MAYOR BRETT P. SMILEY
CITY OF PROVIDENCE

An Energy Efficiency and Carbon Neutral Plan for Providence Municipal Buildings

2026 Decarbonization Roadmap

City of Providence

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PowerOptions

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MAYOR BRETT P. SMILEY
CITY OF PROVIDENCE

LETTER TO THE COMMUNITY

Since my first day in office, I have focused on strengthening economic, health and environmental benefits for all Providence residents. Investing in public spaces and infrastructure that prioritizes climate resiliency remains one of my Administration's cornerstones to improve quality of life in the City of Providence.

Energy use in our buildings across the City account for most of the carbon pollution that impacts our community's health. This is why I proudly signed the Energy Efficiency and Carbon Neutral Goals for Municipal Buildings Ordinance into law two years ago, marking a historic commitment by Providence to lead by example in phasing out fossil fuels from all municipal buildings by 2040.

In two short years, we have made significant progress towards making our municipal buildings cleaner, greener and more climate resilient. Our concrete steps towards this goal have resulted in 19 building electrification projects, 80 energy efficiency improvements and audits and 4 planned solar installations, capturing energy utility savings and creating revenue that can be reinvested into new clean energy projects.

Working with PowerOptions, a nonprofit energy consortium, we have developed the 2026 Decarbonization Roadmap that evaluates cost-effective strategies to de-carbonize 130 city-owned facilities while maintaining reliable public services and supporting long-term capital planning. It provides a framework to guide energy efficiency, electrification, and carbon reduction investment decisions, informing the prioritization of municipal building capital improvements.

Investing in our buildings is also investing in the economic prosperity of our communities and in family-sustaining green union jobs and apprenticeship opportunities.

This roadmap puts Providence on a path to strategically and cost-effectively achieve the ambitious and attainable goal of eliminating on-site fossil fuel use in municipal buildings over the next 14 years, while also creating a plan for maximizing energy efficiency measures and energy savings opportunities.

More than ever, as federal programs and clean energy incentives are being scaled back, the leadership of municipalities like our Capital City are needed to prepare our buildings for the 21st century with clean energy technologies to ensure a sustainable and climate resilient future for our communities

Sincerely,

Brett P. Smiley

Mayor Brett P. Smiley

Executive Summary

Meeting an Ambitious Carbon Neutral Goal

In Providence, most carbon emissions come from our buildings. Reducing these emissions will provide significant impact for our city. Energy use in our buildings contributes to climate pollution and impacts quality of life for our residents. Anchored on the goals of the Climate Justice Plan, Mayor Smiley signed into law the Energy Efficiency and Carbon Neutral Goals for Municipal Buildings Ordinance in March 2024. This commitment to lead by example in phasing out fossil fuels from all municipal buildings by 2040 marked a historic commitment by Providence to unlock the economic, health and environmental benefits of improving our public buildings.

Providence's commitment to achieving carbon neutrality in all city-owned buildings by 2040 also recognized the importance of ensuring a just and equitable transition away from fossil fuels by sustaining and creating green union jobs. While the City of Providence continues to prepare its buildings to be more resilient in the face of a changing climate, federal programs and clean energy incentives are being scaled back. For the city, this current reality results in the urgent need to advance clean energy projects diligently, strategically, and even more cost-effectively. The investments we can make today will safeguard the resiliency of our community centered spaces, including schools and recreation centers, the prosperity of our local economy, and the path to energy affordability by changing how we power, heat, cool, and operate our municipal buildings.

Creating an Energy Efficiency and Carbon Neutral Plan for Municipal Buildings

The City of Providence developed this Decarbonization Roadmap for municipal buildings to advance the lead by example goals of its Climate Justice Plan and to establish a clear pathway for reducing greenhouse gas (GHG) emissions from municipal buildings. The roadmap evaluates cost-effective strategies to decarbonize 130 city-owned facilities while maintaining reliable public services and supporting long-term capital planning. It provides a framework to guide investment decisions and inform prioritization of projects as Providence works toward eliminating on-site fossil fuel use in municipal buildings by 2040.

The roadmap focuses on three decarbonization strategies: energy efficiency, electrification, and on-site solar photovoltaics. Energy efficiency measures reduce overall energy use, and therefore costs, through upgrades such as improved lighting, building envelope, and operational controls. Electrification replaces fossil fuel powered equipment with high-efficiency electric technologies, specifically heat pumps, that can operate on New England's increasingly renewable electric grid. On-site solar systems further reduce emissions and operating costs by supplying clean electricity directly to municipal facilities.

The total estimated investment identified in this roadmap is close to $61 million, reflecting equipment and installation costs associated with energy efficiency, electrification, and on-site solar measures. The roadmap also identifies available utility, state and federal incentives, resulting in reducing the upfront estimated net cost to $54 million. These incentives significantly improve project economics and support implementation. The implementation of the measures outlined in this roadmap could save the city up to $12 million by 2040 (Figure 4).

The costs presented in this roadmap do not include electrical service upgrades, major building renovations, or other infrastructure improvements that may be required to fully electrify certain facilities. As a result, the estimates represent a partial scope of costs and should not be interpreted as the full capital investment needed to electrify all municipal buildings.

There are also options available to finance the implementation of this roadmap. These include capital planning, coordination with scheduled equipment replacements, and the use of available incentives to further reduce net project costs. The city may also pursue alternative delivery models, such as performance contracting or an as-a-service model, which allows projects to be implemented with little or no upfront capital through a service-based payment structure. Together, these approaches allow for emissions reductions while maintaining fiscal responsibility.

By 2040, the roadmap is projected to eliminate fossil fuel use and reduce municipal building emissions by 80%.[1] These reductions position Providence to meet climate commitments and deliver long-term financial, environmental, and public health benefits for residents.

Progress to date: Investments and Cost-Savings Achieved Since 2024

22 Building Electrification Projects have either been completed or are currently under construction. Since 2024, 1.2 million square feet or 22% of the city's building portfolio has been built new or will be updated with heat pump technology by 2028.

Energy efficiency projects and audits have touched more than 60 buildings over the past two years and have resulted in $3.2 million in utility incentives for lighting, HVAC, and building management system upgrades.

Retro Commissioning (RCx) with assistance from RI Energy and the Rhode Island Department of Education (RIDE) Healthy Environments Advance Learning (HEAL) Program, 18 Providence school buildings have undergone RCx audits to identify energy and cost savings opportunities. Retro commissioning, the tuning up existing mechanical systems will play an important and reoccurring role in the city's efforts to reach its decarbonization goals.

[1] Compared to the City's Calendar Year 2024 baseline emissions and exclusive of Renewable Energy Certificates (RECs).

On-Site Renewable Energy roof top solar assessments have been conducted for all municipal buildings. 62 facilities and two parking lots have been identified as possible solar candidates with the potential to generate 13 million kilowatt-hours (kWh) of electricity, more than 40% of the current annual electrical consumption of the city's buildings and save up to $2.5 million annually. Installations are planned at four facilities during calendar year 2026.

Off-Site Renewable Energy has been part of the Providence energy mix since 2019. Annually, the city receives 29 million kWh of virtual net metering credits which reduce energy expenditure by $1.5 million per year and supports the creation of new renewable energy projects. Starting in 2029, the city will retain the environmental attributes generated by this renewable energy system and can use them to meet its building decarbonization and clean energy goals.

Implementation of the Energy Intelligence Suite (EIS) for strategic energy management. PowerOptions' Energy Intelligence Suite (EIS) brought the city's energy management into the 21st century by revamping utility bill tracking and payments for nearly 800 electric and gas accounts and performing better energy data analytics for municipal-owned buildings and streetlights. PowerOptions used data from EIS to develop the decarbonization roadmap and will remain a strategic tool to track and meet the city's energy goals.

Energy benchmarking shows that building energy use is trending down. Over the past four years total energy use in the city's buildings has decreased by 7%. And as would be expected with any decarbonization effort, natural gas usage has decreased by 15% while electricity usage has increased by 10%. As Providence removes fossil fueled energy systems from its buildings and replaces them with dramatically more efficient electric energy systems, total energy use will continue to decline.

Preparing for the next phase and achieving the 2040 Goal

This decarbonization roadmap comprehensively assesses and guides how 130 municipal buildings can be made more energy efficient and eventually be carbon neutral by 2040 where the design, construction, and operations do not contribute to a building emitting greenhouse gas that cause climate change.

The analysis in this roadmap will be updated yearly to report on: the prioritization and progress of projects; the latest investment cost estimates; energy savings from avoided costs; and secured federal, state, and utility incentives and rebates factored into return on investments; the latest improvements in technology and feasibility studies conducted to explore technologies, such as heating districts or thermal energy networks; and, begin to track jobs that are created or sustained by project investments.

The carbon neutral ordinance also calls for the implementation of cost-effective energy efficiency and clean energy projects. And while the efficiency, electrification, and renewable energy recommendations found within this roadmap move from concept to construction, the

project management and operational experience gained from the 22-electrification projects referenced above, coupled with an existing Strategic Energy Management Partnership (SEMP) agreement between the city and RI Energy that provides technical and financial support to develop these projects, the city can move forward with confidence that it will continue to deploy technologies that will save energy and emission and provide more insight into how much savings are possible in the future.

Additionally, to achieve both innovation and economies of scale, the city is looking to create public and private partnerships and identify new funding and financing mechanisms to advance more projects and allocate capital improvement dollars more strategically to better integrate building electrification with our municipal fleet transition to electric vehicles and charging infrastructure expansion.

Introduction

Climate Justice and Clean Energy in the City of Providence

The City of Providence, Rhode Island (Providence) launched their Climate Justice Plan in 2019, which advocates for a fair and equitable strategy to move the city away from reliance on fossil fuels. The plan focuses on seven key sections: Lead by Example, Collaborative Governance and Accountability, Housing and Buildings, Community Health, Local and Regenerative Economy, Clean Energy, and Transportation. To help advance the Lead by Example, Housing and Buildings component, and Clean Energy components of the Plan, PowerOptions with the city, developed this Building Decarbonization Roadmap for reducing greenhouse gas (GHG) emissions from 130 of the existing buildings owned by Providence. Based on our analysis, Providence can cost-effectively reduce its Scope 1 building-related emissions to net zero by 2040 and reach their emissions reductions goals.

In 2021, the state enacted the Act on Climate, making carbon emission reductions mandatory and binding economy wide. Shortly after this climate legislative landmark in the Ocean State, the state updated its Renewable Energy Standard (RES) to require that 100% of Rhode Island's electricity come from renewable sources by 2033, which is one of the most ambitious renewable electricity mandates in the United States. The RES establishes the mandatory targets for the proportion of electricity supplied from renewable sources such as solar, wind, and small hydroelectric generation. This statewide requirement creates a regulatory and economic environment that directly enables the City of Providence to advance its own municipal building decarbonization goals, including the city's commitment to eliminate fossil fuel use in all municipal facilities by 2040.

The emissions factors used in this roadmap to estimate Scope 2 electricity emissions are based exclusively on projected New England grid-average emissions factors and do not reflect Rhode Island's RES. For reference, the Appendix Table 33 includes a comparative table summarizing both the grid-only emissions factors and an alternative RES-adjusted scenario, which depicts electricity-related emissions declining to zero beginning in 2033 under the RES requirements.

In addition, Providence's ORD-2023-35 Chapter 5, Article X - Building Energy Reporting Program (BERO) and ORD-2024-3 Chapter 5, Article X - Energy Efficiency and Carbon Neutral Goals for Municipal Buildings (Decarb Ordinance) work together to accelerate the decarbonization of municipal facilities by establishing both the data infrastructure and the performance requirements needed to meet them. BERO requires systematic benchmarking and public reporting of municipal building energy consumption, enabling the city to track progress, identify underperforming facilities, and prioritize investments in electrification and efficiency upgrades. In 2024, the city successfully reported energy usage for all occupied and operated city-owned buildings 10,000 square feet and above, achieving full compliance and setting a strong energy benchmarking baseline for our carbon neutrality goals for municipal buildings. The Decarb Ordinance mandates that all municipal buildings eliminate on site

fossil fuel use by 2040, pushing the city toward prompt electrification, improved efficiency, and carbon neutral operations. Together, these ordinances create a regulatory framework that support Providence's long-term strategy to fully decarbonize municipal buildings, ensuring alignment with state climate mandates and the city's broader Climate Justice Plan.

The alignment between these ordinances, Rhode Island's RES, and Providence's municipal building goals demonstrates a multi-level governance approach to climate action. The state provides the regulatory framework and clean energy supply, while the city implements localized measures such as building electrification, energy efficiency retrofits, and carbon-neutral procurement policies. This synergy ensures that by the time Providence achieves full electrification of its municipal buildings by 2040, the electricity powering those facilities will already be fully renewable.

Providence has implemented several measures and projects relating to environmental justice, energy efficiency, conservation, and building and fleet infrastructure, all of which are discussed throughout this roadmap. Although the city has been successful in reducing energy consumption and GHG emissions, the 130 buildings and 5,265,809 square feet owned and operated by the City of Providence emit over 19,500 metric tons of carbon dioxide equivalent (MT CO_2e) annually.[2] The responsibility to decarbonize this developed space falls on the four City of Providence administrative divisions that maintain the city's buildings: Public Property, Providence Public School District, Parks and the Roger Williams Park Zoo. To help address the challenges of electrifying and decarbonizing each of these individual portfolio's, PowerOptions, in consultation with the city, developed this Building Decarbonization Roadmap for reducing greenhouse gas (GHG) emissions for each of these divisions.

This roadmap evaluates the following strategies to decarbonize those facilities owned by the city and that use fossil fuels: energy efficiency, electrification (fuel-switching away from fossil fuels to electric alternatives), on-site solar photovoltaics, and Renewable Energy Certificates. PowerOptions used a combination of an in-house economic model, an open-source virtual energy efficiency audit tool, and solar software to produce this roadmap. This analysis also considers that the city is projected to take ownership of approximately 29 million kWh of off-site Renewable Energy Certificates (RECs) beginning in 2029. The off-site renewable energy agreement is expected to provide more than $1 million in annual value and may result in offsetting the city's electricity-based emissions by 100% by 2040. Having this contract in place offers flexibility to the city as it increases its electric load due to fuel-switching away from fossil fuels.

The City of Providence Building Portfolio

The City of Providence portfolio from Calendar Year 2024 includes 130 buildings and approximately 5,265,809 square feet of conditioned space. In alignment with the reporting protocols of the Building Energy Reporting (BERO) program, only those buildings that were

[2] These values reflect the City's energy consumption from January – December of 2024.

occupied and operational for the full 12 months of the calendar year were included in the decarbonization analysis. In future years, as buildings cycle in and out of service, the roadmap will be updated to include those buildings' electrification and decarbonization needs.

As stated earlier, the portfolio is spread across four semi-autonomous administrative divisions, each with separate budgets and staff that work to maintain and improve their respective facilities. The four divisions include: Public Property, Providence Public School District (PPSD), Parks, and the Roger Williams Park Zoo (RWP Zoo). This roadmap will first provide a summary of all the City of Providence holdings , then, a separate, detailed analysis of the decarbonization and electrification strategies for each of the four divisions will be described in each section.

Presented below in Table 1 is a summary of the city's portfolio broken down by administrative division. With PPSD accounting for 80% of the square footage and 73% of the GHG emissions, success in meeting the 2040 building decarbonization goals will depend on how the city modernizes its school buildings.

Table 1. The City of Providence's building portfolio, summarized by administrative division.

City of Providence Building Portfolio						
Administrative Division	**Building Count**		**Building Size**		**GHG Emissions (CY24)**	
	Count	**Percentage**	**Square Feet**	**Percentage**	**MTCO₂e**	**Percentage**
Public Property	34	26%	695,205	13.20%	2,790	14%
Providence Public School District	38	29%	4,210,907	79.97%	14,248	73%
Parks	14	11%	210,419	4.00%	1,086	6%
Roger Williams Park Zoo	44	34%	149,278	2.83%	1,388	7%
Total	**130**	**100%**	**5,265,809**	**100%**	**19,512**	**100%**

At this time the portfolio summary does not include 15 leased or recently acquired properties. Insufficient 2024 calendar year utility data prevented this additional 240,000 square feet to be included in this release of the roadmap. Future releases and updates to the roadmap will include these properties and any additional acquisitions.

Summary of Findings

This roadmap is estimated to reduce Providence's GHG emissions by over 150,000 MT CO_2e cumulatively through 2040 (Figure 1), lowering each division's Energy Use Intensity (EUI) by at least 50%. Not only could the city meet its Housing and Buildings goals, but it could also save up to $12 million on energy costs in the process.

Fossil fuels accounted for about 60% of the city's GHG emissions in 2024. The Hope High School, Central & Classical High School, Providence Career and Technical Academy, Nathanael Greene Middle School, and Public Safety Complex were the top five contributors of GHG emissions in 2024 (Table 3). These five buildings accounted for 25% of the city's total fossil fuel emissions and should be prioritized for decarbonization. While an emissions focused worst-to-first approach to decarbonization may be intuitive, many factors must be considered when developing a

Roadmap Timeline (Table 4). The age of the existing heating, ventilation, and air condition (HVAC) equipment, the source of the emissions, expected technological advancements, available funding, and unexpected situations that require immediate HVAC equipment replacement, all play a role in determining when decarbonization projects could occur.

The city has already begun to incorporate energy reduction planning and electrification into its capital improvement projects and through Rebuild PVD Schools, a plan for the largest portfolio of GHG emitting properties has been developed, which is already in the implementation stage (Table 2). A summary of the planned projects and those currently under construction are provided in the individual sections that follow.

Table 2. Planned decarbonization projects at buildings owned by City of Providence, RI.

Administrative Division	Planned Decarbonization Project(s)
Public Property	10 projects totaling 182,000 sq. ft. 3 solar installations totaling 356 kW
Providence Public School Department	20 planned renovations totaling 2.8M sq. ft. 7 electrification projects totaling 845,000 sq. ft.
Parks	3 electrification projects totaling 27,000 sq. ft. 1 solar installation totaling 110.9 kW
Roger Williams Park Zoo	1 electrification project totaling 13,469 sq. ft.

The roadmap aims to take these planned projects into consideration when suggesting decarbonization measures. Figure 1 compares emissions under three scenarios: a "no decarbonization" scenario, the roadmap's "decarbonization without RECs" scenario, and a "decarbonization with RECs" scenario.

The scenario without RECs assumes that all proposed energy efficiency, electrification, and on-site solar measures are fully implemented. The scenario with RECs assumes the same measures are implemented, with the additional inclusion of Providence's REC ownership beginning in 2029.

To estimate Scope 2 electricity emissions, this roadmap uses projected New England grid-average emissions factors. These projections do not account for Rhode Island's Renewable Energy Standard (RES). For reference, Appendix Table 33 provides a comparison of grid-only emissions factors and an alternative RES-adjusted scenario. Under the RES-adjusted scenario, electricity-related emissions decline to zero beginning in 2033 in accordance with RES requirements.

Figure 1. CO_2e emissions from the City of Providence municipal buildings, by scenario, 2024-2040.

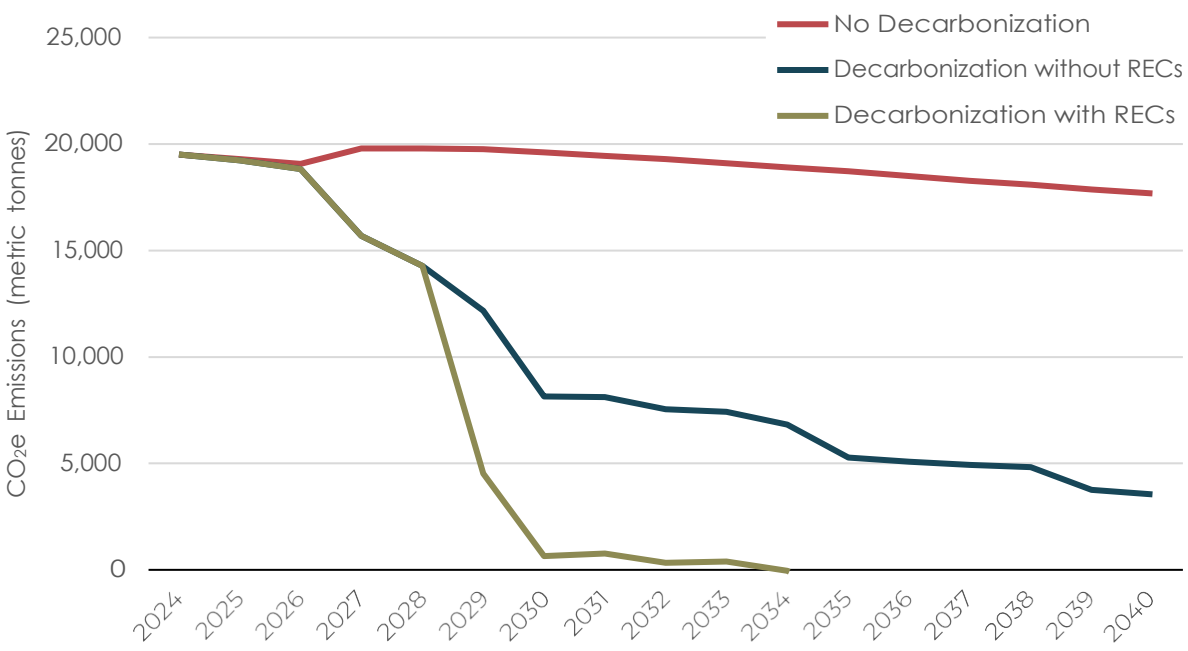


Table 3. City of Providence's comprehensive building list, organized by Administrative Division, and ranked by highest to lowest GHG emissions from Calendar Year 2024.
** Schools currently scheduled for replacement or renovation and full electrification.*
 # Phase 4 Rebuild PVD Schools project.

Administrative Division	Overall Building Ranking	Building Name	Electricity MT CO_2e	On-Site Fossil Fuels MT CO_2e	Total MT CO_2e	Percent of Total %	Percent Fossil Fuel %
PPSD	1	Hope High School#	243	1,108	1,351	6.92%	82%
PPSD	2	Central & Classical High School#	577	740	1,317	6.75%	56%
PPSD	3	Providence Career & Technical Academy#	503	360	864	4.43%	42%
PPSD	4	Nathanael Greene Middle School#	82	671	754	3.86%	89%
Public Property	5	Public Safety Complex	672	58	731	3.74%	8%
PPSD	6	Nathan Bishop Middle School#	362	318	680	3.48%	47%
PPSD	7	Mount Pleasant High School*	221	446	668	3.42%	67%
PPSD	8	The Leviton Complex (Alfred Lima)	213	319	532	2.72%	60%
PPSD	9	William D'Abate Elementary School	503	-	503	2.58%	0%
PPSD	10	DelSesto Middle School#	242	258	501	2.57%	52%
PPSD	11	Roger Williams Middle School#	79	411	490	2.51%	84%
PPSD	12	William Cooley Sr. High School @ JSEC (Mandela Woods)#	208	234	442	2.26%	53%
Parks	13	Roger Williams Park - Botanical Center and Mounted Command	51	344	394	2.02%	87%
PPSD	14	Gilbert Stuart Middle School*	57	335	392	2.01%	85%
PPSD	15	George J. West Elementary School	69	318	386	1.98%	82%
PPSD	16	Pleasant View Elementary School	143	226	369	1.89%	61%
PPSD	17	Dr. Jorge Alvarez High School#	164	177	341	1.75%	52%
PPSD	18	Narducci Learning Center	134	172	306	1.57%	56%
PPSD	19	Veazie Street Elementary School	98	202	300	1.54%	67%
PPSD	20	Frank D. Spaziano Elementary School	284	-	284	1.45%	0%
PPSD	21	Dr. Robert F. Roberti Administration Building	192	90	282	1.45%	32%
PPSD	22	Vartan Gregorian Elementary School#	58	214	272	1.40%	79%
PPSD	23	Asa Messer Elementary School @ Samuel W. Bridgham*	142	129	271	1.39%	48%
PPSD	24	Carl G. Lauro Elementary School	41	221	263	1.35%	84%
PPSD	25	Esek Hopkins Middle School	63	190	253	1.30%	75%
RWPark Zoo	26	Elephant/Giraffe Holding	140	111	251	1.29%	44%
PPSD	27	Sgt. Cornel Young Jr. & Charlotte Woods Elementary School#	102	129	231	1.19%	56%
PPSD	28	Dr. Martin Luther King Elementary School#	61	159	220	1.13%	72%
PPSD	29	Harry Kizirian Elementary School*	63	155	218	1.12%	71%
PPSD	30	West Broadway Middle School	67	147	214	1.10%	69%
PPSD	31	Anthony Carnevale Elementary School#	114	96	211	1.08%	46%
PPSD	32	Robert F. Kennedy Elementary School*	60	148	208	1.07%	71%
Public Property	33	City Hall	122	78	201	1.03%	39%
PPSD	34	E-Cubed Academy#	101	97	198	1.01%	49%
Public Property	35	Providence Police Training Academy @ Academy Ave	43	151	194	1.00%	78%
PPSD	36	Robert L. Bailey, IV Elementary School#	95	83	178	0.91%	47%

Administrative Division	Overall Building Ranking	Building Name	Electricity	On-Site Fossil Fuels	Total	Percent of Total	Percent Fossil Fuel
			MT CO_2e	MT CO_2e	MT CO_2e	%	%
PPSD	37	Lillian Feinstein Elementary School	64	114	178	0.91%	64%
RWPark Zoo	38	Rainforest Building	56	119	175	0.89%	68%
Parks	39	Roger Williams Park - Maintenance Facility	50	115	165	0.85%	70%
RWPark Zoo	40	Tropical America - Lower Level	60	96	156	0.80%	62%
RWPark Zoo	41	Tropical America - Upper Level	60	96	156	0.80%	62%
PPSD	42	Webster Avenue Elementary	37	109	146	0.75%	75%
PPSD	43	Mary E. Fogarty Elementary School*	36	86	121	0.62%	71%
RWPark Zoo	44	Vet Hospital	39	76	115	0.59%	66%
PPSD	45	Leviton Dual Language School - Leviton Annex#	73	38	110	0.57%	34%
Parks	46	North Burial Ground Greenhouse	5	101	105	0.54%	95%
Parks	47	City Center Ice Rink	89	15	104	0.53%	14%
Parks	48	Roger Williams Park - Museum of Natural History and Planetarium	90	10	101	0.52%	10%
Public Property	49	West End Recreation Center	53	46	100	0.51%	46%
RWPark Zoo	50	Sophie Danforth Administration Building	41	50	90	0.46%	55%
Public Property	51	Department of Communications	50	40	90	0.46%	44%
PPSD	52	Reservoir Avenue Elementary School	32	57	89	0.46%	64%
Public Property	53	DPW Maintenance, Traffic and Roller Shed	39	49	88	0.45%	55%
Public Property	54	DPW Administration Building	22	63	85	0.44%	74%
Public Property	55	Dexter Street Garage	19	63	82	0.42%	77%
Public Property	56	Madeline Rogers - Selim Recreation Center	18	63	81	0.41%	78%
Public Property	57	Atwells Avenue Fire Station	21	55	76	0.39%	72%
Public Property	58	Branch Avenue Fire Station	23	50	73	0.37%	69%
Public Property	59	Admiral Street Fire Station	19	50	69	0.35%	72%
Public Property	60	Vincent Brown Recreation Center	11	57	68	0.35%	84%
Parks	61	Roger Williams Park - The Casino	32	35	67	0.35%	52%
Public Property	62	A. Vincent Igliozzi Recreation Center	17	48	65	0.33%	74%
Public Property	63	Elmwood Community Center	27	37	64	0.33%	58%
Public Property	64	Providence Emergency Management Agency	44	19	63	0.32%	31%
Public Property	65	Providence Police Academy @ Chad Brown Street	2	59	61	0.31%	97%
PPSD	66	AVENTURE	17	43	60	0.31%	71%
RWPark Zoo	67	Children's Zoo Greenhouse	17	42	59	0.30%	72%
Public Property	68	Broad Street Fire Station	21	37	58	0.30%	64%
RWPark Zoo	69	Zoo Stables - Offices and Holding	42	15	57	0.29%	26%
Public Property	70	North Main Street Fire Station	23	31	54	0.28%	57%
Parks	71	Roger Williams Park - Carousel	11	43	54	0.28%	79%
Public Property	72	Messer Street Fire Station	12	38	51	0.26%	76%
Public Property	73	Hartford Avenue Fire Station	16	32	48	0.24%	66%
PPSD	74	The Family and Community Engagement Center	23	21	44	0.23%	48%
Public Property	75	Joslin Recreation Center and Resilience Hub	5	39	44	0.23%	89%
Public Property	76	Reservoir Avenue Fire Station	10	33	43	0.22%	76%

Administrative Division	Overall Building Ranking	Building Name	Electricity	On-Site Fossil Fuels	Total	Percent of Total	Percent Fossil Fuel
			MT CO_2e	MT CO_2e	MT CO_2e	%	%
Public Property	77	Davey Lopes Recreation Center	12	30	42	0.22%	71%
Public Property	78	Allens Avenue Fire Station	15	26	41	0.21%	64%
RWPark Zoo	79	Zebra/Wildebeest/Watusi	12	29	41	0.21%	71%
Public Property	80	John H. Rollins Rec Center - Woods ES	18	23	41	0.21%	56%
Public Property	81	Zuccolo Recreation Center	9	29	38	0.19%	75%
RWPark Zoo	82	Education - Danforth/Mellor Ed Center	22	15	36	0.19%	40%
Public Property	83	Brook Street Fire Station	13	21	35	0.18%	61%
RWPark Zoo	84	Adaptations (formerly Australasia)	16	17	33	0.17%	52%
Parks	85	Roger Williams Park - Dalrymple Boat House	15	18	33	0.17%	54%
Public Property	86	Mount Pleasant Avenue Fire Station	6	22	29	0.15%	78%
Public Property	87	Lillian Feinstein Senior Center	12	12	24	0.12%	50%
RWPark Zoo	88	Commissary Building	21	-	21	0.11%	0%
Public Property	89	Sackett Rec Center - Lillian Feinstein ES	7	13	20	0.10%	64%
RWPark Zoo	90	Sea Lion/Penguin Holding (Moon Bear)	16	3	20	0.10%	18%
Parks	91	North Burial Ground Garage	3	17	19	0.10%	85%
Public Property	92	Department of Recreation	12	6	18	0.09%	31%
RWPark Zoo	93	Bongo Building (Holding Facility)	10	7	17	0.09%	41%
RWPark Zoo	94	Discover The Wild Gift Shop	16	-	16	0.08%	0%
RWPark Zoo	95	Flamingo/Anteater Building	5	11	16	0.08%	71%
RWPark Zoo	96	Marco Polo Venice Plaza	10	4	14	0.07%	31%
Parks	97	Esek Hopkins House	6	8	13	0.07%	58%
RWPark Zoo	98	Education - ZooLab	5	8	13	0.07%	59%
RWPark Zoo	99	Children's Zoo Visitor Center	8	5	12	0.06%	39%
Parks	100	Garvin House	3	9	12	0.06%	78%
Public Property	101	Peter A. Rocchio District 6 Community Police Sub Station	9	2	11	0.05%	19%
RWPark Zoo	102	Greenhouse/Horticulture	7	-	7	0.04%	0%
RWPark Zoo	103	Gibbon Holding	2	5	7	0.04%	69%
Parks	104	North Burial Ground Visitors Center	7	-	7	0.04%	0%
RWPark Zoo	105	Admissions Offices and Gates	6	-	6	0.03%	0%
RWPark Zoo	106	Nourish 401 (Formerly Wilderness Café)	6	-	6	0.03%	0%
Parks	107	Betsey Williams Cottage	3	3	6	0.03%	58%
RWPark Zoo	108	Marco Polo Camel Holding	4	2	6	0.03%	41%
Public Property	109	Steven M. Shaw District 5 Police Substation	2	4	6	0.03%	61%
RWPark Zoo	110	Conservation Holding Building (1)	2	3	5	0.03%	66%
Parks	111	Roger Williams Park - Gateway and Visitors Center	5	-	5	0.02%	0%
RWPark Zoo	112	Tuskers (Formerly Serengeti Restaurant)	5	-	5	0.02%	0%
RWPark Zoo	113	Rainforest Annex (Formerly Kangaroo)	5	-	5	0.02%	0%
RWPark Zoo	114	Admissions Restroom/Storage Building	4	-	4	0.02%	0%
RWPark Zoo	115	Cones Ice Cream	2	2	4	0.02%	60%

Administrative Division	Overall Building Ranking	Building Name	Electricity	On-Site Fossil Fuels	Total	Percent of Total	Percent Fossil Fuel
			MT CO_2e	MT CO_2e	MT CO_2e	%	%
RWPark Zoo	116	Cheetah (Formerly Wild Dogs)	4	-	4	0.02%	0%
RWPark Zoo	117	Farmyard Barn	3	-	3	0.02%	0%
RWPark Zoo	118	Gate 3 Receiving Building	3	-	3	0.02%	0%
RWPark Zoo	119	Binturong	3	-	3	0.01%	0%
RWPark Zoo	120	Invertebrate Housing 1(Conservation Cabin)	3	-	3	0.01%	0%
RWPark Zoo	121	Red River Hog (Formerly Kopje)	3	-	3	0.01%	0%
RWPark Zoo	122	Serval	2	-	2	0.01%	0%
RWPark Zoo	123	Hornbill	2	-	2	0.01%	0%
RWPark Zoo	124	Polar Bear (a.k.a. Eagles)	2	-	2	0.01%	0%
RWPark Zoo	125	Babirusa Barn	2	-	2	0.01%	0%
RWPark Zoo	126	Marco Polo Moon Bear/Snow Leopard Holding	2	-	2	0.01%	0%
RWPark Zoo	127	African Aviary	2	-	2	0.01%	0%
RWPark Zoo	128	Slice (Formerly River Camp Sweet Shop)	1	-	1	0.01%	0%
RWPark Zoo	129	Small Bird Aviary	1	-	1	0.01%	0%
RWPark Zoo	130	Gate 3 Security Guard Office	0	-	0	0.00%	0%
		TOTAL	8,073	11,438	19,512	100%	

Roadmap Timeline

The timeline presented below is informed by an analysis of baseline emissions, existing equipment types and ages, and planned or ongoing capital projects. By incorporating these factors, the roadmap identifies opportunities to sequence decarbonization measures alongside anticipated upgrades and investments.

Table 4. The overarching decarbonization roadmap timeline for Providence's buildings.

Suggested Implementation Year	Decarbonization Measure	Description
2026–2027	Optimize or install Building Management Systems (BMS)	Optimizing building controls early can deliver immediate energy savings, improve operational visibility, and ensure existing equipment operates only when needed. Establishing effective BMS control is an important measure to implement before beginning larger efficiency or electrification projects.
2026–2027	Demand Response (DR) program participation	Buildings with large electric loads can generate near-term cost savings and revenue by reducing peak demand. Early participation aligns with City of Providence energy management initiatives and leverages existing utility programs without major capital investment.
2026–2027	Ensure efficient ventilation and airflow optimization	Reviewing and adjusting ventilation rates reduces unnecessary heating and cooling energy while maintaining health and safety standards. In addition, implementing this after BMS improvements allows for ventilation schedules to be better managed.
2026–2027	New Build or Like-New Renovation	The New Build or Like-New Renovation projects will be built to the NE CHPS v4.0 design standard. They will be all electric, solar ready facilities with zero fossil fuels used on site to fuel the building's primary space heating and hot water mechanical systems.
2026–2028	Install heat recovery ventilation where feasible	Heat recovery systems significantly reduce heating energy in cold climates, RI. These upgrades are typically best timed with ventilation system renewals or retrofits to maximize cost-effectiveness.
2026–2027	Reduce lighting and plug loads (fixtures, controls, equipment upgrades)	Lighting and plug load upgrades provide fast payback, reduced baseline electricity use, and lower future electrification and solar system sizing requirements.
2026–2028	Add or improve wall, ceiling, and roof insulation	Envelope improvements reduce heating demand, improve comfort, and prepare buildings for efficient electric heating systems. These measures can be done with routine maintenance and capital renewal cycles.
2027–2029	Upgrade windows (glazing, coatings, ENERGY STAR–certified replacements)	Window upgrades can require a large upfront cost and are most cost-effective when installed with other envelope work. Upgraded windows also help further reduce heating and cooling loads ahead of electrification.
2029–2030	Performance verification and electrification readiness assessment	Verifying savings and updated load profiles ensures future electrification systems are right-sized and financially optimized, supporting a smooth transition after 2030.

Suggested Implementation Year	Decarbonization Measure	Description
2028–2035	Electrification of heating systems	Replacing fossil fuel heating systems with high-efficiency electric heat pumps or electric heating technologies eliminates on-site emissions and reduces long-term exposure to fuel price volatility.
2027–2035	On-site solar photovoltaic installations	Installing solar photovoltaic systems on rooftops, or as canopies on parking lots, provides clean electricity to offset increased electric demand from electrification and supports long-term energy cost stability.
2035–2040	Renewable Energy Certificates (RECs) / renewable electricity procurement	Purchasing and properly allocating renewable electricity or RECs will reduce emissions from electricity and will bridge gap to net zero if the New England grid is not 100% renewable.

Energy Efficiency

Energy efficiency (EE) refers to any upgrade to a building that reduces energy usage and, in many cases, costs. Energy efficiency is intentionally prioritized as the first step in the roadmap. By lowering energy demand upfront, efficiency investments reduce the size and cost of future electrification equipment, minimize impacts on building electrical systems, and improve the overall cost-effectiveness of decarbonization. Based on one year of utility bills, at least the following efficiency projects are recommended at buildings that do not have any concreate plans for decarbonizing already:[3]

Optimize or install Building Management System (BMS): When building equipment load is higher than that of a building with a similar use type, there could be opportunities to turn off equipment during times of low occupancy or reduced building use. A building management system (BMS) could also be used to schedule equipment and systems that operate within a building. The BMS should be checked routinely to ensure optimal performance. Buildings with large electric loads may be able to participate in demand response programs as a way to reduce consumption and generate revenue and coast savings.

Demand Response Program Participation: A 2023 study found 17 city owned buildings could participate in DR programs which could curtail 1,930 kW per month and generate, ~$250,000 a year in cost savings and revenue. Since that time, the city has either completed or broken ground on 6 buildings that are likely candidates for DR Program participation.

Ensure efficient ventilation: Although a building must provide safe and comfortable conditions for occupants, it is possible to provide more fresh air than necessary. It could

[3] Adapted from recommendations by the U.S. Department of Energy (DOE) Office of Energy Efficiency and Renewable Energy (EERE) Building Technologies Office (BTO).

be feasible to reduce the amount of air and reduce energy consumption while still meeting all standards, guidelines, and building codes for air ventilation. It is also recommended to consider heat recovery ventilation systems for even more efficient circulation of air.

Reduce lighting and plug loads: Lighting efficiency and controls contribute significantly to a building's energy consumption and lighting performance. Upgrading lamps, fixtures, and controls will improve lighting efficiency. Upgrades to office equipment to more efficient models will reduce the load on standard electric receptacles and outlets.

Add Wall/Ceiling/Roof Insulation: Monitoring and checking current insulation levels could help identify opportunities for adding additional insulation or improving existing insulation. This will help buildings remain comfortable in the warmer and cooler months, while consuming less energy.

Upgrade Windows: Windows can be checked for things like U-value or solar heat gain coefficient (SHGC) to ensure that they are impacting cooling loads appropriately. Upgrade options could include glazing/coating, multiple panes, or ENERGY STAR certified windows. These upgrades could result in energy savings in the summer and winter.

Efficiency Opportunities

The efficiency measures described above and listed below are expected to help reduce GHG emissions by at least 9% annually, or 18,730 MT CO_2e cumulatively, through 2040:

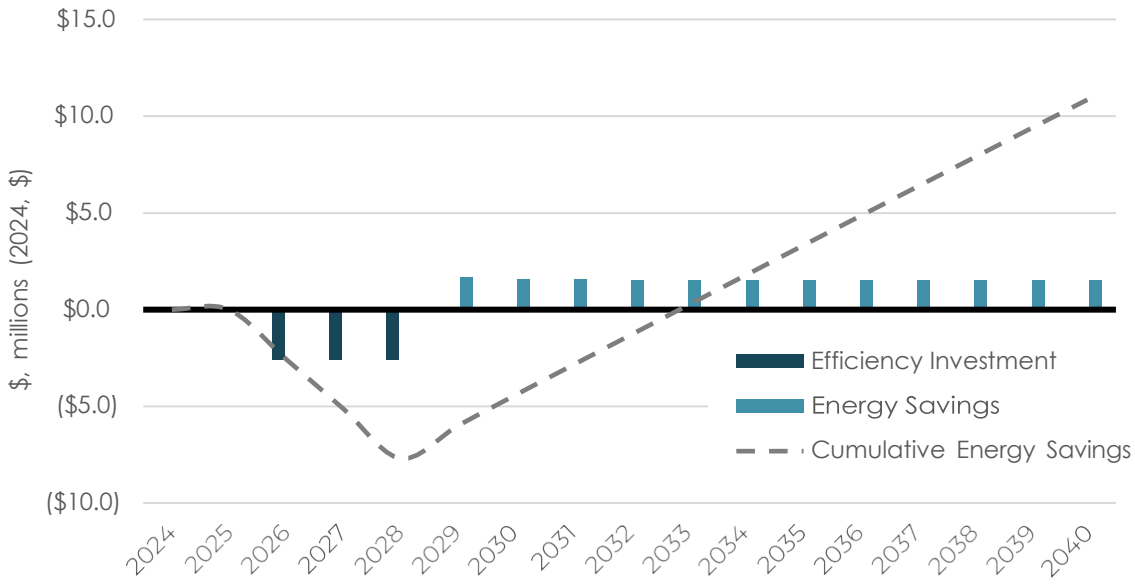
- Optimize existing Building Management System (BMS) run times and temperature settings or install new BMS.
- Ensure ventilation rates are efficient and implement heat recovery.
- Upgrade single-pane windows to double-pane.

Energy Efficiency Impacts	
Total Investment	$8.0m
Available Incentives	$0.57m
Net Upfront Cost	$7.4m
Annual Savings After Completion	$1.4m
Payback Period	8 years
Annual CO_2e reduction compared to CY24 baseline	7%

Rhode Island Energy offers incentives for commercial customers to implement Providence's selected energy efficiency projects.[4] As a result, the up-front cost of efficiency projects is reduced by about 7% and the payback period is about 8 years. Some of investment cost comes from the replacement of single-pane windows to double-pane, for which there are no available incentives.[5] Relative to operating "no decarbonization," Providence will save about $1.4 million annually on energy costs by implementing efficiency projects.

[4] Rhode Island Energy

Figure 2. Net savings from implementing energy efficiency projects, 2024-2040.



Electrification

After buildings have been made as efficient as possible, the next step is to electrify existing fossil fuel equipment by converting space and water heating equipment, and gas cooking ranges to high-efficiency heat pump (HPs) and induction stoves and cooktop alternatives. Several of the city's buildings already use heat pumps in some capacity (Table 5).

Providence currently utilizes natural gas, oil, and electricity for space heating. Based on the size and heating load at each of the buildings, we recommend conversion to either ducted or ductless air-source heat pumps (ASHP), Variable Refrigerant Flow (VRF) heat pumps, heat pump package units (RTUs), or ground-source heat pump systems (GSHP). These electrification projects could begin around 2027 to align with the city's phased approach.

Table 5. Existing heat pump equipment and use types at the City of Providence.

Building Name	Heat Pump Use Type	Whole or Partial Building Use	Notes
William D'Abate Elementary School	Heating and cooling	Whole	Completed Summer 2023
Frank D. Spaziano Elementary School	Heating and cooling	Whole	Completed Summer 2023

Building Name	Heat Pump Use Type	Whole or Partial Building Use	Notes
Frank D. Spaziano Middle School	Heating and cooling	Whole	Phase 2 - Targeted Completion Summer 2026
Harry Kizirian Elementary School	Heating and cooling	Whole	Phase 2 - Targeted Completion Summer 2027
Mary E. Fogarty Elementary School	Heating and cooling	Whole	Phase 2 - Targeted Completion Summer 2027
Gilbert Stuart Middle School	Heating and cooling	Whole	Phase 3 - Targeted Completion Summer 2027
Asa Messer Elementary School @ Samuel W. Bridgham	Heating and cooling	Whole	Phase 3 - Targeted Completion Summer 2027
Mount Pleasant High School	Heating and cooling	Whole	Phase 3 - Targeted Completion Summer 2027
Robert F. Kennedy Elementary School	Heating and cooling	Whole	Phase 3 - Targeted Completion Summer 2027
Gateway and Visitors Center	Heating and cooling	Whole	Ducted Air-source heat pump (ASHP)
North Burial Ground Visitors Center	Heating	Whole	Heat Pump RTU
Elmwood Community Center	Cooling	Partial	ASHP

The expected lifetime of most heating equipment is between 15 and 20 years. Most of Providence's buildings have HVAC systems that have reached or are close to reaching their projected end of useful life and are being considered for electrification in the near term. If electrification is not feasible during this timeframe, Providence may delay electrification, but this roadmap assumes that most of these buildings will be electrified in the near term.

The cost estimates provided in this roadmap reflect only equipment and installation expenses and do not include broader infrastructure improvements or building upgrades that may be required to support these investments. As a result, total project costs may ultimately be higher than those shown, depending on site-specific conditions and implementation requirements.

Electrification Impacts	
Total Heat Pump Investment	$18.9- $26.9m
Available Heat Pump Incentives	$2.7 -$3.8m
Net Upfront Heat Pump Cost	$16.2-$23.2m
Total HPWH Investment	$2.53m
Available HPWH Incentives	$0.05m
Net Upfront HPWH Cost	$2.48m
Annual Savings After Completion	$5m
Annual CO_2e reduction compared to CY24 baseline	34%

Both air-source and ground-source heat pumps (GSHP) are eligible for incentives through Rhode Island Energy, while only ground-source heat pumps are eligible for the federal Investment Tax Credit (ITC).[6] Based on the heat pumps recommended at each building, it is estimated that the total cost of the heat pump equipment and installation will be between $18.9 and $26.9 million. The net cost after incentives could be between $16.2 and $23.2 million. A 30% federal ITC was applied to GSHP projects with recommended

[6] https://www.irs.gov/credits-deductions/businesses/advanced-energy-project-credit

equipment replacement dates prior to 2032 when this federal credit is scheduled to end. This credit was modeled in addition to available Rhode Island state incentives, further reducing the net upfront cost of GSHP installations. Together, these incentives significantly improve the cost-effectiveness of early GSHP implementation.

Today, Providence's 130 buildings' utility bills sum to about $11.5 million per year. After implementing energy efficiency projects and converting them to heat pumps, the city's utility bills may sum to about $6.6 million per year, saving about $5 million per year.

Heat pumps can also be used for water heating, in the form of a domestic heat pump water heater, which transfers heat from the air into the water. Providence currently uses a mix of natural gas, electric resistance, and oil water heaters; these units could be replaced with domestic heat pump water heaters (HPWH) beginning in 2027, near the end of the units' useful lifetimes. After Rhode Island incentives, these will cost about $2.48 million. Finally, the 51 natural gas cooking ranges may be replaced with induction ranges, costing about $155 thousand.

On-site Solar

PowerOptions evaluated the potential for on-site solar photovoltaics (PV) at each of the 130 Providence managed buildings included in this roadmap. In addition to three ongoing projects at Public Safety, Joslin Recreation Center, and RWP Maintenance, 60 of the roofs and two parking lots evaluated could be suitable for rooftop and parking lot canopy solar installations. Roofs that were too shaded, had a significant amount of equipment that would obstruct panels, or that already had solar panels were determined as unviable. A summary of these findings can be found in Appendix Table 29.

While additional engineering and utility level evaluations will be needed to fully qualify these projects, the 63 proposed solar arrays are predicted to produce about 13,780 megawatt-hours (MWh) of electricity annually, reducing emissions by about 25 thousand $MTCO_2e$ through 2040.[7,8]

On-Site Solar Impacts	
Net Upfront Cost	$24.5m
Annual Savings After Completion	$2.5m
Annual Generation (MWh)	13,780
Annual CO_2e reduction compared to CY24 baseline	12%

The estimated cost to own the rooftop systems is about $24.5 million. It is assumed that the three solar projects currently underway will still reap the benefits of the Investment Tax Credit (ITC), but there are no assumed ITC-related cost savings associated with the remaining projects due to uncertainty in future programs that support rooftop installations. There are, however, two solar programs in Rhode Island that should be considered when conducting formal assessments of

[7] This is an indicative assessment and not an executable offer. These cost estimates do not include interconnection fees or roof replacement costs.

[8] There are 3 PVD and 2 PPSD buildings that have had a new roof installed within the past 5 years. Due to this, solar installation is projected to occur later than 2040, when the roofs need to be replaced again. Total investment costs include the projected costs associated with these installations. Cost and emissions savings throughout the roadmap, however, are only through 2040.

the proposed rooftop installations: the Renewable Energy (RE) Growth Program; and the Renewable Energy Fund (REF). Both programs aim to deliver economic support for renewable energy projects in Rhode Island and were not included in this analysis. Based on the analysis, the 63 systems could save the city over $2.4 million a year in electricity costs, in addition to the reduction in GHG emissions.

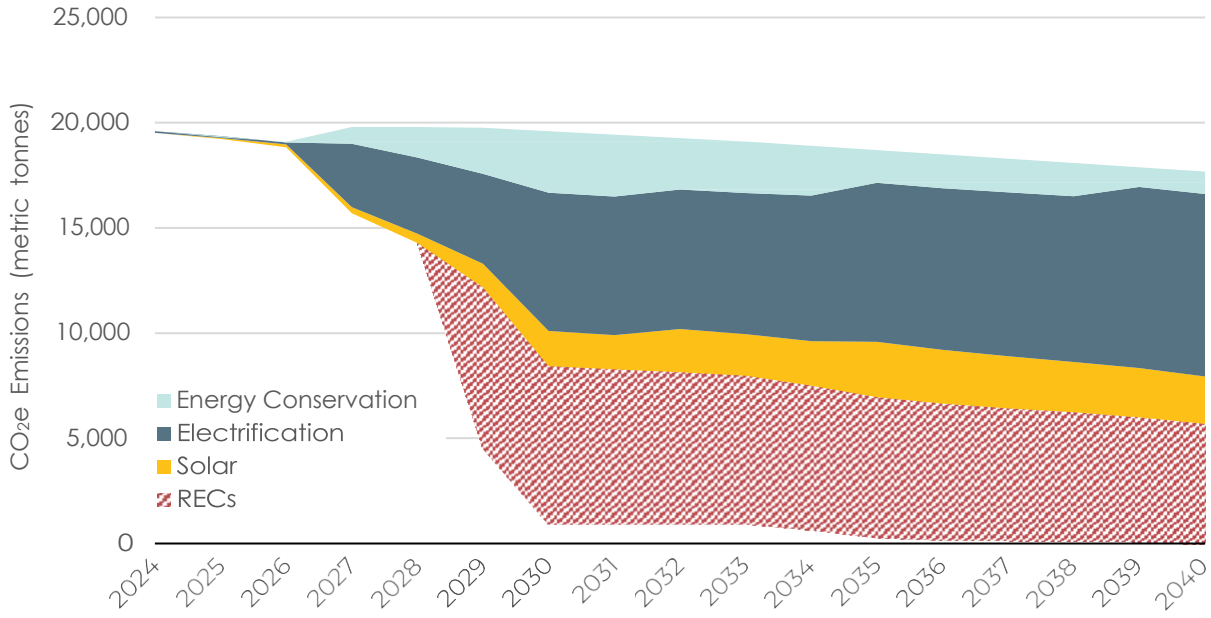
This evaluation did not include new construction projects already underway, or properties acquired after 2024. PowerOptions is mindful that the new DPW building has a solar component and the seven Phase 2 schools under construction must be built as solar-ready facilities. The solar evaluation in this roadmap may serve as a baseline which will need to be updated on an annual basis as Providence moves forward with its decarbonization efforts, its new construction projects, and its solar initiatives.

Getting to Net Zero

After completing all energy efficiency projects and installing heat pumps, Providence may still need to purchase approximately 30,000 megawatt-hours (MWh) of electricity annually from the grid. It is possible the New England electric grid will be powered by 100% renewable energy, but there is a chance that it will not happen before 2040. In that case, Providence's building load may equate to about 3,545 metric tons of CO_2e emissions remaining in 2040.

Beginning in 2029, the City of Providence is projected to take ownership of off-site Renewable Energy Certificates (RECs) equivalent to approximately 29,000 MWh of renewable electricity generation. For planning purposes, these RECs were primarily distributed across administrative divisions based on building square footage to reflect relative electricity demand. One exception to this involved the Providence Public School District (PPSD) and the Roger Williams Park Zoo. When allocated strictly by square footage, the RWP Zoo still exhibited an electricity emissions overage in 2040, while PPSD retained surplus RECs. To address this imbalance, excess RECs from PPSD were reallocated to the RWP Zoo to ensure a more accurate and consistent representation of emissions offsets across divisions. In addition, the city may retain an overall REC overage in 2040, which provides flexibility to account for future changes in heat pump performance assumptions and updates to published electricity emissions factors.

Figure 3. Impact of carbon dioxide reduction by type of project, 2024-2040.



Financial Investment and Cost Savings

After incentives, the total net investment required to execute this roadmap is estimated at $54 million. Of the possible ways to decarbonize Providence's buildings, this is projected to be the most cost-effective way. Depending on future energy prices, Providence could save up to $12 million by 2040. If this investment were financed through PowerOptions' Building-Decarbonization-as-a-service (BDaaS) model, the savings from the energy efficiency and solar projects would be used to offset the costs of the electrification projects. In this type of arrangement, Providence would not have to pay any capital up front, rather the city would pay a fixed annual fee comparable to the city's current operating expenses for approximately 15 years.[9]

[9] Note that federal incentives are also available if the electrification project is paired with energy efficiency projects to reduce the building's total energy consumption by over 25%. Additionally, this estimate does not include the cost to upgrade the electrical service to the building or the cost of removing existing HVAC systems and/or equipment.

Figure 4. Cumulative savings from Decarbonization Scenario, by price case.

Public Property

Background

With 34 buildings and 695,205 square feet of developed space, the Public Property portfolio of buildings represents the second largest share of the city's 5.2 million square footage of municipal building space. This 13% of the city's square footage accounts for 14% of the city's building-related fossil fuel emissions mostly from office buildings, public safety buildings and rec centers, which makes decarbonization and electrification efforts important for not only achieving the city's municipal goal of reaching carbon-neutral operations by 2040, but for providing a healthier work environment for city employees.

Over the past few years Public Property has implemented several projects focused on energy efficiency, conservation, and electrification. The list includes a new all-electric DPW Maintenance Building, seven Recreation Centers that are being renovated and electrified, and the Providence Public Safety Complex that has undergone several energy efficiency upgrades and has recently brought online a new building management system (BMS) that is projected to decrease the buildings' energy use by 15%. However, even with these achievements, its buildings still emit over 2,790 metric tons of carbon dioxide equivalent (MT CO_2e) annually.

The Public Property Portfolio

The Public Property division manages a diverse portfolio of municipal buildings that support core city services and operations. This section provides an overview of the facilities included in the Public Property portfolio and summarizes key characteristics relevant to the decarbonization analysis, including building size, age, and primary uses. These factors inform the identification and prioritization of emissions reduction opportunities across the portfolio.

Presented below in Table 6 is a summary of the city's portfolio broken down by administrative division. With Public Property accounting for 13% of the square footage and 14% of the GHG emissions, this division will play an important role in meeting the city's 2040 building decarbonization goals.

Table 6. The City of Providence's building portfolio, summarized by administrative division.

City of Providence Building Portfolio						
Administrative Division	**Building Count**		**Building Size**		**GHG Emissions (CY24)**	
	Count	**Percentage**	**Square Feet**	**Percentage**	**$MTCO_2e$**	**Percentage**
Public Property	34	26%	695,205	13.20%	2,790	14%
Providence Public School District	38	29%	4,210,907	79.97%	14,248	73%
Parks	14	11%	210,419	4.00%	1,086	6%
Roger Williams Park Zoo	44	34%	149,278	2.83%	1,388	7%
Total	**130**	**100%**	**5,265,809**	**100%**	**19,512**	**100%**

Summary of Findings

This roadmap is estimated to reduce the GHG emissions of the Public Property building portfolio by over 33,730 MT CO_2e cumulatively through 2040, and lower the Energy Use Intensity (EUI) of buildings by over 50% (Figure 5). Not only could Public Property meet city-wide carbon reduction goals but could save up to $2.4 million in the process.

Fossil fuels accounted for about 49% of Public Property's GHG emissions in 2024. Fossil fuel emissions from the Providence Police Training Academy @ Academy Ave , City Hall and Public Safety Complex are notably higher than other buildings and should be prioritized for decarbonization. While an emissions focused worst-to-first approach to decarbonization may be intuitive, many factors must be considered when developing a Roadmap Timeline (Table 9). The existing equipment, the source of emissions, expected technological advancements, available funding, and unexpected situations that require immediate HVAC equipment replacement have and will influence when decarbonization projects occur. Public Property has already begun to incorporate energy reduction planning and electrification into their capital improvement projects. A summary of the planned projects and those currently under construction are listed below in Table 7.

Table 7. Planned decarbonization projects at the Public Property division, City of Providence, RI.

Building	Planned Decarbonization Project(s)
Public Safety Complex	New HVAC systems, BMS, lighting and controls and a 150.7 kW rooftop solar project.
New DPW Headquarters Building	44,000 sq.ft. new construction, all electric building with VRF air source heat pumps, 188.7 kW rooftop solar, and battery storage system.
Fire Stations (North Main & Branch Ave.)	Electrification projects expected to be completed before the end of 2027. New BMS systems are included as well.
Rec Center Buildings (Josin, Davey Lopes, West End, Zuccolo, Vincent Brown, Igliozzi, & Rollins	Electrification projects expected to be completed before the end of 2027. New BMS systems are included as well.
Joslin Rec Center	94.56 kW rooftop solar, and battery storage system
New DPW Complex	110.90 kW rooftop solar project

The roadmap aims to take these planned projects into consideration when suggesting decarbonization measures. Figure 5 compares emissions under three scenarios: a "no decarbonization" scenario, the roadmap's "decarbonization without RECs" scenario, and a "decarbonization with RECs" scenario.

The scenario without RECs assumes that all proposed energy efficiency, electrification, and on-site solar measures are fully implemented. The scenario with RECs assumes the same measures are implemented, with the additional inclusion of Providence's REC ownership beginning in 2029.

To estimate Scope 2 electricity emissions, this roadmap uses projected New England grid-average emissions factors. These projections do not account for Rhode Island's Renewable Energy Standard (RES). For reference, Appendix Table 33 provides a comparison of grid-only emissions factors and an alternative RES-adjusted scenario. Under the RES-adjusted scenario, electricity-related emissions decline to zero beginning in 2033 in accordance with RES requirements.

Figure 5. CO_2e emissions at the Public Property buildings, by scenario, 2024-2040.

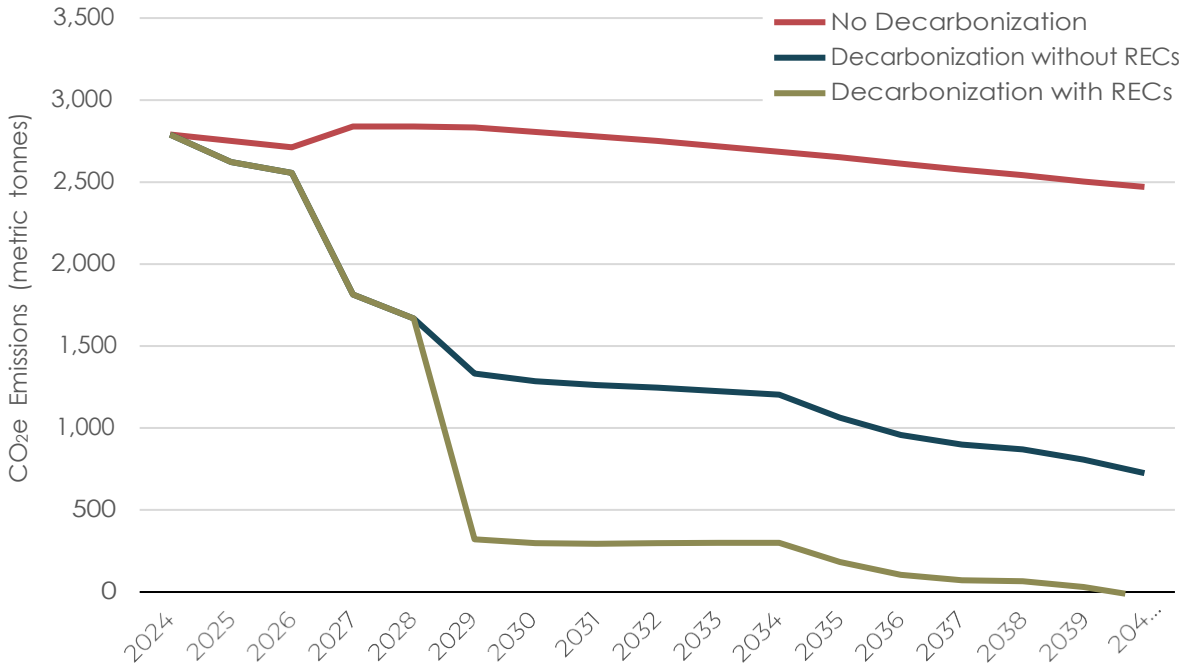


Table 8. City of Providence's Public Property comprehensive building list, ranked by highest to lowest GHG emissions from Calendar Year 2024.

Public Property Buildings							
Administrative Division	**Overall Building Ranking**	**Building Name**	**Electricity**	**On-Site Fossil Fuels**	**Total**	**Percent of Total**	**Percent Fossil Fuel**
			MT CO_2e	**MT CO_2e**	**MT CO_2e**	**%**	**%**
Public Property	5	Public Safety Complex	672	58	731	4.15%	8%
Public Property	33	City Hall	122	78	201	1.14%	39%
Public Property	35	Providence Police Training Academy @ Academy Ave	43	151	194	1.10%	78%
Public Property	49	West End Recreation Center	53	46	100	0.57%	46%
Public Property	51	Department of Communications	50	40	90	0.51%	44%
Public Property	53	DPW Maintenance, Traffic and Roller Shed	39	49	88	0.50%	55%
Public Property	54	DPW Administration Building	22	63	85	0.49%	74%
Public Property	55	Dexter Street Garage	19	63	82	0.46%	77%
Public Property	56	Madeline Rogers - Selim Recreation Center	18	63	81	0.46%	78%
Public Property	57	Atwells Avenue Fire Station	21	55	76	0.43%	72%
Public Property	58	Branch Avenue Fire Station	23	50	73	0.41%	69%
Public Property	59	Admiral Street Fire Station	19	50	69	0.39%	72%
Public Property	60	Vincent Brown Recreation Center	11	57	68	0.38%	84%
Public Property	62	A. Vincent Igliozzi Recreation Center	17	48	65	0.37%	74%
Public Property	63	Elmwood Community Center	27	37	64	0.36%	58%
Public Property	64	Providence Emergency Management Agency	44	19	63	0.36%	31%
Public Property	65	Providence Police Academy @ Chad Brown Street	2	59	61	0.35%	97%
Public Property	68	Broad Street Fire Station	21	37	58	0.33%	64%
Public Property	70	North Main Street Fire Station	23	31	54	0.31%	57%
Public Property	72	Messer Street Fire Station	12	38	51	0.29%	76%
Public Property	73	Hartford Avenue Fire Station	16	32	48	0.27%	66%
Public Property	75	Joslin Recreation Center and Resilience Hub	5	39	44	0.25%	89%
Public Property	76	Reservoir Avenue Fire Station	10	33	43	0.24%	76%
Public Property	77	Davey Lopes Recreation Center	12	30	42	0.24%	71%
Public Property	78	Allens Avenue Fire Station	15	26	41	0.23%	64%
Public Property	80	John H. Rollins Rec Center - Woods ES	18	23	41	0.23%	56%
Public Property	81	Zuccolo Recreation Center	9	29	38	0.22%	75%
Public Property	83	Brook Street Fire Station	13	21	35	0.20%	61%
Public Property	86	Mount Pleasant Avenue Fire Station	6	22	29	0.16%	78%
Public Property	87	Lillian Feinstein Senior Center	12	12	24	0.13%	50%
Public Property	89	Sackett Rec Center - Lillian Feinstein ES	7	13	20	0.11%	64%
Public Property	92	Department of Recreation	12	6	18	0.10%	31%
Public Property	101	Peter A. Rocchio District 6 Community Police Sub Station	9	2	11	0.06%	19%

Public Property	109	Steven M. Shaw District 5 Police Substation	2	4	6	0.03%	61%
		TOTAL	**1,408**	**1,381**	**2,790**	**100%**	

Roadmap Timeline – Public Property

The timeline presented below is informed by an analysis of baseline emissions, existing equipment types and ages, and planned or ongoing capital projects. By incorporating these factors, the roadmap identifies opportunities to sequence decarbonization measures alongside anticipated upgrades and investments. The timeline further indicates which buildings are prioritized for decarbonization in each implementation year or phase.

Table 9. The overarching decarbonization roadmap timeline for Public Property buildings.

Suggested Implementation Year	Decarbonization Measure	Buildings	
	Optimize existing Building Management System (BMS) run times and temperature settings, or install new BMS	• Allens Avenue Fire Station • Admiral Street Fire Station • Atwells Avenue Fire Station • Branch Avenue Fire Station • Broad Street Fire Station • Brook Street Fire Station • Hartford Fire Station • City Hall • Mount Pleasant Avenue Fire Station	• Dexter Street Garage Maintenance • Providence Water Authority Building • Department of Communications • Messer Street Fire Station
Near-term 2025-2029	Ensure ventilation rates are efficient and implement heat recovery as needed	• Atwells Avenue Fire Station • Messer Street Fire Station • Mount Pleasant Avenue Fire Station	• Providence Water Authority Building
	Implement air sealing and insulation upgrades	• Branch Avenue Fire Station • Broad Street Fire Station • Brook Street Fire Station • Hartford Fire Station • Messer Street Fire Station	• Mount Pleasant Avenue Fire Station • City Hall • DPW Administration Building • Providence Water Authority Building
	Reduce lighting and plug loads	• Allens Avenue Fire Station • Admiral Street Fire Station • Atwells Avenue Fire Station	• Department of Communications • Mount Pleasant Avenue Fire Station
	Upgrade single-pane windows to double-pane	• Brook Street Fire Station • Mount Pleasant Avenue Fire Station	• City Hall

Suggested Implementation Year	Decarbonization Measure	Buildings	
Near-term 2026-2029	Replace existing space heating and cooling equipment with heat pump alternative	• Allens Avenue Fire Station • Public Safety Complex • Peter A. Rocchio Substation • Steven M. Shaw District 5 Substation • DPW Maintenance, Traffic and Roller Shed • Providence Water Authority Building • Department of Communications • North Main Street Fire Station (planned)	• Sackett Rec Center - Lillian Feinstein ES • Brook Street Fire Station • Hartford Avenue Fire Station • Messer Street Fire Station • Mount Pleasant Avenue Fire Station • Reservoir Avenue Fire Station • City Hall • Branch Avenue Fire Station (planned)
	Replace existing water heating equipment with heat pump water heater (HPWH)	• Peter A. Rocchio Substation • DPW Administration Building • Department of Communications • Sackett Rec Center - Lillian Feinstein ES • Garvin House) • North Burial Ground Greenhouse	• Steven M. Shaw District 5 Substation • Providence Water Authority Building • Providence Emergency Management Agency • Public Safety Complex • City Hall • DPW Maintenance, Traffic and Roller Shed • Atwells Avenue Fire Station • Broad Street Fire Station
	Continuation of on-site solar projects	• Roger Williams Park Maintenance Facility • Public Safety Complex	• Joslin - D'Abate
2027	Conduct formal solar assessment on new roofs or roofs reaching end-of-life	• Allens Avenue Fire Station • Admiral Street Fire Station • Branch Avenue Fire Station • Brook Street Fire Station • Hartford Avenue Fire Station • Messer Street Fire Station • City Hall • Zuccolo Recreation Center	• DPW Administration Building • Department of Communications • Vincent Brown Recreation Center • West End Recreation Center • Davey Lopes Recreation Center • John H. Rollins Rec Center - Woods ES
2030	Replace existing water heating equipment with heat pump water heater (HPWH)	• Reservoir Avenue Fire Station • Dexter Street Garage Maintenance	• Department of Recreation
	Installation of on-site solar with roof upgrade	• Selim Madelin Rogers Recreation Center	
2031	Replace existing water heating equipment with heat pump water heater (HPWH)	• Branch Avenue Fire Station • Brook Street Fire Station • Hartford Avenue Fire Station	• Messer Street Fire Station • North Main Street Fire Station
2035	Replace existing space heating and cooling equipment with heat pump alternative	• Providence Police Academy @ Chad Brown Street • Dexter Street Garage Maintenance	• Department of Recreation
	Replace existing water heating equipment with heat pump water heater (HPWH)	• Mount Pleasant Avenue Fire Station	

Suggested Implementation Year	Decarbonization Measure	Buildings	
2036	Replace existing space heating and cooling equipment with heat pump alternative	• Admiral Street Fire Station • Broad Street Fire Station	
	Replace existing water heating equipment with heat pump water heater (HPWH)	• Allens Avenue Fire Station	
2037	Replace existing water heating equipment with heat pump water heater (HPWH)	• Admiral Street Fire Station	• Selim Madelin Rogers Recreation Center
	Installation of on-site solar with roof upgrade	• Atwells Avenue Fire Station • Mount Pleasant Avenue Fire Station • North Main Street Fire Station	
2038	Replace existing water heating equipment with heat pump water heater (HPWH)	• Providence Police Academy @ Chad Brown Street • Elmwood Community Center	
2039	Replace existing space heating and cooling equipment with heat pump alternative	• Atwells Avenue Fire Station	
2040	Replace existing water heating equipment with heat pump water heater (HPWH)	• Lillian Feinstein Senior Center • Selim Madelin Rogers Recreation Center • Elmwood Community Center	• Providence Emergency Management Agency • Lillian Feinstein Senior Center
	Replace existing space heating and cooling equipment with heat pump alternative	• Selim Madelin Rogers Recreation Center • Elmwood Community Center	• Providence Emergency Management Agency
	Installation of on-site solar with roof upgrade	• Lillian Feinstein Senior Center	

Efficiency Opportunities

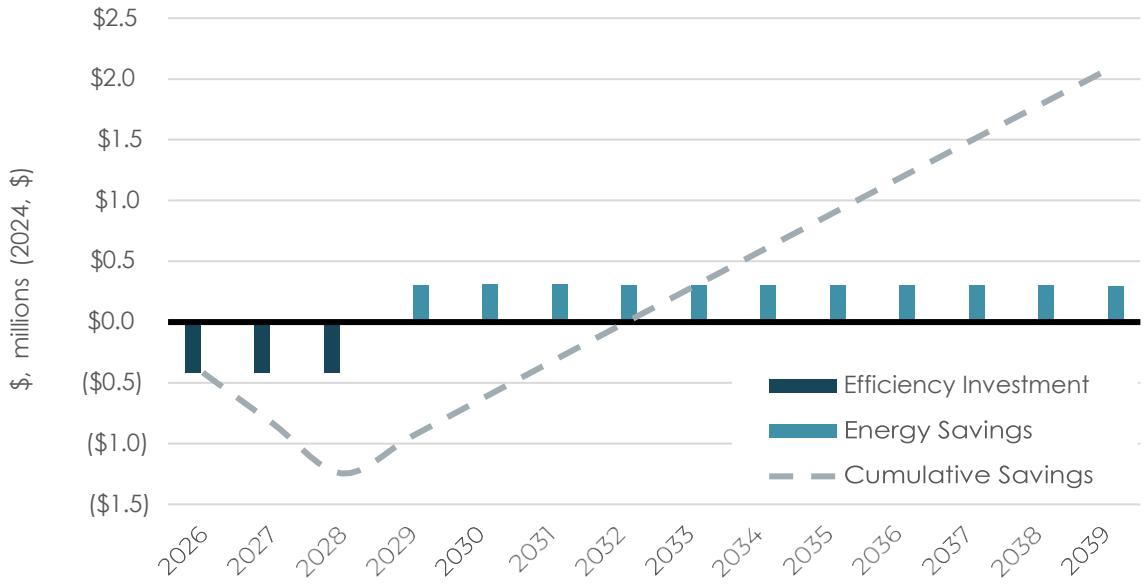
The efficiency measures described on page 18 and listed below, are expected to reduce GHG emissions of the Public Property portfolio by over 4,630 MT CO_2e through 2040.

- Optimize existing Building Management System (BMS) run times and temperature settings or install new BMS.
- Ensure ventilation rates are efficient and implement heat recovery.
- Implement air sealing and insulation upgrades.
- Reduce lighting and plug loads.
- Upgrade single-pane windows to double-pane.

Energy Efficiency Impacts	
Total Investment	$1.4m
Available Incentives	$0.12m
Net Upfront Cost	$1.2m
Annual Savings After Completion	$300k
Payback Period	7 years
Annual CO_2e reduction compared to CY24 baseline	14%

Rhode Island Energy offers incentives for commercial customers to implement Providence's selected energy efficiency projects.[10] As a result, the up-front cost of efficiency projects is reduced by about 9%, and the payback period is about seven years. Relative to operating "no decarbonization," Providence will save about $0.3 million annually on energy costs by implementing efficiency projects.

Figure 6. Net savings from implementing energy efficiency projects, 2026-2040.



Electrification

After buildings have been made as efficient as possible, the next step is to electrify existing fossil fuel equipment by converting space and water heating equipment, and gas cooking ranges into high-efficiency heat pumps (HPs). Several of the Public Property buildings already use heat pumps in some capacity, an example is listed below in Table 10.

Table 10. Existing heat pump equipment and use types at the City of Providence.

Building Name	Heat Pump Use Type	Whole or Partial Building Use	Notes
City Hall	Heating and cooling	Partial	Ducted ASHP & Mini splits
Davey Lopes Recreation Center	Heating and Cooling	Partial	Mini Splits
Elmwood Community Center	Heating and Cooling	Partial	ASHP

[10] Rhode Island Energy

The Public Property division currently utilizes natural gas and oil for space heating. Based on the size and heating load at each of the buildings, Public Property could install 19 Variable Refrigerant Flow (VRF) air source heat pumps, seven ducted air-source heat pumps, 6 heat pump packaged units (HP RTU), and one ground-source heat pump (GSHP) (see Appendix Table 29 for recommendations by building). These electrification projects could begin around 2027 to align with the city's phased approach.

The expected lifetime of most heating equipment is between 15 and 20 years. The majority of Providence's buildings have HVAC systems that have reached or are close to reaching their projected end of useful life and are being considered for electrification in the near-mid term. If electrification is not feasible during this timeframe, Providence may delay electrification, but this roadmap assumes that most buildings will be electrified in the near term.

The cost estimates provided in this roadmap reflect only equipment and installation expenses and do not include broader infrastructure improvements or building upgrades that may be required to support these investments. As a result, total project costs may ultimately be higher than those shown, depending on site-specific conditions and implementation requirements.

Electrification Impacts	
Total Heat Pump Investment	$6.0-8.5m
Available Heat Pump Incentives	$0.6-0.8m
Net Upfront Heat Pump Cost	$5.3-7.7m
Total HPWH Investment	$0.5m
Available HPWH Incentives	$5,250
Net Upfront HPWH Cost	$0.49m
Annual Savings After Completion	$0.5m
Annual CO2e reduction compared to CY24 baseline	31%

Both air-source and ground-source heat pumps (GSHP) are eligible for incentives through Rhode Island Energy, while only ground-source heat pumps are eligible for the federal Investment Tax Credit (ITC).[11] Based on the suggestion above, the total cost of the heat pump equipment and installation is estimated to be between $6.0 and $8.5 million. The net cost after incentives could be between $5.3 and $7.7 million. A 30% federal ITC was applied to GSHP projects with recommended equipment replacement dates prior to 2032. This credit was modeled in addition to available Rhode Island state incentives, further reducing the net upfront cost of GSHP installations. Together, these incentives significantly improve the cost-effectiveness of early GSHP implementation.

[11] https://www.irs.gov/credits-deductions/businesses/advanced-energy-project-credit

Today, Public Property's buildings' utility bills amount to about $1.8 million per year. After doing energy efficiency projects and converting to heat pumps, Public Property's utility bills may sum to about $1.3 million per year, saving about $0.5 million per year. If this investment were financed through PowerOptions' Building-Decarbonization-as-a-service (BDaaS) model, Providence would not have to pay for the electrification project upfront; rather, they would have a fixed annual payment for 15 years, in addition to the utility bill costs of $1.3 million per year.[12]

Heat pumps can also be used for water heating, in the form of a domestic heat pump water heater, which transfers heat from the air into the water. Providence currently uses about 31 natural gas, two oil, and one electric water heater(s); these units could be replaced with domestic heat pump water heaters (HPWH) beginning in 2027, near the end of the units' useful lifetimes. After incentives, these could cost about $0.5 million. The 12 natural gas cooking ranges could be replaced with induction ranges, costing about $24 thousand.

Solar

PowerOptions evaluated Public Property for on-site solar PV potential. 21 (in addition to two ongoing projects) of the roofs evaluated are thought to be suitable for rooftop solar installation. Roofs that were determined to not be viable were too shaded, had a significant amount of equipment that would obstruct panels, or already had solar installed. A summary of these findings can be found in Appendix Table 29.

Solar Impacts	
Net Upfront Cost	$2.5m
Available Incentives	$0.12m
Net Upfront Cost	$2.4m
Annual Savings After Completion	$0.19m
Annual Generation (MWh)	995
Annual CO_2e reduction compared to CY24 baseline	6%

The solar arrays are predicted to produce about 995 MWh of electricity annually, reducing emissions by nearly 2,570 $MTCO_2e$ through 2040.[13]
The estimated cost to own the rooftop systems is about $2.4 million. It is assumed that solar projects currently underway will still reap the benefits of the Investment Tax Credit (ITC), but there are no assumed cost savings associated with the remaining projects due to uncertainty in future programs that support rooftop installations. There are however, two solar programs in Rhode Island that should be considered when conducting formal assessments of the proposed rooftop installations: the Renewable Energy (RE) Growth Program; and the Renewable Energy Fund (REF). Both programs aim to deliver economic support for renewable energy projects in Rhode Island.

The 21 systems could still save the city nearly $0.2 million a year in electricity costs, in addition to the reduction in GHG emissions. These savings total more than $2.5 million through 2040.

[12] Note that federal incentives are also available if the electrification project is paired with energy efficiency projects to reduce the building's total energy consumption by over 25%. Additionally, this estimate does not include the cost to upgrade the electrical service to the building or the cost of removing existing HVAC systems and/or equipment.
[13] This is an indicative assessment and not an executable offer. These cost estimates do not include interconnection fees or roof replacement costs.

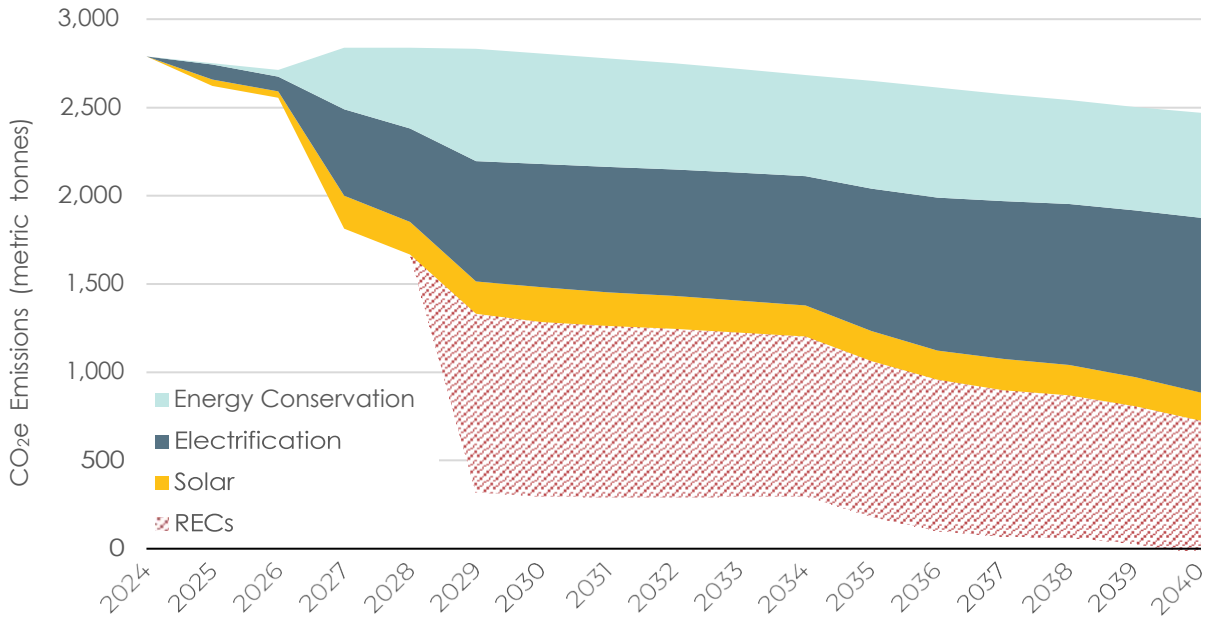
It is important to note that this evaluation did not include new construction projects started, or properties acquired after 2024. PowerOptions is mindful that the new DPW Complex currently under construction has a solar component, and that the city recently acquired several additional properties, but the solar potential of these buildings is not included here. This 2024 solar evaluation serves as a baseline which will be updated on an annual basis to track changes to the Public Property portfolio and the solar potential of any new buildings.

Getting to Net Zero

After completing all energy efficiency projects and installing heat pumps, Public Property may still need to purchase approximately 5,580 MWh of electricity annually from the grid. It is possible the New England electric grid will be powered by 100% renewable energy, but there is a chance that it will not happen before 2040. In that case, Providence's load may equate to about 725 metric tons of CO_2e emissions remaining in 2040.

Beginning in 2029, the City of Providence is projected to take ownership of off-site Renewable Energy Certificates (RECs) equivalent to approximately 29 million kilowatt-hours (kWh) of renewable electricity generation. For the purposes of this roadmap, RECs were allocated to each administrative division primarily based on building square footage to reflect relative electricity demand, with adjustments made where necessary. The results of this allocation process are depicted below in Figure 7.

Figure 7. Impact of carbon dioxide reduction by type of project, 2024-2040.



Financial Investment and Cost Savings

After incentives, the total investment required to execute this roadmap is estimated at $10.6 million. Of the possible ways to decarbonize Public Property buildings, this is projected to be the most cost-effective way. Depending on future energy prices, Providence could save up to $2.4 million by 2040.

Figure 8. Cumulative savings from Decarbonization Scenario, by price case.

Providence Public School Department

Background

The buildings occupied by the Providence Public School District (PPSD) represent the largest share of the city's municipal square footage. At 4.2 million square feet, PPSD inhabits 80% of the city's developed space. Decarbonizing these buildings through electrification, high-efficiency systems, and deep envelope improvements is essential to achieving the city's municipal goals and reaching carbon-neutral operations by 2040. The City of Providence has already established the Rebuild PVD Schools program to help achieve these goals.[14]

The Rebuild PVD Schools is a multi-year, districtwide initiative to transform Providence's aging school infrastructure into safe, healthy modern learning environments that meet today's educational and community needs. Many school buildings in Providence are 75-100 years old, and were not designed for contemporary instructional models, technological demands, accessibility standards, or modern heating, ventilation and air conditioning (HVAC) systems. Through a structured capital plan, the city is undertaking new construction, major Pre-K-8 conversions, high school modernizations, and targeted "Restore-to-New" upgrades. By 2030, the goal is for every Providence student to attend a new or like-new school that supports 21st-century teaching and learning.

This initiative is not only about replacing outdated facilities; it is also a strategic effort to improve educational equity, resilience, and long-term operational sustainability. Consolidated Pre-K-8 campuses reduce student transitions and better align with enrollment patterns, while swing-space investments such as the Narducci Learning Center allow major construction to proceed without widespread disruption. Completed Phase I projects, active Phase II and III builds, and the mix of approved and recommended Phase IV projects collectively ensure that the city can modernize at scale while addressing capacity needs, programmatic priorities, and neighborhood infrastructure challenges (Table 11).[15] At the same time, "Restore-to-New" investments stabilize buildings that can remain in service with targeted improvements to roofs, mechanical systems, and learning spaces. A description of each Phase and what it encompasses can be found in Appendix Table 30.

Table 11. Phase I – III School Projects and their status, and Phase IV School Projects and their status. From October 2025 PPSD Capital Plan Updates | Phase 4A.

Phase	Project	Grades	Status / Target
Completed – Phase 1	Narducci Learning Center *(District swing space)*	PK-8	Completed Summer 2023
	D'Abate Elementary School *(bilingual)*	PK-5	Completed Fall 2023

[14] Rebuild PVD Schools

[15] PPSD Capital Plan Updates

Phase	Project	Grades	Status / Target
	Frank Spaziano Elementary School *(dual language)*	PK-5	Completed Fall 2023
	Pleasant View Elementary School	PK-5	Completed Fall 2024
	Classical High School	9-12	Phase 1 Completed Fall 2025
	Hope High School	9-12	Phase 1: Winter 2024; Phase 2: Winter 2025
Pre-Construction – Phase 2	Frank Spaziano Middle School *(dual language)*	6-8	Target Fall 2026
	Harry Kizirian PreK-8	PK-8	Target Fall 2027
	Fogarty PreK-8	PK-8	Target Fall 2027
Design Development – Phase 3	Lima PK-8 *(dual language)*	PK-8	Target Fall 2027
	Messer / West Broadway PK-8	PK-8	Target Fall 2027
	Mount Pleasant High School	9-12	Target Fall 2027
	Kennedy Elementary School	PK-8	Target Fall 2027

The program aligns closely with Rhode Island's Act on Climate, which mandates statewide GHG reductions of 45% by 2030, 80% by 2040, and net-zero emissions by 2050, as well as Providence's goal of achieving carbon-neutral municipal operations by 2040. Providence's decarbonization strategy also supports compliance with the state's Renewable Energy Standard (RES), which requires Rhode Island's electricity supply to reach 100% renewable energy by 2033. As PPSD buildings transition to all-electric HVAC and water heating systems, their energy consumption will increasingly be served by a decarbonizing grid, resulting in continued reductions in operational emissions over time.

New school construction and major renovation projects must also comply with the Northeast Collaborative for High Performance Schools (NE-CHPS) protocol, which establishes performance standards for energy efficiency, indoor environmental quality, and sustainable building design. By requiring high-efficiency systems, improved ventilation and indoor air quality, and enhanced daylighting, NE-CHPS helps ensure that newly constructed or modernized school facilities minimize energy use while supporting healthy learning environments. Together, these policies and standards reinforce the city's long-term strategy to reduce emissions from school operations while improving building performance and occupant wellbeing.

In support of these goals, the following decarbonization roadmap analyzes 32 school buildings, which primarily fall into Phase IV and onwards, to outline a clear pathway for achieving net-zero emissions by 2040 through a combination of energy-efficiency measures, full electrification (fuel-switching away from fossil fuels), on-site solar photovoltaics, and Renewable Energy Certificates (RECs).

The Providence Public School Department Portfolio

The Providence Public School District (PPSD) operates a large and diverse portfolio of school buildings that serve students and staff across the city. This section provides an overview of the PPSD facilities portfolio, including key building characteristics and ongoing capital projects that influence decarbonization opportunities. Understanding the condition, age, and planned upgrades of these facilities helps inform the sequencing of emissions reduction measures across the district. Closed buildings and the school buildings scheduled for demolition and replacement were not included. In future years as buildings cycle in and out of service, the roadmap will be updated to address their electrification and decarbonization needs.

The following eight schools: Asa Messer/West Broadway (formerly Asa Messer ES @ Samuel W. Bridgham), Lima/Stuart PK-8 (formerly Gilbert Stuart Middle School), Harry Kizirian Elementary School, Mary E. Fogarty Elementary School, Mount Pleasant High School, Robert F. Kennedy Elementary School, Frank D. Spaziano Elementary School, and William D'Abate Elementary School, are included in the Calendar Year 2024 baseline emissions inventory, and their projected future electricity emissions are incorporated into the roadmap analysis. However, they are excluded from the electrification and cost analysis because they are already under construction and are therefore not considered candidates for additional electrification measures within this planning cycle. In addition, Spaziano Middle School is included in the emissions forecast and roadmap projections, but it is not reflected in the baseline inventory because it did not yet exist during the baseline year.

Presented below in Table 12 is a summary of the city's portfolio broken down by administrative division. With PPSD accounting for 80% of the square footage and 73% of the GHG emissions, this division will play an important role in meeting the city's 2040 building decarbonization goals.

Table 12. The City of Providence's building portfolio, summarized by administrative division.

City of Providence Building Portfolio						
Administrative Division	**Building Count**		**Building Size**		**GHG Emissions (CY24)**	
	Count	**Percentage**	**Square Feet**	**Percentage**	**$MTCO_2e$**	**Percentage**
Public Property	34	26%	695,205	13.20%	2,790	14%
Providence Public School District	38	29%	4,210,907	79.97%	14,248	73%
Parks	14	11%	210,419	4.00%	1,086	6%
Roger Williams Park Zoo	44	34%	149,278	2.83%	1,388	7%
Total	**130**	**100%**	**5,265,809**	**100%**	**19,512**	**100%**

Summary of Findings

This roadmap is estimated to reduce the GHG emissions of the Providence Public School Department (PPSD) building portfolio by over 100,000 MT CO_2e cumulatively through 2040, lowering Energy Use Intensity (EUI) of buildings by over 52% (Figure 9). Not only could the PPSD meet city-wide carbon reduction goals and improve learning environments for students and staff, but they could save up to $8.5 million in the process.

On-site fossil fuels accounted for about 60% of PPSD's GHG emissions in 2024. Fossil fuel emissions from Hope High School, Central and Classical High School, and Nathanael Greene Middle School are notably higher than other buildings and should be prioritized for decarbonization. While an emissions focused worst-to-first approach to decarbonization may be intuitive, many factors must be considered when developing a Roadmap Timeline (Table 15). The age of existing equipment, the source of emissions, expected technological advancements, available funding, and unexpected situations that require immediate HVAC equipment replacement have and will influence when decarbonization projects occur. Public Property has already begun to incorporate energy reduction planning and electrification into their capital improvement projects. A summary of the planned projects and those currently under construction are listed below in Table 13.

Table 13. School buildings identified in Rebuild Providence Schools planning process, and the current Phase and Project notes for each.

Building	Current Project Phase and Notes
Hope High School	Phase 4 Project - $25.5M budgeted for New Build or Like-New Renovation
Central & Classical High School	Phase 4 Project - $30M budgeted for Restore to New
Providence Career & Technical Academy	Phase 4 Project - $5M budgeted for Restore to New
Nathanael Greene Middle School	Phase 4 Project - $78M budgeted for New Build or Like-New Renovation
Nathan Bishop Middle School	Phase 4 Project - $5M budgeted for Restore to New
DelSesto Middle School	Phase 4 Project - $11.4M budgeted for New Build or Like-New Renovation
Roger Williams Middle School	Phase 4 Project - $95M budgeted for New Build or Like-New Renovation
The Leviton Complex (Alfred Lima)	Swing space through 2030
William Cooley Sr. High School @ JSEC (Mandela Woods)	Phase 4 Project - $10M budgeted for Restore to New
Dr. Jorge Alvarez High School	Phase 4 Project - $10M budgeted for Restore to New
Pleasant View Elementary School	Phase 1 - 2023 Like New Renovation completed but heated with natural gas. A few heat pumps were included in the renovation to provide cooling in central/critical areas of the facility.
Narducci Learning Center	Phase 1 - 2023 Like New Renovation completed but heated with natural gas. A 217.9 kW roof-top solar array has been designed by SolectEnergy. Sustainability hopes to have that system under contract before 6/30/2026.
Veazie Street Elementary School	2022 new boiler and controls
Vartan Gregorian Elementary School	Phase 4 Project - $30M budgeted for New Build or Like-New Renovation
Carl G. Lauro Elementary School	Swing space through 2030
Esek Hopkins Middle School	2022 new boiler and controls - Swing space through 2030

Building	Current Project Phase and Notes
Dr. Martin Luther King Elementary School	Phase 4 Project - $48.4M budgeted for New Build or Like-New Renovation
Anthony Carnevale Elementary School	Phase 4 Project - $12.9M budgeted for New Build or Like-New Renovation
Sgt. Cornel Young Jr. & Charlotte Woods Elementary School	Phase 4 Project - $10M budgeted for Restore to New
E-Cubed Academy	Phase 4 Project - $5M budgeted for Restore to New
Robert L. Bailey, IV Elementary School	Phase 4 Project - $10M budgeted for Restore to New
Leviton Dual Language School - Leviton Annex	Phase 4 Project - $5M budgeted for Restore to New

Figure 9. CO_2e emissions at the PPSD buildings, by scenario, 2024-2040.

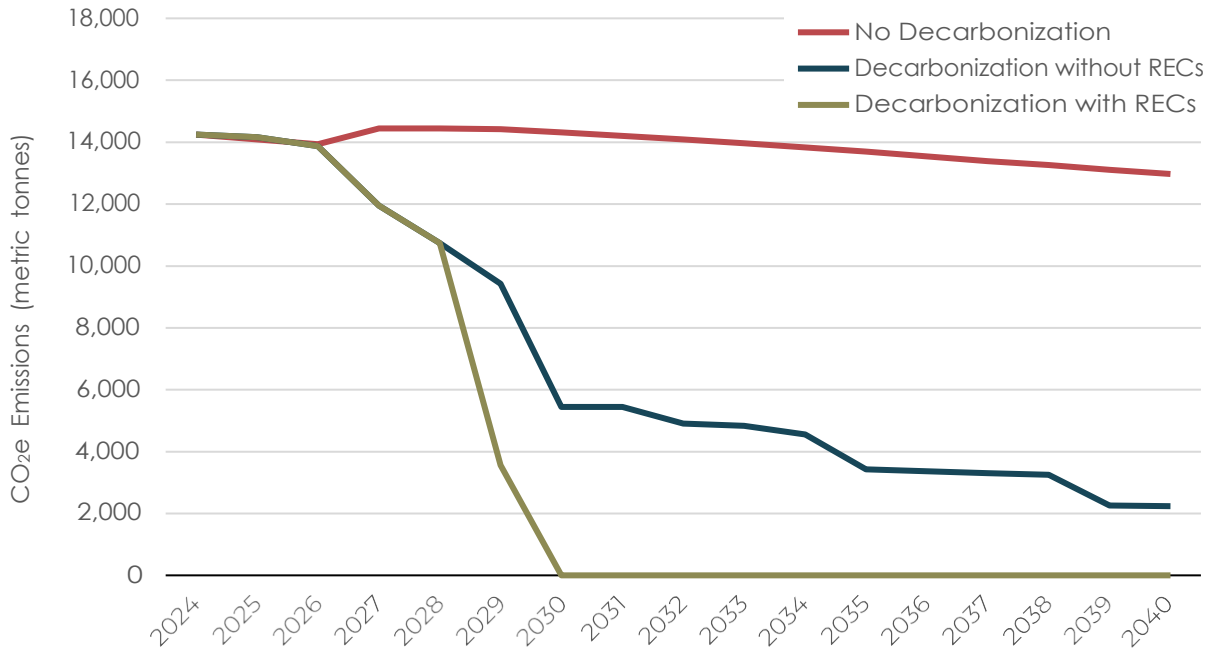


Table 14. City of Providence's PPSD comprehensive building list, organized by highest to lowest GHG emissions from Calendar Year 2024.
**Schools currently scheduled for replacement or renovation and full electrification.*
 # Phase 4 Rebuild PVD Schools project.

Providence Public School Department Buildings							
Administrative Division	Overall Building Ranking	Building Name	Electricity	On-Site Fossil Fuels	Total	Percent of Total	Percent Fossil Fuel
			MT CO_2e	MT CO_2e	MT CO_2e	%	%
PPSD	1	Hope High School#	243	1,108	1,351	9.48%	82%
PPSD	2	Central & Classical High School#	577	740	1,317	9.24%	56%
PPSD	3	Providence Career & Technical Academy#	503	360	864	6.06%	42%
PPSD	4	Nathanael Greene Middle School#	82	671	754	5.29%	89%
PPSD	6	Nathan Bishop Middle School#	362	318	680	4.77%	47%
PPSD	7	Mount Pleasant High School*	221	446	668	4.68%	67%
PPSD	8	The Leviton Complex (Alfred Lima)	213	319	532	3.73%	60%
PPSD	9	William D'Abate Elementary School	503	-	503	3.53%	0%
PPSD	10	DelSesto Middle School#	242	258	501	3.51%	52%
PPSD	11	Roger Williams Middle School#	79	411	490	3.44%	84%
PPSD	12	William Cooley Sr. High School @ JSEC (Mandela Woods)#	208	234	442	3.10%	53%
PPSD	14	Gilbert Stuart Middle School*	57	335	392	2.75%	85%
PPSD	15	George J. West Elementary School	69	318	386	2.71%	82%
PPSD	16	Pleasant View Elementary School	143	226	369	2.59%	61%
PPSD	17	Dr. Jorge Alvarez High School#	164	177	341	2.40%	52%
PPSD	18	Narducci Learning Center	134	172	306	2.15%	56%
PPSD	19	Veazie Street Elementary School	98	202	300	2.10%	67%
PPSD	20	Frank D. Spaziano Elementary School	284	-	284	1.99%	0%
PPSD	21	Dr. Robert F. Roberti Administration Building	192	90	282	1.98%	32%
PPSD	22	Vartan Gregorian Elementary School#	58	214	272	1.91%	79%
PPSD	23	Asa Messer Elementary School @ Samuel W. Bridgham*	142	129	271	1.90%	48%
PPSD	24	Carl G. Lauro Elementary School	41	221	263	1.84%	84%
PPSD	25	Esek Hopkins Middle School	63	190	253	1.78%	75%
PPSD	27	Sgt. Cornel Young Jr. & Charlotte Woods Elementary School#	102	129	231	1.62%	56%
PPSD	28	Dr. Martin Luther King Elementary School#	61	159	220	1.54%	72%
PPSD	29	Harry Kizirian Elementary School*	63	155	218	1.53%	71%
PPSD	30	West Broadway Middle School	67	147	214	1.51%	69%
PPSD	31	Anthony Carnevale Elementary School#	114	96	211	1.48%	46%
PPSD	32	Robert F. Kennedy Elementary School*	60	148	208	1.46%	71%
PPSD	34	E-Cubed Academy#	101	97	198	1.39%	49%
PPSD	36	Robert L. Bailey, IV Elementary School#	95	83	178	1.25%	47%
PPSD	37	Lillian Feinstein Elementary School	64	114	178	1.25%	64%
PPSD	42	Webster Avenue Elementary	37	109	146	1.02%	75%
PPSD	43	Mary E. Fogarty Elementary School*	36	86	121	0.85%	71%

Providence Public School Department Buildings							
Administrative Division	Overall Building Ranking	Building Name	Electricity	On-Site Fossil Fuels	Total	Percent of Total	Percent Fossil Fuel
			MT CO_2e	MT CO_2e	MT CO_2e	%	%
PPSD	45	Leviton Dual Language School - Leviton Annex#	73	38	110	0.77%	34%
PPSD	52	Reservoir Avenue Elementary School	32	57	89	0.62%	64%
PPSD	66	AVENTURE	17	43	60	0.42%	71%
PPSD	74	The Family and Community Engagement Center	23	21	44	0.31%	48%
		TOTAL	**5,625**	**8,623**	**14,248**	**100%**	

Roadmap Timeline – PPSD

The timeline presented below is informed by an analysis of baseline emissions, existing equipment types and ages, and planned or ongoing capital projects. By incorporating these factors, the roadmap identifies opportunities to sequence decarbonization measures alongside anticipated upgrades and investments. The timeline further indicates which buildings are prioritized for decarbonization in each implementation year or phase.

Table 15. The overarching decarbonization roadmap timeline for PPSD buildings.

Suggested Implementation Year	Decarbonization Measure	Buildings	
Near-term 2026-2029	Optimize existing Building Management System (BMS) run times and temperature settings, or install new BMS	• Vartan Gregorian Elementary School • E-Cubed Academy • George J. West Elementary School • Dr. Jorge Alvarez High School • Nathan Bishop Middle School • Veazie Street Elementary School • Dr. Martin Luther King Elementary School	• DelSesto Middle School • Providence Career & Technical Academy • Dr. Robert F. Roberti Administration Building • Leviton Dual Language School - Leviton Annex • The Family and Community Engagement Center
	Ensure ventilation rates are efficient and implement heat recovery as needed	• George J. West Elementary School • William Cooley Sr. High School @ JSEC (Mandela Woods) • Dr. Jorge Alvarez High School • Veazie Street Elementary School	• Providence Career & Technical Academy • Leviton Dual Language School - Leviton Annex
	Upgrade single-pane windows to double-pane	• William Cooley Sr. High School @ JSEC (Mandela Woods) • Dr. Jorge Alvarez High School • Nathan Bishop Middle School • DelSesto Middle School	• Dr. Robert F. Roberti Administration Building • Leviton Dual Language School - Leviton Annex • The Family and Community Engagement Center

Suggested Implementation Year	Decarbonization Measure	Buildings	
Near-term 2026-2029	Replace existing space heating and cooling equipment with heat pump alternative	• AVENTURE • Vartan Gregorian Elementary School • E-Cubed Academy • Dr. Jorge Alvarez High School • Dr. Robert F. Roberti Administration Building • Lillian Feinstein Elementary School - Sackett Street • Reservoir Avenue Elementary School • Sgt. Cornel Young Jr. & Charlotte Woods Elementary School	• Webster Avenue Elementary • Roger Williams Middle School • Anthony Carnevale Elementary School • Dr. Martin Luther King Elementary School • Carl G. Lauro Elementary School • The Leviton Complex (Alfred Lima) • Providence Career & Technical Academy
	Replace existing water heating equipment with heat pump water heater (HPWH)	• Dr. Jorge Alvarez High School • Sgt. Cornel Young Jr. & Charlotte Woods Elementary School • Roger Williams Middle School • Anthony Carnevale Elementary School • Dr. Martin Luther King Elementary School • Carl G. Lauro Elementary School • The Leviton Complex (Alfred Lima) • AVENTURE • Vartan Gregorian Elementary School • E-Cubed Academy	• Dr. Robert F. Roberti Administration Building • Lillian Feinstein Elementary School @ Sackett Street • Reservoir Avenue Elementary School • Webster Avenue Elementary • Providence Career & Technical Academy • Leviton Dual Language School - Leviton Annex • The Family and Community Engagement Center • West Broadway Middle School
	New Build or Like-New Renovation	• Asa Messer/West Broadway • Lima/Stuart PK-8 • Harry Kizirian Elementary School	• Mary E. Fogarty Elementary School • Mount Pleasant High School • Robert F. Kennedy Elementary School
Mid-term 2030-2035	Replace existing space heating and cooling equipment with heat pump alternative	• Leviton Dual Language School - Leviton Annex • Hope High School • Central & Classical High School • Nathanael Greene Middle School • William Cooley Sr. High School @ JSEC • Nathan Bishop Middle School	• DelSesto Middle School • Robert L. Bailey, IV Elementary School • The Family and Community Engagement Center • West Broadway Middle School • George J. West Elementary School
	Replace existing water heating equipment with heat pump water heater (HPWH)	• Hope High School • Central & Classical High School • Nathanael Greene Middle School • William Cooley Sr. High School @ JSEC (Mandela Woods)	• Nathan Bishop Middle School • DelSesto Middle School • Robert L. Bailey, IV Elementary School • George J. West Elementary School

Suggested Implementation Year	Decarbonization Measure	Buildings	
	Conduct formal solar assessment on roofs reaching end-of-life	• Dr. Martin Luther King Elementary School • Dr. Jorge Alvarez High School • Sgt. Cornel Young Jr. & Charlotte Woods Elementary School • Roger Williams Middle School • Anthony Carnevale Elementary School • AVENTURE • Vartan Gregorian Elementary School • E-Cubed Academy • Dr. Robert F. Roberti Administration Building • Lillian Feinstein Elementary School @ Sackett Street • Veazie Street Elementary School • Esek Hopkins Middle School	• Providence Career & Technical Academy • Leviton Dual Language School - Leviton Annex • The Family and Community Engagement Center • West Broadway Middle School • Hope High School • Central & Classical High School • Nathanael Greene Middle School • William Cooley Sr. High School @ JSEC (Mandela Woods) • Nathan Bishop Middle School • DelSesto Middle School • Robert L. Bailey, IV Elementary School • George J. West Elementary School
Long-term 2026-2040	Replace existing space heating and cooling equipment with heat pump alternative	• Narducci Learning Center • Veazie Street Elementary School	• Esek Hopkins Middle School • Pleasant View Elementary School
	Replace existing water heating equipment with heat pump water heater (HPWH)	• Narducci Learning Center • Veazie Street Elementary School	• Esek Hopkins Middle School • Pleasant View Elementary School
	Conduct formal solar assessment on roofs reaching end-of-life	• Pleasant View Elementary School • The Leviton Complex (Alfred Lima) • Webster Avenue Elementary	• Carl G. Lauro Elementary School

Efficiency Opportunities

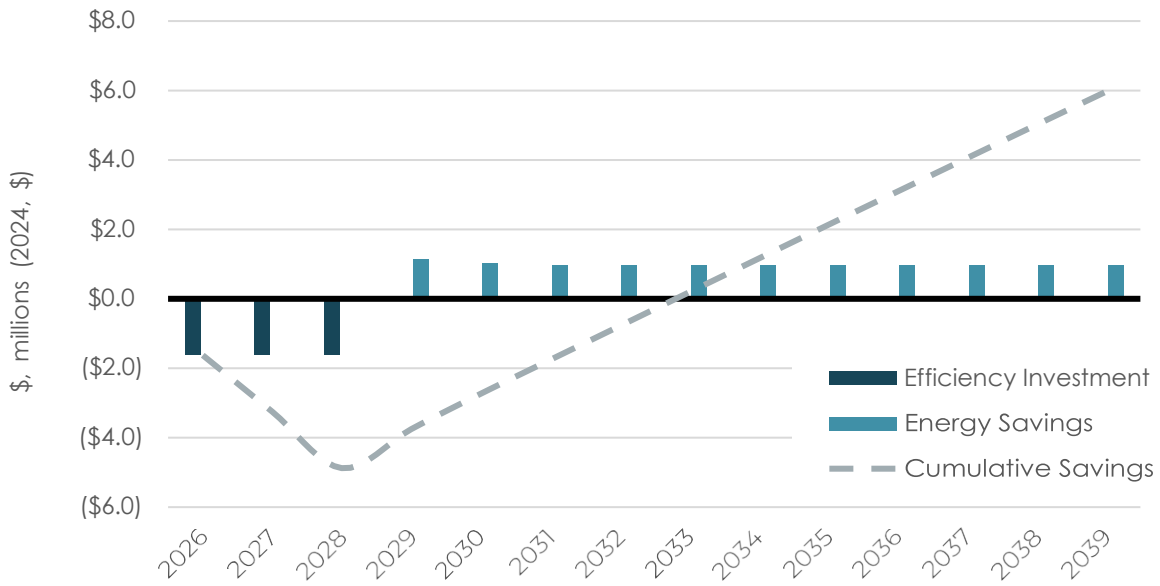
The efficiency measures described in the Introduction and listed below, are expected to reduce the PPSD's GHG emissions by over 11,000 MT CO_2e through 2040.

- Optimize existing Building Management System (BMS) run times and temperature settings or install new BMS.
- Ensure ventilation rates are efficient and implement heat recovery.
- Upgrade single-pane windows to double-pane.

Energy Efficiency Impacts	
Total Investment	$5.0m
Available Incentives	$0.13m
Net Upfront Cost	$4.9m
Annual Savings After Completion	$1.1m
Payback Period	7 years
Annual CO_2e reduction compared to CY24 baseline	7%

Rhode Island Energy offers incentives for commercial customers to implement Providence's selected energy efficiency projects.[16] As a result, the up-front cost of efficiency projects is reduced by about 3%, and the payback period is about seven years. The majority of the investment cost comes from the replacement of single-pane windows to double-pane, for which there are no available incentives.[17] Relative to operating "no decarbonization," the PPSD will save about $1 million annually on energy costs by implementing efficiency projects (Figure 10).

Figure 10. Net savings from implementing energy efficiency projects, 2026-2040.



Electrification

After these 32 PPSD buildings have been made as efficient as possible, the next step is to electrify existing fossil fuel equipment by converting space and water heating equipment, and gas cooking ranges into high-efficiency heat pumps (HPs). Several of the PPSD's buildings already use heat pumps in some capacity, these are listed below in Table 16.

The Providence Public School Department currently utilizes natural gas and electricity for space heating. Based on the size and heating load at each of the buildings, 17 Variable Refrigerant Flow (VRF) air source heat pumps, one ducted air-source heat pump, and 12 ground-source heat pump systems could replace the existing fossil fuel systems (Appendix Table 29). The school department could begin these electrification projects around 2027 to align with the PPSD's phased approach.

The expected lifetime of most heating equipment is between 15 and 20 years. The majority of Providence's school buildings have HVAC systems that have reached or are close to

[16] Rhode Island Energy

[17] Excluding window replacements from the analysis reduces upfront cost to $1.8 million (after incentives) and payback period to 4 years.

reaching their projected end of useful life and are being considered for electrification in the near-mid term (Phase IV). If electrification is not feasible during this timeframe, Providence may delay electrification, but this roadmap assumes that most buildings will be electrified in the near term.

Table 16. Existing heat pump equipment and use types at the PPSD.

Building Name	Heat Pump Use Type	Whole or Partial Building Use	Notes
Frank D. Spaziano Elementary School	Heating and cooling	Whole	Completed Summer 2023
William D'Abate Elementary School	Heating and cooling	Whole	Completed Summer 2023
Pleasant View Elementary School	Heating and cooling	Partial	Completed Summer 2023
Frank D. Spaziano Middle School	Heating and Cooling	Whole	Phase 2 - Targeted Completion Summer 2026
Harry Kizirian Elementary School	Heating and Cooling	Whole	Phase 2 - Targeted Completion Summer 2027
Mary E. Fogarty Elementary School	Heating and cooling	Whole	Phase 2 - Targeted Completion Summer 2027
Gilbert Stuart Middle School	Heating and cooling	Whole	Phase 3 - Targeted Completion Summer 2027
Asa Messer Elementary School @ Samuel W. Bridgham	Heating and cooling	Whole	Phase 3 - Targeted Completion Summer 2027
Mount Pleasant High School	Heating and cooling	Whole	Phase 3 - Targeted Completion Summer 2027
Robert F. Kennedy Elementary School	Heating and cooling	Whole	Phase 3 - Targeted Completion Summer 2027

Both air-source and ground-source heat pumps (GSHP) are eligible for incentives through Rhode Island Energy, while only ground-source heat pumps are eligible for the federal Investment Tax Credit (ITC).[18] Based on the suggestion above, the total cost of the heat pump equipment and installation is estimated to be between $11.3 and $16.0 million. Based on current incentive levels through Rhode Island Energy and federal ITC, the net cost after incentives could

[18] https://www.irs.gov/credits-deductions/businesses/advanced-energy-project-credit

be between $9.2 and $13.0 million. A 30% federal ITC was applied to GSHP projects with recommended equipment replacement dates prior to 2032. This credit was modeled in addition to available Rhode Island state incentives, further reducing the net upfront cost of GSHP installations. Together, these incentives significantly improve the cost-effectiveness of early GSHP deployment.

Today, the PPSD's 32 school buildings' utility bills come to about $8.4 million per year. After doing energy efficiency projects and converting to heat pumps, the utility bills may sum to about $4.2 million per year, saving about $4.3 million per year. If this investment were financed through PowerOptions' Building-Decarbonization-as-a-service (BDaaS) model, Providence would not have to pay for the electrification project upfront; rather, they would have a fixed annual payment for 15 years, in addition to the utility bill costs of $4.3 million per year.[19]

Electrification Impacts	
Total Heat Pump Investment	$11.3-16.0m
Available Heat Pump Incentives	$2.1-2.9m
Net Upfront Heat Pump Cost	$9.2-13.0m
Total HPWH Investment	$1.69m
Available HPWH Incentives	$0.02m
Net Upfront HPWH Cost	$1.67m
Annual Savings After Completion	$1.2m
Annual CO_2e reduction compared to CY24 baseline	35%

Heat pumps can also be used for water heating, in the form of a heat pump water heater, which transfers heat from the air into the water. PPSD currently uses 28 natural gas and four electric water heaters; these units could be replaced with domestic heat pump water heaters (HPWH) beginning in 2027, near the end of the units' useful lifetimes.[20] After incentives, these will cost about $1.7 million. Finally, 51 natural gas cooking ranges could be replaced with induction ranges, costing about $102 thousand.

Solar

PowerOptions evaluated Providence's PPSD buildings for on-site solar PV potential. 28, in addition to seven planned and one ongoing, of the roofs evaluated were found to be candidates for rooftop solar installation. Roofs that were determined to not be viable were too shaded, had a significant amount of equipment that would obstruct panels, or were no longer in use. A summary of these findings can be found in Appendix Table 29.

The 36 solar arrays are predicted to produce about 12,290 MWh (Table 17) of electricity annually, reducing emissions by over 22,270 $MTCO_2e$ through 2040.[21]

Solar Impacts	
Net Upfront Cost	$20m

[19] Note that federal incentives are also available if the electrification project is paired with energy efficiency projects to reduce the building's total energy consumption by over 25%. Additionally, this estimate does not include the cost to upgrade the electrical service to the building or the cost of removing existing HVAC systems and/or equipment.
[20] Inclusive of the Frank D. Spaziano Elementary School and William D'Abate Elementary School.
[21] This is an indicative assessment and not an executable offer. These cost estimates do not include interconnection fees or roof replacement costs.

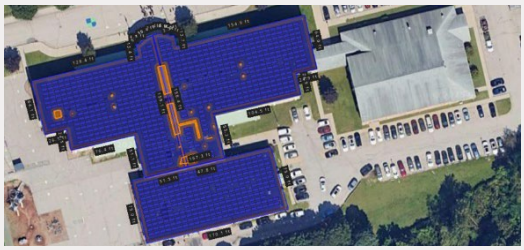
Annual Savings After Completion	$2.2m
Annual Generation (MWh)	12,293
Annual CO_2e reduction compared to CY24 baseline	14%

The estimated cost to own the 35 (excluding the ongoing project at the Frank D. Spaziano Middle School) rooftop systems is about $20 million. It is assumed that the solar projects currently underway will still reap the benefits of the Investment Tax Credit (ITC), but there is no assumed cost savings associated with the remaining projects due to uncertainty in future programs that support rooftop installations. There are however, two solar programs in Rhode Island that should be considered when conducting formal assessments of the proposed rooftop installations: the Renewable Energy (RE) Growth Program; and the Renewable Energy Fund (REF). Both programs aim to deliver economic support for renewable energy projects in Rhode Island.

The 36 systems could still save PPSD nearly $2.2 million a year in electricity costs, in addition to the reduction in GHG emissions.

Table 17. On-site solar PV design on top 5 PPSD buildings with greatest production potential.

Building Name	Generation (kWh)	Design
Pleasant View Elementary School	860,971	
Providence Career & Technical Academy *(addition to existing panels)*	821,015	
Dr. Martin Luther King Elementary School	557,456	

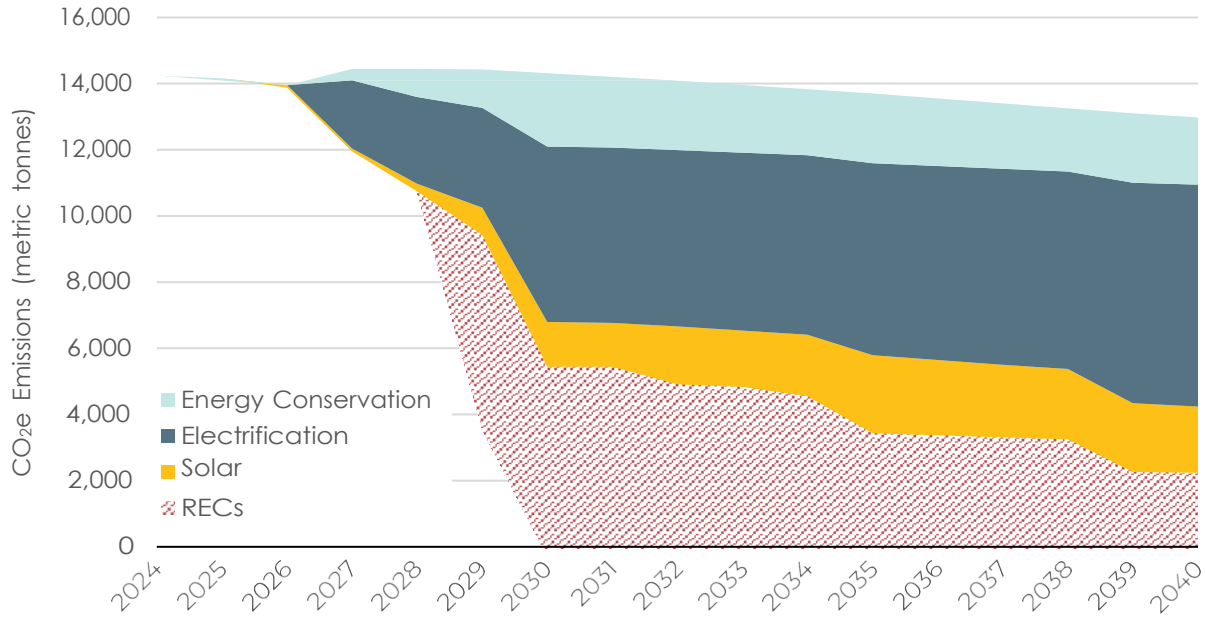
Building Name	Generation (kWh)	Design
Sgt. Cornel Young Jr. & Charlotte Woods Elementary School	477,919	
The Leviton Complex	458,029	

Getting to Net Zero

After completing all energy efficiency projects and installing heat pumps, PPSD may still need to purchase approximately 19,325 MWh of electricity annually from the grid. It is possible the New England electric grid will be powered by 100% renewable energy, but there is a chance that it will not happen before 2040. In that case, Providence's school building load may equate to about 2,240 metric tons of CO_2e emissions remaining in 2040.

Beginning in 2029, the City of Providence is projected to take ownership of off-site Renewable Energy Certificates (RECs) equivalent to approximately 29 million kilowatt-hours (kWh) of renewable electricity generation. For the purposes of this roadmap, RECs were allocated to each administrative division primarily based on building square footage to reflect relative electricity demand, with adjustments made where necessary. The results of this allocation process are depicted below in Figure 11.

Figure 11. Impact of carbon dioxide reduction by type of project, 2024-2040.



Financial Investment and Cost Savings

After incentives, the total investment required to execute this roadmap is estimated at $40 million. Of the possible ways to decarbonize Providence's buildings, this is projected to be the most cost-effective way. Depending on future energy prices, the PPSD could save up to $8.5 million by 2040.

Table 18. Cumulative savings from Decarbonization Scenario at PPSD, by price case.

Parks

Background

The Parks division manages a range of facilities that support recreational programming, park operations, and community spaces throughout Providence. This section summarizes the Parks facilities portfolio and highlights key characteristics of the buildings included in the decarbonization analysis. These facilities vary widely in size, function, and energy use, which influences the types and timing of potential decarbonization measures.

With 14 buildings and campus settings, and 210,419 square feet of developed space, the Park's portfolio of buildings represents the second smallest share of the city's square footage of municipal building space. With 5% of the square footage, Parks accounted for 7% of the city's fossil fuel emissions from buildings that are very public facing, and that can serve as led by example decarbonization projects. About 1.5 million people visit Roger Williams Park, Botanical Center, the city Center Ice Rink, and the North Burial Ground Offices annually, which makes decarbonization and electrification efforts important for not only achieving the city's municipal goal of reaching carbon-neutral operations by 2040, but for showcasing the work and the successes of the city.[22]

These efforts align well with a published strategy statement of the Parks Department, "Maximize the value of the investments in our parks by transitioning from new construction to ongoing excellence, ensuring that our parks continue to feel fresh and valuable overtime.

- Plan for the lifecycle of park assets and amenities by developing holistic proactive strategies to ensure long-term functionality and sustainability.
- Highlight the value of past investments through visible, high-quality upkeep that excites and engages the community.
- Build on our foundation with upgrades and programming that adapts to evolving community needs, enhances accessibility, and increases the value and impact of parks over time."

This declaration can and has been applied to open spaces as well as the buildings Parks maintains. In recent years Parks has implemented several projects relating to environmental justice, energy efficiency, conservation, and building and fleet infrastructure. The Roger Williams Park Gateway and Visitors Center, completed in 2022, is solar powered, and the Museum of Natural History and Planetarium was fully electrified in 2024. However, even with these achievements, its buildings still emit over 1,086 metric tons of carbon dioxide equivalent (MT CO_2e) annually, 6% of the city's total building emissions.

In support of these efforts and goals, the following decarbonization roadmap analyzes 12 buildings maintained by Parks to outline a clear pathway for achieving net-zero emissions by

[22] RWPC_Strategic_Plan-2025-2030

2040 through a combination of energy-efficiency measures, full electrification (fuel-switching away from fossil fuels), on-site and off-site solar photovoltaics (PV), and Renewable Energy Certificates (RECs). All but two buildings, the Gateway and Visitors Center and the Museum of Natural History and Planetarium will not be included in the roadmap. These buildings have already been electrified. This roadmap is developed using a combination of an in-house economic model, an open-source virtual energy-efficiency audit tool, and advanced solar-analysis software.

The Parks Portfolio

As stated in the Introduction, the 2024 City of Providence portfolio includes 130 buildings and 5,265,809 square feet of conditioned space. The Parks division manages a range of facilities that support recreational programming, park operations, and community spaces throughout Providence. This section summarizes the Parks facilities portfolio and highlights key characteristics of the buildings included in the decarbonization analysis. These facilities vary widely in size, function, and energy use, which influences the types and timing of potential decarbonization measures.

Presented below in Table 19 is a summary of the city's portfolio broken down by administrative division. With Parks accounting for 4% of the square footage and 6% of the GHG emissions, this division will play an important role in meeting the city's 2040 building decarbonization goals, given the public facing nature of the department and its ability to showcase the decarbonization efforts of the city.

Table 19. The City of Providence's building portfolio, summarized by administrative division.

City of Providence Building Portfolio						
Administrative Division	**Building Count**		**Building Size**		**GHG Emissions (CY24)**	
	Count	**Percentage**	**Square Feet**	**Percentage**	**$MTCO_2e$**	**Percentage**
Public Property	34	26%	695,205	13.20%	2,790	14%
Providence Public School District	38	29%	4,210,907	79.97%	14,248	73%
Parks	14	11%	210,419	4.00%	1,086	6%
Roger Williams Park Zoo	44	34%	149,278	2.83%	1,388	7%
Total	**130**	**100%**	**5,265,809**	**100%**	**19,512**	**100%**

Summary of Findings

This roadmap is estimated to reduce the GHG emissions of the Parks building portfolio by 11,560 MT CO_2e cumulatively through 2040, lowering Energy Use Intensity (EUI) of buildings by over 50%. Not only could Parks meet emissions reduction goals but they save over $0.97 million in the process.

Fossil fuels accounted for about 65% of Parks' GHG emissions in 2024. Fossil fuel emissions from Roger Williams Park Maintenance Facility and the Botanical Center are notably higher than other buildings and should be prioritized for decarbonization (Table 21). While an emissions focused worst-to-first approach to decarbonization may be intuitive, many factors must be

considered when developing a Roadmap Timeline (Table 22). The age of existing equipment, the source of emissions, expected technological advancements, available funding, and unexpected situations that require immediate HVAC equipment replacement have and will influence when decarbonization projects occur. Parks has already begun to incorporate energy reduction planning and electrification into their capital improvement projects. A summary of the planned and are listed below in Table 20.

Table 20. Planned decarbonization projects at the Parks Department, City of Providence, RI.

Building	Planned Decarbonization Project(s)
Roger Williams Park Maintenance Facility	110.90 kW rooftop solar project expected to generate $26,000 annually in savings and avoided costs
Gateway and Visitors Center	100% electric building completed 2022
North Burial Ground Offices	Heat pumps installed in 2025
Museum of Natural History and Planetarium	Heat pumps installed in 2024

The roadmap aims to take these planned projects into consideration when suggesting decarbonization measures. Figure 12 compares emissions under three scenarios: a "no decarbonization" scenario, the roadmap's "decarbonization without RECs" scenario, and a "decarbonization with RECs" scenario.

The scenario without RECs assumes that all proposed energy efficiency, electrification, and on-site solar measures are fully implemented. The scenario with RECs assumes the same measures are implemented, with the additional inclusion of Providence's REC ownership beginning in 2029.

To estimate Scope 2 electricity emissions, this roadmap uses projected New England grid-average emissions factors. These projections do not account for Rhode Island's Renewable Energy Standard (RES). For reference, Appendix Table 33 provides a comparison of grid-only emissions factors and an alternative RES-adjusted scenario. Under the RES-adjusted scenario, electricity-related emissions decline to zero beginning in 2033 in accordance with RES requirements.

Figure 12. CO_2e emissions by scenario, 2024-2040.

Table 21. City of Providence's Roger Williams Park comprehensive building list, organized by ranking, and GHG emissions from Calendar Year 2024.

Roger Williams Park Buildings							
Administrative Division	**Overall Building Ranking**	**Building Name**	**Electricity**	**On-Site Fossil Fuels**	**Total**	**Percent of Total**	**Percent Fossil Fuel**
			MT CO_2e	**MT CO_2e**	**MT CO_2e**	**%**	**%**
Parks	13	Roger Williams Park - Botanical Center and Mounted Command	51	344	394	2.02%	87%
Parks	39	Roger Williams Park - Maintenance Facility	50	115	165	0.85%	70%
Parks	46	North Burial Ground Greenhouse	5	101	105	0.54%	95%
Parks	47	City Center Ice Rink	89	15	104	0.53%	14%
Parks	48	Roger Williams Park - Museum of Natural History and Planetarium	90	10	101	0.52%	10%
Parks	61	Roger Williams Park - The Casino	32	35	67	0.35%	52%
Parks	71	Roger Williams Park - Carousel	11	43	54	0.28%	79%
Parks	85	Roger Williams Park - Dalrymple Boat House	15	18	33	0.17%	54%
Parks	91	North Burial Ground Garage	3	17	19	0.10%	85%
Parks	97	Esek Hopkins House	6	8	13	0.07%	58%
Parks	100	Garvin House	3	9	12	0.06%	78%
Parks	104	North Burial Ground Visitors Center	7	-	7	0.04%	0%
Parks	107	Betsey Williams Cottage	3	3	6	0.03%	58%
Parks	111	Roger Williams Park - Gateway and Visitors Center	5	-	5	0.02%	0%
		TOTAL	**369**	**717**	**1,086**	**100%**	

Roadmap Timeline – Parks

The timeline presented below is informed by an analysis of baseline emissions, existing equipment types and ages, and planned or ongoing capital projects. By incorporating these factors, the roadmap identifies opportunities to sequence decarbonization measures alongside anticipated upgrades and investments. The timeline further indicates which buildings are prioritized for decarbonization in each implementation year or phase.

Table 22. The overarching decarbonization roadmap timeline for Parks buildings.

Suggested Implementation Year	Decarbonization Measure	Buildings	
Near-term 2026-2029	Optimize existing Building Management System (BMS) run times and temperature settings, or install new BMS	• Dalrymple Boat House • Museum of Natural History and Planetarium	• RWP Botanical Center & Mounted Command • Garvin House
	Reduce lighting and plug loads	• RWP Botanical Center & Mounted Command	
	Upgrade single-pane windows to double-pane (Historic structures may be exempt or have difficulty in implementing this measure.)	• Dalrymple Boat House • Museum of Natural History and Planetarium • Roger Williams Park Carousel • The Casino at Roger Williams Park • North Burial Ground Garage • North Burial Ground Greenhouse	• Esek Hopkins House • Betsey Williams Cottage • RWP Botanical Center & Mounted Command • Roger Williams Park Maintenance Facility • Garvin House (Rented) • North Burial Ground Visitors Center
Near-term 2026-2029	Replace existing space heating and cooling equipment with heat pump alternative	• Garvin House	• North Burial Ground Greenhouse
	Replace existing water heating equipment with heat pump water heater (HPWH)	• Garvin House	• North Burial Ground Greenhouse
	Continuation of on-site solar projects	• Roger Williams Park Maintenance Facility	
2030	Replace existing water heating equipment with heat pump water heater (HPWH)	• Roger Williams Park Carousel • Betsey Williams Cottage	• North Burial Ground Garage • Roger Williams Park Maintenance Facility
2033	Replace existing water heating equipment with heat pump water heater (HPWH)	• Esek Hopkins House	

Suggested Implementation Year	Decarbonization Measure	Buildings	
2035	Replace existing space heating and cooling equipment with heat pump alternative	• Betsey Williams Cottage • North Burial Ground Garage	• Roger Williams Park Carousel • Roger Williams Park Maintenance Facility
	Replace existing water heating equipment with heat pump water heater (HPWH)	• Dalrymple Boat House • RWP Botanical Center	
2036	Replace existing water heating equipment with heat pump water heater (HPWH)	• The Casino at Roger Williams Park	
2037	Replace existing water heating equipment with heat pump water heater (HPWH)	• Gateway and Visitors Center	
2038	Replace existing space heating and cooling equipment with heat pump alternative	• Esek Hopkins House	
	Replace existing water heating equipment with heat pump water heater (HPWH)	• North Burial Ground Offices	
2039	Replace existing water heating equipment with heat pump water heater (HPWH)	• Museum of Natural History and Planetarium	
2040	Replace existing space heating and cooling equipment with heat pump alternative	• Dalrymple Boat House • RWP Botanical Center & Mounted Command • The Casino at Roger Williams Park	• City Center Rink • Museum of Natural History and Planetarium
	Replace existing water heating equipment with heat pump water heater (HPWH)	• City Center Rink	

Efficiency Opportunities

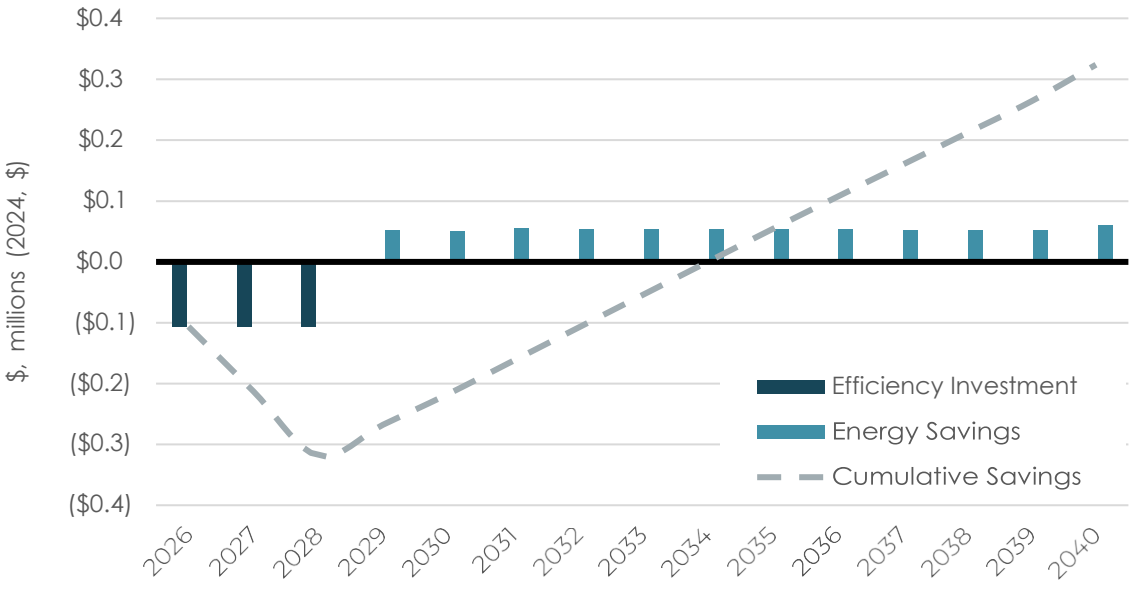
The efficiency measures described in the Introduction and listed below, are expected to reduce Parks' GHG emissions of the Parks portfolio by 1,015 MT CO_2e through 2040.

- Optimize existing Building Management System (BMS) run times and temperature settings or install new BMS.
- Ensure ventilation rates are efficient and implement heat recovery.
- Implement air sealing and insulation upgrades.

Energy Efficiency Impacts	
Total Investment	$0.33m
Available Incentives	$0.012m
Net Upfront Cost	$0.32m
Annual Savings After Completion	$60k
Payback Period	9 years
Annual CO_2e reduction compared to CY24 baseline	8%

Rhode Island Energy offers incentives for commercial customers to implement Providence's selected energy efficiency projects.[23] As a result, the up-front cost of efficiency projects is reduced by about 4% and the payback period is about nine years. Relative to operating "no decarbonization," Providence will save about $60 thousand annually on energy costs by implementing efficiency projects.

Figure 13. Net savings from implementing energy efficiency projects, 2026-2040.



[23] Rhode Island Energy

Electrification

After buildings have been made as efficient as possible, the next step is to electrify existing fossil fuel equipment by converting space and water heating equipment, and gas cooking ranges into high-efficiency heat pumps (HPs). Some of the Parks' buildings already use heat pumps in some capacity, these are listed below in Table 23.

Table 23. Existing heat pump equipment and use types at the Parks division.

Building Name	Heat Pump Use Type	Whole or Partial Building Use	Notes
Gateway and Visitors Center	Heating and cooling	Whole	Ducted ASHP
North Burial Ground Offices	Heating	Whole	Heat Pump RTU
Museum of Natural History and Planetarium	Heating & Cooling	Whole	Ducted ASHP

Roger Williams Park currently utilizes natural gas, oil and electricity for space heating. Based on the size and heating load at each of the buildings, the Parks Department could install five Variable Refrigerant Flow (VRF) air source heat pumps, six ducted air-source heat pumps, and one ductless air-source heat pump (see Appendix Table 29 for recommendations by building). These electrification projects could begin around 2027 to align with the city's phased approach.

The expected lifetime of most heating equipment is between 15 and 20 years. The majority of the Parks buildings have HVAC systems that have reached or are close to reaching their projected end of useful life and are being considered for electrification in the near-mid term. If electrification is not feasible during this timeframe, Providence may delay electrification, but this roadmap assumes that most buildings will be electrified in the near term.

The cost estimates provided in this roadmap reflect only equipment and installation expenses and do not include broader infrastructure improvements or building upgrades that may be required to support these investments. As a result, total project costs may ultimately be higher than those shown, depending on site-specific conditions and implementation requirements.

Air-source heat pumps are eligible for incentives through Rhode Island Energy. Based on the suggestion above, the total cost of the heat pump equipment and installation may be between $1.19 and $1.79 million. After considering incentive levels through Rhode Island Energy, the net cost could be between $1.18 and $1.76 million.

Today, the Parks buildings' utility bills sum to about $0.6 million per year. After doing energy efficiency projects and converting to heat pumps, Parks' utility bills may sum to about $0.50 million per year, saving about $0.1 million per year. If this investment were financed through PowerOptions' Building-Decarbonization-as-a-service (BDaaS) model, Providence would not have to pay for the electrification project upfront; rather, they would have a fixed annual payment for 15 years, in addition to the utility bill costs of $0.50 million per year.[24]

Electrification Impacts	
Total Heat Pump Investment	$1.2-1.8m
Available Heat Pump Incentives	$0.024-0.034m
Net Upfront Heat Pump Cost	$1.2-1.8m
Total HPWH Investment	$0.20m
Available HPWH Incentives	$2,100
Net Upfront HPWH Cost	$0.19m
Annual Savings After Completion	$0.12m
Annual CO_2e reduction compared to CY24 baseline	43%

Heat pumps can also be used for water heating, in the form of a domestic heat pump water heater, which transfers heat from the air into the water. Parks currently uses about five natural gas and nine electric water heater(s); these units could be replaced with domestic heat pump water heaters (HPWH) beginning in 2027, near the end of the units' useful lifetimes. After incentives, these will cost about $0.2 million. The natural gas cooking ranges could be replaced with induction range, costing about $2,000.

Solar

PowerOptions evaluated the 14 Parks buildings for on-site solar PV potential. Roofs that were determined to not be viable were too shaded, had a significant amount of equipment that would obstruct panels, or already had solar installed. A summary of these findings can be found in Appendix Table 32.

Two roofs were determined to be good solar candidates: Roger Williams Park Gateway and Visitors Center and the Roger Williams Park Maintenance Facility. The Gateway and Visitors Center has an existing 33.6 kW system that is operational and the Maintenance Facility has a 110.9 kW system scheduled for installation in the spring of 2026. These two solar arrays are predicted to produce about close to 124 MWh of electricity annually, reducing emissions by nearly 382 $MTCO_2e$ through 2040.[25]

Solar Impacts	
Total Investment	$0.46
Available Incentives	$96k
Net Upfront Cost	$0.32m
Annual Savings After Completion	$24k
Annual Generation (MWh)	124
Annual CO_2e reduction compared to CY24 baseline	2%

[24] Note that federal incentives are also available if the electrification project is paired with energy efficiency projects to reduce the building's total energy consumption by over 25%. Additionally, this estimate does not include the cost to upgrade the electrical service to the building or the cost of removing existing HVAC systems and/or equipment.
[25] This is an indicative assessment and not an executable offer. These cost estimates do not include interconnection fees or roof replacement costs.

With the Gateway system has already been paid for, the estimated cost to own the Maintenance Facility system is $0.32 million. It is assumed that the project will still reap the benefits of the Investment Tax Credit (ITC), but there are no assumed cost savings associated with the remaining projects due to uncertainty in future programs that support rooftop installations

The two systems, once built and fully optimized, could save the city nearly $24,000 a year in electricity costs, in addition to the reduction in GHG emissions. These savings total more than $0.39 million through 2040.

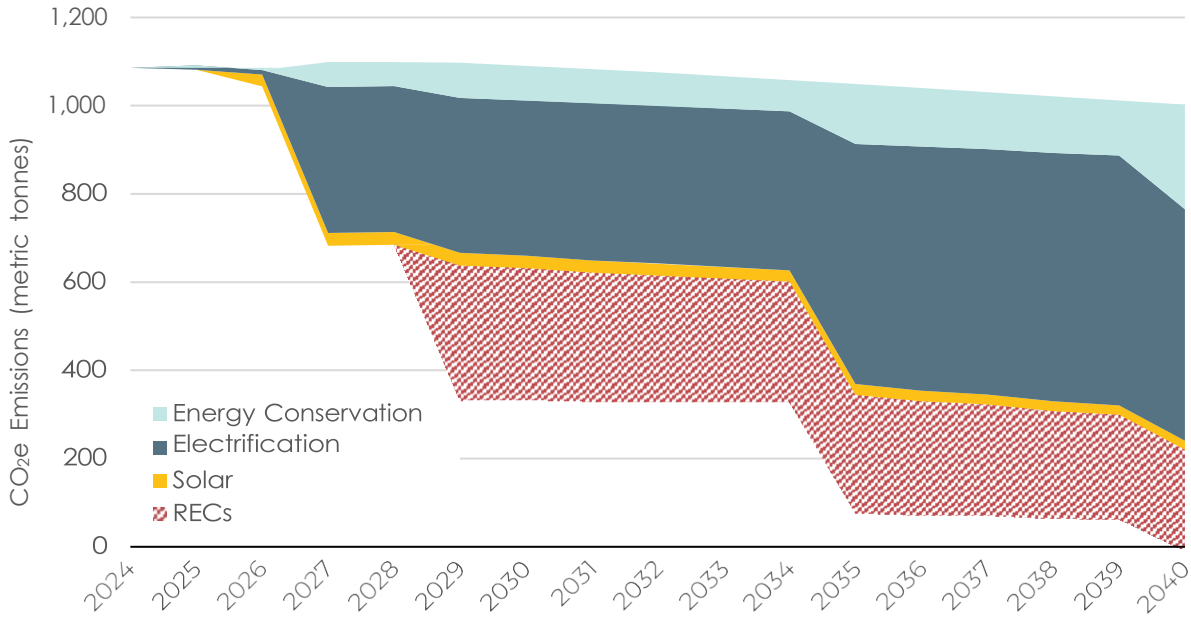
Figure 14. Existing on-site solar system at the Gateway

Getting to Net Zero

After completing all energy efficiency projects and installing heat pumps, Parks may still need to purchase approximately 2,140 MWh of electricity annually from the grid. It is possible the New England electric grid will be powered by 100% renewable energy, but there is a chance that it will not happen before 2040. In that case, the Parks' building load may equate to about 220 metric tons of CO_2e emissions remaining in 2040.

Beginning in 2029, the City of Providence is projected to take ownership of off-site Renewable Energy Certificates (RECs) equivalent to approximately 29 million kilowatt-hours (kWh) of renewable electricity generation. For the purposes of this roadmap, RECs were allocated to each administrative division primarily based on building square footage to reflect relative electricity demand, with adjustments made where necessary. The results of this allocation process are depicted below in Figure 15.

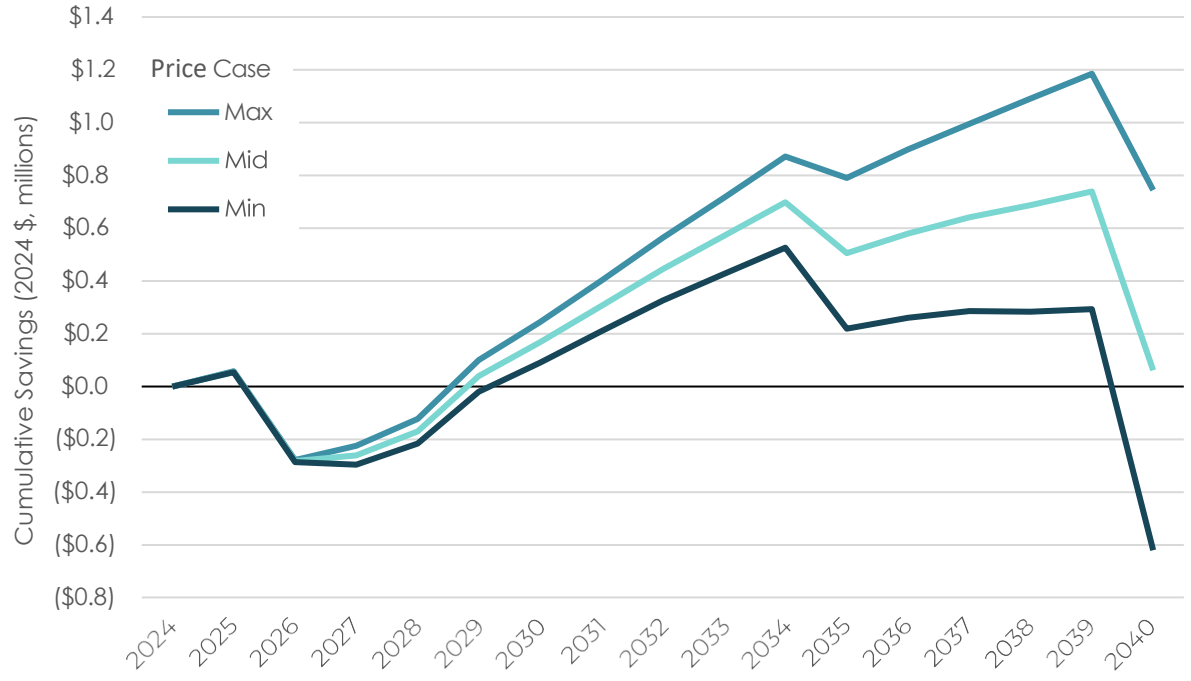
Figure 15. Impact of carbon dioxide reduction by type of project, 2024-2040.



Financial Investment and Cost Savings

After incentives, the total investment required to execute the decarbonization of the Parks buildings is estimated at $2.6 million. Of the possible ways to decarbonize Providence's buildings, this is projected to be the most cost-effective way. Depending on future energy prices, Providence could save up to $0.75 million by 2040.

Figure 16. Cumulative savings from Parks' Decarbonization Scenario, by price case.



Roger Williams Park Zoo

Background

The Roger Williams Park Zoo (RWP Zoo) operates a specialized portfolio of buildings that support animal care, conservation, education, and public engagement within Roger Williams Park. These facilities include animal habitats, visitor amenities, and operational buildings with unique energy and system requirements. This section of the roadmap assesses decarbonization strategies for Zoo facilities, focusing on reducing greenhouse gas emissions while ensuring operational reliability, animal welfare, and alignment with the RWP Zoo's conservation and sustainability mission.

The Roger Williams Park Zoo Portfolio

With 44 buildings totaling 149,278 square feet, the RWP Zoo represents the smallest share of the city's municipal building space. Despite accounting for only 3% of total square footage, the RWP Zoo was responsible for 7% of the city's fossil fuel emissions in 2024. These are buildings that are very public facing, and that can serve as led by example decarbonization projects. About 835 thousand people visit Roger Williams Park annually, which makes decarbonization and electrification efforts important for not only achieving the city's municipal goal of reaching carbon-neutral operations by 2040, but for showcasing the work and the successes of the city.[26] This section provides an overview of the RWP Zoo's building portfolio and key characteristics relevant to the decarbonization analysis.

Table 24. The City of Providence's building portfolio, summarized by administrative division.

City of Providence Building Portfolio						
Administrative Division	**Building Count**		**Building Size**		**GHG Emissions (CY24)**	
	Count	**Percentage**	**Square Feet**	**Percentage**	**$MTCO_2e$**	**Percentage**
Public Property	34	26%	695,205	13.20%	2,790	14%
Providence Public School District	38	29%	4,210,907	79.97%	14,248	73%
Parks	14	11%	210,419	4.00%	1,086	6%
Roger Williams Park Zoo	44	34%	149,278	2.83%	1,388	7%
Total	**130**	**100%**	**5,265,809**	**100%**	**19,512**	**100%**

Summary of Findings

Greenhouse gas emissions for Calendar Year 2024 were estimated for certain RWP Zoo facilities due to limitations in available building-level energy data. In these cases, a single electricity meter serves multiple buildings, making it impractical to assign exact electricity consumption and emissions to individual facilities. As a result, estimates were developed to ensure that the roadmap reflects the best available information while maintaining consistency with city

[26] https://www.RWP Zoo.org/

reporting requirements. Electricity consumption was measured at a single campus-level meter and allocated to individual buildings using a weighted floor-area methodology informed by building use type and natural gas intensity (MMBtu/ft²).

Emissions are highly concentrated at the Tropical America, Rainforest Building, Elephant/Giraffe Holding, and the Veterinary Hospital which together account for more than half of total site emissions. These buildings are characterized by high ventilation rates, humidity control, and year-round conditioning requirements typical of tropical exhibits and animal care facilities at zoos. This inventory provided a baseline for the RWP Zoo so that the decarbonization roadmap analysis could be completed. Energy efficiency, electrification, and renewable energy opportunities, particularly in high-intensity animal holding and tropical exhibit buildings, are prioritized and outlined below.

This roadmap is estimated to reduce the GHG emissions of the RWP Zoo building portfolio by over 15,000 MT CO_2e cumulatively through 2040, lowering the Energy Use Intensity (EUI) of buildings by over 45%. Not only could RWP Zoo meet emissions reductions goals but save up to $0.26 million in the process.

Fossil fuels accounted for about 51% of the RWP Zoo's GHG emissions in 2024. The age of existing equipment, source of emissions, expected technological advancements, available funding, and unexpected situations that require immediate HVAC equipment replacement have and will influence when decarbonization projects occur. The RWP Zoo has already begun to incorporate energy reduction planning and electrification into their capital improvement projects. A summary of the planned projects and those currently under construction are included in Table 25.

Table 25. Planned decarbonization projects at the RWP Zoo, City of Providence, RI.

Building	Planned Decarbonization Project(s)
Education Center and Pavilion	New Construction 13,469 sq.ft. all electric, solar ready facility

The roadmap aims to take these planned projects into consideration when suggesting decarbonization measures. Figure 17 compares emissions under three scenarios: a "no decarbonization" scenario, the roadmap's "decarbonization without RECs" scenario, and a "decarbonization with RECs" scenario.

The scenario without RECs assumes that all proposed energy efficiency, electrification, and on-site solar measures are fully implemented. The scenario with RECs assumes the same measures are implemented, with the additional inclusion of Providence's REC ownership beginning in 2029.

To estimate Scope 2 electricity emissions, this roadmap uses projected New England grid-average emissions factors. These projections do not account for Rhode Island's Renewable Energy Standard (RES). For reference, Appendix Table 33 provides a comparison of grid-only

emissions factors and an alternative RES-adjusted scenario. Under the RES-adjusted scenario, electricity-related emissions decline to zero beginning in 2033 in accordance with RES requirements.

Figure 17. CO_2e emissions at the RWP Zoo by scenario, 2024-2050.

Table 26. City of Providence's Roger Williams Park Zoo comprehensive building list, organized by ranking, and GHG emissions from Calendar Year 2024.

Roger Williams Park Zoo Buildings							
Administrative Division	Overall Building Ranking	Building Name	Electricity	On-Site Fossil Fuels	Total	Percent of Total	Percent Fossil Fuel
			MT CO_2e	MT CO_2e	MT CO_2e	%	%
RWPark Zoo	26	Elephant/Giraffe Holding	140	111	251	1%	44%
RWPark Zoo	38	Rainforest Building	56	119	175	1%	68%
RWPark Zoo	40	Tropical America - Lower Level	60	96	156	1%	62%
RWPark Zoo	41	Tropical America - Upper Level	60	96	156	1%	62%
RWPark Zoo	44	Vet Hospital	39	76	115	1%	66%
RWPark Zoo	50	Sophie Danforth Administration Building	41	50	90	1%	55%
RWPark Zoo	67	Children's Zoo Greenhouse	17	42	59	0%	72%
RWPark Zoo	69	Zoo Stables - Offices and Holding	42	15	57	0%	26%
RWPark Zoo	79	Zebra/Wildebeest/Watusi	12	29	41	0%	71%
RWPark Zoo	82	Education - Danforth/Mellor Ed Center	22	15	36	0%	40%
RWPark Zoo	84	Adaptations (formerly Australasia)	16	17	33	0%	52%
RWPark Zoo	88	Commissary Building	21	-	21	0%	0%
RWPark Zoo	90	Sea Lion/Penguin Holding (Moon Bear)	16	3	20	0%	18%
RWPark Zoo	93	Bongo Building (Holding Facility)	10	7	17	0%	41%
RWPark Zoo	94	Discover The Wild Gift Shop	16	-	16	0%	0%
RWPark Zoo	95	Flamingo/Anteater Building	5	11	16	0%	71%
RWPark Zoo	96	Marco Polo Venice Plaza	10	4	14	0%	31%
RWPark Zoo	98	Education - Zoolab	5	8	13	0%	59%
RWPark Zoo	99	Children's Zoo Visitor Center	8	5	12	0%	39%
RWPark Zoo	102	Greenhouse/Horticulture	7	-	7	0%	0%
RWPark Zoo	103	Gibbon Holding	2	5	7	0%	69%
RWPark Zoo	105	Admissions Offices and Gates	6	-	6	0%	0%
RWPark Zoo	106	Nourish 401 (Formerly Wilderness Café)	6	-	6	0%	0%
RWPark Zoo	108	Marco Polo Camel Holding	4	2	6	0%	41%
RWPark Zoo	110	Conservation Holding Building (1)	2	3	5	0%	66%
RWPark Zoo	112	Tuskers (Formerly Serengeti Restaurant)	5	-	5	0%	0%
RWPark Zoo	113	Rainforest Annex (Formerly Kangaroo)	5	-	5	0%	0%
RWPark Zoo	114	Admissions Restroom/Storage Building	4	-	4	0%	0%
RWPark Zoo	115	Cones Ice Cream	2	2	4	0%	60%
RWPark Zoo	116	Cheetah (Formerly Wild Dogs)	4	-	4	0%	0%
RWPark Zoo	117	Farmyard Barn	3	-	3	0%	0%
RWPark Zoo	118	Gate 3 Receiving Building	3	-	3	0%	0%
RWPark Zoo	119	Binturong	3	-	3	0%	0%
RWPark Zoo	120	Invertebrate Housing 1(Conservation Cabin)	3	-	3	0%	0%
RWPark Zoo	121	Red River Hog (Formerly Kopje)	3	-	3	0%	0%
RWPark Zoo	122	Serval	2	-	2	0%	0%
RWPark Zoo	123	Hornbill	2	-	2	0%	0%
RWPark Zoo	124	Polar Bear (a.k.a. Eagles)	2	-	2	0%	0%
RWPark Zoo	125	Babirusa Barn	2	-	2	0%	0%
RWPark Zoo	126	Marco Polo Moon Bear/Snow Leopard Holding	2	-	2	0%	0%

Roger Williams Park Zoo Buildings							
Administrative Division	Overall Building Ranking	Building Name	Electricity	On-Site Fossil Fuels	Total	Percent of Total	Percent Fossil Fuel
			MT CO_2e	MT CO_2e	MT CO_2e	%	%
RWPark Zoo	127	African Aviary	2	-	2	0%	0%
RWPark Zoo	128	Slice (Formerly River Camp Sweet Shop)	1	-	1	0%	0%
RWPark Zoo	129	Small Bird Aviary	1	-	1	0%	0%
RWPark Zoo	130	Gate 3 Security Guard Office	0	-	0	0%	0%
		TOTAL	**671**	**718**	**1,388**	**100%**	

Roadmap Timeline – Zoo

The timeline presented below is informed by an analysis of baseline emissions, existing equipment types and ages, and planned or ongoing capital projects. By incorporating these factors, the roadmap identifies opportunities to sequence decarbonization measures alongside anticipated upgrades and investments. The timeline further indicates which buildings are prioritized for decarbonization in each implementation year or phase.

Table 27. The overarching decarbonization roadmap timeline for Providence's RWP Zoo buildings.

Suggested Implementation Year	Decarbonization Measure	Buildings	
Near-term 2026-2029	Optimize existing Building Management System (BMS) run times and temperature settings, or install new BMS	• Elephant/Giraffe Holding • Rainforest Building • Tropical America	• Vet Hospital • Sophi Danforth Admin. Bldg.
	Reduce lighting and plug loads (fixtures, controls, equipment upgrades)	• Elephant/Giraffe Holding • Rainforest Building • Tropical America • Sophie Danforth Administration Building	• Children's Zoo Greenhouse • Zoo Stables - Offices and Holding • Zebra/Wildebeest/Watusi • Education - Danforth/Mellor Ed Center • Adaptations
	Add or improve wall, ceiling, and roof insulation	• Elephant/Giraffe Holding • Rainforest Building • Tropical America • Sophie Danforth Administration Building • Children's Zoo Greenhouse • Zoo Stables - Offices and Holding • Zebra/Wildebeest/Watusi • Education - Danforth/Mellor Ed Center	• Commissary Building • Sea Lion/Penguin Holding (Moon Bear) • Bongo Building (Holding Facility) • Discover The Wild Gift Shop • Flamingo/Anteater Building • Marco Polo Venice Plaza
Near-term 2026-2029	Replace existing space heating and cooling equipment with heat pump alternative	• Binturong • Commissary Building • Cheetah (Formerly Wild Dogs) • Admissions Offices and Gates • Admissions Restroom/Storage Building • Invertebrate Housing (Conservation Cabin) • Children's Zoo Greenhouse • Children's Zoo Visitor Center • Cones Ice Cream • Adaptations (formerly Australasia) • Education - Danforth/Mellor Ed Center • Education - ZooLab • Nourish 401 (Formerly Wilderness Café)	• Marco Polo Camel Holding • Tuskers (Formerly Serengeti Restaurant) • Discover The Wild Gift Shop • Greenhouse/Horticulture • Marco Polo Moon Bear/Snow Leopard Holding • Polar Bear (a.k.a. Eagles) • Tropical America - Lower Level • Tropical America - Upper Level • Zebra/Wildebeest/Watusi • Conservation Holding Building • Babirusa Barn • Zoo Stables - Offices and Holding Sea Lion/Penguin Holding (Moon Bear)

Suggested Implementation Year	Decarbonization Measure	Buildings	
		• Sophie Danforth Administration Building	
	Replace existing water heating equipment with heat pump water heater (HPWH)	• Flamingo/Anteater Building • Tuskers (Formerly Serengeti Restaurant)	• Discover The Wild Gift Shop • Elephant/Giraffe Holding
	Exploration of on-site solar canopy projects	• Parking Lots A and B	
2032	Replace existing space heating and cooling equipment with heat pump alternative	• Red River Hog (Formerly Kopje)	
2034	Replace existing space heating and cooling equipment with heat pump alternative	• African Aviary • Hornbill • Small Bird Aviary • Gate 3 Receiving Building • Gate 3 Security Guard Office • Rainforest Building	• Farmyard Barn • Gibbon Holding • Vet Hospital • Marco Polo Venice Plaza • Flamingo/Anteater Building • Elephant/Giraffe Holding
2035	Exploration of on-site solar	• Vet Hospital • Commissary Building	• Rainforest Building
	Replace existing electric water heating equipment with heat pump water heater (HPWH)	• African Aviary • Binturong • Hornbill • Small Bird Aviary • Commissary Building • Rainforest Building • Children's Zoo Greenhouse • Children's Zoo Visitor Center • Cones Ice Cream • Farmyard Barn • Adaptations (formerly Australasia)	• Education - Danforth/Mellor Ed Center • Education - Zoolab • Gibbon Holding • Nourish 401 (Formerly Wilderness Café) • Sophie Danforth Administration Building • Vet Hospital • Marco Polo Camel Holding • Marco Polo Venice Plaza
2040	Replace existing space heating and cooling equipment with heat pump alternative	• Serval • Slice (Formerly River Camp Sweet Shop)	• Rainforest Annex (Formerly Kangaroo) • Bongo Building (Holding Facility)

Efficiency Opportunities

Energy efficiency impacts were estimated in correspondence with the RWP Zoo's overall energy consumption estimates, reflecting the use of aggregated energy data across multiple facilities and ensuring that projected savings are consistent with total site-level energy use. The

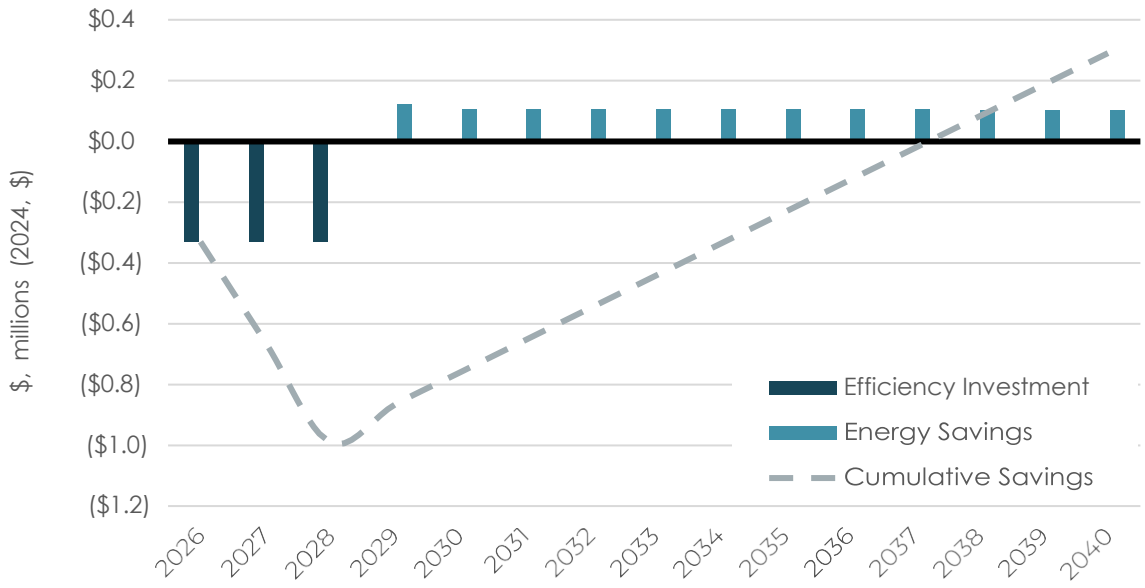
efficiency measures described in the Introduction and listed below, could reduce GHG emissions of the RWP Zoo portfolio by 2,300 MT CO_2e through 2040:

- Optimize existing Building Management System (BMS) run times and temperature settings or install new BMS.
- Reduce lighting and plug loads (fixtures, controls, equipment upgrades).
- Implement air sealing and insulation upgrades.

Energy Efficiency Impacts	
Total Investment	$1.3m
Available Incentives	$0.31m
Net Upfront Cost	$0.99m
Annual Savings After Completion	$0.1m
Payback Period	12 years
Annual CO_2e reduction compared to CY24 baseline	14%

Rhode Island Energy offers incentives for commercial customers to implement Providence's selected energy efficiency projects.[27] As a result, the up-front cost of efficiency projects is reduced by about 7% and the payback period is about 12 years. Relative to operating "no decarbonization," Providence will save about $0.1 million annually on energy costs by implementing efficiency projects.

Figure 18. Net savings from implementing energy efficiency projects, 2026-2040.



Electrification

After buildings have been made as efficient as possible, the next step is to electrify existing fossil fuel equipment by converting space and water heating equipment, and gas cooking ranges into high-efficiency heat pumps (HPs). Electrification impacts were estimated in correspondence with the RWP Zoo's overall energy consumption and fuel use estimates. This reflects the use of aggregated data across multiple facilities and ensures consistency between

[27] Rhode Island Energy

projected fuel switching, electric load increases, and total building energy use. Twelve of the RWP Zoo buildings already use heat pumps in some capacity; this is listed below in Table 28.

Table 28. Existing heat pump equipment and use types at the RWP Zoo.

Building Name	Heat Pump Use Type	Whole or Partial Building Use	Notes
Gate 3 Security Guard Office	Heating and cooling	Whole	Ductless ASHP
Children's Zoo Visitor Center	Heating and Cooling	Partial	ASHP
Conservation Holding Building	Heating and Cooling	Partial	ASHP
Elephant/Giraffe Holding	Heating and Cooling	Partial	ASHP
Gate 3 Security Guard Office	Heating and Cooling	Partial	ASHP
Gibbon Holding	Heating and Cooling	Partial	ASHP
Hornbill	Heating and Cooling	Partial	ASHP
Nourish 401	Heating and Cooling	Partial	ASHP
Sophie Danforth Administration Building	Heating and Cooling	Partial	ASHP
Tropical America - Lower Level	Heating and Cooling	Partial	ASHP
Vet Hospital	Heating and Cooling	Partial	ASHP
Zoo Stables - Offices and Holding	Heating and Cooling	Partial	ASHP
Gate 3 Security Guard Office	Heating and cooling	Whole	Ductless ASHP

Roger Williams Park Zoo currently utilizes natural gas and electricity for space heating. Based on the size and heating load at each of the buildings, the RWP Zoo could install 34 ducted or ductless air-source heat pumps, three Variable Refrigerant Flow (VRF) air source heat pumps, and seven HP Packaged Unit (RTU) (see Appendix Table 29 for recommendations by building). These electrification projects could begin around 2029 to align with the city's phased approach.

The expected lifetime of most heating equipment is between 15 and 20 years. Most Providence's buildings have HVAC systems that have reached or are close to reaching their projected end of useful life and are being considered for electrification in the near-mid-term. If electrification is not feasible during this timeframe, Providence may delay electrification, but this roadmap assumes that most buildings will be electrified in the near term.

The cost estimates provided in this roadmap reflect only equipment and installation expenses and do not include broader infrastructure improvements or building upgrades that may be required to support these investments. As a result, total project costs may ultimately be higher than those shown, depending on site-specific conditions and implementation requirements.

Heat pumps are eligible for incentives through Rhode Island Energy. Based on the suggestion above, the total cost of the heat pump equipment and installation may be between $0.43 and $0.66 million. Based on current incentive levels through Rhode Island Energy, the net cost after incentives could be between $0.42 and $0.65 million.

Today, the RWP Zoo buildings' utility bills sum to about $0.8 million per year. After doing energy efficiency projects and converting to heat pumps, the utility bills could sum to about $0.6 million per year, saving about $0.2 million per year. If this investment were financed through PowerOptions' Building-Decarbonization-as-a-service (BDaaS) model, Providence would not have to pay for the electrification project upfront; rather, they would have a fixed annual payment for 15 years, in addition to the utility bill costs of $0.6 million per year.[28]

Electrification Impacts	
Total Heat Pump Investment	$0.43-0.66m
Available Heat Pump Incentives	$9.8-13.3k
Net Upfront Heat Pump Cost	$0.42-0.45m
Total HPWH Investment	$0.14m
Available HPWH Incentives	$14k
Net Upfront HPWH Cost	$0.12m
Annual Savings After Completion	$0.2m
Annual CO_2e reduction compared to CY24 baseline	32%

Heat pumps can also be used for water heating, in the form of a domestic heat pump water heater, which transfers heat from the air into the water. Providence currently uses about four natural gas and twenty electric water heaters; these units could be replaced with domestic heat pump water heaters (HPWH) beginning in 2027 with the natural gas heaters, near the end of the units' useful lifetimes. After incentives, these will cost about $0.12 million.

Solar

RWP Zoo facilities were evaluated for rooftop solar photovoltaic (PV) potential based on available roof area and age, orientation, structural suitability, and shading. Through this indicative assessment process, three buildings were identified as candidates and selected for further analysis and modeling. In addition, Parking Lots A and B were analyzed for solar canopy installations and are pictured below (Figure 19), reflecting their potential to support large-scale solar generation. Together, these rooftop and canopy solar opportunities account for a substantial portion of the RWP Zoo's projected greenhouse gas emissions reductions and play a key role in advancing on-site renewable energy generation.

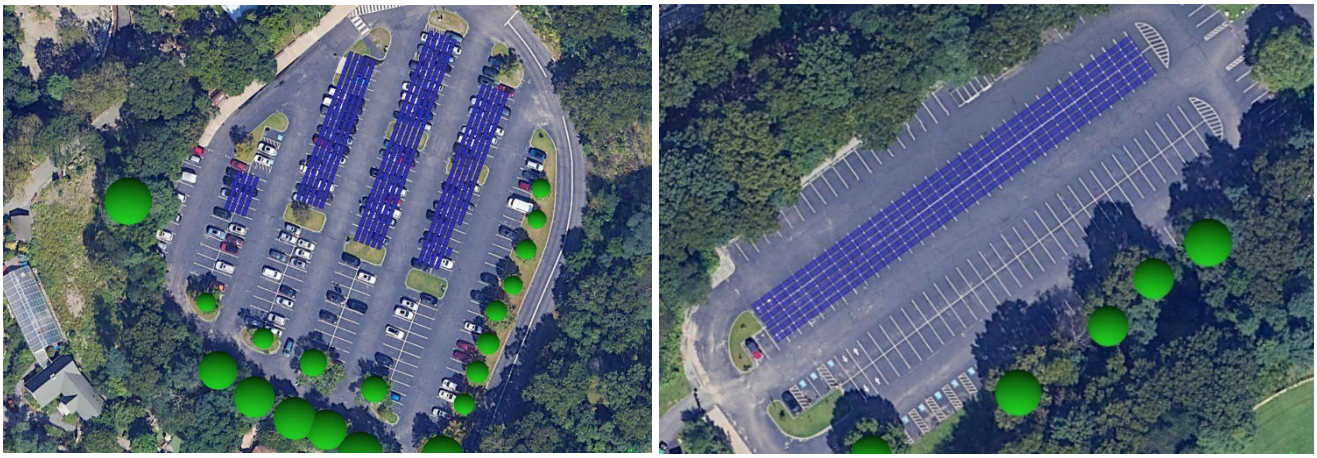
These three rooftop solar arrays are predicted to produce about close to 370 MWh of electricity annually, and the parking lot canopies could generate up to 0.3 million kWh. These arrays could reduce emissions by nearly 900 $MTCO_2e$ through 2040.[29]

Solar Impacts	
Total Investment	$1.7m
Annual Savings After Completion	$65k
Annual Generation (MWh)	370
Annual CO_2e reduction compared to CY24 baseline	5%

[28] Note that federal incentives are also available if the electrification project is paired with energy efficiency projects to reduce the building's total energy consumption by over 25%. Additionally, this estimate does not include the cost to upgrade the electrical service to the building or the cost of removing existing HVAC systems and/or equipment.
[29] This is an indicative assessment and not an executable offer. These cost estimates do not include interconnection fees or roof replacement costs.

The estimated cost to own the three rooftop systems is $0.27 million, and the cost to own the two parking lot canopies is $1.4 million. It is assumed that these projects will not reap the benefits of the Investment Tax Credit (ITC), projects due to uncertainty in future programs that support rooftop installations. The five systems, once built and fully optimized, could save the city nearly $65,000 a year in electricity costs, in addition to the reduction in GHG emissions. These savings total more than $750,000 through 2040.

Figure 19. Preliminary design of solar canopy arrays at Parking Lot A (left) and Parking Lot B (right).

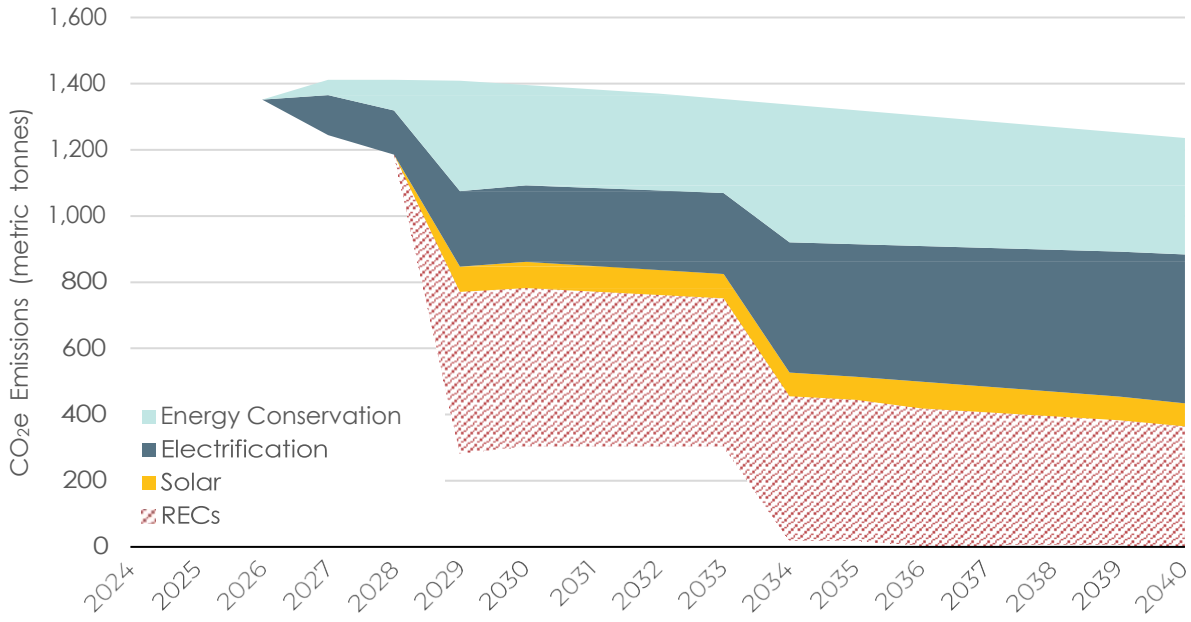


Getting to Net Zero

After completing all energy efficiency projects and installing heat pumps, the RWP Zoo buildings may still need to purchase approximately 3,118 MWh of electricity annually from the grid. It is possible the New England electric grid will be powered by 100% renewable energy, but there is a chance that it will not happen before 2040. In that case, the RWP Zoo's building load may equate to about 365 metric tons of CO_2e emissions remaining in 2040.

Beginning in 2029, the City of Providence is projected to take ownership of off-site Renewable Energy Certificates (RECs) equivalent to approximately 29 million kilowatt-hours (kWh) of renewable electricity generation. For the purposes of this roadmap, RECs were allocated to each administrative division primarily based on building square footage to reflect relative electricity demand, with adjustments made where necessary. The results of this allocation process are depicted below in Figure 20.

Figure 20. Impact of carbon dioxide reduction by type of project, 2024-2040.



Financial Investment and Cost Savings

After incentives, the total investment required to execute the decarbonization of the RWP Zoo buildings is estimated at $3.4 million. The majority of this investment is from solar projects. Of the possible ways to decarbonize Providence's buildings, this is projected to be the most cost-effective way. Depending on future energy prices, the RWP Zoo could save up to $0.26 million by 2040.

Figure 21. Cumulative savings from the RWP Zoo's Decarbonization Scenario, by price case.

Conclusions

The City of Providence's (Providence) municipal- and school-owned buildings present opportunities for reducing greenhouse gas emissions, stabilizing long-term operating costs, and improving indoor and outdoor spaces used by residents, students, and staff. Buildings account for a large portion of Providence's energy use and emissions, driven primarily by aging infrastructure, inefficient building envelopes, and reliance on fossil fuels for heating. The roadmap outlined in this plan utilizes a phased strategy to decarbonize 130 of Providence's buildings distributed across four major Administrative Divisions, while also aligning with Providence's broader climate, equity, and capital planning goals.

The roadmap first prioritizes energy efficiency, followed by electrification of heating systems and broader use of renewable electricity, including onsite solar. Reducing energy demand lowers the size and cost of future heating system upgrades, minimizes operational risk, and can make electrification more cost effective. While these upgrades require upfront capital investment, they significantly reduce long-term energy expenses, protect the city from volatile fossil fuel prices, and lower deferred maintenance costs over time. When assessed on a lifecycle basis (i.e. equipment age and replacement schedules), these investments are expected to both generate net savings and extend the useful life of city buildings.

This approach aligns with Providence's existing planning and policy frameworks, including the city's Climate Justice Plan, capital improvement planning processes, school facilities modernization efforts, and commitments to fiscal responsibility. By pairing decarbonization with routine equipment replacement and scheduled capital projects, rather than treating it as a separate or optional effort, the city can ensure every investment supports both reliable operations and climate goals. This roadmap also helps position Providence to take advantage of the current range of state and utility incentives available for energy efficiency, electrification, and renewable energy projects. It also enables the city to identify economies of scale, opportunities for innovation and public and private partnerships, and to leverage new funding and financing mechanisms.

In addition to emissions and cost savings, building decarbonization can also improve environments used by residents and building occupants. Improved insulation, ventilation, and temperature control create healthier, more comfortable learning environments for students, better working conditions for municipal employees, and more resilient facilities during extreme weather. These advancements result in improved learning, better workforce productivity, and heathier communities. They also support equity by focusing efforts on buildings that are most critical to community services.

This roadmap outlines a decarbonization pathway that modernizes critical infrastructure, reduces long-term costs, improves quality of life, and demonstrates leadership in addressing climate impacts. Through implementation and aligning investments with existing plans, Providence can ensure its municipal and school buildings serve current and future generations efficiently, safely, and sustainably.

Assumptions & Terms

Assumptions

Emissions Factors

Fossil Fuels

Emissions factors for fossil fuels are held constant throughout the roadmap and were derived from the EPA published factors.[30]

Electricity

Electricity emissions factors are sourced from the Boston Building Emissions Reduction and Disclosure Ordinance (BERDO), which uses projected ISO-New England Electric Grid emissions factors, published through the BERDO policies and procedures and updated regularly to support planning and compliance with emissions standards in Boston, and represent estimates based off the New England grid, inclusive of Rhode Island.[31]

The emissions factors used to estimate Scope 2 electricity emissions are based exclusively on projected New England grid-average emissions factors and do not reflect Rhode Island's Renewable Energy Standard (RES) (Table 33).

Energy Efficiency

Energy efficiency measures were identified using a virtual energy audit approach for each building. This analysis incorporated historical energy consumption data, building size, use type, operating schedules, and system characteristics to estimate potential savings from measures such as lighting upgrades, controls improvements, and HVAC system efficiency improvements.

Electrification

Electrification recommendations were developed based on existing heating system characteristics, including equipment age, fuel type, installed capacity, building size, and system configuration (e.g., boiler, furnace, or rooftop unit). Recommended replacement is based off equipment end-of-life and ongoing planning.

Heat Pump Technologies

The roadmap evaluates multiple heat pump technologies:

- **Variable Refrigerant Flow (VRF):** Best suited for buildings with diverse heating and cooling zones and moderate to large floor areas
- **Ducted Air-Source Heat Pumps (ASHP):** Appropriate for buildings with existing ductwork and centralized air distribution
- **Ductless Air-Source Heat Pumps:** Best for smaller buildings or spaces without ductwork
- **Heat Pump Packaged Rooftop Units (RTUs):** Suitable for commercial and institutional buildings with rooftop-mounted HVAC systems

[30] Greenhouse Gas Emissions Technical Reference
[31] BERDO Emissions Factors List - Google Docs

- **Ground-Source Heat Pumps (GSHP):** Most effective for sites with available land, offering high efficiency and long-term operating cost stability

Cost Contingencies and Uncertainty

All costs presented in the roadmap are planning-level estimates intended to inform long-term decision-making. Actual project costs may vary based on site conditions, final system design, market conditions, labor availability, and evolving technology performance and pricing. As heat pump and renewable energy technologies continue to mature, future costs may differ from those assumed in this analysis.

Terms and Definitions

- **Greenhouse Gas (GHG)**: A gas that traps heat in the Earth's atmosphere and contributes to climate warming.
- **Emissions Factor:** A value used to convert energy consumption into associated greenhouse gas emissions[32,33]
- **Scope 1 emissions**: Direct greenhouse gas emissions from sources that are owned or controlled by the city, including fuel combustion in buildings, facilities, and municipal vehicles
- **Scope 2 emissions**: Indirect greenhouse gas emissions associated with the generation of purchased electricity, heating, and cooling consumed by the city.[34]
- **Fossil Fuel:** Energy sources derived from coal, oil, or natural gas that produce carbon emissions when combusted[35]
- **Electricity:** Energy supplied from the regional electric grid, with associated emissions based on generation sources[36,37]
- **MT (Metric Ton):** A unit of mass equal to 1,000 kilograms and is commonly used to quantify greenhouse gas emissions[38]
- **CO_2e (Carbon Dioxide Equivalent):** A metric used to compare emissions from different greenhouse gases based on their global warming potential
- **kWh (Kilowatt-hour):** A unit of electrical energy equal to one kilowatt used for one hour
- **MWh (Megawatt-hour):** Equal to 1,000 kilowatt-hours[39]
- **MMBtu (Million British Thermal Units):** A unit of thermal energy commonly used to measure fuel consumption[40]
- **EUI (Energy Use Intensity):** Annual energy use per square foot of building area, expressed as kBtu/sf/year[41]
- **ITC (Investment Tax Credit):** A federal tax credit that reduces the cost of eligible clean energy technologies, including certain heat pump and renewable energy systems[42,43]
- **REC (Renewable Energy Certificate):** A market-based instrument representing the environmental attributes of one megawatt-hour of renewable electricity generation[44]
- **PV (Photovoltaic):** Technology that converts sunlight directly into electricity[45]
- **BERO (Building Energy Reporting Ordinance)**: Providence's ordinance requiring benchmarking and public reporting of building energy use to support transparency and emissions reductions[46]

[32] U.S. Environmental Protection Agency (EPA), *Greenhouse Gas Emissions Factors Hub*
[33] U.S. Environmental Protection Agency (EPA), *Understanding Global Warming Potentials (GWP)*
[34] World Resources Institute (WRI) and World Business Council for Sustainable Development (WBCSD), *The Greenhouse Gas Protocol: A Corporate Accounting and Reporting Standard*, Revised Edition, Chapter 4.
[35] U.S. Energy Information Administration (EIA), *Energy Explained: Fossil Fuels*
[36] EPA *eGRID (Emissions & Generation Resource Integrated Database)*
[37] ISO New England, *Regional Electricity System and Emissions Data*
[38] U.S. Environmental Protection Agency (EPA), *Units and Conversions for Greenhouse Gas Emissions*
[39] ENERGY STAR Portfolio Manager, *Energy Measurement Units*
[40] U.S. Energy Information Administration (EIA), *Glossary and Energy Units*
[41] ENERGY STAR Portfolio Manager, *EUI Definitions and Benchmarking Methodology*
[42] Internal Revenue Service (IRS), *Clean Energy Investment Tax Credit Guidance*

[43] U.S. Department of Energy (DOE), *Federal Tax Credits for Energy Efficiency and Clean Energy*
[44] U.S. Environmental Protection Agency (EPA), *Green Power Partnership: Renewable Energy Certificates*
[45] National Renewable Energy Laboratory (NREL), *Solar Photovoltaic Technology Basics*

Appendix

Table 29. Decarbonization measures by building.
** Schools currently scheduled for replacement or renovation and full electrification.*
 # Phase 4 Rebuild PVD Schools project.

CY 2024 Overall Ranking	Administrative Division	Building	2024 Emissions (MT CO_2e)	Building Square Footage	Space Heating		Domestic Water Heating		Estimated Cost of Decarbonization		
					Existing (installation year, fuel type)	Replacement (installation year, heat pump type)	Existing (installation year, fuel type)	Replacement (installation year, heat pump type)	Investment Cost ($ million)	Incentives Available ($ million)	Net Investment ($ million)
78	Public Property	Allens Avenue Fire Station	41	9,440	2005, Natural Gas	2027, VRF or other heat pump	2021, Natural Gas	2036, HPWH	$0.227	$0.005	$0.222
59	Public Property	Admiral Street Fire Station	69	12,850	2016, Natural Gas	2036, VRF or other heat pump	2022, Natural Gas	2037, HPWH	$0.303	$0.006	$0.297
57	Public Property	Atwells Avenue Fire Station	77	10,022	2019, Natural Gas	2039, VRF or other heat pump	2013, Natural Gas	2028, HPWH	$0.263	$0.005	$0.258
58	Public Property	Branch Avenue Fire Station	73	14,616	2016, Natural Gas	2026, VRF or other heat pump	2016, Natural Gas	2031, HPWH	$0.390	$0.011	$0.380
68	Public Property	Broad Street Fire Station	58	9,426	2016, Natural Gas	2036, VRF or other heat pump	2013, Natural Gas	2028, HPWH	$0.191	$0.008	$0.182
83	Public Property	Brook Street Fire Station	35	7,580	2000, Natural Gas	2028, VRF or other heat pump	2016, Natural Gas	2031, HPWH	$0.200	$0.008	$0.192
73	Public Property	Hartford Avenue Fire Station	48	9,150	2001, Oil	2028, VRF or other heat pump	2016, Natural Gas	2031, HPWH	$0.248	$0.008	$0.240
72	Public Property	Messer Street Fire Station	51	9,150	1999, Oil	2029, VRF or other heat pump	2016, Natural Gas	2031, HPWH	$0.195	$0.008	$0.186
86	Public Property	Mount Pleasant Avenue Fire Station	29	5,332	2005, Natural Gas	2029, VRF or other heat pump	2020, Natural Gas	2035, HPWH	$0.141	$0.016	$0.125
70	Public Property	North Main Street Fire Station	55	14,760	2016, Natural Gas	2026, VRF or other heat pump	2016, Oil	2031, HPWH	$0.231	$0.004	$0.227
76	Public Property	Reservoir Avenue Fire Station	43	7,360	2005, Oil	2029, VRF or other heat pump	2015, Natural Gas	2030, HPWH	$0.120	$0.003	$0.118
64	Public Property	Providence Emergency Management Agency	64	12,776	2010 & 2024, Natural Gas	2040, HP Packaged Unit (RTU) or	2010, Natural Gas	2029, HPWH	$0.114	$0.003	$0.111

CY 2024 Overall Ranking	Administrative Division	Building	2024 Emissions (MT CO_2e)	Building Square Footage	Space Heating		Domestic Water Heating		Estimated Cost of Decarbonization		
					Existing (installation year, fuel type)	Replacement (installation year, heat pump type)	Existing (installation year, fuel type)	Replacement (installation year, heat pump type)	Investment Cost ($ million)	Incentives Available ($ million)	Net Investment ($ million)
						other heat pump					
5	Public Property	Public Safety Complex	749	119,002	2004, Natural Gas	2027, GSHP or other heat pump	2004, Natural Gas	2027, HPWH	$0.808	$0.251	$0.557
101	Public Property	Peter A. Rocchio District 6 Community Police Sub Station	11	914	2000, Electricity	2027, Ducted ASHP or other heat pump	2000, Natural Gas	2029, HPWH	$0.024	$0.000	$0.024
109	Public Property	Steven M. Shaw District 5 Police Substation	6	546	2005, Natural Gas	2027, Ducted ASHP or other heat pump	2005, Natural Gas	2029, HPWH	$0.020	$0.000	$0.020
33	Public Property	City Hall	204	99,675	2009, Natural Gas	2029, VRF or other heat pump	2009, Electricity (resistance coils)	2029, HPWH	$1.980	$0.070	$1.910
65	Public Property	Providence Police Academy @ Chad Brown Street	61	20,175	2015, Natural Gas	2035, VRF or other heat pump	2023, Natural Gas	2038, HPWH	$0.283	$0.005	$0.278
55	Public Property	Dexter Street Garage	82	17,000	2015, Natural Gas	2035, VRF or other heat pump	2015, Natural Gas	2030, HPWH	$0.309	$0.007	$0.302
54	Public Property	DPW Administration Building	86	20,511	2000, Natural Gas	2029, VRF or other heat pump	2000, Natural Gas	2029, HPWH	$0.402	$0.005	$0.397
53	Public Property	DPW Maintenance, Traffic and Roller Shed	89	110,450	2000, Natural Gas	2027, GSHP or other heat pump	2000, Natural Gas	2027, HPWH	$1.109	$1.095	$0.014
35	Public Property	Providence Police Training Academy @ Academy Ave	196	46,416	2005, Natural Gas	2027, VRF or other heat pump	2005, Natural Gas	2029, HPWH	$0.904	$0.033	$0.872
87	Public Property	Lillian Feinstein Senior Center	24	8,520	2025, Natural Gas	2040, HP Packaged Unit (RTU) or other heat pump	2025, Natural Gas	2040, HPWH	$0.114	$0.002	$0.112
51	Public Property	Department of Communications	91	13,608	2000, Natural Gas	2027, VRF or other heat pump	2000, Natural Gas	2029, HPWH	$0.417	$0.006	$0.411
62	Public Property	A. Vincent Igliozzi	65	15,345	2000, Natural Gas	*New construction*	2000, Natural Gas	*New construction*	$0.27	$0.000	$0.27

CY 2024 Overall Ranking	Administrative Division	Building	2024 Emissions (MT CO_2e)	Building Square Footage	Space Heating		Domestic Water Heating		Estimated Cost of Decarbonization		
					Existing (installation year, fuel type)	Replacement (installation year, heat pump type)	Existing (installation year, fuel type)	Replacement (installation year, heat pump type)	Investment Cost ($ million)	Incentives Available ($ million)	Net Investment ($ million)
		Recreation Center				*and/or electrification underway.* ***Associated costs are for on-site solar only.***		*and/or electrification underway.* ***Associated costs are for on-site solar only.***			
60	Public Property	Vincent Brown Recreation Center	68	18,111	2000, Natural Gas		2000, Natural Gas		$0.20	$0.000	$0.20
49	Public Property	West End Recreation Center	101	25,760	2000, Natural Gas		2000, Natural Gas		$0.24	$0.000	$0.24
81	Public Property	Zuccolo Recreation Center	38	11,592	2000, Natural Gas		2000, Natural Gas		$0.09	$0.000	$0.09
80	Public Property	John H. Rollins Rec Center - Woods ES	41	15,000	2000, Natural Gas		2000, Natural Gas		$0.00	$0.000	$0.00
63	Public Property	Elmwood Community Center	64	16,834	2023, Natural Gas	2040, HP Packaged Unit (RTU) or other heat pump	2023, Natural Gas	2038, HPWH	$0.213	$0.007	$0.206
75	Public Property	Joslin Recreation Center and Resilience Hub	44	11,815	1990, Natural Gas	*New construction and/or electrification underway.* ***Associated costs are for on-site solar only.***	2022, Natural Gas	*New construction and/or electrification underway.* ***Associated costs are for on-site solar only.***	$0.26	$0.000	$0.26
77	Public Property	Davey Lopes Recreation Center	43	11,860	2000, Natural Gas		2000, Natural Gas		$0.16	$0.000	$0.16
92	Public Property	Department of Recreation	18	4,186	2015, Oil	2035, Ducted ASHP or other heat pump	2015, Oil	2030, HPWH	$0.055	$0.001	$0.054
56	Public Property	Madeline Rogers - Selim Recreation Center	81	9,350	2022, Natural Gas	2040, HP Packaged Unit (RTU) or other heat pump	2022, Natural Gas	2037, HPWH	$0.304	$0.004	$0.300
89	Public Property	Sackett Rec Center - Lillian Feinstein ES	20	6,850	2000, Natural Gas	2027, VRF or other heat pump	2000, Natural Gas	2029, HPWH	$0.113	$0.002	$0.111
66	PPSD	AVENTURE	61	25,060	1999, Natural Gas	2027, VRF or other heat pump	2010, Natural Gas	2029, HPWH	$0.478	$0.007	$0.472
11	PPSD	Roger Williams Middle School#	492	135,228	2005, Natural Gas	2028, GSHP or other heat pump	2016, Natural Gas	2028, HPWH	$1.696	$0.422	$1.273

CY 2024 Overall Ranking	Administrative Division	Building	2024 Emissions (MT CO_2e)	Building Square Footage	Space Heating		Domestic Water Heating		Estimated Cost of Decarbonization		
					Existing (installation year, fuel type)	Replacement (installation year, heat pump type)	Existing (installation year, fuel type)	Replacement (installation year, heat pump type)	Investment Cost ($ million)	Incentives Available ($ million)	Net Investment ($ million)
1	PPSD	Hope High School#	1,358	257,089	2010, Natural Gas	2030, GSHP or other heat pump	2010, Natural Gas	2030, HPWH	$1.266	$0.269	$0.997
2	PPSD	Central & Classical High School#	1,333	454,059	2010, Natural Gas	2030, GSHP or other heat pump	2010, Natural Gas	2030, HPWH	$3.279	$0.711	$2.569
22	PPSD	Vartan Gregorian Elementary School#	274	63,000	2000, Natural Gas	2027, VRF or other heat pump	2000, Natural Gas	2029, HPWH	$1.435	$0.018	$1.417
31	PPSD	Anthony Carnevale Elementary School#	214	78,000	2000, Natural Gas	2028, VRF or other heat pump	2000, Natural Gas	2029, HPWH	$0.862	$0.007	$0.855
34	PPSD	E-Cubed Academy#	201	44,600	2004, Natural Gas	2027, Ducted ASHP or other heat pump	2004, Natural Gas	2029, HPWH	$0.670	$0.015	$0.655
4	PPSD	Nathanael Greene Middle School#	756	168,500	2010, Natural Gas	2030, GSHP or other heat pump	2010, Natural Gas	2030, HPWH	$1.191	$0.264	$0.928
15	PPSD	George J. West Elementary School	388	112,030	2010, Natural Gas	2035, GSHP or other heat pump	2010, Natural Gas	2035, HPWH	$1.393	$0.027	$1.366
12	PPSD	William Cooley Sr. High School @ JSEC (Mandela Woods)#	447	110,000	2010, Natural Gas	2030, GSHP or other heat pump	2010, Natural Gas	2030, HPWH	$1.288	$0.173	$1.115
17	PPSD	Dr. Jorge Alvarez High School#	346	88,000	2000, Natural Gas	2027, GSHP or other heat pump	2000, Natural Gas	2027, HPWH	$1.576	$0.152	$1.424
6	PPSD	Nathan Bishop Middle School#	690	136,000	2010, Natural Gas	2030, GSHP or other heat pump	2010, Natural Gas	2030, HPWH	$1.656	$0.175	$1.481
19	PPSD	Veazie Street Elementary School	302	110,000	2022, Natural Gas	2039, GSHP or other heat pump	2012, Natural Gas	2039, HPWH	$1.259	$0.024	$1.234
28	PPSD	Dr. Martin Luther King Elementary School#	222	71,724	2005, Natural Gas	2028, VRF or other heat pump	2005, Natural Gas	2029, HPWH	$1.814	$0.022	$1.792
25	PPSD	Esek Hopkins Middle School	255	87,560	2022, Natural Gas	2039, VRF or other heat pump	2000, Natural Gas	2029, HPWH	$0.465	$0.007	$0.458

CY 2024 Overall Ranking	Administrative Division	Building	2024 Emissions (MT CO_2e)	Building Square Footage	Space Heating		Domestic Water Heating		Estimated Cost of Decarbonization		
					Existing (installation year, fuel type)	Replacement (installation year, heat pump type)	Existing (installation year, fuel type)	Replacement (installation year, heat pump type)	Investment Cost ($ million)	Incentives Available ($ million)	Net Investment ($ million)
10	PPSD	DelSesto Middle School#	507	146,000	2010, Natural Gas	2030, GSHP or other heat pump	2010, Natural Gas	2030, HPWH	$1.696	$0.178	$1.518
3	PPSD	Providence Career & Technical Academy#	878	300,000	2009, Natural Gas	2029, GSHP or other heat pump	2018, Natural Gas	2029, HPWH	$3.326	$0.283	$3.042
21	PPSD	Dr. Robert F. Roberti Administration Building	287	56,744	2000, Natural Gas	2027, VRF or other heat pump	2000, Natural Gas	2029, HPWH	$0.717	$0.014	$0.703
45	PPSD	Leviton Dual Language School - Leviton Annex#	112	40,000	2010, Natural Gas	2030, VRF or other heat pump	2010, Natural Gas	2029, HPWH	$1.227	$0.017	$1.210
#N/A	PPSD	Lillian Feinstein Elementary School @ Sackett Street	180	68,400	2005, Natural Gas	2027, VRF or other heat pump	2005, Natural Gas	2029, HPWH	$0.569	$0.002	$0.568
18	PPSD	Narducci Learning Center	310	86,140	2023, Natural Gas	2039, GSHP or other heat pump	2023, Natural Gas	2039, HPWH	$0.916	$0.005	$0.911
52	PPSD	Reservoir Avenue Elementary School	90	22,000	2005, Natural Gas	2027, VRF or other heat pump	2005, Natural Gas	2029, HPWH	$0.389	$0.003	$0.386
36	PPSD	Robert L. Bailey, IV Elementary School#	181	78,000	2010, Natural Gas	2030, VRF or other heat pump	2010, Natural Gas	2029, HPWH	$1.040	$0.007	$1.033
27	PPSD	Sgt. Cornel Young Jr. & Charlotte Woods Elementary School#	234	103,000	2005, Natural Gas	2027, VRF or other heat pump	2005, Natural Gas	2029, HPWH	$0.523	$0.009	$0.514
74	PPSD	The Family and Community Engagement Center	45	8,700	2010, Natural Gas	2035, VRF or other heat pump	2010, Natural Gas	2029, HPWH	$0.141	$0.002	$0.139
42	PPSD	Webster Avenue Elementary	147	44,290	2005, Natural Gas	2027, VRF or other heat pump	2005, Natural Gas	2029, HPWH	$0.621	$0.006	$0.615
30	PPSD	West Broadway Middle School	216	46,000	2010, Natural Gas	2035, VRF or other heat pump	2010, Electricity (resistance coils)	2029, HPWH	$0.811	$0.013	$0.798

CY 2024 Overall Ranking	Administrative Division	Building	2024 Emissions (MT CO_2e)	Building Square Footage	Space Heating		Domestic Water Heating		Estimated Cost of Decarbonization		
					Existing (installation year, fuel type)	Replacement (installation year, heat pump type)	Existing (installation year, fuel type)	Replacement (installation year, heat pump type)	Investment Cost ($ million)	Incentives Available ($ million)	Net Investment ($ million)
24	PPSD	Carl G. Lauro Elementary School	264	117,482	1990, Natural Gas	2028, GSHP or other heat pump	2010, Electricity (resistance coils)	2028, HPWH	$0.610	$0.184	$0.426
16	PPSD	Pleasant View Elementary School	373	74,800	2022, Natural Gas	2027, GSHP or other heat pump	2015, Natural Gas	2027, HPWH	$0.662	$0.058	$0.604
8	PPSD	The Leviton Complex (Alfred Lima)	537	178,654	1990, Natural Gas	2039, GSHP or other heat pump	2010, Natural Gas	2039, HPWH	$2.155	$0.014	$2.141
23	PPSD	Asa Messer/West Broadway (formerly, Asa Messer ES @ Samuel W. Bridgham)*	271	137,762	*The New Build or Like-New Renovation projects will be built to the NE CHPS v4.0 design standard. They will be all electric, solar ready facilities with zero fossil fuels used on site to fuel the building's primary space heating and hot water mechanical systems.* ***Associated costs are for on-site solar only.***				$1.126	$0.338	$0.788
14	PPSD	Lima/Stuart PK-8 (formerly, Gilbert Stuart Middle School)*	392	85,000					$1.862	$0.559	$1.303
29	PPSD	Harry Kizirian Elementary School*	218	124,603					$0.827	$0.248	$0.579
43	PPSD	Mary E. Fogarty Elementary School*	121	121,838					$1.677	$0.503	$1.174
7	PPSD	Mount Pleasant High School*	668	185,000					$2.106	$0.632	$1.474
32	PPSD	Robert F. Kennedy Elementary School*	208	114,665					$0.994	$0.298	$0.696
new	PPSD	Frank D. Spaziano Middle School	91	39,000	*New building under construction*				*Underway*		
20	PPSD	Frank D. Spaziano Elementary School	291	75,166	*Electrification completed 2023*				$0.780	$0.000	$0.780
9	PPSD	William D'Abate Elementary School	517	55,813					*Underway*		
85	Parks	Roger Williams Park - Dalrymple Boat House	15	17,474	2020, Natural Gas	2040, VRF or other heat pump	2020, Natural Gas	2035, HPWH	$0.217	$0.005	$0.212

CY 2024 Overall Ranking	Administrative Division	Building	2024 Emissions (MT CO_2e)	Building Square Footage	Space Heating		Domestic Water Heating		Estimated Cost of Decarbonization		
					Existing (installation year, fuel type)	Replacement (installation year, heat pump type)	Existing (installation year, fuel type)	Replacement (installation year, heat pump type)	Investment Cost ($ million)	Incentives Available ($ million)	Net Investment ($ million)
48	Parks	Roger Williams Park - Museum of Natural History and Planetarium	103	19,500	2024, Oil	2024, VRF or other heat pump	2024, Electricity (resistance coils)	2039, HPWH	$0.379	$0.008	$0.371
71	Parks	Roger Williams Park - Carousel	54	51,600	2015, Natural Gas	2035, Ducted ASHP or other heat pump	2015, Electricity (resistance coils)	2030, HPWH	$0.014	$0.000	$0.014
61	Parks	Roger Williams Park - The Casino	68	16,782	2021, Natural Gas	2040, VRF or other heat pump	2021, Natural Gas	2036, HPWH	$0.229	$0.005	$0.224
47	Parks	City Center Ice Rink	107	6,373	2025, Natural Gas	2040, Ducted ASHP or other heat pump	2025, Electricity (resistance coils)	2040, HPWH	$0.073	$0.001	$0.071
97	Parks	Esek Hopkins House	13	3,492	2018, Natural Gas	2038, Ducted ASHP or other heat pump	2018, Electricity (resistance coils)	2033, HPWH	$0.047	$0.001	$0.046
107	Parks	Betsey Williams Cottage	6	1,600	2015, Natural Gas	2035, Ducted ASHP or other heat pump	2015, Natural Gas	2030, HPWH	$0.030	$0.000	$0.029
13	Parks	Roger Williams Park - Botanical Center and Mounted Command	396	44,331	2020, Natural Gas	2040, VRF or other heat pump	2020, Natural Gas	2035, HPWH	$0.753	$0.018	$0.735
111	Parks	Roger Williams Park - Gateway and Visitors Center	8	1,463	2022, Electricity	Already electrified	2022, Electricity (resistance coils)	Already electrified	$0.014	$0.000	$0.014
39	Parks	Roger Williams Park - Maintenance Facility	166	27,937	2015, Oil	2035, VRF or other heat pump	2015, Electricity (resistance coils)	2030, HPWH	$0.802	$0.103	$0.699
100	Parks	Garvin House	12	1,500	2005, Oil	2027, Ductless ASHP or other heat pump	2005, Electricity (resistance coils)	2029, HPWH	$0.036	$0.001	$0.035
91	Parks	North Burial Ground Garage	20	3,930	2015, Oil	2035, Ducted ASHP or other heat pump	2015, Electricity (resistance coils)	2030, HPWH	$0.052	$0.001	$0.051

CY 2024 Overall Ranking	Administrative Division	Building	2024 Emissions (MT CO_2e)	Building Square Footage	Space Heating		Domestic Water Heating		Estimated Cost of Decarbonization		
					Existing (installation year, fuel type)	Replacement (installation year, heat pump type)	Existing (installation year, fuel type)	Replacement (installation year, heat pump type)	Investment Cost ($ million)	Incentives Available ($ million)	Net Investment ($ million)
46	Parks	North Burial Ground Greenhouse	106	6,300	2005, Natural Gas	2027, Ducted ASHP or other heat pump	2005, Natural Gas	2029, HPWH	$0.080	$0.001	$0.079
104	Parks	North Burial Ground Visitors Center	7	1,274	2023, Electricity	Already electrified	2023, Electricity (resistance coils)	Already electrified	$0.014	$0.000	$0.014
127	RWP Zoo	African Aviary	2	288	2014, Electricity	2034, Ducted ASHP or other heat pump	2007, Electric	2029, HPWH	$0.005	$0.000	$0.005
119	RWP Zoo	Binturong	3	400	2003, Electricity	2029, Ducted ASHP or other heat pump	2007, Electric	2029, HPWH	$0.007	$0.001	$0.007
123	RWP Zoo	Hornbill	2	324	2014, Electricity	2034, Ducted ASHP or other heat pump	2014, Electric	2029, HPWH	$0.006	$0.001	$0.005
129	RWP Zoo	Small Bird Aviary	1	200	2014, Electricity	2034, Ducted ASHP or other heat pump	2007, Electric	2029, HPWH	$0.004	$0.000	$0.003
88	RWP Zoo	Commissary Building	22	3,240	2007, Electricity	2029, Ducted ASHP or other heat pump	2014, Electric	2029, HPWH	$0.183	$0.007	$0.176
116	RWP Zoo	Cheetah (Formerly Wild Dogs)	4	600	2003, Electricity	2029, Ducted ASHP or other heat pump	No water heating		$0.008	$0.001	$0.007
118	RWP Zoo	Gate 3 Receiving Building	3	480	2014, Electricity	2034, Ducted ASHP or other heat pump	No water heating		$0.002	$0.000	$0.002
130	RWP Zoo	Gate 3 Security Guard Office	0	40	2014, Electricity	2034, Ducted ASHP or other heat pump	No water heating		$0.000	$0.000	$0.000
105	RWP Zoo	Admissions Offices and Gates	7	983	1991, Electricity	2029, Ducted ASHP or other heat pump	No water heating		$0.004	$0.000	$0.004
114	RWP Zoo	Admissions Restroom/Storage Building	5	680	1996, Electricity	2029, Ducted ASHP or other heat pump	No water heating		$0.003	$0.000	$0.003
120	RWP Zoo	Invertebrate Housing 1(Conservation Cabin)	3	396	2002, Electricity	2029, Ducted ASHP or other heat pump	No water heating		$0.002	$0.000	$0.002
121	RWP Zoo	Red River Hog (Formerly Kopje)	3	391	2012, Electricity	2032, Ducted ASHP or other heat pump	No water heating		$0.005	$0.001	$0.004

CY 2024 Overall Ranking	Administrative Division	Building	2024 Emissions (MT CO_2e)	Building Square Footage	Space Heating		Domestic Water Heating		Estimated Cost of Decarbonization		
					Existing (installation year, fuel type)	Replacement (installation year, heat pump type)	Existing (installation year, fuel type)	Replacement (installation year, heat pump type)	Investment Cost ($ million)	Incentives Available ($ million)	Net Investment ($ million)
122	RWP Zoo	Serval	2	361	2024, Electricity	2040, Ducted ASHP or other heat pump	No water heating		$0.001	$0.000	$0.001
128	RWP Zoo	Slice (Formerly River Camp Sweet Shop)	1	216	2020, Electricity	2040, Ducted ASHP or other heat pump	No water heating		$0.001	$0.000	$0.001
38	RWP Zoo	Rainforest Building	176	10,000	2014, Natural Gas	2034, HP Packaged Unit (RTU) or other heat pump	2007, Electric	2029, HPWH	$0.196	$0.024	$0.172
67	RWP Zoo	Children's Zoo Greenhouse	59	2,250	2009, Natural Gas	2029, HP Packaged Unit (RTU) or other heat pump	2003, Electric	2029, HPWH	$0.033	$0.005	$0.028
99	RWP Zoo	Children's Zoo Visitor Center	13	2,562	2007, Natural Gas	2029, HP Packaged Unit (RTU) or other heat pump	2014, Electric	2029, HPWH	$0.037	$0.006	$0.031
115	RWP Zoo	Cones Ice Cream	4	400	2007, Natural Gas	2029, Ducted ASHP or other heat pump	2007, Electric	2029, HPWH	$0.007	$0.001	$0.007
117	RWP Zoo	Farmyard Barn	3	2,400	2014, Natural Gas	2034, Ducted ASHP or other heat pump	2014, Electric	2029, HPWH	$0.037	$0.005	$0.032
84	RWP Zoo	Adaptations (formerly Australasia)	33	4,540	2003, Natural Gas	2029, Ducted ASHP or other heat pump	2007, Electric	2029, HPWH	$0.066	$0.013	$0.052
82	RWP Zoo	Education - Danforth/Mellor Ed Center	37	7,238	2007, Natural Gas	2029, HP Packaged Unit (RTU) or other heat pump	2014, Electric	2029, HPWH	$0.094	$0.019	$0.076
98	RWP Zoo	Education - ZooLab	13	1,324	2003, Natural Gas	2029, Ductless ASHP or other heat pump	2007, Electric	2029, HPWH	$0.023	$0.003	$0.020
103	RWP Zoo	Gibbon Holding	7	392	2014, Natural Gas	2034, Ducted ASHP or other heat pump	2014, Electric	2029, HPWH	$0.007	$0.001	$0.006
106	RWP Zoo	Nourish 401 (Formerly Wilderness Café)	6	1,460	2003, Natural Gas	2029, Ducted ASHP or other heat pump	2007, Electric	2029, HPWH	$0.025	$0.003	$0.021

CY 2024 Overall Ranking	Administrative Division	Building	2024 Emissions (MT CO_2e)	Building Square Footage	Space Heating		Domestic Water Heating		Estimated Cost of Decarbonization		
					Existing (installation year, fuel type)	Replacement (installation year, heat pump type)	Existing (installation year, fuel type)	Replacement (installation year, heat pump type)	Investment Cost ($ million)	Incentives Available ($ million)	Net Investment ($ million)
50	RWP Zoo	Sophie Danforth Administration Building	92	11,232	2007, Natural Gas	2029, VRF or other heat pump	2007, Electric	2029, HPWH	$0.172	$0.027	$0.145
44	RWP Zoo	Vet Hospital	116	7,626	2014, Natural Gas	2034, VRF or other heat pump	2009, Electric	2029, HPWH	$0.184	$0.020	$0.165
108	RWP Zoo	Marco Polo Camel Holding	6	1,176	1996, Natural Gas	2029, Ductless ASHP or other heat pump	2007, Electric	2029, HPWH	$0.021	$0.003	$0.018
96	RWP Zoo	Marco Polo Venice Plaza	15	3,528	2014, Natural Gas	2034, Ductless ASHP or other heat pump	2014, Electric	2029, HPWH	$0.052	$0.007	$0.044
95	RWP Zoo	Flamingo/Anteater Building	16	690	2014, Natural Gas	2034, HP Packaged Unit (RTU) or other heat pump	2007, Natural Gas	2029, HPWH	$0.008	$0.001	$0.007
112	RWP Zoo	Tuskers (Formerly Serengeti Restaurant)	5	1,148	2007, Natural Gas	2029, Ducted ASHP or other heat pump	2014, Natural Gas	2029, HPWH	$0.021	$0.003	$0.018
94	RWP Zoo	Discover The Wild Gift Shop	16	5,000	2007, Natural Gas	2029, HP Packaged Unit (RTU) or other heat pump	2014, Natural Gas	2029, HPWH	$0.067	$0.014	$0.052
26	RWP Zoo	Elephant/Giraffe Holding	255	44,850	2014, Natural Gas	2034, VRF or other heat pump	2007, Natural Gas	2029, HPWH	$0.657	$0.092	$0.565
102	RWP Zoo	Greenhouse/Horticulture	8	1,012	2011, Natural Gas	2029, Ductless ASHP or other heat pump	No water heating		$0.013	$0.002	$0.011
126	RWP Zoo	Marco Polo Moon bear/Snow Leopard Holding	2	1,518	1996, Natural Gas	2029, Ductless ASHP or other heat pump	No water heating		$0.020	$0.003	$0.017
124	RWP Zoo	Polar Bear (a.k.a. Eagles)	2	735	2006, Natural Gas	2029, Ducted ASHP or other heat pump	No water heating		$0.003	$0.000	$0.003
40	RWP Zoo	Tropical America - Lower Level	158	3,750	2007, Natural Gas	2029, Ductless ASHP or other heat pump	No water heating		$0.050	$0.011	$0.038
41	RWP Zoo	Tropical America - Upper Level	158	3,750	2007, Natural Gas	2029, HP Packaged Unit (RTU) or	No water heating		$0.046	$0.011	$0.035

CY 2024 Overall Ranking	Administrative Division	Building	2024 Emissions (MT CO_2e)	Building Square Footage	Space Heating		Domestic Water Heating		Estimated Cost of Decarbonization		
					Existing (installation year, fuel type)	Replacement (installation year, heat pump type)	Existing (installation year, fuel type)	Replacement (installation year, heat pump type)	Investment Cost ($ million)	Incentives Available ($ million)	Net Investment ($ million)
						other heat pump					
79	RWP Zoo	Zebra/Wildebeest/Watusi	41	1,771	2003, Natural Gas	2029, Ducted ASHP or other heat pump	No water heating		$0.023	$0.003	$0.020
110	RWP Zoo	Conservation Holding Building (1)	5	361	2007, Natural Gas	2029, Ducted ASHP or other heat pump	No water heating		$0.001	$0.000	$0.001
125	RWP Zoo	Babirusa Barn	2	416	1999, Natural Gas	2029, Ducted ASHP or other heat pump	No water heating		$0.002	$0.000	$0.002
113	RWP Zoo	Rainforest Annex (Formerly Kangaroo)	5	1,000	2020, Natural Gas	2040, Ductless ASHP or other heat pump	No water heating		$0.013	$0.002	$0.011
69	RWP Zoo	Zoo Stables - Offices and Holding	58	11,500	2007, Natural Gas	2029, Ducted ASHP or other heat pump	2007, Electric	2029, HPWH	$0.163	$0.027	$0.136
93	RWP Zoo	Bongo Building (Holding Facility)	17	2,400	2020, Natural Gas	2040, Ducted ASHP or other heat pump	No water heating		$0.859	$0.005	$0.855
90	RWP Zoo	Sea Lion/Penguin Holding (Moon Bear)	20	4,650	1986, Natural Gas	2029, Ductless ASHP or other heat pump	No water heating		$0.659	$0.013	$0.646

Table 30. Description of each project phase, key projects/schools included, and notes about the phase.

Phase	Description	Key Projects Included	Notes
Phase 1	First wave of major modernization and new construction projects. Delivered early wins and addressed several of the most urgent school needs.	Narducci Learning Center, Frank Spaziano Elementary, D'Abate Elementary, Pleasant View Elementary, Classical HS (Phase I), Hope HS (Phase 1).	All projects completed by 2025. Established early momentum and delivered new swing space (Narducci).
Phase 2	Transition from initial rebuilds to full PK-8 conversions and middle-school modernization. Establishes backbone of updated PK-8 pipeline.	Frank Spaziano Middle School (6-8), Harry Kizirian PK-8, Mary Fogarty PK-8.	Includes schools entering schematic design or early construction, targeted completion between 2026-2027.

Phase	Description	Key Projects Included	Notes
Phase 3	Major expansion of modernized PK-8 and high-school campuses; deep renovations aligned with educational programming and capacity needs.	Lima/Stuart PK-8, Messer/West Broadway PK-8, Mount Pleasant Early College & Career Academy (HS), RFK PK-8.	Represents the district's largest set of active rebuilds; all targeted for 2027 completion.
Phase 4 (Approved)	Largest future wave of capital construction; includes new-built PK-8 campuses, additional high-school modernization work, and a dedicated Pre-K Center.	New / Like-New ($359M): Roger Williams PK-8, Nathanael Greene PK-8, MLK K-5 + ECC, Vartan K-5, Carnevale/DelSesto PK-8, Hope HS (additional scope), Classical HS (additional scope), Pre-K Center.	All approved by city Council + School Building Authority. Not all can be funded immediately-requires prioritization.
Phase 4 (Restore-to-New)	Targeted renovation program focused on stabilizing buildings that do not require full replacement but need system and envelope upgrades.	Central HS, E-Cubed HS, Alvarez HS, Nathan Bishop MS, Bailey ES, Young & Woods ES, JSEC HS, Leviton DL ES, PCTA HS.	~$70M program oriented around essential repairs, EE improvements, and building stabilization.

Table 31. Cost of decarbonization before and after incentives, by year of investment.

Investment Year	Gross Investment (pre-incentives)	Net Up-Front Investment (after incentives)
2024	$286,948	$282,115
2025	$402,369	$281,658
2026	$4,114,856	$3,822,069
2027	$10,861,976	$9,707,696
2028	$6,922,775	$5,770,132
2029	$10,123,446	$8,509,788
2030	$11,377,429	$8,653,727
2031	$71,677	$70,927
2032	$3,707,863	$3,707,836
2033	$38,348	$30,998
2034	$2,163,000	$2,160,912
2035	$7,012,293	$6,972,978
2036	$519,204	$513,384
2037	$223,271	$192,221

2038	$75,800	$74,732
2039	$2,044,798	$2,017,733
2040	$1,377,521	$1,346,301
TOTAL	$61,323,574	$54,115,205

Table 32. On-site solar projects and results of indicative solar assessment.

Administrative Division	Building Name	On-site Solar Assessment	Current Roof Age	Proposed Year of Installation	Proposed Size (kW)
Public Property	Allens Avenue Fire Station	Formal assessment recommended	2001	2027	11.48
Public Property	Admiral Street Fire Station	Formal assessment recommended	2001	2027	20.83
Public Property	Atwells Avenue Fire Station	Formal assessment recommended	2012	2037	28.9
Public Property	Branch Avenue Fire Station	Formal assessment recommended	2001	2027	30.6
Public Property	Broad Street Fire Station	Roof fund unsuitable for solar in indicative assessment	2001		
Public Property	Brook Street Fire Station	Formal assessment recommended	2001	2027	11.05
Public Property	Hartford Avenue Fire Station	Formal assessment recommended	2001	2027	16.58
Public Property	Messer Street Fire Station	Formal assessment recommended	2001	2027	18.28
Public Property	Mount Pleasant Avenue Fire Station	Formal assessment recommended	2012	2037	12.75
Public Property	North Main Street Fire Station	Formal assessment recommended	2012	2037	44.2
Public Property	Reservoir Avenue Fire Station	Roof fund unsuitable for solar in indicative assessment	2001		
Public Property	Providence Emergency Management Agency	Roof fund unsuitable for solar in indicative assessment	2010		
Public Property	Public Safety Complex	Formal assessment recommended	2004	2025	150.7
Public Property	Peter A. Rocchio District 6 Community Police Sub Station	Roof fund unsuitable for solar in indicative assessment	2005		
Public Property	Steven M. Shaw District 5 Police Substation	Roof fund unsuitable for solar in indicative assessment	TBD		
Public Property	City Hall	Formal assessment recommended	1992	2027	30.6
Public Property	Providence Police Academy @ Chad Brown Street	Roof fund unsuitable for solar in indicative assessment	2015		
Public Property	Dexter Street Garage	Roof fund unsuitable for solar in indicative assessment	2010		
Public Property	DPW Administration Building	Formal assessment recommended	2000	2027	36.13
Public Property	DPW Maintenance, Traffic and Roller Shed	Roof fund unsuitable for solar in indicative assessment	2000		
Public Property	Providence Police Training Academy @ Academy Ave	Roof fund unsuitable for solar in indicative assessment	2000		

Administrative Division	Building Name	On-site Solar Assessment	Current Roof Age	Proposed Year of Installation	Proposed Size (kW)
Public Property	Lillian Feinstein Senior Center	Formal assessment recommended	2025	2049	10.63
Public Property	Department of Communications	Formal assessment recommended	1995	2027	56.1
Public Property	A. Vincent Igliozzi Recreation Center	Formal assessment recommended	1996	2027	100.73
Public Property	Vincent Brown Recreation Center	Formal assessment recommended	1996	2027	74.38
Public Property	West End Recreation Center	Formal assessment recommended	1996	2027	88.4
Public Property	Zuccolo Recreation Center	Formal assessment recommended	2025	2049	31.88
Public Property	John H. Rollins Rec Center - Woods ES	Roof fund unsuitable for solar in indicative assessment	2000		
Public Property	Elmwood Community Center	Roof fund unsuitable for solar in indicative assessment	2025		
Public Property	Joslin Recreation Center and Resilience Hub	Formal assessment recommended	2022	2042	94.56
Public Property	Davey Lopes Recreation Center	Formal assessment recommended	1985	2027	57.8
Public Property	Department of Recreation	Roof fund unsuitable for solar in indicative assessment	2000		
Public Property	Madeline Rogers - Selim Recreation Center	Formal assessment recommended	2005	2030	66.3
Public Property	Sackett Rec Center - Lillian Feinstein ES	Roof fund unsuitable for solar in indicative assessment	2010		
PPSD	AVENTURE	Formal assessment recommended	1999	2032	24.06
PPSD	Roger Williams Middle School	Formal assessment recommended	2005	2032	96.24
PPSD	Hope High School	Formal assessment recommended	2010	2035	144.36
PPSD	Central & Classical High School	Formal assessment recommended	2010	2035	288.72
PPSD	Vartan Gregorian Elementary School	Formal assessment recommended	2000	2032	288.72
PPSD	Anthony Carnevale Elementary School	Formal assessment recommended	2000	2032	168.42
PPSD	E-Cubed Academy	Roof fund unsuitable for solar in indicative assessment	2004		
PPSD	Nathanael Greene Middle School	Formal assessment recommended	2010	2035	96.24
PPSD	George J. West Elementary School	Formal assessment recommended	2010	2035	120.3
PPSD	William Cooley Sr. High School @ JSEC (Mandela Woods)	Formal assessment recommended	2010	2035	264.66

Administrative Division	Building Name	On-site Solar Assessment	Current Roof Age	Proposed Year of Installation	Proposed Size (kW)
PPSD	Dr. Jorge Alvarez High School	Formal assessment recommended	2000	2032	240.6
PPSD	Nathan Bishop Middle School	Formal assessment recommended	2010	2035	120.3
PPSD	Veazie Street Elementary School	Formal assessment recommended	2005	2032	144.36
PPSD	Dr. Martin Luther King Elementary School	Formal assessment recommended	2005	2030	443.27
PPSD	Esek Hopkins Middle School	Formal assessment recommended	2000	2032	72.18
PPSD	DelSesto Middle School	Formal assessment recommended	2010	2035	192.48
PPSD	Providence Career & Technical Academy	Formal assessment recommended	2009	2034	505.26
PPSD	Dr. Robert F. Roberti Administration Building	Formal assessment recommended	2000	2032	72.18
PPSD	Leviton Dual Language School - Leviton Annex	Formal assessment recommended	2010	2035	144.36
PPSD	Lillian Feinstein Elementary School @ Sackett Street	Formal assessment recommended	2005	2032	96.24
PPSD	Narducci Learning Center	Formal assessment recommended	2023	2026	217.9
PPSD	Reservoir Avenue Elementary School	Formal assessment recommended	2005	2032	48.12
PPSD	Robert L. Bailey, IV Elementary School	Formal assessment recommended	2010	2035	216.54
PPSD	Sgt. Cornel Young Jr. & Charlotte Woods Elementary School	Roof fund unsuitable for solar in indicative assessment	2005		
PPSD	The Family and Community Engagement Center	Formal assessment recommended	2010	2035	24.06
PPSD	Webster Avenue Elementary	Formal assessment recommended	2022	2039	96.24
PPSD	West Broadway Middle School	Formal assessment recommended	2010	2035	24.06
PPSD	Carl G. Lauro Elementary School	Roof fund unsuitable for solar in indicative assessment	2015		
PPSD	Pleasant View Elementary School	Formal assessment recommended	2022	2047	72.18
PPSD	The Leviton Complex (Alfred Lima)	Formal assessment recommended	2020	2045	553.38
PPSD	Asa Messer/W. Broadway PK-8	Formal assessment recommended	2027	2028	481.29
PPSD	Lima/Stuart PK-8	Formal assessment recommended	2027	2029	795.76
PPSD	Harry Kizirian PK-8	Formal assessment recommended	2027	2029	353.38
PPSD	Mary Fogarty PK-8	Formal assessment recommended	2027	2029	716.75

Administrative Division	Building Name	On-site Solar Assessment	Current Roof Age	Proposed Year of Installation	Proposed Size (kW)
PPSD	Mount Pleasant High School	Formal assessment recommended	2028	2030	900.00
PPSD	Robert F. Kennedy PK-8	Formal assessment recommended	2028	2030	424.70
PPSD	Spaziano Middle School	Formal assessment recommended	2023	2026	273.40
PPSD	Frank D. Spaziano Elementary School	Underway or planned			
PPSD	William D'Abate Elementary School				
Parks	Roger Williams Park - Dalrymple Boat House	Roof fund unsuitable for solar in indicative assessment	2005		
Parks	Roger Williams Park - Museum of Natural History and Planetarium	Roof fund unsuitable for solar in indicative assessment	2005		
Parks	Roger Williams Park - Carousel	Roof fund unsuitable for solar in indicative assessment	2005		
Parks	Roger Williams Park - The Casino	Roof fund unsuitable for solar in indicative assessment	2005		
Parks	City Center Ice Rink	Roof fund unsuitable for solar in indicative assessment	2005		
Parks	Esek Hopkins House	Roof fund unsuitable for solar in indicative assessment	2005		
Parks	Betsey Williams Cottage	Roof fund unsuitable for solar in indicative assessment	2005		
Parks	Roger Williams Park - Botanical Center and Mounted Command	Roof fund unsuitable for solar in indicative assessment	2005		
Parks	Roger Williams Park - Gateway and Vistors Center	Roof fund unsuitable for solar in indicative assessment	2023		
Parks	Roger Williams Park - Maintenance Facility	Formal assessment recommended	2005	2026	110.9
Parks	Garvin House	Roof fund unsuitable for solar in indicative assessment	2005		
Parks	North Burial Ground Garage	Roof fund unsuitable for solar in indicative assessment	2005		
Parks	North Burial Ground Greenhouse	Roof fund unsuitable for solar in indicative assessment	2005		
Parks	North Burial Ground Visitors Center	Roof fund unsuitable for solar in indicative assessment	2005		

Administrative Division	Building Name	On-site Solar Assessment	Current Roof Age	Proposed Year of Installation	Proposed Size (kW)
RWP Zoo	African Aviary	Roof fund unsuitable for solar in indicative assessment	2024		
RWP Zoo	Binturong	Roof fund unsuitable for solar in indicative assessment	n/a		
RWP Zoo	Hornbill	Roof fund unsuitable for solar in indicative assessment	2023		
RWP Zoo	Small Bird Aviary	Roof fund unsuitable for solar in indicative assessment	2024		
RWP Zoo	Commissary Building	Formal assessment recommended	2019	2036	48.12
RWP Zoo	Cheetah (Formerly Wild Dogs)	Roof fund unsuitable for solar in indicative assessment	n/a		
RWP Zoo	Gate 3 Receiving Building	Roof fund unsuitable for solar in indicative assessment	2019		
RWP Zoo	Gate 3 Security Guard Office	Roof fund unsuitable for solar in indicative assessment	2019		
RWP Zoo	Admissions Offices and Gates	Roof fund unsuitable for solar in indicative assessment	1991		
RWP Zoo	Admissions Restroom/Storage Building	Roof fund unsuitable for solar in indicative assessment	1996		
RWP Zoo	Invertebrate Housing 1(Conservation Cabin)	Roof fund unsuitable for solar in indicative assessment	2002		
RWP Zoo	Red River Hog (Formerly Kopje)	Roof fund unsuitable for solar in indicative assessment	2012		
RWP Zoo	Serval	Roof fund unsuitable for solar in indicative assessment	2024		
RWP Zoo	Slice (Formerly River Camp Sweet Shop)	Roof fund unsuitable for solar in indicative assessment	n/a		
RWP Zoo	Rainforest Building	Formal assessment recommended	2018	2036	24.06
RWP Zoo	Children's Zoo Greenhouse	Roof fund unsuitable for solar in indicative assessment	2011		
RWP Zoo	Children's Zoo Visitor Center	Roof fund unsuitable for solar in indicative assessment	2011		
RWP Zoo	Cones Ice Cream	Roof fund unsuitable for solar in indicative assessment	2017		

Administrative Division	Building Name	On-site Solar Assessment	Current Roof Age	Proposed Year of Installation	Proposed Size (kW)
RWP Zoo	Farmyard Barn	Roof fund unsuitable for solar in indicative assessment	2014		
RWP Zoo	Adaptaions (formerly Australasia)	Roof fund unsuitable for solar in indicative assessment	1977		
RWP Zoo	Education - Danforth/mellor Ed Center	Roof fund unsuitable for solar in indicative assessment	1995		
RWP Zoo	Education - Zoolab	Roof fund unsuitable for solar in indicative assessment	1992		
RWP Zoo	Gibbon Holding	Roof fund unsuitable for solar in indicative assessment	2004		
RWP Zoo	Nourish 401 (Formerly Wilderness Café)	Roof fund unsuitable for solar in indicative assessment	1993		
RWP Zoo	Sophie Danforth Administration Building	Roof fund unsuitable for solar in indicative assessment	1985		
RWP Zoo	Vet Hospital	Formal assessment recommended	2010	2030	24.06
RWP Zoo	Marco Polo Camel Holding	Roof fund unsuitable for solar in indicative assessment	1996		
RWP Zoo	Marco Polo Venice Plaza	Roof fund unsuitable for solar in indicative assessment	1995		
RWP Zoo	Flamingo/Anteater Building	Roof fund unsuitable for solar in indicative assessment	2018		
RWP Zoo	Tuskers (Formerly Serengeti Restaurant)	Roof fund unsuitable for solar in indicative assessment	2005		
RWP Zoo	Discover The Wild Gift Shop	Roof fund unsuitable for solar in indicative assessment	1890		
RWP Zoo	Elephant/Giraffe Holding	Roof fund unsuitable for solar in indicative assessment	1989		
RWP Zoo	Greenhouse/Horticultur e	Roof fund unsuitable for solar in indicative assessment	2011		
RWP Zoo	Marco Polo Moonbear/Snow Leopard Holding	Roof fund unsuitable for solar in indicative assessment	1996		
RWP Zoo	Polar Bear (a.k.a. Eagles)	Roof fund unsuitable for solar in indicative assessment	1977		
RWP Zoo	Tropical America - Lower Level	Roof fund unsuitable for solar in indicative assessment	1936		

Administrative Division	Building Name	On-site Solar Assessment	Current Roof Age	Proposed Year of Installation	Proposed Size (kW)
RWP Zoo	Tropical America - Upper Level	Roof fund unsuitable for solar in indicative assessment	1936		
RWP Zoo	Zebra/Wildebeest/Watusi	Roof fund unsuitable for solar in indicative assessment	n/a		
RWP Zoo	Conservation Holding Building (1)	Roof fund unsuitable for solar in indicative assessment	n/a		
RWP Zoo	Babirusa Barn	Roof fund unsuitable for solar in indicative assessment	1999		
RWP Zoo	Rainforest Annex (Formerly Kangaroo)	Roof fund unsuitable for solar in indicative assessment	n/a		
RWP Zoo	Zoo Stables - Offices and Holding	Roof fund unsuitable for solar in indicative assessment	2002		
RWP Zoo	Bongo Building (Holding Facility)	Formal assessment recommended	n/a		
RWP Zoo	Sea Lion/Penguin Holding (Moon Bear)	Formal assessment recommended	1986		
RWP Zoo	Parking Lot A	Formal assessment recommended	Canopy	2029	144.36
RWP Zoo	Parking Lot B	Formal assessment recommended	Canopy	2029	96.24

Table 33. Comparative table summarizing both the grid-only emissions factors and an alternative RES-adjusted scenario, which illustrates electricity-related emissions declining to zero beginning in 2033 under the RES requirements.[47,48]

Year	Projected Grid Emissions Factor (kg CO_2e/MWh)[49]	RI Renewable Energy Standard (%)	RES-Adjusted Emissions Factor (kg CO_2e/MWh)
2022	270.0	19.0	218.7
2023	263.0	23.0	202.5
2024	256.0	28.0	184.3
2025	249.0	34.0	164.3
2026	242.0	41.0	142.8
2027	265.0	48.0	137.8
2028	265.0	55.5	117.9
2029	264.0	63.5	96.4
2030	259.0	72.0	72.5
2031	254.0	81.0	48.3
2032	249.0	90.5	23.7
2033	243.0	100.0	0.0
2034	237.0	100.0	0.0
2035	231.0	100.0	0.0
2036	224.0	100.0	0.0
2037	217.0	100.0	0.0
2038	211.0	100.0	0.0
2039	204.0	100.0	0.0
2040	198.0	100.0	0.0
2041	192.0	100.0	0.0
2042	187.0	100.0	0.0
2043	182.0	100.0	0.0
2044	177.0	100.0	0.0
2045	173.0	100.0	0.0
2046	168.0	100.0	0.0
2047	163.0	100.0	0.0
2048	159.0	100.0	0.0
2049	155.0	100.0	0.0
2050	150.0	100.0	0.0

[47] RI Energy 25-05-EL (2025 RES Factor) Ord25311.pdf
[48] 2025 Final Policies and Procedures
[49] Used in roadmap emissions projections