow owners to make informed decisions about building upgrades. Boston provides such an assurance policy by allowing owners to use the published projected grid emissions factor if the actual factor for that year is higher than the projected factor, thus insulating them from a slow-to-decarbonize grid while allowing them to benefit from a fast-to-decarbonize grid.[73] While a building owner may prefer to calculate their building's emissions based on the emissions factor of their actual purchased or generated electricity, allowing owners to use their own specific electricity emissions factor increases regulatory complexity and could even disincentivize energy-efficiency improvements (by allowing building owners to reduce their emissions through offsite renewable power purchases). As such, the same effective Rhode Island electricity emissions intensity should be used in calculating building emissions across all buildings, regardless of their actual electricity emissions.

Green Buildings Act

The Green Buildings Act requires all new construction and renovation projects of state facilities and state-funded school projects larger than 10,000 SF of finished space to be constructed to at least the LEED, LEED for neighborhood development, or SITES green building standards. Compared to a statewide building performance standard program for over 2,000 existing large buildings, this act has a similar goal of decarbonizing the built environment but has a considerably smaller scope and expected impact.[74]

[73] City of Boston, "BERDO Policies and Procedures, Version 2.5," 20.
[74] The State of Rhode Island, The Green Buildings Act, sec. 4.

APPENDIX 4: RESIDENTIAL SPACE HEATING EMISSIONS

Narrative:

1. We calculate the weighted average space-heating efficiency for Rhode Island based on the 2018 Residential Appliance Saturation Survey.
2. We extract the average Rhode Island residential space heating energy consumption from the 2020 RECS microdata, to which we apply the average space-heating equipment efficiency for RI to find the average RI space heating load. We construct this average heating load rather than using the underlying RECS data on energy usage for space heating by equipment type, filtered by primary heating fuel, because of the small number of RI data points within each of these subsets and incomplete data caused by reporting (and use) of more than one space heating source (especially for heat-pumps).
3. We calculate the annual operational emissions of various heating system types meeting this average heating load based on reported emissions intensities.

Part 1

Table 18: Rhode Island Space Heating Efficiencies, 2018

Heating System	Customers[75]	Efficiency[76]	Weighted Efficiency
Natural Gas			
Boiler	37%	83.20	30.78
Furnace	23%	82.90	19.07
Fuel Oil			
Boiler	28%	83.50	23.38
Furnace	6%	80.70	4.84
Electric			
Space heater	13%	1.00	0.13
Electric baseboard	11%	100.00	11.00
Central air source heat pump	3%	281.36	8.44
Ductless	2%	325.32	6.51
MSHP			0.00
Ground source heat pumps	1%	470.00	4.70
Propane			
Furnace	2%	N/A	
Boiler	<1%	N/A	
Other			
Fireplace or heating stove	5%	N/A	
% Customers With Efficiency Data	**124%**		
Weighted-Average Heating Equipment Efficiency			**87.78**

[75] NMR Group, "National Grid Rhode Island Residential Appliance Saturation Survey Report," tbl. 4.
[76] NMR Group, tbl. 6.

Part 2

Average annual Rhode Island space heating consumption across all housing types: 62.16 MBtu[77]

For reference, the average residential square footage is 1,675 SF, across all housing types.[78]

Therefore, the average annual Rhode Island space heating load across all housing types is: 54.56 MBtu.

Part 3

Table 19: Equipment Efficiency, Energy Usage, Fuel Usage, and Emissions of Residential Space Heating Equipment

Fuel Type	Fuel Unit	Space Heating Appliance Type	Type of Effic. Rating	Effic. Rating	Effic. %	Average Space Heating Energy Use (MBtu)	Average Space Heating Fuel Use (Units Vary)	Emissions Factor (kgCO2e/ MBtu)	Average Space Heating Emissions (kg CO2e)
Elec	**kWh**	Baseboard/Room Heater	**Estimate**	100.0	100%	55	15,992	70	3,805
Elec	**kWh**	CC Ducted ASHP	**HSPF2**	8.8	258%	21	6,201	70	1,475
Elec	**kWh**	CC Ductless ASHP	**HSPF2**	10.5	308%	18	5,192	70	1,235
Elec	**kWh**	Closed W-A GSHP	**COP**	3.6	360%	15	4,442	70	1,057
Elec	**kWh**	Ducted ASHP	**HSPF2**	8.0	234%	23	6,829	70	1,625
Elec	**kWh**	Ductless ASHP	**HSPF2**	9.5	278%	20	5,750	70	1,368
Gas	**Therm**	Furnace or Boiler	**AFUE**	80.0	80%	68	682	53	3,622
Gas	**Therm**	Furnace or Boiler	**AFUE**	90.0	90%	61	606	53	3,220
Oil	**Gallon**	Furnace or Boiler	**AFUE**	80.0	80%	68	492	74	5,061
Oil	**Gallon**	Furnace or Boiler	**AFUE**	90.0	90%	61	437	74	4,499
Propane	**Gallon**	Furnace or Boiler	**AFUE**	80.0	80%	68	747	62	4,225
Propane	**Gallon**	Furnace or Boiler	**AFUE**	90.0	90%	61	664	62	3,756

Unless otherwise noted, efficiency values are based on an EIA workbook[79]

ASHP efficiency data are the average for that product class, as listed in the Energy Star database.[80]

The GSHP efficiency is the ENERGY STAR 2024 most efficient threshold.[81]

Emissions factors are the same as those reported in Table 16 in Appendix 2.

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[77] US Energy Information Administration, "Residential Energy Consumption Survey Public Use Microdata."
[78] US Energy Information Administration.
[79] Adams Air, "Understanding HSPF (Heating Seasonal Performance Factor)."
[80] US Environmental Protection Agency, "ENERGY STAR Certified Air-Source Heat Pumps."
[81] US Environmental Protection Agency, "ENERGY STAR Most Efficient Final Criteria 2024," October 5, 2023, 6.

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