

Local Law 97 Implementation Action Plan

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NYC
DCAS
Citywide Administrative
Services



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Fellow New Yorkers,

Climate change is the most pressing issue facing the future of our planet, and the City of New York and the NYC Department of Citywide Administrative Services (DCAS) are at the forefront in tackling the climate crisis. Without immediate, drastic, and sustained reductions in greenhouse gas emissions, we face a future of irreversible warming that will increase the frequency and intensity of catastrophic events like coastal flooding, flash flooding, and heatwaves. This is why we must act, and we must act now.

Building upon many years of landmark work addressing the climate crisis, the City of New York passed Local Law 97 of 2019 (LL97), a groundbreaking piece of legislation to help mitigate climate change. LL97 sets New York City on the path to becoming carbon neutral by 2050, including setting near-term emissions reduction mandates for city government. The law requires that the City achieve a 40% reduction in annual emissions by 2025 and 50% by 2030 for city government operations, compared to a 2006 baseline. This Local Law 97 Implementation Action Plan offers a clear roadmap for how we will achieve these ambitious goals in tandem with the City's other emissions reduction and energy mandates and commitments.

DCAS is uniquely positioned to serve as a leader in achieving the City's climate goals and delivering on this plan. DCAS provides shared services to support the operations of city government, including overseeing energy management for all City facilities, managing the City's vehicle fleet, directly operating over 50 large public buildings and 15 million square feet of real estate, handling city government procurement, and performing other essential functions.

This Action Plan, among other critical steps, calls for:

- Scaling up investments in cost-effective emissions reduction opportunities.
- Achieving a 20% reduction in building energy consumption by 2030.
- Converting more municipal buildings' heating to electric power.
- Expanding solar installations on City properties to generate 100MW of solar power annually by 2025.
- Sourcing 100% of electricity used by city government from renewable sources by 2026.
- Investing in energy and emissions projects at wastewater and water treatment facilities.
- Purchasing electric vehicles and renewable fuels for the City's vehicle fleet.

The measures outlined in this plan will also have a ripple effect. Implementation of this plan will help the City achieve other policy goals, such as enhancing social infrastructure, improving public health, and further developing the market for renewable energy and energy efficiency technologies.

Taking these steps will require significant resources and extraordinary effort by many entities and partners across the City. To support achievement of the City's core emissions reduction and energy mandates and commitments, including LL97, the City has dedicated nearly \$4 billion over the next 9 years to invest in its assets, facilities and energy supply. The result of this work will be dramatic emissions reductions from City operations and improved conditions in City buildings, providing a model for what cities across the globe can do to tackle climate change by operating better and smarter.

Sincerely,



Dawn M. Pinnock

Acting Commissioner

NYC Department of Citywide Administrative Services

Executive Summary



1 Centre Street | Source: DCAS

Executive Summary

New York is a city on the forefront of climate action. Under Mayor Bill de Blasio’s leadership, New York City has divested its pension funds from fossil fuels and invested in climate solutions, committed to net-zero emissions by 2050, and worked to decarbonize the City’s electricity, transportation and building systems. Because nearly 70% of New York City’s emissions come from the fossil fuels used to heat, cool, and power our buildings, improving building energy efficiency and reducing building-based emissions is a top priority in the fight against climate change.

In 2019, Mayor de Blasio signed the landmark Climate Mobilization Act, an ambitious set of bills passed by the New York City Council to curb the worst effects of climate change. The centerpiece of this legislation is Local Law 97 (LL97), which sets near-term greenhouse gas (GHG) emissions reduction targets for the city government portfolio and private-sector buildings.

LL97 sets forth a portfolio-based approach for city government operations, whereby the City is mandated to achieve a 40% reduction in emissions from city government operations by 2025 and a 50% reduction by 2030¹, using a baseline year of 2006. These mandates bolster and add new urgency to the City’s longstanding commitment to climate change mitigation, reflecting our growing understanding of the consequences of climate change and the imminent need to dramatically curtail emissions.

Plan Overview

Compliance with LL97 requires significantly scaling up emissions reduction efforts across city government operations, which encompasses the City’s portfolio of assets over which it has control. The LL97 Implementation Action Plan (the Action Plan) will help the City—led by DCAS and its agency partners—act upon LL97. In addition to mapping a clear path to achieve the City’s LL97 mandated emissions reductions, the Action Plan meets other near-term policy mandates and commitments, and establishes a trajectory beyond 2030 that is necessary to meet the longer-term mandates and commitments² identified in Figure 1. In this context, near-term refers to 2030 or before, while longer-term refers to 2031 to 2050.







DCAS staff training agency personnel in load management practices | Source: DCAS



1 The City’s fiscal year (FY) begins July 1 and ends June 30 of the following calendar year (CY). In this report, all years represent fiscal years (e.g., “2025” represents Fiscal Year 2025), unless they are specifically stated to represent calendar years.

2 Mandates are codified by law, and commitments are policies described in published plans or mayoral announcements.

Policy objectives focused on city government operations

Mandate 	Commitment 	Mandate 	Commitment 
Emission reductions of 40% by 2025 and 50% by 2030 for city government operations (LL97 mandates)	100% of electricity for city government operations from renewable sources by 2025 (100% renewable electricity)	Emissions reductions of 80% by 2050 for city government operations (80x50)	Carbon neutrality by 2050 for city government operations (100x50)
Source: <i>Local Law 97 of 2019</i>	Source: <i>2021 State of the City</i>	Source: <i>Local Law 66 of 2014</i>	Source: <i>OneNYC 2019</i>

Policy objectives focused on City buildings

Commitment 	Commitment 
20% energy consumption reduction for City Buildings by 2025 (20% energy reduction)	100MW of solar on City assets by 2025 (100MWx25)
Source: <i>1.5 Degree Plan</i>	Source: <i>One City: Built to Last</i>

Policy objectives focused on City non-building asset categories



Commitment 	Commitment 
Net-zero energy consumption at wastewater resource recovery facilities by 2050	Reduce fleet fossil fuel consumption 50% by 2025 and 80% by 2035
Source: <i>OneNYC 2015</i>	Source: <i>NYC Fleet Sustainability Plan</i>

Figure 1: City’s Core Emissions Reduction and Energy Mandates and Commitments

This report includes four sections: (1) Plan Context and NYC’s Emissions Reductions Progress to Date, (2) Plan Vision and Development, (3) Plan Findings and Recommendations, and (4) Required Implementation Support. The report is designed to assist a range of stakeholders, including, but not limited to, agency energy management staff implementing work in the field, City and agency leadership seeking information about the actions required to achieve LL97, City staff developing energy policy and legislation and allocating budgetary resources, and members of the public interested in understanding the City’s path forward.

Plan Vision and Development

Plan Vision

The Action Plan balances three considerations—policy compliance, technical and practical feasibility, and cost—to identify a plan for the City to achieve the emissions reductions required to meet LL97 mandates and other emissions reduction and energy mandates and commitments shown in Figure 1. Related to both the policy compliance and cost considerations, the City’s investments in assets and facilities to achieve energy and emissions reductions have further co-benefits which help the City achieve other policy goals as discussed in the Plan Vision section of the report.

Plan Development

Scope

LL97 sets forth emissions reduction mandates for city government operations. Under the law’s definition, city government operations include “operations, facilities, and other assets that are owned or leased by the City for which the City pays all or part of the annual energy bills.”

City government operations consist of three major asset categories: buildings, non-building stationary assets, and non-stationary assets. The asset categories were cross-referenced to different City Government Inventory sectors identified within the Inventory of New York City Greenhouse Gas Emissions³, which is the City’s definitive source for emissions data at both the Citywide and City government levels. Figure 2 summarizes the connections between City asset categories and sectors in the context of the Action Plan.

The Action Plan evaluated emissions reduction opportunities (EROs) for all asset categories at a high level but focused on identifying EROs within the buildings asset category (buildings), which is functionally equivalent to the buildings sector in the City Government Inventory.⁴ Buildings were selected as a focus of the Action Plan as the buildings sector is the largest single contributor to emissions from city government operations, representing 66% of emissions in 2019. The Action Plan evaluated the assets of 24 City agencies, accounting for the vast majority of energy consumption within buildings. The full list of agencies included in the Action Plan is found in the Appendix: Section C.

In addition to the asset categories comprising city government operations, the Action Plan considered emissions reduction opportunities associated with the City’s electricity supply, which serves as a source of energy and thereby emissions for all City asset categories. The Action Plan considers two major actions affecting the electricity supply: (1) expected changes in the emissions intensity of the electricity grid supplying New York City due to factors outside of the City’s direct control and (2) the procurement of large-scale renewables (LSR) in relation to the electricity supply for city government operations. In the context of this report, expected declines in the emissions intensity of the electricity grid supplying New York City are referred to by the term cleaner electricity grid.

3 The [Inventory of New York City Greenhouse Gas Emissions](#) includes both a Citywide Inventory and a City Government Inventory.

4 In contrast, the Non-Building Stationary Assets category includes four sectors, and the Non-Stationary Assets category includes two sectors.

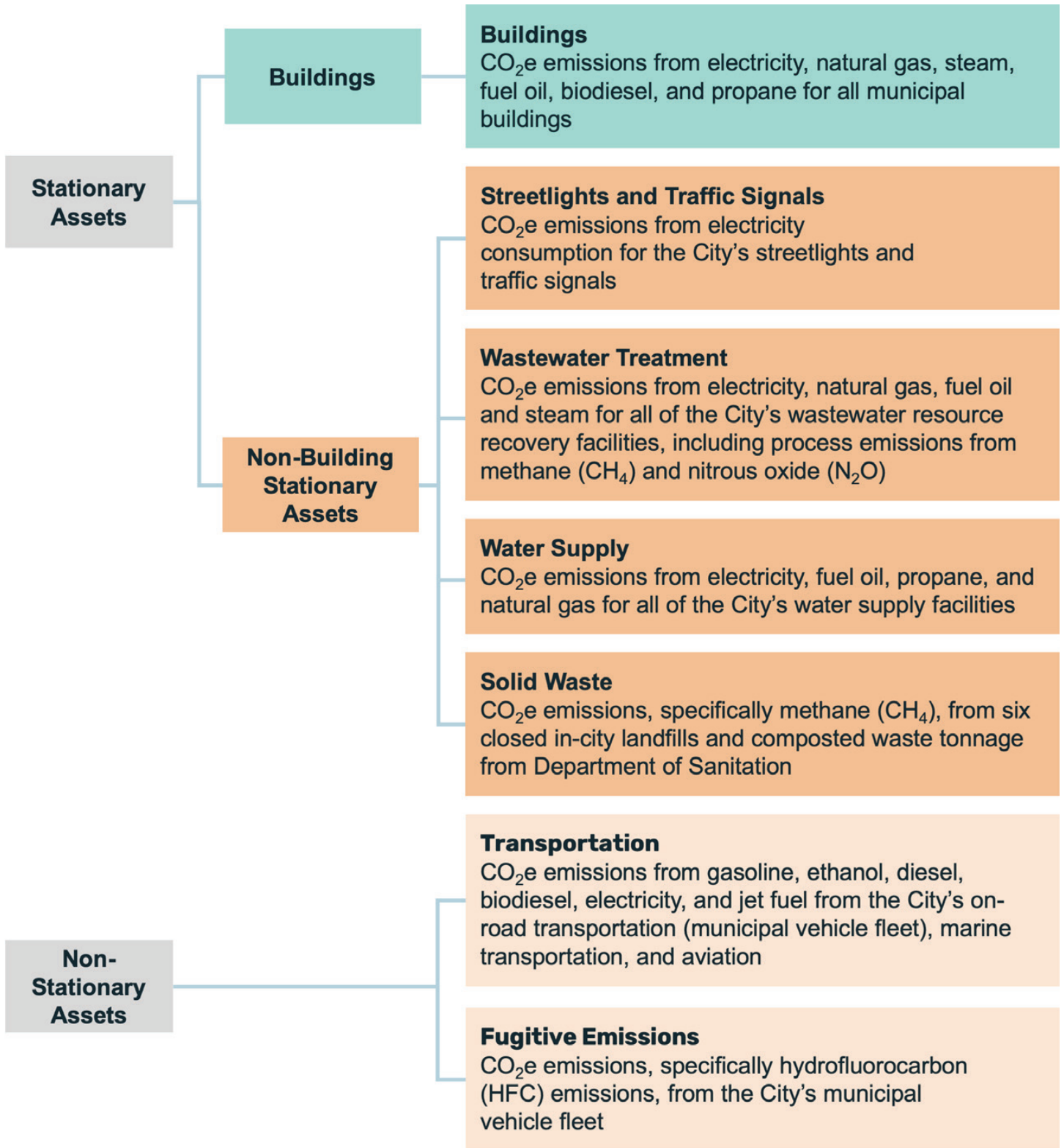
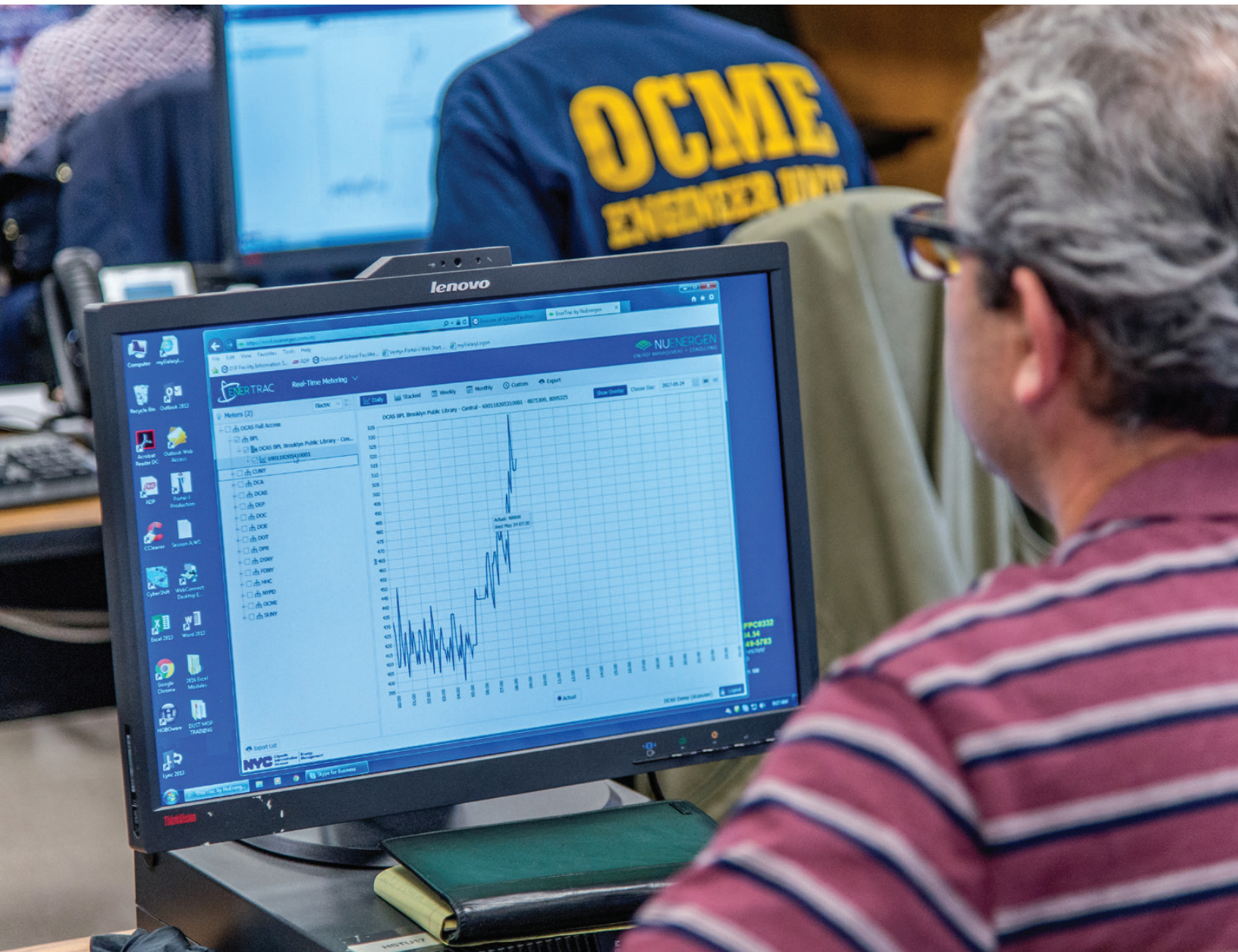


Figure 2: Action Plan Scope: Asset Categories and Sectors

As established by the law, the LL97 compliance deadlines are 2025 and 2030, with 2006 serving as the emissions baseline year against which the required total annual emissions reductions are measured for each compliance deadline. Consequently, there are two key LL97 compliance periods that are considered within the Action Plan. The first LL97 compliance period is 2022 to 2025, during which the focus is on the actions the City must take now to reach a 40% reduction from the baseline by 2025. The second LL97 compliance period is 2026 to 2030, during which the focus is on the actions the City must start planning for now and implementing shortly to reach a 50% reduction by 2030. The Action Plan identifies the actions necessary during both LL97 compliance periods (i.e., 2022 to 2025 and 2026 to 2030) to put the City on a sustainable path towards complying with longer-term emissions reductions mandates and commitments; however, it does not extensively review the actions required after 2030.



Agency staff studying real-time electricity metering technology | Source: DCAS

Methodology

The Action Plan was developed through an analytical process comprising four steps: (1) Agency Building Segmentation; (2) Emissions Reduction Opportunity Assessment; (3) City Emissions Reduction Scenario Analysis; and (4) City Buildings Pathways Development. Figure 3 summarizes the main analyses performed in each step, with a more detailed description of the methodology provided in Section 2 of this report.

Step	Analyses Performed
1. Agency Building Segmentation	<ul style="list-style-type: none"> ■ Segmented agencies' building portfolios to identify a set of major building types that collectively represent 74% of energy consumption in buildings. ■ Developed prototype building energy models for the major building types to represent their typical operations and energy usage, so the impacts of different EROs could be examined in later steps.
2. Emissions Reduction Opportunity Assessment	<ul style="list-style-type: none"> ■ Identified EROs that are applicable to buildings and developed their implementation costs to help understand which EROs are relatively cost-effective to implement. ■ Identified EROs that are applicable to the non-building asset categories (i.e., non-building stationary assets and non-stationary assets) and developed their implementation costs. ■ Identified electricity supply actions and developed their implementation costs.
3. City Emissions Reduction Scenario Analysis	<ul style="list-style-type: none"> ■ Developed and evaluated multiple scenarios, which represent a range of possible emissions futures for the City based on emissions reductions achieved from the electricity supply and non-building asset categories. ■ For each scenario, identified the remaining emissions reductions required from buildings – after accounting for the contributions from the electricity supply and non-building asset categories – to achieve LL97 mandates and comply with other emissions reduction and energy mandates and commitments.
4. City Buildings Pathways Development	<ul style="list-style-type: none"> ■ For each scenario, evaluated the EROs required to achieve the emissions reductions required from buildings, as well as the impact of such EROs on the City's compliance with other emissions reduction and energy mandates and commitments. ■ Identified a recommended buildings pathway, which performs well against the plan's three considerations – policy compliance, technical and practical feasibility, and cost – which was carried forward into agency target-setting and agency-specific pathways development.

Figure 3: Overview of Action Plan Methodology

Plan Findings and Recommendations

Action Plan Overview and Performance Against Vision

The Action Plan puts forth an anticipated City emissions reduction scenario in combination with a recommended buildings pathway. The anticipated scenario (reference case) estimates emissions reductions achieved by the electricity supply and non-building asset categories in 2025 and 2030. This analysis makes it possible to determine the remaining emissions reductions required from buildings to comply with near-term emissions reduction and energy mandates and commitments.

The Action Plan—consisting of the recommended buildings pathway in combination with the reference case—meets the plan vision of balancing policy compliance, technical and practical feasibility, and cost considerations. It positions the City to achieve its near-term emissions reduction and energy mandates and commitments, including the LL97 mandates, and establishes a trajectory to deep decarbonization. However, reflecting feasibility and cost considerations, it does not have the City achieve the 20% energy consumption reduction commitment over an extended period, reaching it by 2030 instead of 2025. Doing so improves feasibility and cost-effectiveness by enabling the selection of relatively cost-effective EROs⁵ with longer project delivery timelines and spreading out what would otherwise be a high level of near-term spending project activity.

Action Plan Components

Reference Case

For changes in electricity supply, the reference case assumes (1) the electricity grid supplying New York City becomes cleaner, achieving a 50% emissions reduction by 2030 and (2) the City procures LSR to achieve its commitment to 100% renewable electricity, with the City beginning the LSR procurement in 2026 and continuing it beyond 2030. The City has made substantial progress towards LSR procurement, having recently signed a letter of intent in partnership with NYSERDA to pursue a joint purchase of Clean Energy Standard (CES) Renewable Energy Certificates (RECs) associated with delivery of renewable energy into Zone J of the New York Control Area.

For actions in non-building asset categories, the reference case assumes that all available EROs for non-building stationary assets and non-stationary assets that have a start date in the four years from the start of 2022 through the end of 2025 will be implemented. Such EROs include, but are not limited to, the use of biogas cogeneration at wastewater resource recovery facilities (WRRFs) and the procurement of renewable diesel for the City's vehicle fleet. These interventions are further described in Section 2.

⁵ Relatively cost-effective EROs are defined for the Action Plan as emissions reduction opportunities with a lifetime marginal abatement cost that is less than that of the estimated large-scale renewables REC marginal abatement cost. Relatively-cost effective EROs are selected in order of lowest cost, to fulfill remaining emission reduction needs.

Recommended Buildings Pathway

The recommended buildings pathway is comprised of four major interventions: (1) planned energy efficiency projects, (2) investment in on-site solar, (3) heat electrification initiative, and (4) additional energy efficiency projects. Figure 4 summarizes each recommended intervention. More details on interventions are provided in Section 2.

Recommended Buildings Pathway Interventions	
Planned Energy Efficiency Projects	The recommended buildings pathway includes completion of the City’s planned energy efficiency projects for buildings. These are projects that are funded and planned to be initiated in the four years from the start of 2022 through the end of 2025.
Investment in On-Site Solar	The recommended buildings pathway includes solar installations required to achieve the City’s commitment to install 100 MW of solar PV on City assets by 2025.
Heat Electrification Initiative	The recommended buildings pathway includes pursuit of electrification opportunities in buildings where feasible to realize emissions reductions associated with displacing fuel use for heating. It is based on a target to complete building heating system electrification projects in City buildings so as to steadily ramp up to a pace of 2% of City building square footage per year by 2030. The City will initiate the first set of projects at the start of 2023, so that those projects produce full-year emissions reductions by the start of 2026. This pace is necessary to position the City to further accelerate achievement of 80x50 and carbon neutrality.
Additional Energy Efficiency Projects	The recommended buildings pathway includes completion of additional relatively cost-effective EROs as they become available across the 2022 to 2025 and 2026 to 2030 compliance periods.

Figure 4: Summary of Recommended Buildings Pathway Interventions

Action Plan Emissions Reduction Impacts

Emissions Reduction Impacts from Full Action Plan

The Action Plan focuses on emissions reductions to be achieved for city government operations from 2022 to 2030. From 2006 to 2019, the City achieved a 23% reduction in annual emissions for its operations. With full implementation of the Action Plan, consisting of the actions included under the reference case and buildings pathway, the City is expected to realize an incremental 17% reduction by 2025 and an additional incremental 27% reduction by 2030, thereby bringing its total reduction in annual emissions to 40% by 2025 and 67% by 2030.

The Action Plan thus puts the City in a position to achieve the 40% LL97 emissions reduction mandate by 2025 and to exceed the 50% LL97 emissions reduction mandate by 2030. However, it is critical to emphasize that the City will only realize these expected reductions and meet its objectives if all actions included under both the recommended buildings pathway and reference case are accomplished on time. Further complicating the situation, not all the actions under the reference case lie within the City's full control. For example, the City is reliant on significant efforts by other entities, such as the State and utilities, to transform the grid. For this reason, the Action Plan includes planned overachievement of the 50% LL97 mandate for 2030 to manage risk and help the City remain on track even if planned emissions reductions from any individual asset category or the electricity supply over 2022 to 2030 are delayed or subject to lower achievement.

Figure 5 presents the breakdown for how emissions reductions will be achieved under the Action Plan by showing the contributions made by each asset category, as well as by the electricity supply via both a cleaner electricity grid and LSR procurement.

- For 2022 to 2025, interventions in buildings (under the recommended buildings pathway) are expected to deliver emissions reductions of 184,000 MTCO₂e (equal to a 5% reduction from the 2006 baseline). In addition, actions in non-building assets (under the reference case) are expected to deliver emissions reductions of 305,000 MTCO₂e (an 8% reduction from the 2006 baseline), with 137,000 MTCO₂e from specific EROs in non-building stationary assets and 168,000 MTCO₂e from specific EROs in non-stationary assets. A cleaner electricity grid (under the reference case), is expected to contribute 167,000 MTCO₂e of reductions (a 4% reduction from the 2006 baseline).⁶ These emissions reductions are combined with a modest gain (19,000 MTCO₂e) in emissions from forecasted portfolio and energy consumption growth. The resulting net emissions impact is an incremental 16% reduction from baseline, yielding a 40% reduction in emissions by 2025.
- From 2026 to 2030, interventions in buildings are expected to deliver emissions reductions of 100,000 MTCO₂e (a 3% reduction from the 2006 baseline), In addition, actions in non-building assets (under the reference case) are expected to deliver 49,000 MTCO₂e (a 1% reduction from the 2006 baseline), with 31,000 MTCO₂e from non-building stationary assets and 18,000 MTCO₂e from non-stationary assets. A cleaner electricity grid is expected to provide emissions reductions of 100,000 MTCO₂e (a 3% reduction from the 2006 baseline). Finally, LSR procurement adds significant emissions reductions of 806,000 MTCO₂e (a 21% reduction from the 2006 baseline). Combined with a modest gain (8,000 MTCO₂e) in emissions from forecasted portfolio and energy consumption growth, the net emissions impact is an incremental 27% reduction for 2026 to 2030 from baseline, yielding the 67% total reduction by 2030.

⁶ The reference case electric grid emissions factor used within the Action Plan assumes that electricity in New York state is 50% renewable by 2030 (50x30). The forecast assumes that the grid emissions factor begins to decline starting in 2019, and therefore some emissions reductions attributed to cleaner electricity grid in 2025 are achieved prior to the start of the Action Plan. The electric grid emissions factor forecast does not fluctuate due to specific generation or decommissioning projects (e.g., Indian Point closure). Rather the electric grid emissions forecast follows a smooth trajectory through both compliance periods, mirroring the pattern of the emissions reduction forecast used as the reference case from Pathways to Carbon-Neutral NYC (2021) report. However, the reference case grid emissions factor used within the Action Plan assumes that New York State achieves a 50x30, as a conservative assumption, while the reference case from Pathways to Carbon-Neutral NYC assumes New York State achieves 70x30.

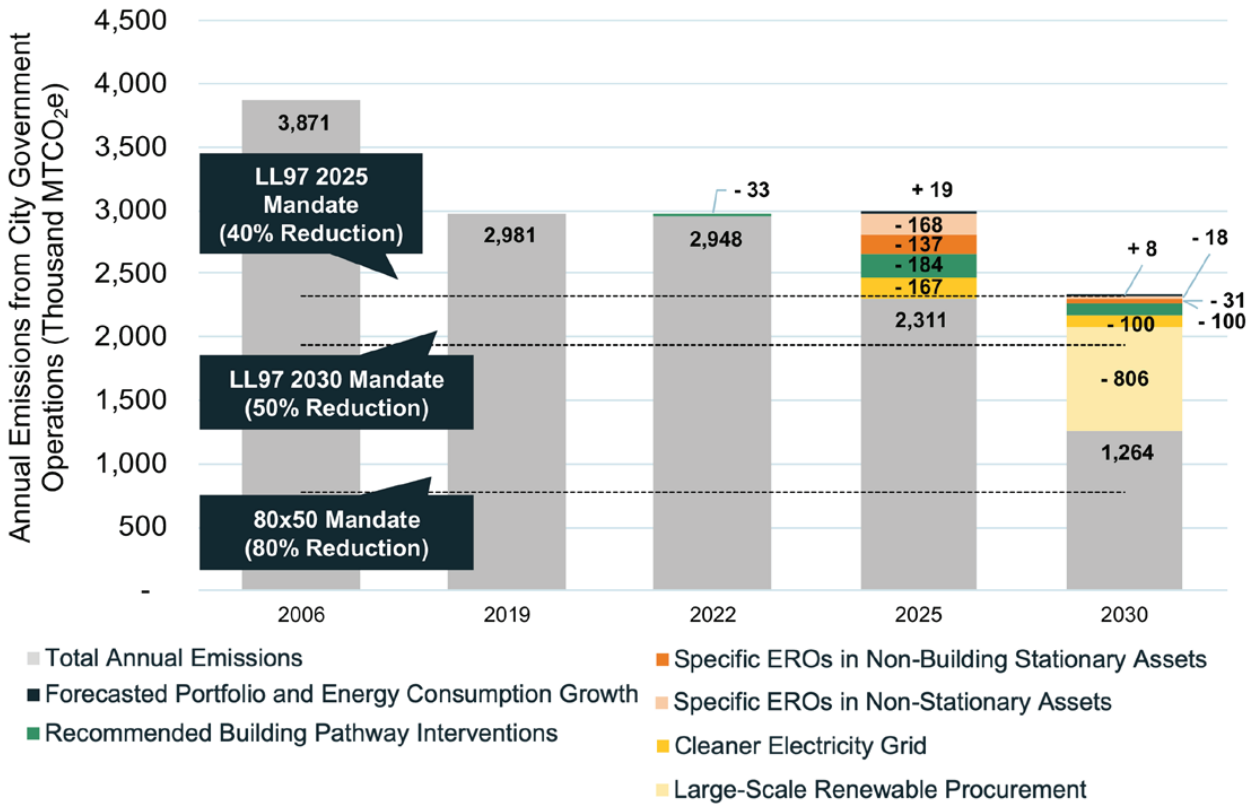


Figure 5: Annual Emissions from City Government Operations Under Action Plan⁷

Emissions Reduction Impacts from Changes in Electricity Supply and Actions in Non-Building Assets

For electricity supply, the combination of LSR procurement with a cleaner electricity grid⁸ emissions reductions of 1,073,000 MTCO₂e by 2030; of these 267,000 MTCO₂e (25%) come from a cleaner electricity grid, while 806,000 MTCO₂e (75%) come from LSR procurement.

For non-building assets, specific EROs in non-building stationary assets and in non-stationary assets collectively yield 354,000 MTCO₂e in annual emissions reductions by 2030; of these, 168,000 MTCO₂e (47%) come from non-building stationary assets, while 186,000 MTCO₂e (53%) come from non-stationary assets.

Emissions Reduction Impacts from Building Interventions

Through the interventions included in the recommended buildings pathway, the City is expected to realize annual emissions reductions of 284,000 MTCO₂e by 2030. Existing planned energy efficiency contributes 128,000 MTCO₂e (45%) of the total from buildings, while the heat electrification initiative and additional energy efficiency projects provide 52,000 (18%) and 83,000 (29%) MTCO₂e, respectively. The remaining 20,000 MTCO₂e of emissions reductions comes from investments in on-site solar, accounting for 7% of the total.

⁷ The annual emissions reduction values have been rounded to the nearest thousand MTCO₂e. Due to rounding, values presented may not add up precisely.

⁸ The term “cleaner electricity grid” reflects expected declines in the emissions intensity of the electricity grid supplying New York City, which will impact emissions generated by all asset categories, due to their use of electricity

Figure 6 shows the emissions reductions associated with all Action Plan components.

Action Plan Annual Emissions Reductions	Annual Emissions Reductions (Thousand MTCO ₂ e)		
	2022-2025	2026-2030	Total 2022-2030
Reference Case			
Cleaner Electricity Grid	167	100	267
Large-Scale Renewables Procurement	-	806	806
Subtotal: Changes in Electricity Supply	167	906	1,073
Specific EROs in Non-Building Stationary Assets	137	31	168
Specific EROs in Non-Stationary Assets	168	18	186
Subtotal: Actions in Non-Building Assets	305	49	354
Recommended Buildings Pathway Interventions			
Planned Energy Efficiency Projects	83	46	128
Investment in On-site Solar	20	- ⁹	20
Heat Electrification Initiative	-	52	52
Additional Energy Efficiency Projects	81	2	83
Subtotal: Buildings Interventions	184	100	284
Total Annual Emissions Reductions	656	1,054	1,710

Figure 6: Summary of Action Plan Annual Emissions Reductions¹⁰

⁹ The Action Plan is focused on achieving the City's 100MW on-site solar installation goal by 2025. As a result, emissions reductions from on-site solar remain constant after 2025. It is anticipated that the City will continue to install solar PV to achieve further emissions reductions and meet potential future goals. Achievement beyond 100MW on-site solar was not included in the Action Plan.

¹⁰ The annual emissions reduction values in thousand MTCO₂e, represent total annual emissions reductions achieved in the last year of the compliance period referenced. The values have been rounded to the nearest thousand metric tons. Due to rounding, values presented may not add up precisely to the totals provided.

Action Plan Required Investments

Required Investments for the Full Action Plan

In total, required City investments to implement the Action Plan are projected to be \$3.68 billion from 2022 to 2030, comprised of \$1.66 billion from 2022 to 2025 and \$2.02 billion from 2026 to 2030. The City has already committed funds at the scale of investment required to implement the Action Plan. The majority of these investments (\$2.54 billion, or 69%) are expected to be directed towards interventions in buildings through the implementation of the recommended buildings pathway. The remaining investments (\$1.14 billion, or 31%) are focused on achieving the emissions reductions for the electricity supply and non-building assets included under the reference case. Of the \$1.14 billion, LSR accounts for \$737 million (65%) and actions in non-building assets account for \$404 million (35%).

Figure 7 presents the required investments for the Action Plan, showing the costs of changes to the electricity supply and actions affecting non-building assets under the reference case and interventions in buildings under the recommended buildings pathway.

- For 2022 to 2025, required investments in buildings (under the recommended buildings pathway) are expected to be \$1.37 billion (equal to 82% of total Action Plan required investments for that period). In addition, required investments in non-building assets (under the reference case) are expected to be \$292 million (17%), with \$242 million associated with specific EROs in non-building stationary assets and \$50 million associated with specific EROs in non-stationary assets.
- From 2026 to 2030, required investments in buildings are expected to be \$1.17 billion (equal to 58% of investments for that period). Required investments in non-building assets (under the reference case) are expected to be \$112 million (6%), with \$55 million associated with non-building stationary assets and \$57 million with non-stationary assets. In addition, LSR procurement adds investments of \$737 million (36%).

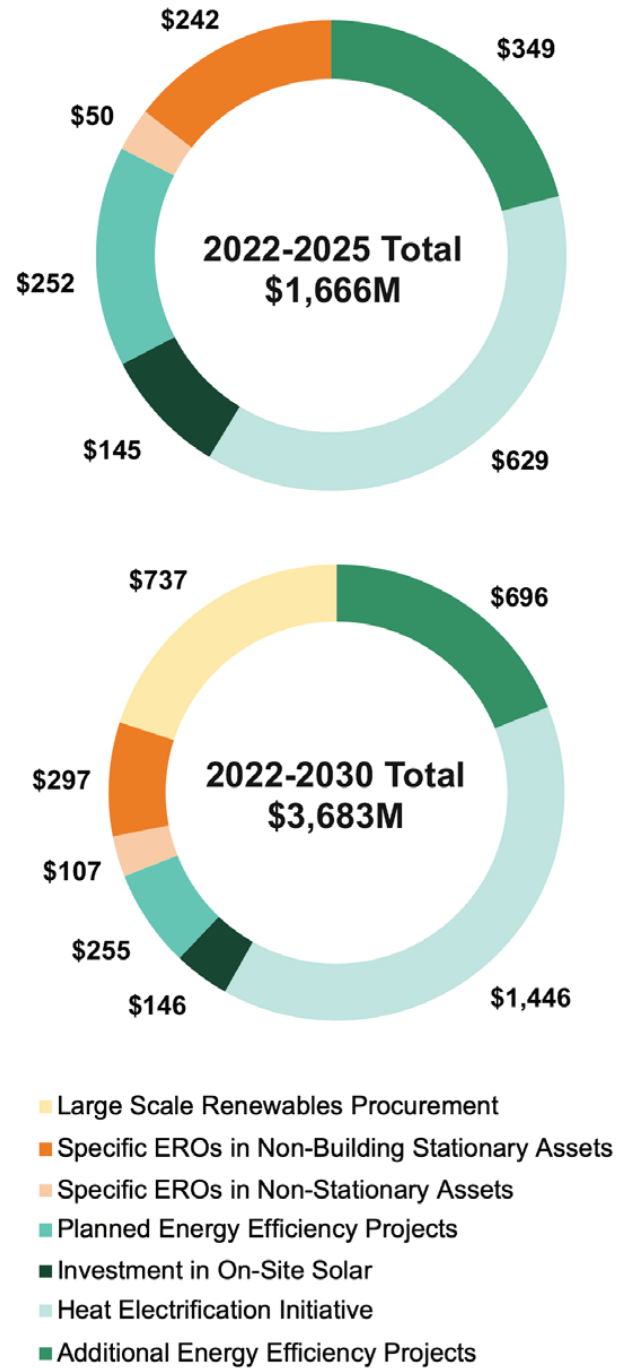


Figure 7: Investment Required by Intervention Type

Required Investments for Changes in Electricity Supply and Actions in Non-Building Assets

For the electricity supply, the required City investments are expected to be \$737 million, comprising 20% of total Action Plan investments from 2022 to 2030. These investments represent the funds required for LSR procurement starting in 2026. The Action Plan does not estimate the cost of investments required to achieve a cleaner electricity grid supplying New York City. Those costs will be planned by other entities, lie outside the City's direct control, and are ultimately paid through utility rates. These costs will ultimately be reflected in overall energy supply costs under the City's utility energy budget, which is also referred to as the Heat, Light, and Power Budget.

For non-building assets, the required investments are expected to be \$404 million, comprising 11% of total Action Plan investments from 2022 to 2030. These investments represent the funds required to implement specific EROs in both non-building stationary assets and non-stationary assets. From 2022 to 2030, 73% of investments for non-building assets are directed towards non-building stationary assets, compared to 27% for non-stationary assets. Non-building stationary assets assume a higher level of investment in the first compliance period (2022 to 2025) because of a robust pipeline of existing planned projects during this time period.

Required Investments for Building Interventions

- The required City investments to achieve the emissions reductions for buildings included under the recommended buildings pathway are projected to be \$2.54 billion from 2022 to 2030. Overall, the heat electrification initiative is the single largest driver of investments from 2022 to 2030, accounting for \$1.45 billion (57%) of total investments in buildings over the full period. Planned energy efficiency projects and additional energy efficiency projects account for another \$951 million (37%), while solar installations comprise \$146 million (6%).
- For 2022 to 2025, investments flow to all building interventions, with \$601 million (43% of investments in buildings for that period) going towards planned and additional energy efficiency projects, \$145 million (11%) going towards solar installations, and \$629 million (46%) going to the heat electrification initiative.
- For 2026 to 2030, investments are focused on the heat electrification initiative, with \$817 million going towards that intervention (70% of investments in buildings for that period). During that period, the City will also invest \$347 million in additional energy efficiency projects (30%). The City's investments in planned energy efficiency projects and solar installations are expected to decrease as it completes most of its planned projects and meets its 100MWx25 solar objective. The City will spend \$3 million on existing planned energy efficiency projects and \$1 million on solar installations (less than 1% of investments in buildings for that period when combined).

Figure 8 below presents the required investments for the Action Plan. The City has already committed funds at the scale of investment required to implement the Action Plan.

Action Plan Investments	Investments (\$, in millions)		
	2022-2025	2026-2030	Total 2022-2030
Reference Case			
Cleaner Electricity Grid	Not costed within Action Plan	Not costed within Action Plan	Not costed within Action Plan
Large-Scale Renewables Procurement	-	737	737
Subtotal: Changes in Electricity Supply	-	737	737
Specific EROs in Non-Building Stationary Assets	242	55	297
Specific EROs in Non-Stationary Assets ¹¹	50	57	107
Subtotal: Actions in Non-Building Assets	292	112	404
Recommended Buildings Pathways Interventions			
Planned Energy Efficiency Projects	252	3	255
Investment in On-site Solar	145	1	146
Heat Electrification Initiative	629	817	1,446
Additional Energy Efficiency Projects	349	347	696
Subtotal: Buildings Interventions	1,375	1,168	2,543
Total Required Investments	1,666	2,017	3,683

Figure 8: Summary of Action Plan Investments¹²

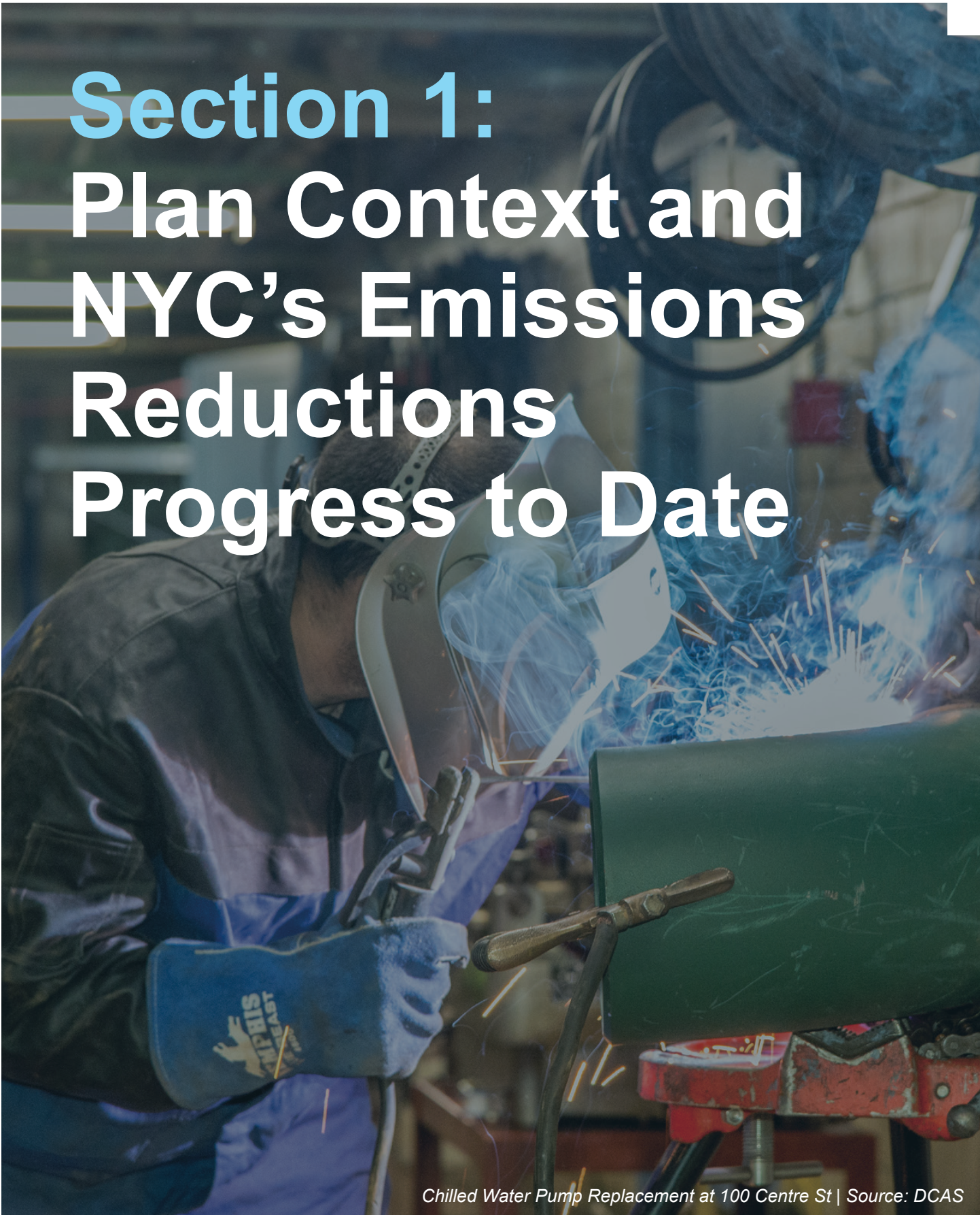
Required Implementation Support

The Action Plan sets forth specific initiatives, consisting of policy and operational changes, that will be required to help the City achieve the planned emissions reductions. These initiatives fall into five categories: (1) accountability infrastructure; (2) human capital; (3) project implementation support; (4) integrated capital planning; and (5) optimized building operations.

¹¹ As of September 2021, these estimated investments were provisional and under development.

¹² Investment values have been rounded to the nearest \$1 million and discounted to reflect the time value of money. Due to rounding, values presented may not add up precisely to the totals provided.

Section 1: Plan Context and NYC's Emissions Reductions Progress to Date



Chilled Water Pump Replacement at 100 Centre St | Source: DCAS

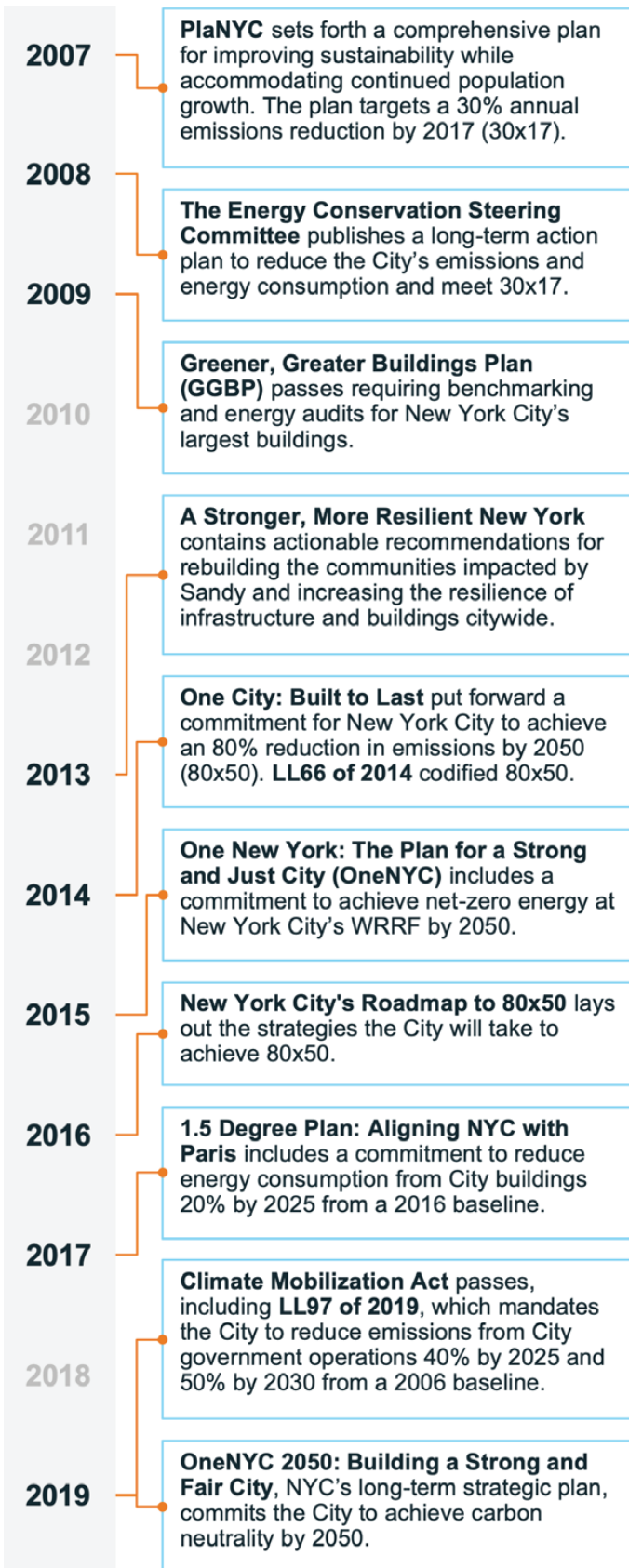


Figure 9: Timeline of New York City's Climate Action Leadership

NYC's History of Climate Action

In August 2021, the International Panel on Climate Change (IPCC) released their Sixth Assessment (AR6), which found that humans have unequivocally caused changes to the climate system that are unprecedented over many centuries. We are already seeing the effects of these changes in more frequent and extreme weather patterns, such as heat waves, heavy precipitation, and tropical storms. According to AR6, without deep reductions in emissions over the coming decades, we will exceed global warming of 1.5°C within the 21st century, resulting in devastating and irreversible changes for centuries to millennia.¹³ These findings add increased urgency to New York City's efforts to reduce greenhouse gas emissions. Preventing warming from exceeding 1.5°C will require reaching at least net-zero CO₂ emissions by 2050, as well as rapid and sustained reductions in leakage of CH₄ and other high global warming potential gases.

New York City has been at the forefront of climate action for nearly 15 years, and LL97 is part of a long trajectory of energy and sustainability planning and associated legislation that began in 2007 with New York City's first comprehensive sustainability strategy, PlaNYC. Figure 9 presents a timeline of NYC's climate action leadership, with key milestones including the release of OneNYC: The Plan for a Strong and Just City, the 80x50 Pathways Report, and the 1.5 Degree Plan.

¹³ More information about IPCC AR6 available at: https://www.ipcc.ch/report/ar6/wg1/downloads/report/IPCC_AR6_WGI_SPM.pdf

The City's efforts to achieve LL97 and other core emissions reduction and energy mandates and commitments are taking place in tandem with the transition occurring at the state level. For example, New York State's CES requires 70% of New York's electricity to come from renewable energy sources by 2030¹⁴, and the Climate Leadership and Community Protection Act (CLCPA) targets 100% zero-emission electricity by 2040.¹⁵ The State's clean energy transition has significant overlap with the City's commitment to achieve 100% renewable electricity by 2025, because the State has indicated prioritization of the delivery of clean energy into New York City to directly displace fossil fuel generation. The City has announced an intent to partner with the State on a joint purchase of clean electricity delivered into New York City¹⁶, which will have the combined benefit of satisfying the City's intent to procure enough electricity to power 100% of government operations and supporting the State's efforts to reduce statewide emissions.

The Action Plan development began in August 2020 with foundational analysis that focused on understanding the drivers of change for the City's emissions reduction progress to date. The 2019 Inventory of New York City Greenhouse Gas Emissions was the latest available GHG inventory data at the time of analysis and was used as the basis for the Action Plan.



Department of Sanitation staff reviewing performance of HVAC equipment via digital interface | Source: DCAS

14 More information about New York's Clean Energy Standard available at: <https://www.nysed.gov/all-programs/programs/clean-energy-standard>

15 More information about New York's Climate Leadership and Community Protection Act available at: <https://www.nysed.gov/all-programs/programs/clean-energy-standard>

16 Press release available at: <https://www1.nyc.gov/office-of-the-mayor/news/281-21/recovery-all-mayor-de-blasio-major-step-forward-towards-purchase-large-scale>

NYC's Emissions Reduction Progress to Date

For city government operations overall, the City has achieved a 23% reduction in annual emissions through 2019 from a 2006 baseline. The City's emissions reduction progress over time is shown in Figure 10. Under the 23% emissions reduction for overall city government operations, different asset categories have experienced greater or lesser declines. Annual emissions from buildings have been reduced by 21% from baseline, annual emissions from non-building stationary assets have decreased by 35%, and annual emissions from non-stationary assets have decreased by 4%.

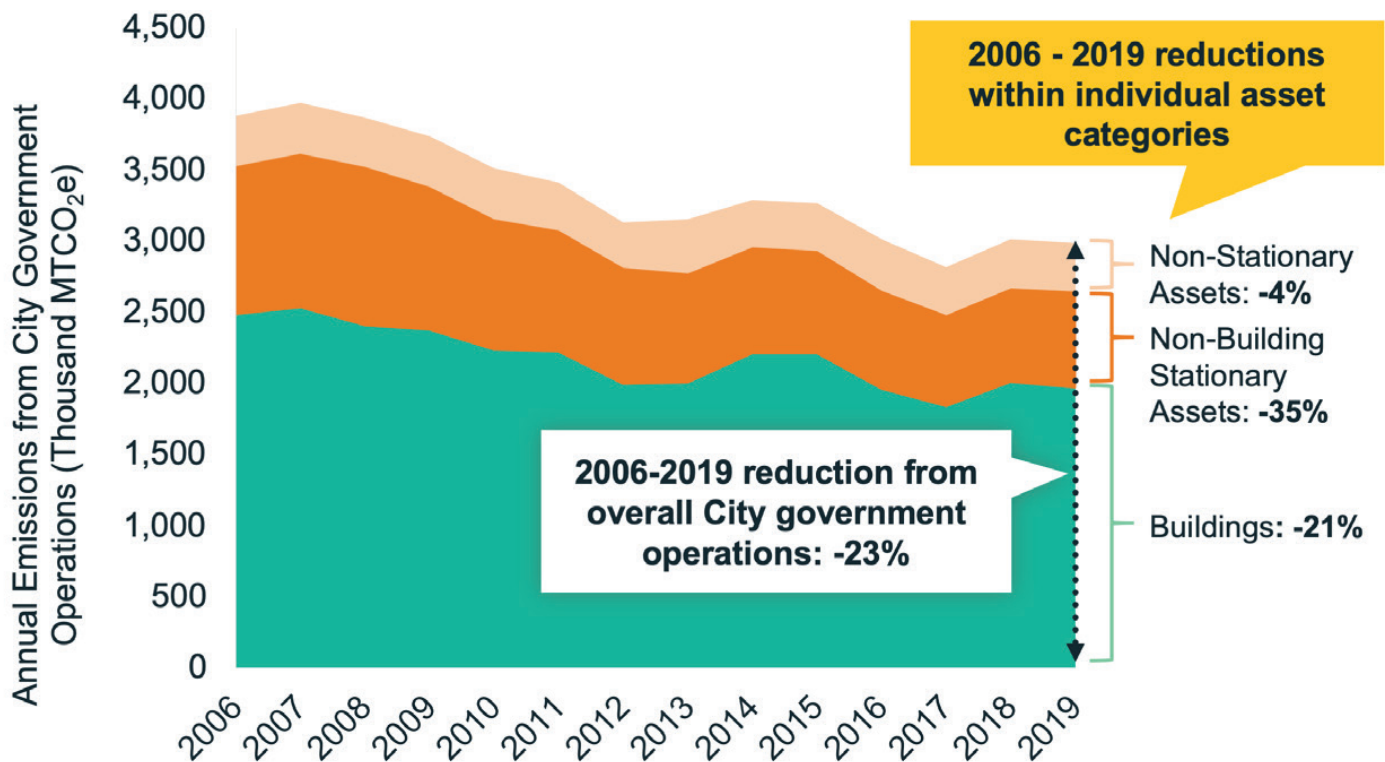


Figure 10: Annual Emissions Reductions Progress for City Government Operations, 2006-2019

Most of the emissions reductions realized before 2014 came from the electricity supply transitioning from coal and oil to natural gas. However, some of these gains are now at risk, and the City must accelerate its investment to offset any loss of existing reductions and prepare for future growth. For example, the recent closure of the Indian Point Energy Center nuclear facility is expected to lead to a near-term increase in electricity supply emissions as its generation is replaced by increases in natural gas generation. The need to maintain and expand access to clean electricity is the reason why the Action Plan includes consideration of LSR procurement.

The City has also achieved substantial emission reductions from conducting energy efficiency and clean energy projects. A significant portion of emissions reductions achieved over that timeframe was delivered through demand-side interventions and tied to actions following the One City: Built to Last plan, including the launch of major new retrofit programs for City buildings, ACE and ExCEL.¹⁷

17 The Accelerated Conservation and Efficiency (ACE) and the Expenses for Conservation and Efficiency Leadership (ExCEL) programs were launched to provide capital and expense funding, respectively, for agency-implemented energy efficiency projects.

The Importance of Buildings

Buildings remain the largest contributor to the City's total carbon footprint, accounting for 66% of the annual emissions from city government operations in 2019. While there have been changes over time, the share of emissions from buildings in city government operations has been largely consistent. For this reason, the principle focus of the Action Plan is reducing emissions in buildings.

Based on analysis to isolate why emissions have changed historically, several drivers of emissions reductions in buildings from 2006 to 2019 were identified, as summarized in Figure 11.

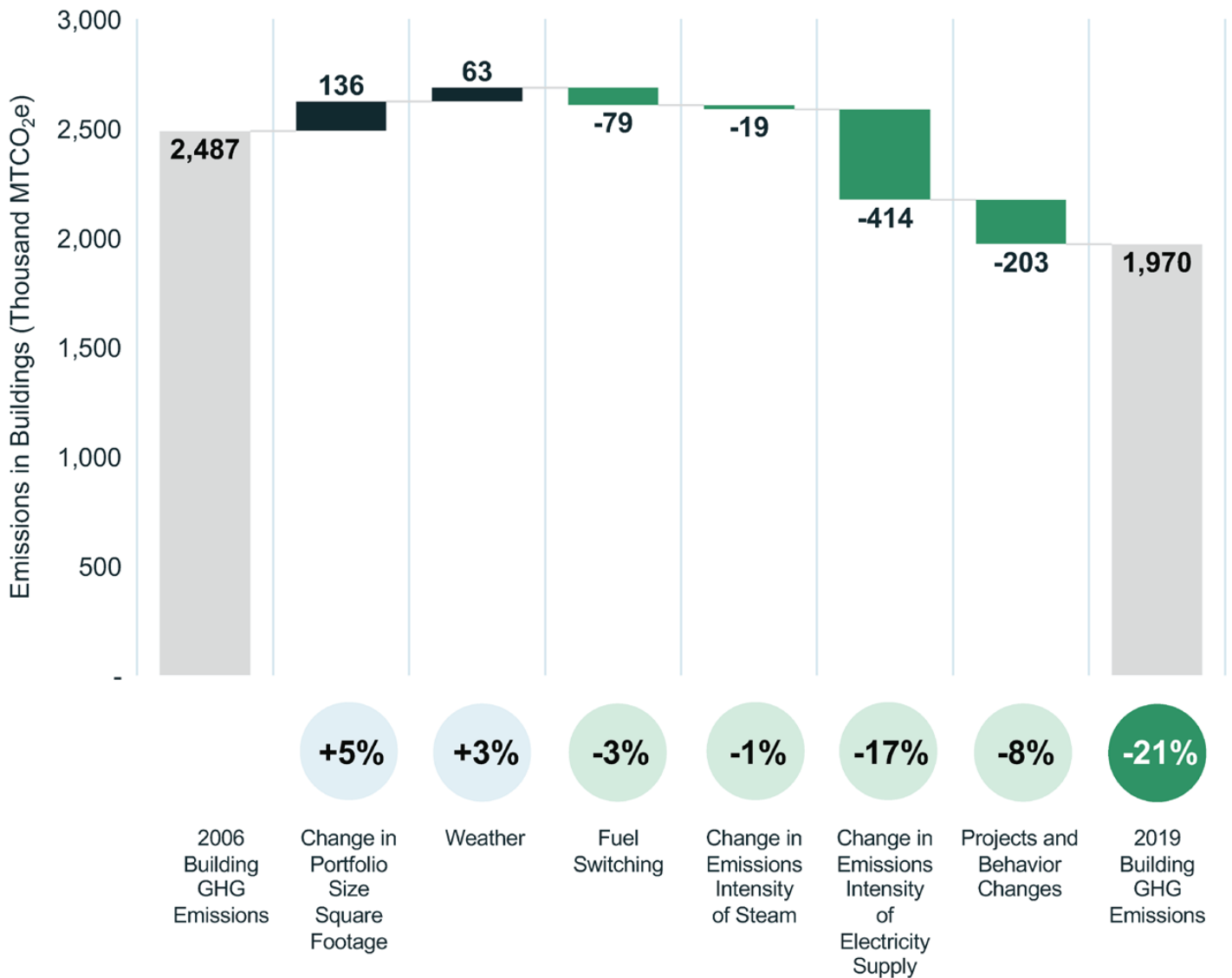


Figure 11: Sources of Emissions Reductions in Buildings, 2006-2019

- **Fuel Oil Switching:** During this time, many buildings switched from using more carbon-intensive (or heavier) fuels, such as No. 4 and No. 6 fuel oil, to using less carbon-intensive (or lighter) fuels, such as No. 2 fuel oil, bio-fuel blends, and natural gas. Based on 2019 fuel consumption figures, the City has reduced its overall usage of fuel oil by 43% since 2006. In particular, the City has phased out No. 6 fuel oil use. Given the City's various goals to achieve deep decarbonization, it is expected that, in future years, the City will also phase out use of the lighter fuels.
- **Changes in Emissions Intensity of Steam:** The emissions intensity of steam has decreased by roughly 18% between 2006 and 2019¹⁸.
- **Changes in Emissions Intensity of Electricity Supply:** The emissions intensity of the electricity supply has decreased by roughly 31% between 2006 and 2019¹⁹.
- **Projects and Behavior Changes:** The City has also reduced emissions through fostering behavioral change and implementing energy efficiency and clean energy projects at City buildings. These initiatives have changed building energy usage intensity and usage patterns and have delivered emissions reductions.
- **Changes in Portfolio Size:** Between 2006 and 2019 the City building portfolio grew by approximately 23 million square feet. The incremental square footage that entered the City's building portfolio after 2006 is estimated to have increased emissions by 5% due to increased energy consumption.
- **Adjustment for Weather:** The winter of 2019 was relatively colder than the winter of 2006. This change in weather is estimated to have caused a slight increase in 2019 emissions (3%).



Cooling towers on roof of Metropolitan Museum of Art | Source: DCAS

¹⁸ Emissions intensity of steam represents the MTCO_2e of emissions emitted per unit of steam. Decreases in the emissions intensity of steam are attributable to changes in the efficiency of steam generation.

¹⁹ Emissions intensity of electric supply represents the MTCO_2e of emissions emitted per unit of electricity. Decreases in the emissions intensity of electricity supply are attributable to changes in the efficiency of generation and changes in the mix of primary fuel used for generation.

DCAS and Agencies' Roles in Contributing to Emissions Reductions

Over the last ten years and beyond, DCAS has played a critical role in supporting our agency partners' progress towards the City's emissions reduction and energy objectives. DCAS works with agencies to identify and implement projects and actions undertaken by agencies to meet the City's energy and emissions goals. DCAS provides agency partners with strategic planning and technical guidance, contracting and procurement support, dedicated energy management staff, relevant funding for energy efficiency and clean energy projects, and utility assistance.

Project Implementation Impacts

As the City has expanded its ambitious emissions reduction and energy mandates and commitments, DCAS and agencies have scaled up their work over time. After the launch of the ACE and ExCEL programs in 2014, the annual emissions reductions attributed to projects funded by DCAS scaled significantly, increasing from 16,000 MTCO₂e to over 200,000 MTCO₂e, as shown in Figure 12. The number of projects completed has similarly increased as shown in Figure 13. Typical projects include lighting upgrades, mechanical system improvements, and boiler upgrades. It is estimated that projects planned to be completed through 2030 are expected to further reduce annual emissions by roughly 129,000 MTCO₂e.

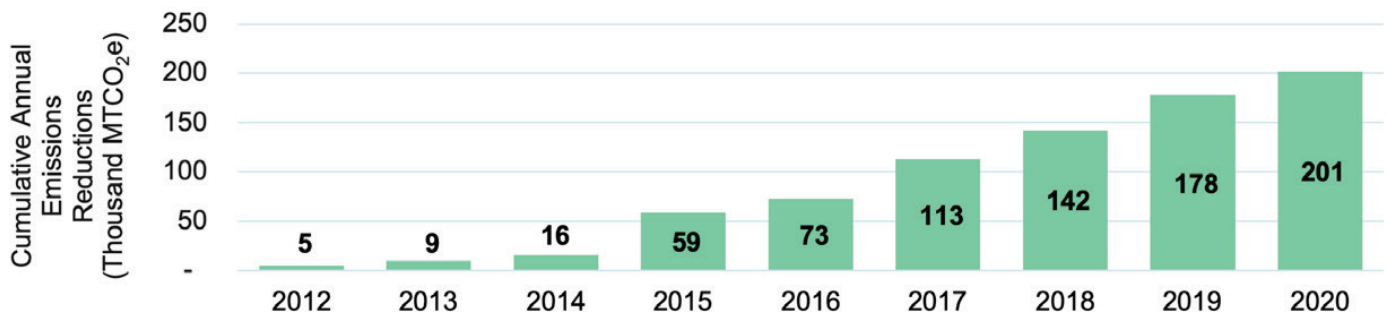


Figure 12: Increasing Annual Emissions Reductions Attributed to Projects Funded by DCAS²⁰

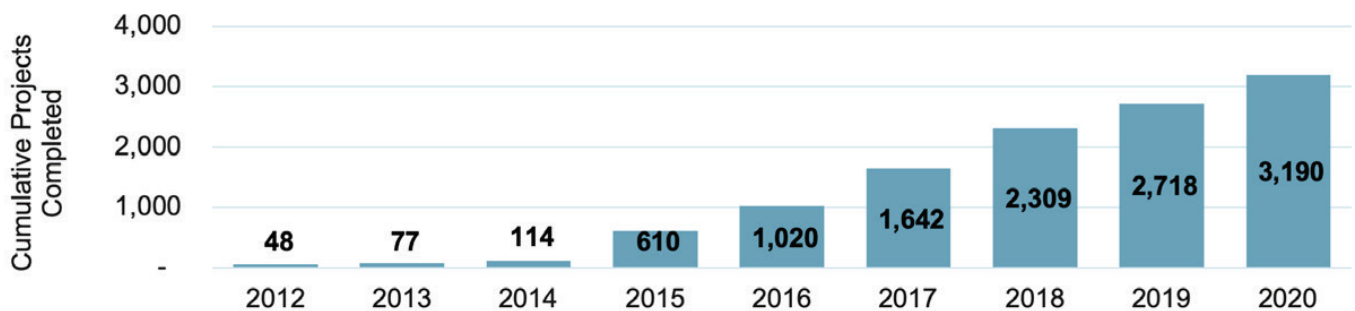


Figure 13: Increasing Numbers of Projects Funded by DCAS

20 For the purposes of developing the Action Plan, the expected emissions reduction impacts of completed DCAS-funded energy efficiency projects had an 80% realization rate applied. This is a conservative assumption that accounts for the possibility that some projects do not achieve their full potential. Moving forward the Action Plan will not apply an 80% realization rate to energy efficiency projects. In addition, the Action Plan assumes that emissions reductions achieved by DCAS-funded energy efficiency projects are not fully realized until the year following project completion. Finally, for each year in the graph, annual emission reductions are for all projects that were completed by the end of that particular year.

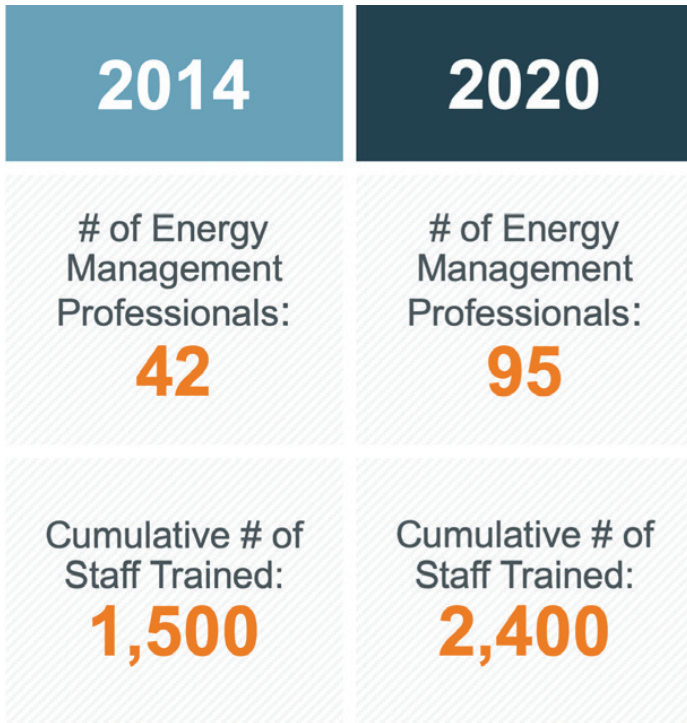


Figure 14: Summary of City Energy Management Workforce Development Efforts, 2014-2020



DCAS Facilities Management building operator examining building generator control panel
Source: DCAS

Energy Management Workforce Development

Agencies' energy teams include DCAS-funded agency energy personnel, energy liaison officers, building operators, and facilities management staff. Staff in these roles are critical to supporting energy management at their agencies. To successfully carry out energy-related tasks, energy teams work with a diverse group of other agency staff, including members of the budget or fiscal, procurement, and capital planning teams, among others.

DCAS and agencies have worked together to build and train the City's energy management workforce to ensure that there are sufficient staff embedded across the City to make energy management and emissions reductions part of every agency's capital planning and daily operations. While the City still has strides to make in matching staffing resources to need, the number of dedicated energy management professionals²¹ in place across the City more than doubled from 2014 to 2020, as shown in Figure 14. Over the same time period, the City also trained approximately 900 City staff, ranging from energy and capital project managers, to building operators and maintenance staff.

When executing the Action Plan, it will be critical for the City to build on its important progress and experience to date in delivering projects and growing the energy management workforce.

²¹ In this context, dedicated energy management professionals refer to staff who either sit directly at DCAS or staff who sit at agencies but are funded by DCAS through the Agency Energy Personnel Program.

Required Acceleration of Emissions Reductions

While the City has made significant progress in achieving emissions reductions, LL97 and the City's other emissions reduction and energy mandates and commitments require that the City move even more rapidly towards deep decarbonization. Figure 15 below shows the historical emissions and trend compared to the reductions needed to achieve the LL97 mandates of 40% below 2006 by 2025 and 50% below 2006 by 2030 and the longer-term 2050 goals. Figure 15 also illustrates how the City must accelerate its pace of emissions reductions by comparing the emissions reductions required by the City's mandates and commitments to the average trend if the pace of emissions reductions realized for city government operations from 2006 to 2019 continued.

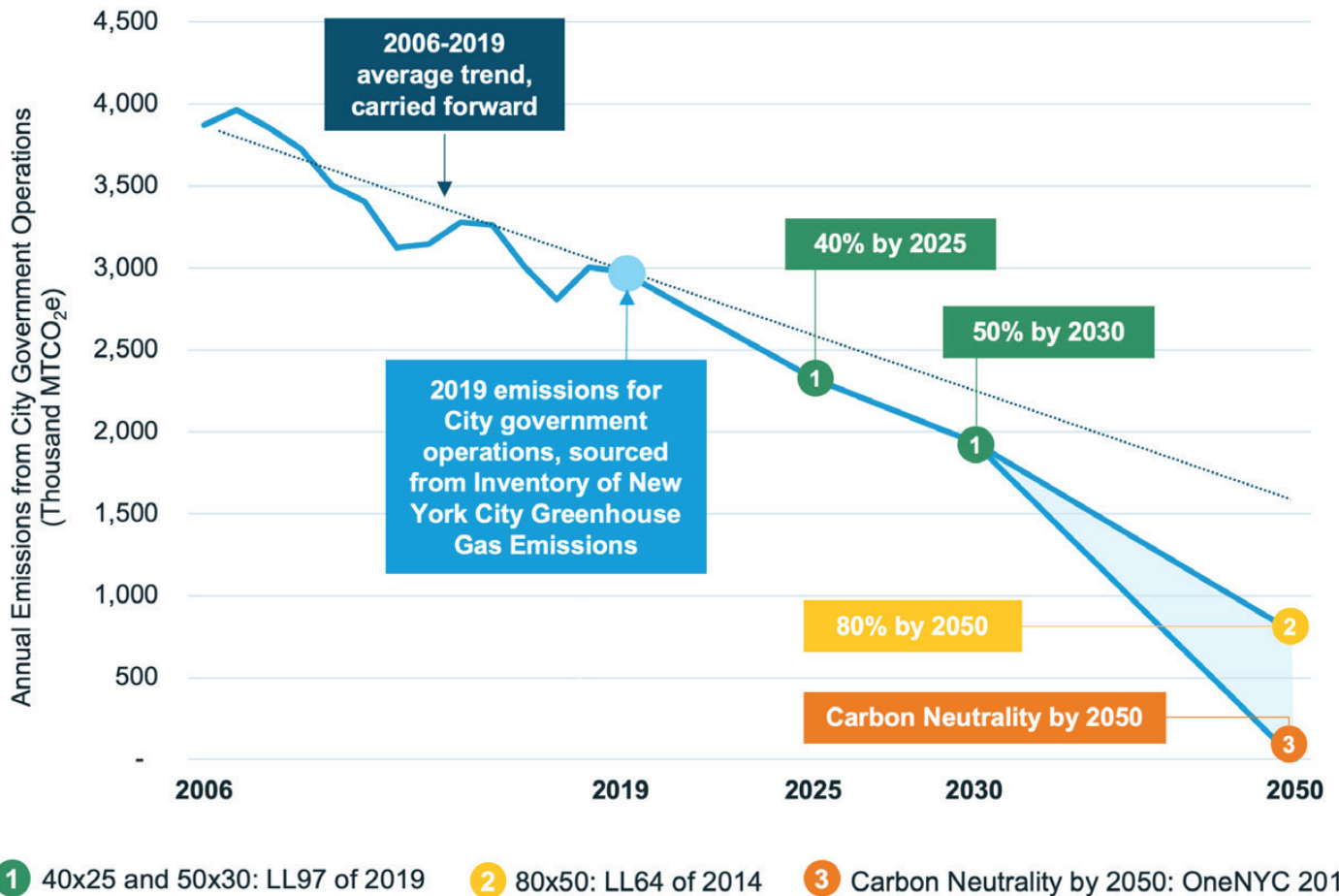


Figure 15: Annual Emissions Reductions Progress to Date and Trajectory Towards Mandates

To complement Figure 15, Figure 16 shows the annual emissions reductions required to reach both LL97 mandates, after accounting for the impact of growth and energy efficiency projects completed before the start of the Action Plan (2019-2021) and planned energy efficiency projects. To comply with the first LL97 mandate, the City must reduce annual emissions by over 550,000 MTCO₂e by 2025. To comply with the 2030 mandate, the City must reduce annual emissions by nearly 857,000 MTCO₂e by 2030. To achieve this, the City must reduce annual emissions in the nine-year time period from 2022 through 2030 more than it did in the 14-year time period from 2006 through 2019 over which 900,000 MTCO₂e in annual reductions were achieved.

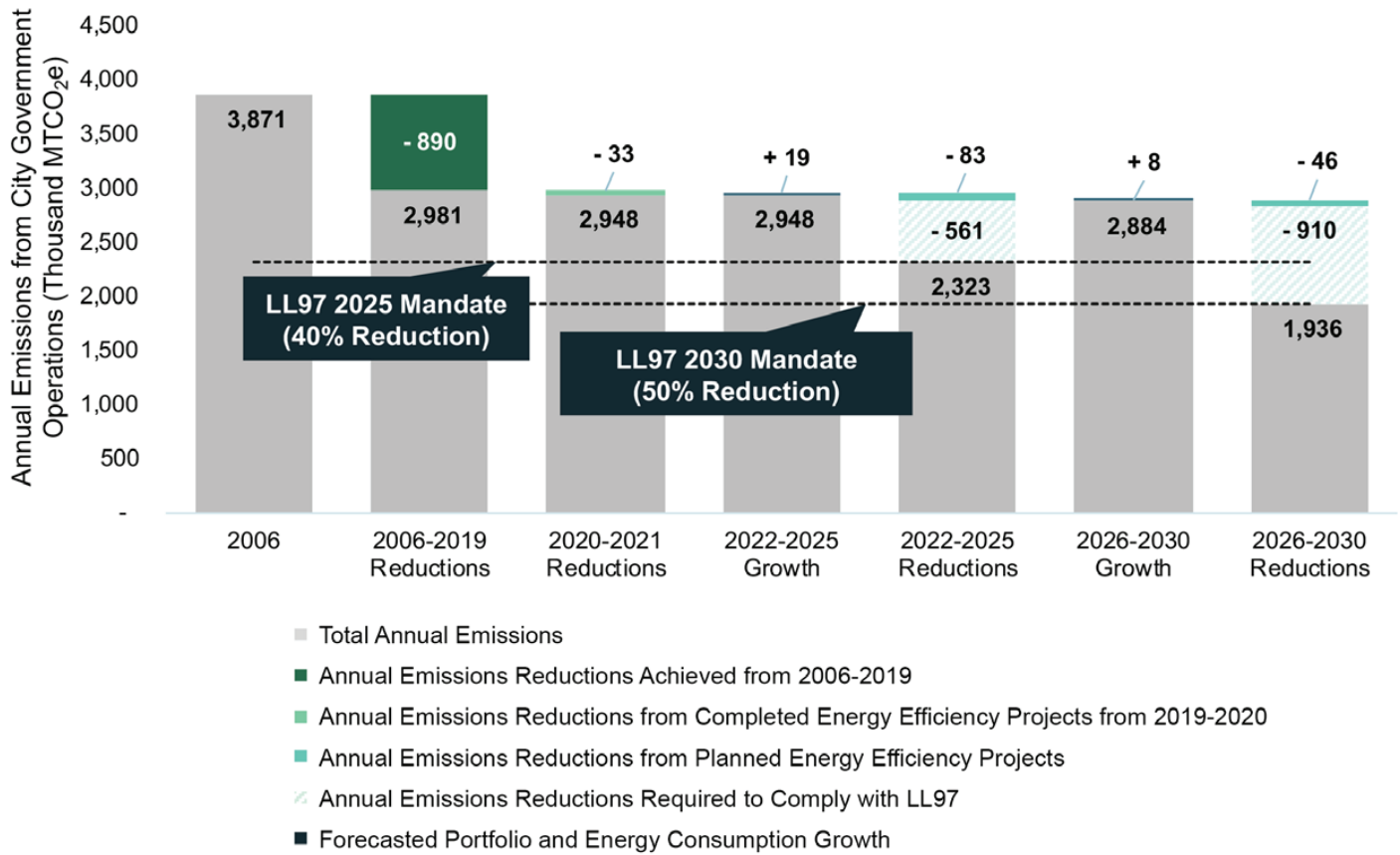


Figure 16. Annual Emissions Reductions Required for the City to Comply with LL97 Mandates²²



Hydropower dam construction | Source: DCAS

²² The annual emissions reduction values have been rounded to the nearest thousand MTCO₂e. Due to rounding, values presented may not add up precisely.

Section 2: Plan Vision and Development

Tweed Court House facade with 1 Centre Street in the background | Source: DCAS



DCAS staff presenting climate change impacts at a municipal energy management recognition ceremony | Source: DCAS

Plan Vision

The Action Plan balances policy compliance, technical and practical feasibility, and cost considerations to achieve the LL97 emissions reductions mandates and other near-term emissions reduction and energy mandates and commitments, while also putting the City on a path to deep decarbonization. Figure 17 below summarizes the Action Plan vision as expressed through each of the three plan considerations.

Consideration	Focus
Policy Compliance	The plan must enable the City to achieve the LL97 mandates, to meet other near-term emissions reduction and energy mandates and commitments, and to establish the trajectory to deep decarbonization by 2030 that is necessary to meet the City’s longer-term mandates and commitments.
Technical and Practical Feasibility	The plan must be responsive to the complexity of agencies’ individual portfolios and to the challenges of fully integrating energy management work into capital planning and daily operations. The plan must manage risk associated with delayed or lower realization of emissions reductions from any single asset category or any single type of action within city government operations. The plan also must consider possible emissions changes due to other drivers, such as changes in the emissions intensity of electric supply, and planning for possible new emissions associated with portfolio and energy consumption growth.
Cost	The plan must efficiently invest City funds by prioritizing actions that are relatively cost-effective and that serve multiple emissions reduction and energy mandates and commitments to the extent possible. In addition, the plan must avoid significant fluctuations in year-over-year investments to enable reasonable staffing ramp-up.

Figure 17: Overview of Action Plan Vision

Policy Compliance Considerations

The Action Plan seeks to achieve the LL97 mandates and other near-term emissions reduction and energy mandates and commitments, while also putting the City on the necessary trajectory for deep decarbonization to meet longer-term mandates and commitments.

The near-term mandates and commitments, which are those with primary objectives that must be realized by 2030, include the following:

- **40x25 and 50x30 LL97 emissions reduction mandates**, which were codified in LL97 of 2019 and require the City to reduce emissions from city government operations 40% by 2025 and 20% by 2030 from a 2006 baseline.
- **100MWx25 solar installation commitment²³**, which was made in *One City: Built to Last* and commits the City to install 100MW of solar on City assets by 2025.
- **20% reduction in energy consumption commitment for City buildings by 2025²⁴**, which was made in the 1.5 Degree Plan and commits the City to reduce energy consumption from City buildings 20% by 2025 from a 2016 baseline.
- **100% renewable electricity commitment²⁵**, which was made in the 2021 State of the City and sets a goal for the City to have 100% of electricity for city government operations come from renewable sources by 2025. This commitment is the driver behind near-term efforts to procure LSR.

Likewise, the longer-term mandates and commitments, which are those with primary objectives that must be realized in the period from 2031 to 2050, include the following:

- **80x50 mandate²⁶**, which was codified in Local Law 66 (LL66) of 2014 and requires the City to reduce emissions from city government operations 80% by 2050.
- **Carbon neutrality commitment for 2050**, which was made in *OneNYC 2019* and sets a goal for the City to achieve carbon neutrality by 2050.
- **Net-zero energy commitment at wastewater resource recovery facilities by 2050²⁷**, which was made in *OneNYC 2015* and commits the City to achieve net-zero energy across WRRFs by 2050.
- **Reduce fleet fossil fuel consumption 50% by 2025 and 80% by 2035²⁸**, which was made in the NYC Fleet Sustainability Plan and commits the City to reduce fossil fuel consumption from the City's municipal vehicle fleet 50% by 2025 and 80% by 2035 below 2005 levels.

23 This is being interpreted as FY25 for alignment with LL97 and other City commitments (FY-basis).

24 This is being interpreted as FY25 for alignment with LL97 and other City commitments (FY-basis).

25 This is being interpreted as CY25. The 100% electricity goal is closely linked to LSR procurement, and the assumed timeframe for LSR coming online in the Action Plan is by the end of CY25, for inclusion in FY26 City government emissions calculations.

26 This is being interpreted as FY50 for alignment with LL97 and other City commitments (FY-basis).

27 This is being interpreted as FY50 for alignment with LL97 and other City commitments (FY-basis).

28 This is being interpreted as FY25 and FY35 for alignment with other City commitments (FY-basis).

Technical and Practical Feasibility Considerations

The Action Plan seeks to respond to the complexity of agencies' individual portfolios and take advantage of opportunities to integrate energy management work into capital planning and daily operations by considering emissions reduction opportunities specific to agencies' portfolios. The opportunities included within the Action Plan were identified by first segmenting agencies' portfolios to understand the types of assets that make up each individual portfolio and then evaluating EROs that are technically and practically feasible for those assets, while accounting for the impact of completed and planned projects. In addition, the Action Plan seeks to manage risk associated with the delay or lower realization of emissions reductions by avoiding overreliance on any single asset category or type of action within city government operations. Finally, the Action Plan seeks to manage risk by considering possible emissions changes due to other drivers, such as changes in the emissions intensity of electric supply, and planning for possible new emissions associated with portfolio and energy consumption growth.

Cost Considerations

The Action Plan seeks to efficiently invest City funds by prioritizing actions that are relatively cost-effective and that serve multiple emissions reduction and energy mandates and commitments. In addition, the plan seeks to avoid significant fluctuations in year-over-year investments to enable reasonable staffing ramp-up.

Other Co-Benefits Considerations

Investing in City assets and facilities will also help the City achieve other policy goals, including:

- Enhancing critical social infrastructure. Improvements made to modernize building energy systems and increase energy efficiency set City facilities up to provide better services for New Yorkers, which is especially important given the City's ongoing recovery from COVID-19.
- Reducing the prevalence of pollutants from in-city combustion by improving access to cleaner electricity and switching heating to electricity or other cleaner fuels where feasible, which will improve air quality and support better health outcomes for New Yorkers.
- Further developing the market for investments in energy efficiency and renewable energy, which can spur private investment and expand opportunities for robust minority-owned and women-owned business enterprise participation.

Plan Development

The Action Plan was developed through four steps to meet the plan vision to balance policy compliance, technical and practical feasibility, and cost considerations. The steps are: (1) Agency Building Segmentation, (2) ERO Assessment, (3) City Emissions Reduction Scenario Analysis, and (4) City Buildings Pathways Development.

1. Agency Building Segmentation

During this step, the building portfolios of the 24 agencies who have assets that were considered in the context of the Action Plan were segmented to identify a set of major building types that collectively represent a large majority of energy consumption in buildings. Prototype building energy models were developed for the building types to represent their typical operations and energy usage. The prototype models were then used in later steps to examine the impacts of different emissions reduction opportunities applied to the buildings.

Building portfolio segmentation

The City’s building portfolio was segmented using data about building type, energy consumption, age, and size to identify major building types that collectively represent 74% of the energy consumption in buildings. Agency energy staff were consulted via interviews and data requests for insight into their individual agencies’ building portfolios.

Figure 18 illustrates that several major building types represent large portions of energy consumption for buildings, including K-12 schools (accounting for 32% of energy consumption in buildings in 2019), hospitals (12%), colleges/universities (12%), and offices (5%). For these building types, given the importance of their role in overall energy consumption for buildings, multiple building energy models were determined to be needed to adequately represent them within the City’s building portfolio.

Building types not modeled using a building energy model are grouped as “Other” in Figure 18. This group includes building types where most of the energy consumption takes place at a small set of unique facilities (e.g., museums, zoos, and prisons). The existing plans for these facilities and their energy and emissions are accounted for separately from the building energy modeling process.

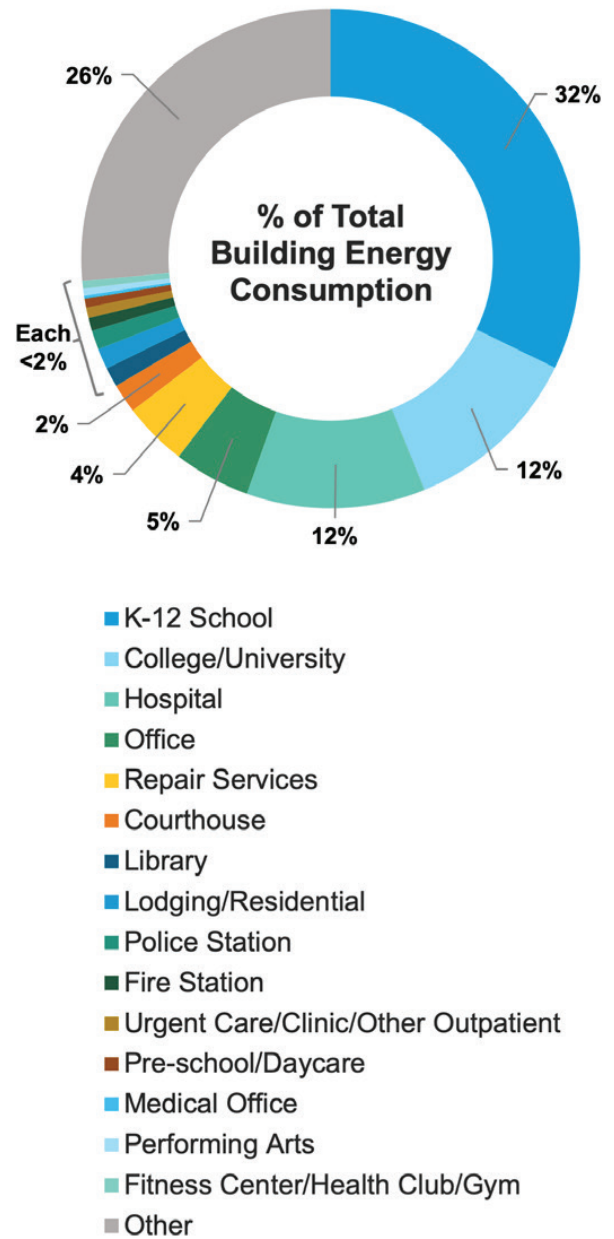


Figure 18: Major Building Types and their Proportion of Energy Consumption

Building prototype model development

For each of the 23 major building types identified through segmentation, a prototype building energy model was developed. The models were created using an energy modeling tool that simulates hourly energy consumption for a prototype building based on available data and assumptions about building energy usage, operations, and equipment and systems.

2. Emissions Reductions Opportunities Assessment

During this step, different emissions reduction opportunities for the asset categories within city government operations were assessed. Specifically, emissions reduction opportunities that are applicable to buildings, non-building stationary assets, and non-stationary assets, respectively, were identified through review of past projects, other planning efforts, industry best practices and consultation with agency staff. The technical potential of these opportunities, in terms of possible energy savings and emissions reductions, was evaluated and implementation costs were developed for them.

The impact of changes in the emissions intensity of the grid was also explored during this step. This assessment included evaluating grid emissions intensity changes that are within the City's control, such as LSR procurement, and changes that are outside of City control, such as the statewide transition towards a cleaner electric grid due to CLCPA policies. The results of this step were used as inputs into the City emissions reduction scenario analysis and resulting recommended buildings pathway development.

Identification and evaluation of EROs applicable to buildings

For each of the 23 major building types, EROs that were potentially applicable to implement as projects within the building type were identified—for example, specific mechanical system improvements. Based on the EROs identified across all building types, related EROs were then grouped into bundles that could be applied across building types to enable comparisons across building types where similar types of projects are applicable. Figure 19 shows the 11 ERO bundles (Bundles 0-10), with each bundle consisting of a set of EROs that can be applied in building types under the given bundle. When a given bundle is applied, the EROs within it are tailored by building type. For example, Bundle 2 (mechanical system improvements) includes a slightly different set of EROs in K-12 schools as compared to hospitals. For Bundles 0-9, the bundle numbering is designed to be additive, with higher-numbered bundles representing more comprehensive projects that involve higher levels of potential emissions reduction impacts, higher costs, and higher levels of implementation complexity. The bundles are also designed to account for interactive effects of implementing multiple EROs within a single building.²⁹ See Appendix Section B for a more detailed description of ERO bundles.

²⁹ Prototype models represent a single building. A subset of building campuses, which include more than one building, is captured outside of the building modeling and bundle application methodology.

ERO Bundles

Operational Interventions³⁰

Bundle 0. Operational improvements

Structural and Mechanical Interventions

Bundle 1. Lighting improvements

Bundle 2. Mechanical system improvements

Bundle 3. Lighting + mechanical system improvements

Bundle 4. Boiler system improvements

Bundle 5. Lighting + mechanical system + boiler system improvements

Bundle 6. HVAC replacement on top of Bundle 5

Bundle 7. HVAC replacement + building envelope improvements on top of Bundle 5

Bundle 8. Heat electrification + supporting energy efficiency

Bundle 9. Heat electrification + building envelope improvements + supporting energy efficiency

Clean Energy Interventions

Bundle 10. Solar PV

Figure 19: Description of Bundles of Emissions Reduction Opportunities Applicable to Buildings

The bundles were applied to the prototype building energy models to evaluate the net energy and emissions reduction impacts associated with deploying the EROs in each bundle at each major building type in the City's portfolio. In addition, dollar-per-square foot cost estimates were developed for each bundle by building type, based on historic City project data and engineering experience.

The bundles were scaled across each agency's building portfolio, and thus the City's overall building portfolio, based on the square footage associated with each major building type.

This scaling process resulted in the identification of the unconstrained technical potential for each bundle at each agency and across the City overall, as well as associated costs. The unconstrained technical potential represents the maximum possible energy savings and emissions reductions attainable through each bundle without considering feasibility constraints.

³⁰ Operational interventions include the following: 1) EROs without upfront materials costs, but labor costs only. Examples include activities such as checking sensors and controls. 2) EROs with low-upfront training and materials costs. Examples include repairs made to electrical wiring or distribution valves with low-cost materials.

The unconstrained technical potential and associated costs were presented via an unconstrained marginal abatement cost curve. The unconstrained technical potential was then adjusted to reflect what likely is possible to practically achieve in buildings by applying the feasibility constraints shown in Figure 20. The key constraints were the following:

- The **“project timing” constraint** accounts for the length of time required to implement a given ERO bundle and removes square footage that cannot be addressed by an ERO within a given year. The length of time required to implement an ERO bundle was estimated based on the project duration of DCAS-funded projects that were mapped to ERO bundles and agencies.
- The **“already implemented” constraint** removes square footage that has either undergone or is presently undergoing work similar in scope to the ERO bundles to avoid duplication of completed or in-progress work. This constraint accounts for energy efficiency projects completed between 2016-2021, as well as efficiency projects that are already funded or are planned to be initiated in the four years from the start of 2022 to the end of 2025. The square footage addressed by work similar in scope to the ERO bundles was estimated based on DCAS-funded project data and information provided by agencies.
- The **“reasonable penetration” constraint** estimates the reasonable proportion of an agency’s portfolio that can be worked on each year. It is defined as the percentage of total square footage that can be impacted by a given bundle in a year and varies by ERO bundle to account for differences in bundle complexity. The reasonable penetration rate was estimated using available data from specific agencies on the square footage addressed during past concerted efforts to implement a specific ERO across their portfolios.

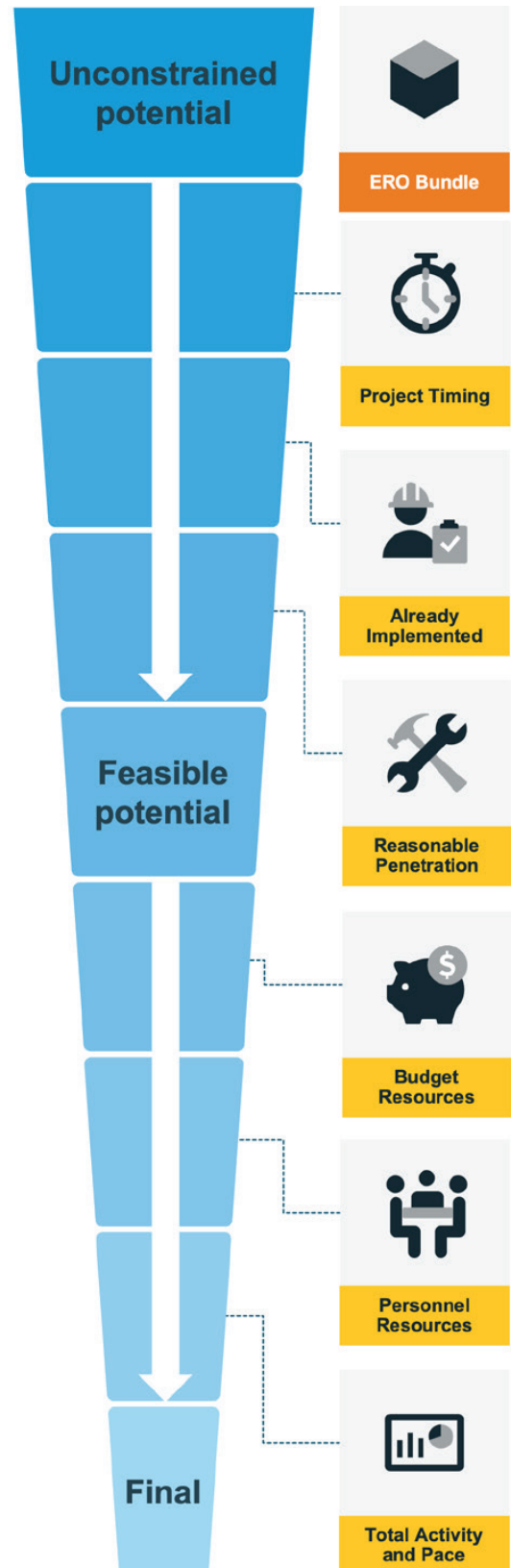


Figure 20: Feasibility Screens of Emissions Reductions Opportunities Applicable to Buildings

Through the application of the feasibility constraints, the unconstrained marginal abatement cost curve was translated into a constrained (feasible) marginal abatement cost curve. The constrained marginal abatement cost curve, illustrated in Figure 21, represents the volume and cost of work that practically can be implemented within each of the LL97 compliance periods and thus is available to be deployed on the basis of relative cost-effectiveness to help the City meet its mandates and commitments. The marginal abatement costs shown in Figure 21 represent the net lifetime costs and benefits, including upfront project costs, energy costs, and value of carbon abatement. The marginal abatement cost curve shows the ranking of the EROs from most cost-effective to least.

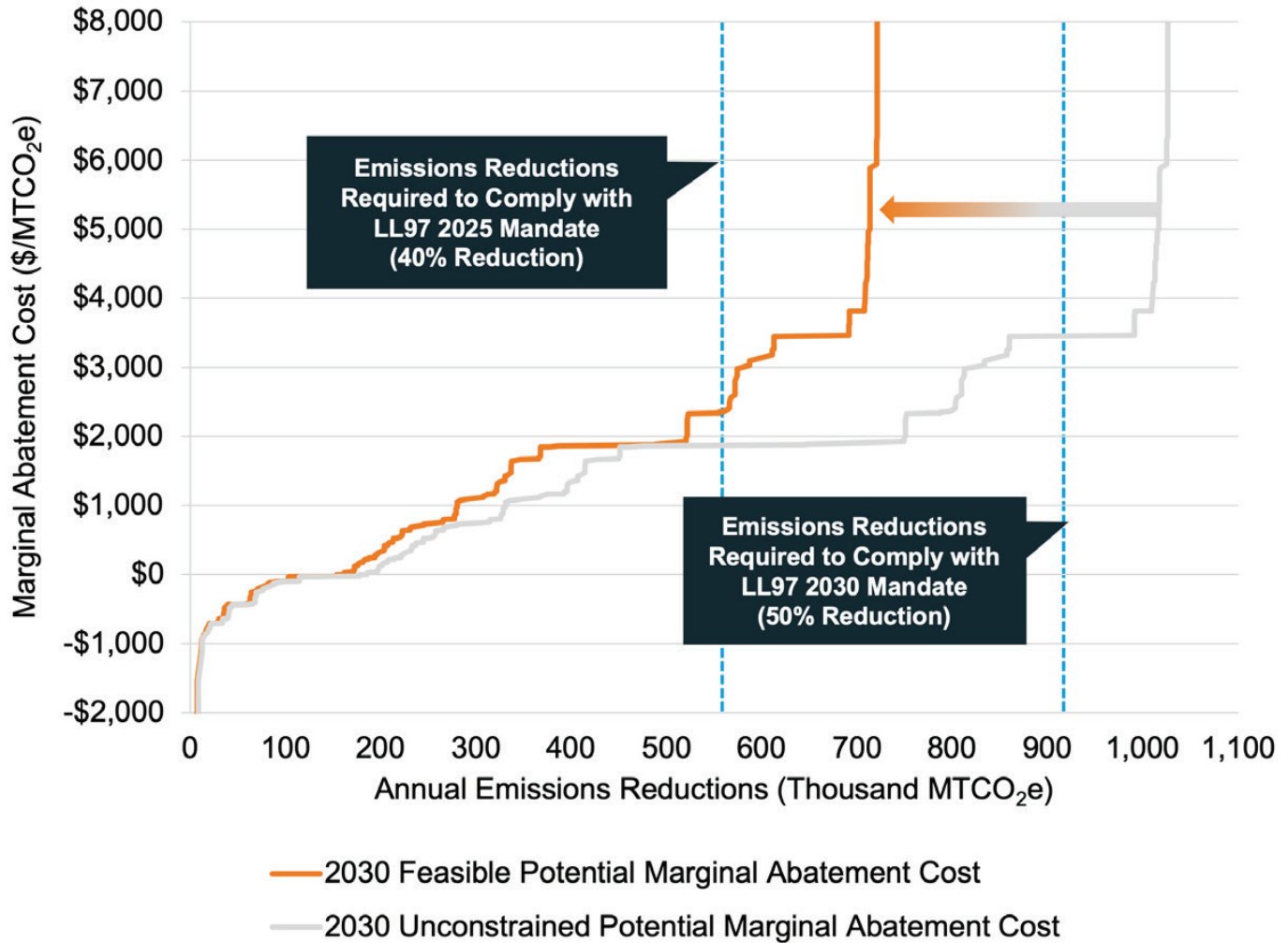


Figure 21: Feasible Potential Marginal Abatement Cost Curve for Buildings

Figure 21 provides both the unconstrained potential for emissions reductions (shown in gray) and the feasible potential for emissions reductions (shown in orange). The feasible potential shown in the marginal abatement cost curve is a product of applying feasibility constraints to the full unconstrained potential which limits the potential EROs available for selection.

The marginal abatement costs curves are shown in relation to the remaining emissions reductions required from city government operations, as identified in Figure 16. Where the marginal abatement cost curve intersects with a remaining emissions reduction line (shown in blue) indicates the highest abatement cost required to achieve that volume of annual emissions reductions.

Actions within other asset categories and changes to electricity supply reduce the remaining emissions reductions required from buildings. These non-building actions shift the 2025 and 2030 remaining emissions reduction lines to the right, lowering the cost of EROs required to comply with the 2025 emissions reduction mandate and enabling the achievement of the 2030 emissions reduction mandate.

Lifetime costs and benefits are represented in the marginal abatement cost curve. EROs with a marginal abatement cost with negative values indicate the lifetime benefits of that ERO fully offset their costs, including upfront and operational costs. Additional information on the marginal abatement cost metric is provided in the Appendix Section A.

Identification and evaluation of EROs applicable to non-building assets

EROs were identified for non-building stationary assets and non-stationary assets. The Department of Environmental Protection (DEP) advised on the EROs applicable to non-building stationary assets,³¹ and DCAS Fleet advised on the EROs applicable to non-stationary assets, based on ongoing and planned projects and activities being pursued by these entities. The identified EROs for non-building stationary assets and non-stationary assets then were assessed for their implementation risk. Based on the level of uncertainty associated with the delivery of specific EROs, a more conservative and more ambitious level of emissions reductions were estimated for each of these non-building asset categories as shown in Figure 22.

Asset Category	More Conservative Potential by 2030 (MTCO ₂ e)	More Ambitious Potential by 2030 (MTCO ₂ e)
Non-Building Stationary Assets	70,000	168,000
Non-Stationary Assets	36,000	186,000

Figure 22: Assessed Potential Emissions Reductions for Each Non-Building Asset Category

More conservative emissions reduction potential: This level of emissions reductions is based on the implementation of only the EROs that are deemed most certain to be delivered. These EROs consist of projects or activities that are planned, funded, and are expected to be underway within a year (during 2022). For non-stationary asset EROs, sample EROs in the more conservative emissions reduction potential include the electrification of non-emergency sedans. For non-building stationary asset EROs, sample EROs in the more conservative emissions reduction potential include specific DCAS-funded projects at DEP facilities, including lighting upgrades planned at the Coney Island, Port Richmond, and Hunts Point Wastewater Resource Recovery Facilities.

More ambitious emissions reduction potential: This level of emissions reductions is based on the implementation of some less certain EROs on top of the most certain EROs included in the more conservative emissions reduction potential. These less certain EROs consist of projects or activities that are planned, funded, and expected to be underway within one to four years (between the start of 2022 and the end of 2025). For non-stationary asset EROs, sample EROs in the more ambitious emissions reduction potential include the procurement of renewable diesel for the City’s vehicle fleet. For non-building stationary asset EROs, sample EROs in the more ambitious emissions reduction potential include sludge thickening improvements, such as the installation of gravity belt thickeners, identified for the Oakwood Beach Wastewater Resource Recovery Facility.

³¹ DEP is in the process of developing an Energy and Carbon Neutrality Plan (ECN), which will outline how the City reduces greenhouse gas emissions from in-City WRRFs by 80% and accomplishing net energy neutral operations by 2050. Results from the ECN will be incorporated into the Action Plan as they become available

The required investments for the ongoing and planned activities were then used to estimate the total required investments for the more conservative and more ambitious emissions reduction potentials for each non-building asset category. During subsequent scenario analysis, these potentials were used to explore the emissions reduction and investment impacts of different alternatives.

Assessment of electricity supply actions

Finally, a set of forecasts for the emissions factor of electricity were developed. The Pathways to Carbon-Neutral NYC (2021) report was consulted for its reference case that assumes that New York State achieves CLCPA policies, including 70x30. For the Action Plan, more conservative forecasts, consisting of 50x30 and an electric grid emissions intensity held flat at 2019 levels, were also considered. In addition, the impact of LSR procurement by the City over different timeframes and at different volumes was analyzed. LSR procurement sizing options were reviewed on a percentage basis relative to 2019 electricity consumption levels for city government operations. Required investments for the LSR procurement were analyzed based on expected project costs of a Tier 4 REC project in New York State, and on recent hydropower solicitations in neighboring states.

3. City Emissions Reduction Scenario Analysis

During this step, multiple City emissions reduction scenarios were developed to represent a range of possible emissions reduction futures for the City and explore how the City could potentially meet the LL97 mandates and other emissions reduction and energy mandates and commitments under the scenarios. In this context, a scenario represents a combination of different volumes of emissions reductions from changes in the electricity supply and specific EROs in non-building assets.

Develop and evaluate multiple scenarios to inform the plan

For each scenario, based on the emissions reductions to be achieved from the electricity supply and EROs in non-building assets, policy compliance, feasibility, and cost considerations were assessed. These considerations focused, respectively, on the capacity of these electricity supply actions and non-building EROs to help achieve mandates and commitments, their likelihood of achievement based on various risks, and their required investments. For the non-building EROs, the primary risks being examined are the risks that planned projects and activities will not be delivered on time and yield the expected level of emissions reductions. For the electricity supply actions, the primary risk being examined is that LSR procurement will not be available at all or on the desired timeline, while the secondary risk is that the cleaning of the grid will occur to a lesser extent or on a slower timeline than planned.

The scenarios also considered the increased emissions associated with growth in City building energy consumption, tied to portfolio growth. Data on the size of agencies' building portfolios in 2006 and in 2019 was used to estimate compound annual growth rates to forecast future portfolio sizes. The square footage forecasts were translated into increased energy consumption using assumptions of energy use intensities measured in thousands of British thermal units (kBtu) per square foot.

The emissions associated with the forecasted growth in building energy consumption increase the overall emissions reductions required from buildings to comply with LL97. For non-building stationary assets and non-stationary asset categories, baseline activity is assumed to remain constant through 2030 based on discussions with DEP and DCAS Fleet.

For each scenario, the remaining emissions reductions required from the buildings (the buildings target) were estimated after accounting for the contributions from non-building assets and changes to the electricity supply, as well as the impact of growth. The buildings target was designed to achieve LL97 and comply with the other near-term emissions reduction and energy mandates and commitments.

Recommend a reasonable reference case and associated buildings target to carry forward into pathway development

The reference case, and associated buildings target, was selected to meet the plan vision of balancing policy compliance, technical and practical feasibility, and cost considerations. Selection of the reference case considered: (1) alignment with near-term and longer-term policy compliance considerations, (2) risk management by sourcing emissions reductions from all asset categories and the electricity supply, (3) and achievement of a relatively balanced level of required investment across both the first and second LL97 compliance periods.

4. City Buildings Pathways Development

The recommended buildings pathway identifies the required emissions reduction opportunities for buildings to achieve the LL97 mandates, plus the other emissions reduction and energy mandates and commitments, after accounting for emissions reductions associated with the electricity supply and non-building assets, as well as growth. It is important to note that, in the context of pathways development, some mandates and commitments dictate the exact ERO bundles required for compliance. For example, the City’s commitment to install 100MW of solar on City assets by 2025 requires solar alone (Bundle 10) to be selected and deployed across the City. Others, such as the LL97 mandates and the 20% energy consumption reduction commitment, do not specify the types of projects that must be done to meet them. For example, the LL97 mandates require a certain volume of emissions reductions to be achieved but do not dictate the type of work required.

The recommended buildings pathways was translated into actionable agency targets and pathways. A list of agency targets can be found in the Appendix.



Lighting upgrades installed at the Staten Island Ferry Maintenance Facility | Source: DCAS

Evaluate the EROs necessary to achieve the remaining emissions reductions required from buildings in the reference scenario

The EROs included in the recommended buildings pathway were selected following the sequential steps described in Figure 23, which were designed to ensure that the City’s emissions reduction and energy mandates and commitments are met, while also deploying relatively cost-effective interventions where possible.

Order	Objective	Specific ERO Type Dictated
1	Completes the City’s planned energy efficiency projects for buildings that already have been funded and are planned to be initiated in the four years from the start of 2022 to the end of 2025.	Planned energy efficiency projects , which are represented by multiple bundles ³²
2	Achieves 100MW of solar installations by the end of 2025.	Investments in on-site solar , which are represented by Bundle 10
3	Puts the City on a sustainable trajectory to 80x50 and Carbon Neutrality by pursuing electrification opportunities where feasible to achieve emissions reductions at a pace consistent with at least 40% reduction in thermal loads by 2050 ³³	Heat electrification initiative and associated energy efficiency measures , which are represented by Bundle 8 ³⁴
4	Pursues other energy efficiency measures as needed to fill any remaining gaps for (a) the LL97 emissions reduction mandates , (b) the 20% energy consumption reduction commitment , and (c) continue to progress toward longer-term reduction requirements	Additional energy efficiency projects (Bundle 0-5) selected using the feasibility constrained buildings marginal abatement cost curve

Figure 23. Recommended Buildings Pathway Development Process

32 Planned energy efficiency projects are associated with multiple bundles and have been cross matched to ERO bundles as a part of the development of the recommended buildings pathway.

33 In this context, a sustainable trajectory for electrification is defined as that which enables the City to feasibly ramp up its pace of electrification from now through 2030, while also putting the City on a trajectory to achieve longer-term mandates and commitments. Under the heat electrification initiative within the recommended buildings pathway, electrification steadily ramps up to 2% per year by 2030. This recommendation is designed to build capabilities and capacity to scale building heating system electrification beyond 2030 levels. Roughly 45% of building thermal loads would be electrified by 2050 if the City were to maintain a pace of 2% per year between 2031-2050. This is equivalent to reaching an 75% emissions reduction for buildings assuming electricity is fully decarbonized. Additional scaling of the heat electrification initiative after 2030 would put the City on track to achieving 80-100% emissions reductions for buildings by 2050.

34 Replacement of existing HVAC systems with a more efficient unit was considered within the ERO assessment (Bundles 6 and 7). The recommended buildings pathway does not include Bundles 6 or 7. Instead investments that electrify HVAC systems (Bundles 8 and 9) are prioritized, and earlier bundles (Bundles 0-5) are selected to fulfill any remaining emissions reduction needs from buildings.

Estimate the required investment and required staffing support associated with the recommended pathway

To estimate the required investments for the full Action Plan, the required investments for the implementation of specific EROs for non-building assets, the LSR procurement, and the EROs in buildings are estimated.

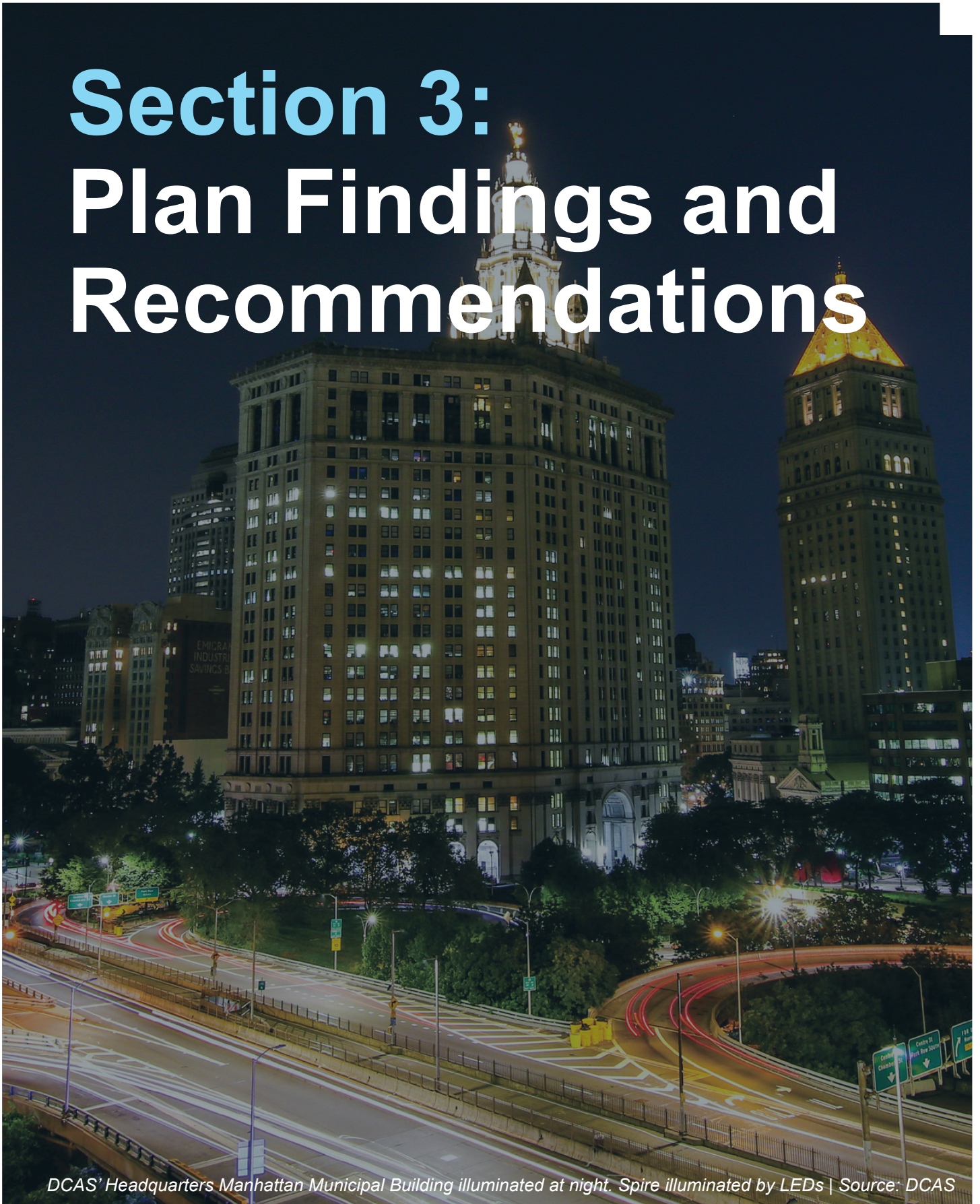
For buildings, the estimated investments reflect the costs of the specific EROs included under the recommended buildings pathway. Costs were estimated for the EROs included under the recommended buildings pathway by applying the dollar-per square foot estimate established for bundles to the square footage addressed by each bundle in each year under the recommended pathway. Relevant to project delivery timing, a conservative approach was deployed, whereby projects' emissions reductions come online the year after they are fully completed, which gives flexibility for projects to be completed up until the very end of the prior year. Expense funding was used for projects that cannot be done using capital funding due to capital eligibility rules or timing constraints. Since expense projects tend to be faster to implement and relatively cost-effective on an abatement cost basis, they are critical to attain compliance for the 2025 mandate. For capital projects, the majority of the required investments are reflected in the year in which projects are registered.

In addition to required investments, annual staffing needs were estimated for the recommended buildings pathway. The annual staffing needs are represented by the number of DCAS and DCAS-funded agency personnel required to support the pace and mix of project work under the recommended buildings pathway. It was estimated by applying personnel ratios to the number of projects completed each year, which were developed during prior DCAS modeling.



Department of Parks and Recreation staff weather-sealing a comfort station entrance | Source: DCAS

Section 3: Plan Findings and Recommendations



DCAS' Headquarters Manhattan Municipal Building illuminated at night. Spire illuminated by LEDs | Source: DCAS

Overview

The Action Plan puts forth a recommended City emissions reduction scenario in combination with a recommended buildings pathway. The recommended scenario (the reference case) estimates emissions reductions achieved by the electricity supply and in non-building asset categories in 2025 and 2030. These emissions reductions are estimated during the City Scenario Analysis Step of the Action Plan development, which makes it possible to determine the remaining emissions reductions required from buildings (the buildings target) to comply with near-term emissions reduction mandates and commitments. The recommended buildings pathway identifies the interventions required to deliver the target.

The Action Plan—consisting of the recommended buildings pathway in combination with the reference case—meets the plan vision of balancing policy compliance, technical and practical feasibility, and cost considerations, as described in Figure 24.



DCAS staff performing preventative maintenance on a boiler | Source: DCAS

Consideration	The Action Plan...
Policy Compliance	<ul style="list-style-type: none"> ■ Has the City achieve the LL97 emission reduction mandates for 2025 and 2030 and the following other near-term objectives: <ul style="list-style-type: none"> ■ 20% energy consumption reduction in City buildings by 2030, instead of 2025 (as further discussed in this section). ■ 100MW of solar installations on City property by 2025. ■ 100% renewable electricity for city government operations. ■ Puts the City on the trajectory to 80x50 and carbon neutrality. ■ Supports co-benefits that advance broader City policy objectives, such as improved local air quality and associated health outcomes and opportunities to accelerate a just energy transition, workforce development, and market transformation through investments in communities across the City to reach every New Yorker.
Technical and Practical Feasibility	<ul style="list-style-type: none"> ■ Emphasizes the necessity of reducing emissions in buildings, the asset category which comprises the largest share of the City’s emissions. ■ Manages risk associated with the delay or non-realization of emissions reductions over both LL97 compliance periods by pursuing substantial emissions reductions for all City asset categories, as well as procuring LSR for the City’s electricity supply, and not over-relying on any single type of action to deliver emissions reductions. ■ Also manages risk by planning for possible new emissions associated with portfolio and energy consumption growth and considering possible emissions changes due to other drivers, such as changes in the emissions intensity of the electricity supply. ■ Considers the implementation time for City projects, including planning, budgeting, procurement, and delivery, and the corresponding limits placed on completing new energy efficiency projects prior to the 2025 LL97 compliance deadline. ■ Establishes a reasonable but ambitious ramp-up of work through 2030 to establish a sustainable trajectory to deep decarbonization.
Cost	<ul style="list-style-type: none"> ■ Positions the City to steadily increase investments in relatively cost-effective EROs over time and avoid significant fluctuations in year-over-year investments. ■ Sets up the City to invest resources into the capital-funded projects necessary to achieve deep decarbonization.

Figure 24: Action Plan Performance Against Vision



Rooftop air handling units on Department of Sanitation's 26th St Garage | Source: DCAS

Reference Case Assumptions

The reference case estimates emissions reductions achieved by and required investments for electricity supply actions and EROs in non-building asset categories. It was developed during the scenario analysis step (Step 3), in which a range of potential emissions reduction futures for the City and their implications for buildings were assessed.

Electricity Supply Assumptions

For electricity supply, the reference case assumes (1) the electricity grid supplying New York City becomes cleaner and (2) the City procures large-scale renewables. The detailed assumptions are summarized below.

Cleaner Electricity Grid

- **Summary:** The reference case assumes that the electricity grid supplying New York City becomes cleaner in light of the State's policy objectives, with 50% of the State's electricity coming from renewable energy sources by 2030. The forecast used for the cleaner electricity grid estimates a grid emissions intensity in 2025 and 2030 and interpolates from 2020 to 2025 and 2025 to 2030 to determine emissions intensity for intermediary years. Though New York State's CES now calls for 70% of the electricity consumed in the state to come from renewable energy resources by 2030, the reference case assumes 50% renewable generation to be conservative and mitigate risks that efforts to reach a cleaner electricity grid fall short.
- **Expected contributions to emissions reduction and energy mandates and commitments:** The cleaner electricity grid will help reduce emissions from electricity usage across all City asset categories, including, but not limited to, buildings. The emissions reduction benefits are expected to be available to contribute to both LL97 compliance periods (2025 and 2030).
- **Required City investments:** The costs associated with realization of the cleaner electricity grid are out of scope for the Action Plan, because the investments are planned by other entities and their costs are borne by all ratepayers. The costs will ultimately be reflected in energy supply costs under the City's utility energy budget. The City develops its utility energy budget on an annual basis by undertaking a range of forecasting analyses.

Large-Scale Renewables Procurement

- **Summary:** The reference case assumes that the City will procure LSR via RECs starting in 2026. Over the course of the Action Plan development process, the City has made substantial progress towards the procurement, having recently signed a letter of intent in partnership with NYSERDA to pursue a joint purchase of large-scale renewables. The City expects the commercial operation date of these projects to begin sometime in 2026. For the reference case, the REC purchase has been sized to be 85% of 2019 electricity consumption, with the intent to offset the remaining 15% not met with RECs by reducing city electricity consumption with energy efficiency projects³⁵.
- **Expected contributions to emissions reduction and energy mandates and commitments:** LSR procurement emissions reductions are assumed to contribute to the second LL97 compliance period (2030) and to the 100% renewable electricity commitment.
- **Required City investments:** The costs associated with LSR procurement were calculated based on expected project costs of a Tier 4 REC project in New York State, and on recent hydropower solicitations in neighboring states. It is expected that the City would fund the REC purchase with expense funds from the City's utility energy budget.

Non-Building Asset Assumptions

The reference case assumes that all available EROs with a start date between the start of 2022 and the end of 2025 for both non-building stationary assets and non-stationary assets are implemented. The detailed assumptions for each category are summarized below.

Specific EROs in Non-Building Stationary Assets

- **Summary:** The reference case assumes that the City will complete all EROs that are planned, funded, and have a confirmed start date between the start of 2022 and the end of 2025, as of March 2021. These EROs include ten projects for which capital funds have already been registered but the projects are ongoing and are expected to be completed during the 2022 to 2030 LL97 implementation period. Non-building stationary asset EROs encompass projects undertaken by DEP at WRRFs and water supply facilities and also reflect declines in landfill gas emissions. During Action Plan development, DEP was developing in parallel its Energy and Carbon Neutrality Plan (ECN), a long-term strategic plan to achieve the goals of reducing energy usage by 20% by 2025, reducing greenhouse gas emissions by 80% by 2050, and accomplishing net energy neutral operation for NYC's 14 in-city WRRFs by 2050.
- **Expected contributions to emissions reduction and energy mandates and commitments:** Non-building stationary asset emissions reductions are assumed to contribute to both LL97 compliance periods, and to the City's commitment to net zero energy consumption at WRRFs by 2050. On the path to 2050, the pace of work at WRRFs will need to be further ramped up after 2030 to fulfill the commitment.

³⁵ The LSR procurement is sized based on an iterative modeling process which identified the average electricity consumption reduced under the reference case and recommended buildings pathway to estimate the LSR procurement needed to meet the City's 100% renewable electricity commitment, given energy efficiency projects expected to occur from 2022 to 2030. There is a relationship between the City's 20% energy reduction commitment, which encompasses all energy types (including but not limited to electricity) and is focused on City buildings, and the City's renewable electricity commitment, which is limited to electricity but affects all city government operations. Depending on the energy source that they impact, energy efficiency projects that contribute to the energy consumption reduction also have the capacity to lower electricity consumption.

- **Required City investments:** The costs to achieve emissions reductions associated with actions in non-building stationary assets were estimated based on the upfront costs for incremental EROs planned by DEP (i.e., energy-specific projects planned by DEP, but eligible for DCAS funding). Of note, significant investments in underlying infrastructure, with objectives not solely focused on reducing energy use, are often required to unlock ERO potential, requiring either DCAS to have the capability to alter its funding model to provide more funding to DEP to cover these costs or DEP to undertake additional cost-sharing (e.g., through DEP’s capital budget). These foundational investments can have an impact on the feasibility of the incremental EROs.

Specific EROs in Non-Stationary Assets

- **Summary:** The reference case assumes that the City will accomplish all non-stationary asset EROs that are planned, funded, and have a confirmed start date between the start of 2022 and end of 2025, as of March 2021. These EROs encompass a reduction in fossil fuel consumption by 2025. This reduction is accomplished by phasing out fossil diesel and procuring renewable diesel by 2025, by ramping up the use of biodiesel in the City’s vehicle fleet, and by electrifying non-emergency sedans.
- **Expected contributions to emissions reduction and energy mandates and commitments:** Non-stationary asset emissions reductions are assumed to contribute both LL97 compliance periods and to meet the City’s commitment to reduce fossil fuel consumption in the City’s vehicle fleet 50% by 2025. On the path to 2050, the City will continue to work towards achieving an all-electric and carbon-neutral fleet by 2040 as a part of the City’s Clean Fleet Plan.
- **Required City investments:** The costs associated with projected non-stationary assets emissions reductions are funded by DCAS through a specific budget for Fleet, as distinct from the budget for interventions in buildings. The cost of renewable diesel procurement was estimated by comparing the incremental costs of renewable diesel fuel as compared to fossil diesel fuel. Electrification of non-emergency sedans is treated as cost-neutral on a lifetime-cost basis, per the recommendation of DCAS-Fleet.



Department of Sanitation trucks under energy efficient lighting | Source: DCAS

Reference case annual emissions reductions and required City investments are summarized in Figure 25.

Reference Case		2022-2025	2026-2030	Total 2022-2030
Changes to Electricity Supply				
Cleaner Electricity Grid	Annual Emissions Reductions (Thousand MTCO ₂ e)	167	100	267
	Investment (\$, in millions)	-	-	-
Large-Scale Renewables Procurement	Annual Emissions Reductions (Thousand MTCO ₂ e)	-	806	806
	Investment (\$, in millions)	-	737	737
Subtotal: Changes to Electricity Supply	Annual Emissions Reductions (Thousand MTCO ₂ e)	167	906	1,073
	Investment (\$, in millions)	-	737	737
Actions in Non-Building Assets				
Specific EROS in Non-Building Stationary Assets	Annual Emissions Reductions (Thousand MTCO ₂ e)	137	31	168
	Investment (\$, in millions)	242	55	297
Specific EROs in Non-Stationary Assets	Annual Emissions Reductions (Thousand MTCO ₂ e)	168	18	186
	Investment (\$, in millions) ³⁶	50	57	107
Subtotal: Actions in Non-Building Assets	Annual Emissions Reductions (Thousand MTCO ₂ e)	305	49	354
	Investment (\$, in millions)	292	112	404
Total Electric Supply and Non-Building Assets Annual Emissions Reductions (Thousand MTCO₂e)		472	955	1,427
Total Electric Supply and Non-Building Assets Investment (\$, in millions)		292	849	1,141

Figure 25: Reference Case Summary: Annual Emissions Reductions and Required Investments³⁷

36 As of September 2021, these estimated investments were provisional and under development.

37 The annual emissions reduction values, in thousand MTCO₂e, represent total annual emissions reductions achieved in the last year of the compliance period referenced. The annual emissions reduction values have been rounded to the nearest thousand MTCO₂e. Investment values have been rounded to the nearest \$1 million and discounted to reflect the time value of money. Due to rounding, values presented may not add up precisely to the totals provided.

Implications for Recommended Buildings Pathway from Reference Case

Under the reference case, the City is expected to achieve a reduction in annual emissions of 2,323,000 MTCO₂e by 2030 from a 2006 baseline. A portion of this progress, 923,000 MTCO₂e, is associated with emissions reductions achieved before the start of the Action Plan. After the start of the Action Plan, changes in electricity supply are expected to provide an additional 1,073,000 MTCO₂e and specific EROs in non-building assets are expected to achieve 354,000 MTCO₂e in annual emissions reductions by 2030. Some of these emissions reductions are expected to be offset by growth in City building energy consumption, which is estimated to increase annual emissions by 27,000 MTCO₂e by 2030. For the purpose of compliance with the LL97 mandates only, setting aside all other City policy objectives, the remaining annual emissions reductions required from buildings is 172,000 MTCO₂e by 2025 and zero MTCO₂e by 2030.

However, this volume of emissions reductions from buildings is not sufficient, and it is imperative that the City undertake additional interventions in buildings beyond those needed to meet the LL97 buildings target in 2025 and 2030. Most importantly, additional interventions in buildings are necessary for the City to meet both other near-term mandates and commitments, such as the 20% energy consumption reduction commitment, and to put the City on a sustainable trajectory to longer-term mandates and commitments. In particular, the heat electrification initiative, which is further discussed under the recommended buildings pathway, is especially critical to deep decarbonization. Additional emissions reductions from buildings are also necessary to manage the risk of delay or lower-achievement of the expected emissions reductions from the electricity supply and non-building assets.



*Solar installation on roof of Queens Junior High School 157
Stephen A. Halsey | Source: DCAS*

Figure 26 illustrates the calculation performed to determine the minimum annual emissions reductions required from buildings.

Minimum Building Annual Emissions Reduction Target	2025 (Thousand MTCO₂e)	2030 (Thousand MTCO₂e)
2006 Annual Emissions from City Government Operations (Reported)	3,871	3,871
Pre-Action Plan Annual Emissions Reductions		
Annual Emissions Reductions, 2006-2019	-890	-890
Annual Emissions Reductions from Completed Energy Efficiency Projects, 2019-2021	-33	-33
2022 Annual Emissions from City Government Operations (Estimated)	2,948	2,948
Reference Case Annual Emissions Reductions		
Annual Emissions Increases from Growth	+19	+27
Annual Emissions Reductions from Cleaner Electricity Grid	-167	-267
Annual Emissions Reductions from Large-Scale Renewables Procurement	-	-806
Annual Emissions Reductions from Actions in Non-Building Assets	-305	-354
2025 and 2030 Reference Case Annual Emissions from City Government Operations (Estimated)	2,495	1,548
LL97 Annual Emission Reduction Mandates	-2,323	-1,936
Net Annual Emissions Reductions Required by Buildings Pathway	-172	-
Additional Annual Emissions Reductions Achieved under the Reference Case to Exceed the LL97 Mandates	-	-388

Figure 26: Calculation of Minimum Annual Emissions Reductions Required from Buildings

Recommended Buildings Pathway Intervention Assumptions

The recommended buildings pathway includes four major interventions: (1) planned energy efficiency projects, (2) investment in on-site solar, (3) heat electrification initiative, and (4) additional energy efficiency projects. The key assumptions associated with each intervention are summarized below.

Planned Energy Efficiency Projects

- **Summary:** This intervention involves the City completing its planned energy efficiency projects for buildings. These are projects that, as of 2022, have already been planned, funded, and have a start date in the four years between the beginning of 2022 and the end of 2025.
- **Expected contributions to emissions reduction and energy mandates and commitments:** This intervention helps the City achieve the LL97 mandates, as well as 20% energy consumption reduction commitment on an extended period.
- **Required City investments:** The recommended buildings pathway assumes these projects are funded through DCAS programs, such as ExCEL for expense-funded projects and ACE and other capital retrofit programs for capital-funded projects.

Investment in On-Site Solar

- **Summary:** This intervention involves the City completing the installation of 100MW of solar PV on City property by the end of 2025. These projects' locations are based on the findings from the City's most recent solar readiness assessment, which was completed in 2020 as required by Local Law 24 of 2016. Implementing this intervention will require accelerated replacement of rooftops to support solar installations at 123 facilities with high solar PV capacity. These facilities represent approximately 20,200,000 gross square feet (total building square footage).
- **Expected contributions to emissions reduction and energy mandates and commitments:** This intervention helps the City achieve the LL97 mandates, as well as its commitment to install 100MW of solar PV on City property by 2025. On the path to 2050, the City will continue to pursue on-site solar to comply with additional mandates and commitments as they are established.
- **Required City investments:** The recommended buildings pathway assumes half of the planned solar installations are funded with capital budget, with some pre-scoping and operations and maintenance (O&M) costs³⁸, and the other half are financed through Power Purchase Agreements (PPAs).³⁹ The PPAs' fiscal impacts are captured under the City's utility energy budget. The investment amount identified for on-site solar in the recommended buildings pathway represents the investment needed to meet the 100MW target during the LL97 compliance period and does not account for continued investments beyond that goal. It is anticipated that the City will continue to invest in on-site solar and these ongoing investments are represented in Figure 32 as steady-state capital and expense. Costs for required rooftop replacements are not included within the investments.

38 The O&M costs considered were based on NREL's 2020 Annual Technology Baseline (<https://atb-archive.nrel.gov/electricity/2020/data.php>) and includes material and labor costs.

39 A Solar Power Purchase Agreement is a financial arrangement in which a third-party owns, operates, and maintains a solar system; and a host customer agrees to site the system on its property and purchases the system's electric output from the third party for a predetermined period.

Heat Electrification Initiative

- **Summary:** This intervention involves the City pursuing electrification opportunities in buildings where feasible. The heat electrification initiative is based on a target that the City will complete heating system electrification projects in City buildings so as to steadily ramp up to a pace of 2% of City building square footage per year by 2030. The City will initiate the first set of projects at the start of 2023, so that those projects produce full-year emissions reductions by the start of 2026. The City will undertake the heat electrification initiative for several reasons. First, it is necessary to position the City to further accelerate building heating system electrification projects after 2030, which is necessary to reach 80x50 and carbon neutrality. Second, it will take near-term opportunities to electrify aging heating systems that otherwise would be replaced in-kind with fossil fuel heating systems and is aligned with the City’s mandate to phase out the use of No. 4 fuel oil by January 1, 2030.⁴⁰ The initiative will prioritize buildings with old and fuel oil-fired heating systems that are nearing or have already reached a need for replacement.⁴¹ The City will focus on transitioning fossil fuel-heated buildings to electric heat pumps and use hybrid space heating systems where full space heat electrification is not cost-effective, given that some buildings may require significant investments.⁴²
- **Expected contributions to emission reduction and energy mandates and commitments:** This intervention helps the City achieve the LL97 mandates, as well as establish a sustainable path to 80x50 and carbon neutrality by 2050. On the path to 2050, the City will seek to further accelerate building heating system electrification projects after 2030, using lessons learned from the Action Plan implementation period.
- **Required City investments:** The recommended buildings pathway assumes that this intervention is primarily a capially-funded program, with some additional expense funding for project pre-scoping and O&M costs. Consistent with costing analyses for other interventions under the Action Plan, electrification cost estimates reflect full project implementation costs. Notably, conversions to electric heat are most cost effective when done at the end of an existing fossil-fuel system’s useful life. Building electrification projects are to be implemented as significant retrofits to existing buildings, which are complex and intensive projects; for this reason, the heat electrification initiative accounts for the largest share of all recommended buildings pathway investments (57%).

40 Mandated in Department of Environmental Protection Promulgation of Amendments to Chapter 2 of Title 15 of the Rules of the City of New York Rules Governing the Emissions from the Use of #4 and #6 Fuel Oil in Heat and Hot Water Boilers and Burners.

41 The initiative also takes into account equity and environmental justice considerations, in terms of identifying buildings sited in communities with local air quality issues where there is a need to reduce on-site combustion.

42 Hybrid systems will provide most of the annual building heating use from electricity but will utilize the existing fossil fuel-based systems to supplement space heating on the coldest days.

Consideration of zero-carbon fuels

Zero-carbon fuels were not considered in the recommended buildings pathway due to lack of visibility into long-term supply availability. Substantial market risk associated with renewable natural gas (RNG) was identified, as there is no material supply for RNG at the time of this study in New York and the long-term market for RNG is uncertain due to limited availability and needs in other industries. There is also policy risk associated with the use of biofuels, beyond levels already mandated by NYC law and available in the existing marketplace, due to uncertainty regarding how they will be treated under the emissions accounting framework defined in the New York State CLCPA and how that will impact the Inventory of New York City Greenhouse Gas Emissions. The City will continue to monitor opportunities to invest in low-carbon fuels, which can be a valuable complementary strategy for decarbonization, especially to help decarbonize hard-to-electrify buildings and enhance energy security through diversified fuel sources. However, there is a need to remain mindful of emissions other than greenhouse gases and their attendant public health effects.

Additional Energy Efficiency Projects

- **Summary:** This intervention involves the City completing additional relatively cost-effective EROs as they become available during the 2022 to 2030 period. In this context, relatively cost-effective EROs are defined as having a lifetime marginal abatement cost that is less than that of the estimated LSR REC marginal abatement cost. Relatively-cost effective EROs are selected in order of lowest cost to fulfill remaining emission reduction needs. The City will invest in these EROs to realize several benefits. First and most importantly, it will continue to make strides towards improving energy efficiency in buildings, which is necessary to meet the City's 20% energy consumption reduction commitment and stay on track towards longer-term emissions reduction and energy mandates and commitments. Second, the City can lower the volume and thus the cost of RECs that must be purchased for it to achieve its 100% renewable electricity commitment by prioritizing projects that will result in lower electricity use. Finally, additional energy efficiency projects can reduce the broader societal costs of building out the electric transmission and distribution systems to support increased electrification.
- **Expected contributions to emission reduction and energy mandates and commitments:** This intervention helps the City achieve the LL97 mandates, as well as the 20% energy consumption reduction commitment on an extended time period by 2030.
- **Required City investments:** The recommended buildings pathway assumes these projects are funded through DCAS programs, such as ExCEL for expense-funded projects and ACE and other capital retrofit programs for capital-funded projects. The additional energy efficiency projects selected to comply with the 2025 mandate are primarily expense-funded, as expense projects tend to be faster to implement. The additional energy efficiency projects selected to comply with the 2030 mandate are primarily capital-funded, as capital projects take longer to implement but tend to be larger projects that can be financed with lower cost long-term debt.

Recommended Buildings Pathway Interventions		2022-2025	2026-2030	Total 2022-2030
Planned Energy Efficiency Projects	Annual Emissions Reductions (Thousand MTCO ₂ e)	83	46	128
	Investment (\$, in millions)	252	3	255
Investment in On-Site Solar	Annual Emissions Reductions (Thousand MTCO ₂ e)	20	-	20
	Investment (\$, in millions)	145	1	146
Heat Electrification Initiative	Annual Emissions Reductions (Thousand MTCO ₂ e)	-	52	52
	Investment (\$, in millions)	629	817	1,446
Additional Energy Efficiency Projects	Annual Emissions Reductions (Thousand MTCO ₂ e)	81	2	83
	Investment (\$, in millions)	349	347	696
Total Recommended Buildings Pathway Annual Emissions Reductions (Thousand MTCO₂e)		184	100	284
Total Recommended Buildings Pathway Investment (\$, in millions)		1,375	1,168	2,543

Figure 27: Recommended Buildings Pathway Summary: Annual Emissions Reductions and Required Investments⁴³

43 The annual emissions reduction values, in thousand MTCO₂e, represent total annual emissions reductions achieved in the last year of the compliance period referenced. The annual emissions reduction values have been rounded to the nearest thousand MTCO₂e. Investment values are based on the year in which the funds are registered, as explained in Plan Vision and Development. Investment values have been rounded to the nearest \$1 million and discounted to reflect the time value of money. Due to rounding, values presented may not add up precisely to the totals provided.

Action Plan Emissions Reduction Impacts

Emissions Reduction Impacts from Overall Action Plan

The Action Plan puts the City in a position to achieve the 40% LL97 emissions reduction mandate by 2025 and to exceed the 50% LL97 emissions reduction mandate by 2030. However, it is critical to emphasize that the City will only realize these expected reductions and meet its objectives if all actions included under both the recommended buildings pathway and reference case are accomplished on time. Further complicating the situation, not all the actions under the reference case lie within the City's full control. For example, the City is reliant on significant efforts by other entities, such as the State and utilities, to transform the grid. For this reason, the Action Plan includes planned overachievement of the 50% LL97 mandate for 2030 to manage risk and help the City remain on track even if planned emissions reductions from any individual asset category or the electricity supply over 2022 to 2030 are delayed or subject to lower achievement.

Figure 28 presents the breakdown for how emissions reductions will be achieved under the Action Plan by showing the contributions made by each asset category, as well as by the electricity supply via both a cleaner electricity grid and LSR procurement.

- For 2022 to 2025, interventions in buildings (under the recommended buildings pathway) are expected to deliver emissions reductions of 184,000 MTCO₂e (equal to a 5% reduction from the 2006 baseline). In addition, actions in non-building assets (under the reference case) are expected to deliver emissions reductions of 305,000 MTCO₂e (an 8% reduction from the 2006 baseline), with 137,000 MTCO₂e from specific EROs in non-building stationary assets and 168,000 MTCO₂e from specific EROs in non-stationary assets. A cleaner electricity grid (under the reference case) is expected to contribute 167,000 MTCO₂e of reductions (a 4% reduction from the 2006 baseline). These emissions reductions are combined with a modest gain (19,000 MTCO₂e) in emissions from forecasted portfolio and energy consumption growth. The resulting net emissions impact is an incremental 16% reduction from baseline, yielding a 40% reduction in emissions by 2025.
- From 2026 to 2030, interventions in buildings are expected to deliver emissions reductions of 100,000 MTCO₂e (a 3% reduction from the 2006 baseline). In addition, actions in non-building assets (under the reference case) are expected to deliver 49,000 MTCO₂e (a 1% reduction from the 2006 baseline), with 31,000 MTCO₂e from non-building stationary assets and 18,000 MTCO₂e from non-stationary assets. A cleaner electricity grid is expected to provide emissions reductions of 100,000 MTCO₂e (a 3% reduction from the 2006 baseline). Finally, LSR procurement adds significant emissions reductions of 806,000 MTCO₂e (a 21% reduction from the 2006 baseline). Combined with a modest gain (8,000 MTCO₂e) in emissions from forecasted portfolio and energy consumption growth, the net emissions impact is an incremental 27% reduction for 2026 to 2030 from baseline, yielding the 67% total reduction by 2030.

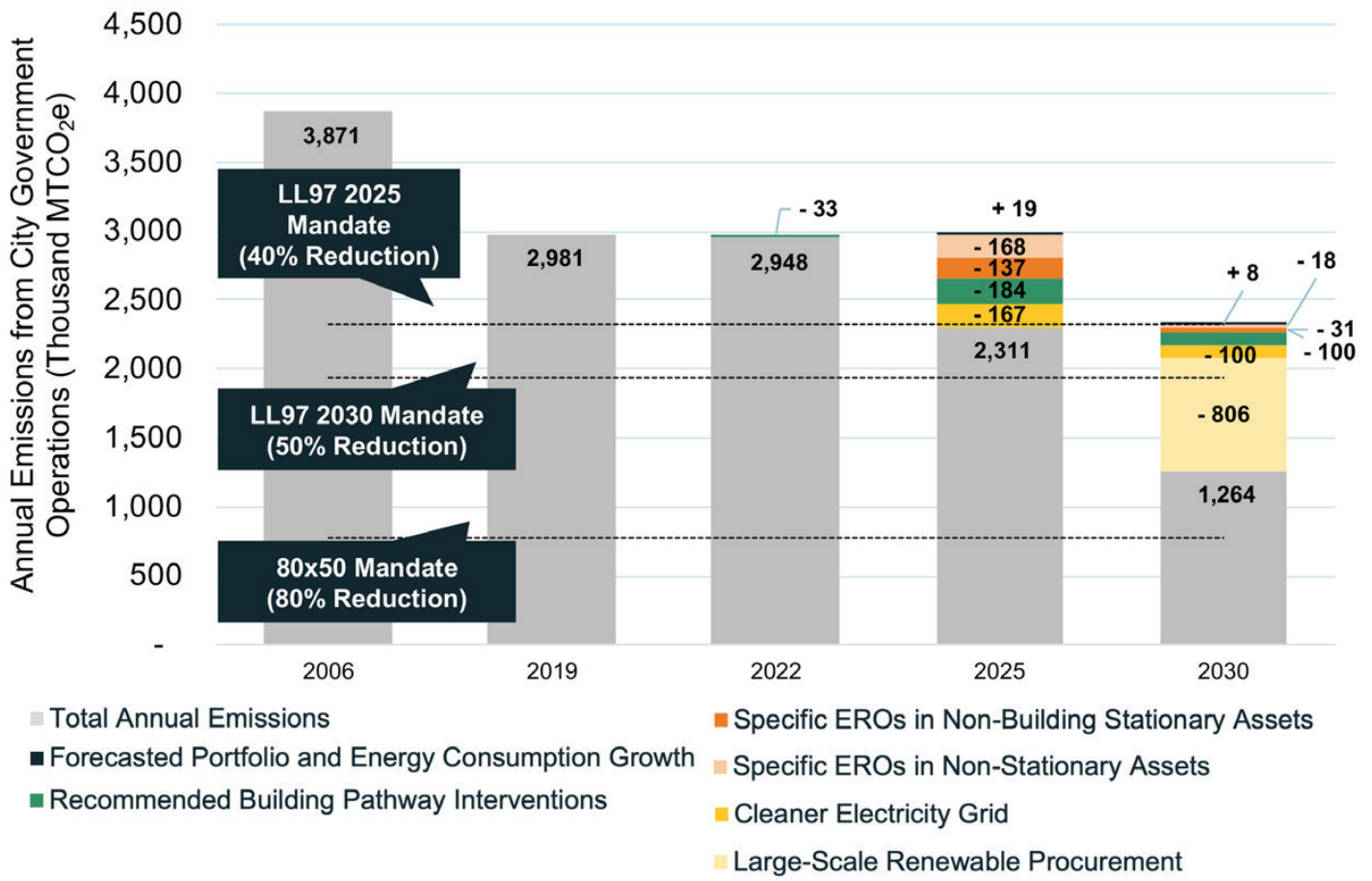


Figure 28: Annual Emissions from City Government Operations Under Action Plan



DCAS and agency staff attending an engineering presentation | Source: DCAS

Action Plan Annual Emissions Reductions	Annual Emissions Reductions (Thousand MTCO ₂ e)		
	2022-2025	2026-2030	Total 2022-2030
Reference Case			
Cleaner Electricity Grid	167	100	267
Large-Scale Renewables Procurement	-	806	806
Subtotal: Changes in Electricity Supply	167	906	1,073
Specific EROs in Non-Building Stationary Assets	137	31	168
Specific EROs in Non-Stationary Assets	168	18	186
Subtotal: Actions in Non-Building Assets	305	49	354
Recommended Buildings Pathway Interventions			
Planned Energy Efficiency Projects	83	46	128
Investment in On-site Solar	20	- ⁴⁴	20
Heat Electrification Initiative	-	52	52
Additional Energy Efficiency Projects	81	2	83
Subtotal: Buildings Interventions	184	100	284
Total Annual Emissions Reductions	656	1,054	1,710

Figure 29: Summary of Action Plan Annual Emissions Reductions⁴⁵

44 The Action Plan is focused on achieving the City's 100MW on-site solar installation goal by 2025. As a result, emissions reductions from on-site solar remain constant after 2025. It is anticipated that the City will continue to install solar PV to achieve further emissions reductions and achieve with potential future goals. Achievement beyond 100MW on-site solar was not included in the Action Plan.

45 The annual emissions reduction values, in thousand MTCO₂e, represent total annual emissions reductions achieved in the last year of the compliance period referenced. The annual emissions reduction values have been rounded to the nearest thousand MTCO₂e. Due to rounding, values presented may not add up precisely to the totals provided.

Action Plan Required Investments

Required Investments for Full Action Plan

In total, required City investments to implement the Action Plan are projected to be \$3.68 billion from 2022 to 2030, comprised of \$1.66 billion from 2022 to 2025 and \$2.02 billion from 2026 to 2030. The City has already committed funds at the scale of investment required to implement the Action Plan. The majority of these investments (\$2.54 billion, or 69%) are expected to be directed towards interventions in buildings through the implementation of the recommended buildings pathway. The remaining investments (\$1.14 billion, or 31%) are focused on achieving the emissions reductions for the electricity supply and non-building assets included under the reference case. Of the \$1.14 billion LSR accounts for \$737 million (65%) and actions in non-building assets account for \$404 million (35%).

Figure 30 presents the required investments for the Action Plan, showing the costs of changes to the electricity supply and actions affecting non-building assets under the reference case and interventions in buildings under the recommended buildings pathway.

- For 2022 to 2025, required investments in buildings (under the recommended buildings pathway) are expected to be \$1.37 billion (equal to 82% of total Action Plan required investments for that period). In addition, required investments in non-building assets (under the reference case) are expected to be \$292 million (18%), with \$242 million associated with specific EROs in non-building stationary assets and \$50 million associated with specific EROs in non-stationary assets.
- From 2026 to 2030, required investments in buildings are expected to be \$1.17 billion (equal to 58% of investments for that period). Required investments in non-building assets (under the reference case) are expected to be \$112 million (6%), with \$55 million associated with non-building stationary assets and \$57 million with non-stationary assets. In addition, LSR procurement adds investments of \$737 million (36%).

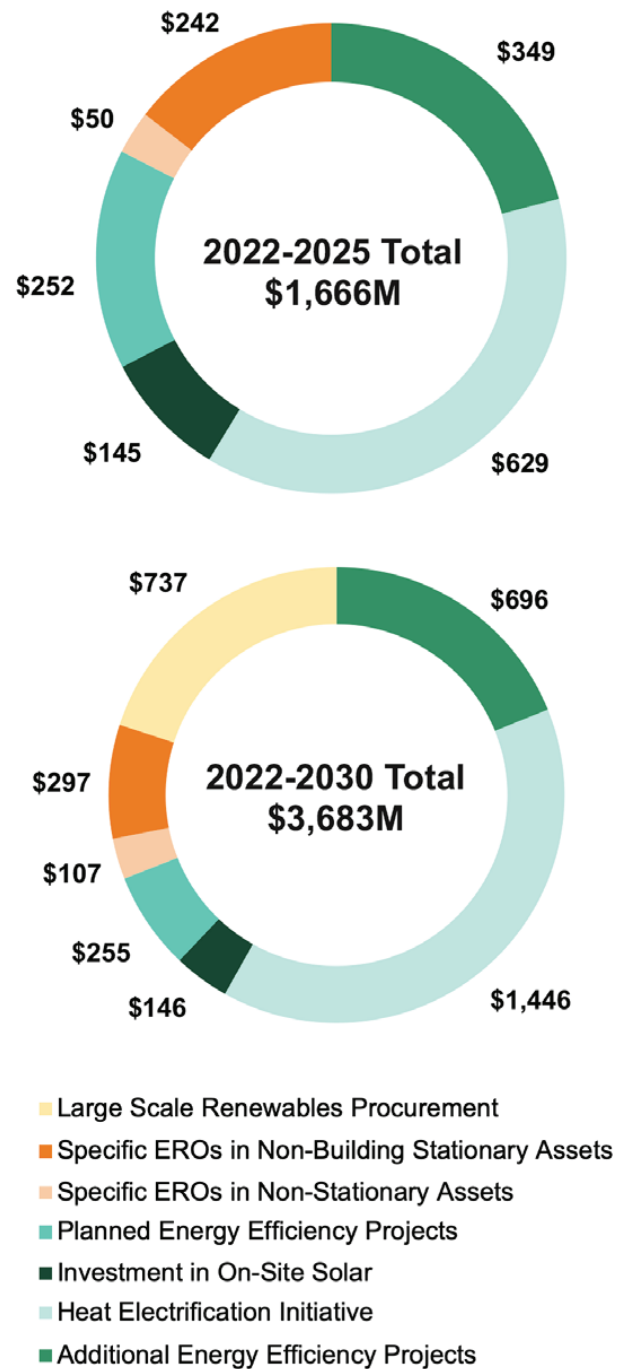


Figure 30: Investments Required by Intervention Type

Figure 31 below shows the required investments for the Action Plan, including the reference case changes to the electricity supply and actions in non-building assets, as well as actions affecting building assets occurring under the recommended buildings pathway. The City has already committed funds at the scale of investment required to implement the Action Plan.

Action Plan Investments	Investments (\$, in millions)		
	2022-2025	2026-2030	Total 2022-2030
Reference Case			
Cleaner Electricity Grid	Not costed within Action Plan	Not costed within Action Plan	Not costed within Action Plan
Large-Scale Renewables Procurement	-	737	737
Subtotal: Changes in Electricity Supply	-	737	737
Specific EROs in Non-Building Stationary Assets	242	55	297
Specific EROs in Non-Stationary Assets ⁴⁶	50	57	107
Subtotal: Actions in Non-Building Assets	292	112	404
Recommended Building Pathway Interventions			
Planned Energy Efficiency Projects	252	3	255
Investment in On-site Solar	145	1	146
Heat Electrification Initiative	629	817	1,446
Additional Energy Efficiency Projects	349	347	696
Subtotal: Buildings Interventions	1,375	1,168	2,543
Total Required Investments	1,666	2,017	3,683

Figure 31: Summary of Action Plan Investments

⁴⁶ As of September 2021, these estimated investments were provisional and under development.

Required Investments for Buildings

Figure 32 shows the required investments to deliver the emissions reductions associated with the recommended buildings pathway. These investments are represented by the solid bars and align with the corresponding numbers presented in Figure 31. Without investments in buildings, the City will not realize the emissions reductions from buildings necessary to achieve compliance with LL97 and other near-term mandates and commitments.

In addition, Figure 32 also shows additional “steady-state” investments, which are represented by the transparent (dashed) bars. For the Action Plan, the focus is on identifying and estimated required investments that the City must undertake through 2030 to comply with LL97 and other near-term mandates and commitments. However, because the City also has ambitious longer-term emissions reductions and energy mandates and commitments (i.e., 80x50 and carbon neutrality), it must continue its investments beyond those identified as part of the Action Plan. The “steady-state” investments show the City’s sustained spending.

To understand the sustained spending pace, the pace of remaining emissions reductions required to achieve carbon neutrality was assessed. Through the Action Plan, from 2022 to 2030, the City is expected to achieve an annual emissions reduction for buildings of 284,000 MTCO₂e, an average annual emissions reduction of 32,000 MTCO₂e per year. To achieve carbon neutrality by 2050, annual emissions for buildings must be reduced by an additional 889,000 MTCO₂e between 2031 through 2050, an average annual emissions reduction of 44,000 MTCO₂e per year. This pace is faster in 2031-2050, and the costs per reduced MTCO₂e will likely increase as lower cost opportunities will have already been addressed in earlier years. There may also be additional emissions due to portfolio growth from 2031-2050 that could need to be offset by additional investments in buildings. For these reasons, it is reasonable to expect that the investment required to achieve longer-term City mandates and commitments will remain steady or increase over time.

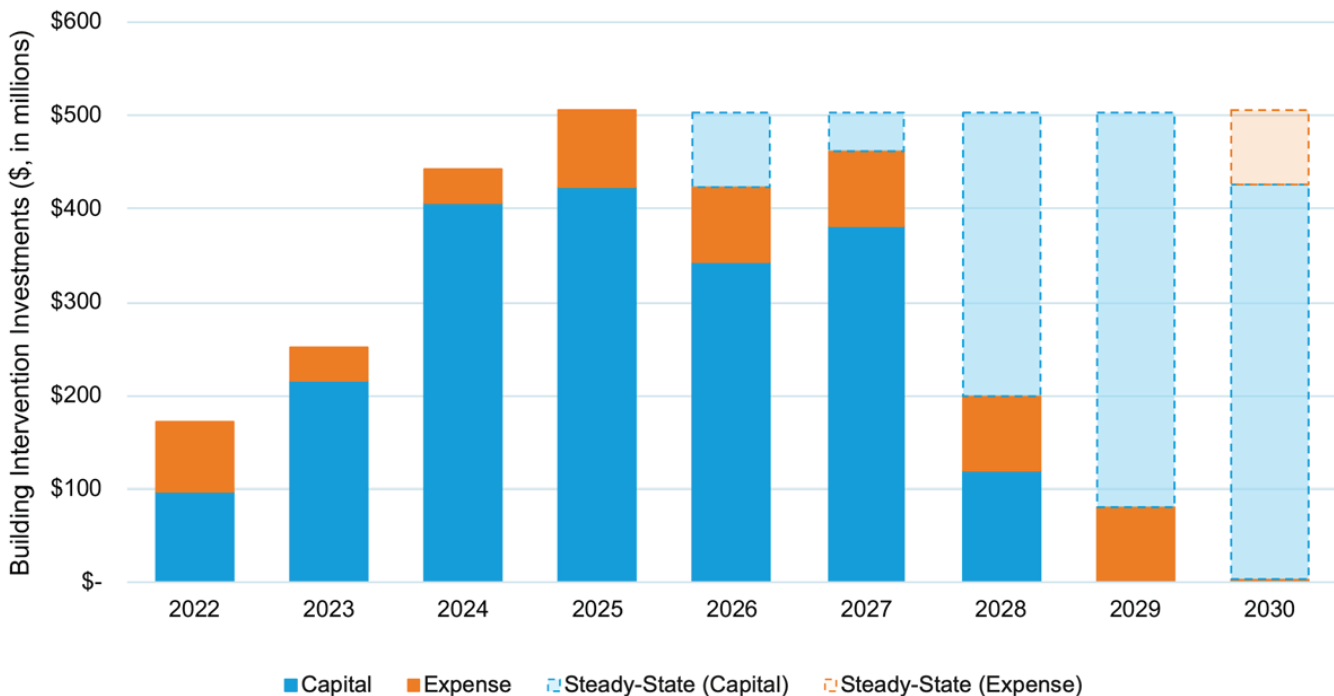


Figure 32: Required Investments for Buildings Interventions

Required Staffing Support

Figure 33 shows the required staffing resources for the recommended buildings pathway by presenting the City staff required to implement the interventions. In this context, these staff include both (1) project delivery staff and (2) project support staff located at both DCAS and agency partners. Project delivery staff are responsible for directly managing or overseeing project delivery. Within DCAS, project delivery staff evaluate and select projects for funding, provide technical assistance and engineering support, help manage contractors engaged in design and construction, and oversee project close-out, among other activities. Within agencies, project delivery staff perform complementary work, including developing projects and submitting them for funding, managing contractors and in-house project delivery staff, and conducting project close-out. Project support staff enable project delivery by performing essential budget, contracting and procurement, and data management work.⁴⁷

In Figure 33, the existing City staff line shows the number of City staff who theoretically have been allocated through 2022 to support energy work. However, it is important to note that there are significant vacancies at present, which means that there are fewer actual staff in place than allocated staff. Figure 33 shows that the need for City staff is expected to ramp up through 2026, following similar trends in required investments. At present, there have been approximately 250 staff theoretically allocated across the City through 2022 to support energy work. The City is expected to need approximately 30 additional personnel, for a total of approximately 280 personnel to support the volume of work identified in the recommended buildings pathway.

It is expected that the City will need to retain these personnel in a steady-state, or sustained pace, of staffing to continue advancing projects aimed at delivering longer-term emissions reductions mandates and commitments. This ongoing need is represented by the dashed boxes in Figure 33.

Please note, Figure 33 does not present staffing needs for the following types of staff:

- General construction (GC) staff, who are responsible for installing projects. GC staff needs have been included in the Action Plan under the project cost estimates.
- Operations and maintenance (O&M) personnel, inclusive of relevant skilled trades staff, who are responsible for operating and maintaining projects once completed. Importantly, O&M staff within the City have sometimes been critical in directly implementing some types of projects at agencies with limited access to relevant construction contracts. O&M staff needs have not been scoped within the Action Plan because they relate to agencies' general operations, although an initiative has been put forth to expand preventative maintenance staff in Section 4.
- Energy staff at key functional entities across the City to support budget management, procurement, and contracting activities. This initiative is described in more detail in Section 4.
- Agency Chief Decarbonization Officers (ACDOs) within each of the individual agencies that cumulatively contribute to more than 90% of GHG emissions from City stationary assets, as well as agencies identified as critical to meeting the City's emissions reduction targets. This initiative is described in more detail in Section 4.

⁴⁷ Within DCAS, project delivery staff evaluate and select projects for funding, provide technical assistance and engineering support, help manage contractors engaged in design and construction, and oversee project close-out, among other activities. Within agencies, project delivery staff perform complementary work, including developing projects and submitting them for funding, managing contractors and in-house project delivery staff, and doing project close-out, among other activities.

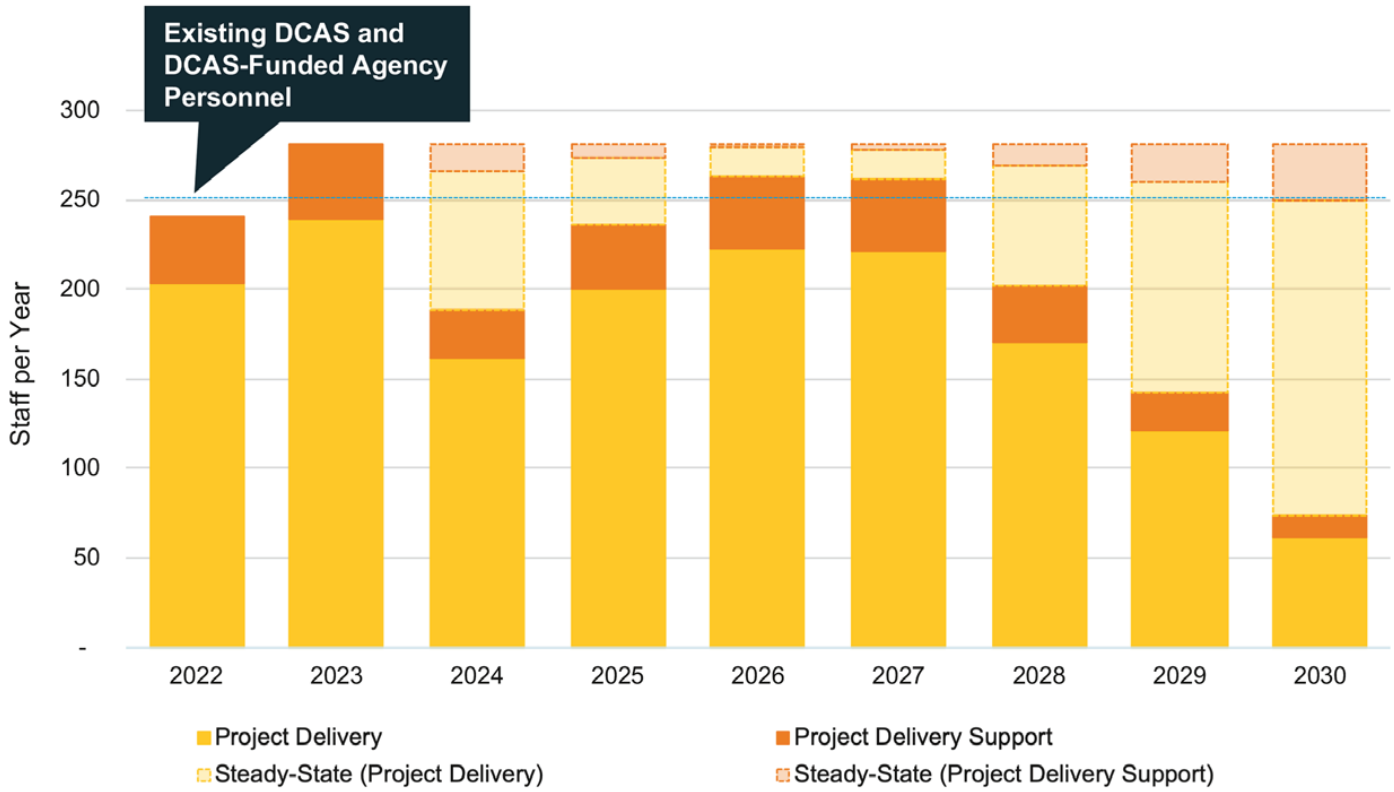


Figure 33: Required Staffing for Buildings Interventions

As part of LL97 implementation, DCAS will continue supporting agency energy personnel needs and proposes to support additional workforce development that may be needed to ensure the City is adequately resourced to realize the necessary emissions reductions (see Section 4. Required Implementation Support for more information).

Risk Management in the Action Plan

Full implementation of the Action Plan—consisting of the recommended pathway in combination with the reference case—rests on actions that are both outside DCAS’s direct control (i.e., changes to the electricity grid supplying New York City, some actions affecting non-building assets) and within its control (i.e., interventions in buildings). For this reason, analysis was done to examine different scenarios, or various emissions reduction futures for the City as informed by changes to the electricity supply and actions affecting non-building assets.

The scenarios were evaluated given their performance against the three Action Plan vision considerations, with special attention paid to their capacity to manage various risks that could result in delayed or non-achievement of emissions reductions across city government operations. The reference case ultimately was selected to be combined with the recommended pathway in the Action Plan because it was deemed to perform well against the plan vision considerations and effectively manage risks relative to other scenarios. Though other emissions futures may come to pass over the nine-year LL97 implementation period, the reference case in combination with the recommended pathway is designed to be resilient.

Scenario Elements

Figure 34 compares the reference case to alternate high and low cases. The high case refers to the scenario that projected both the highest emissions reductions and the highest level of investment relative to other scenarios. The low case refers to the scenario that projected both the lowest emissions reductions and the lowest level of investment relative to other scenarios.

Scenarios/Elements	Reference Case	High Case	Low Case
Electricity Supply Elements			
Cleaner Electricity Grid	50x30 (50% renewable energy resources statewide)	50x30 (50% renewable energy resources statewide)	Emissions intensity of the grid held flat at 2019 levels
Large-Scale Renewables Procurement	Occurs during second LL97 compliance period	Occurs during second LL97 compliance period	No procurement by 2030
Non-Building Asset Elements			
Specific EROs in Non-Building Stationary Assets	More ambitious ⁴⁸	More ambitious	More conservative ⁴⁹
Specific EROs in Non-Stationary Assets	More ambitious	More ambitious	More conservative
Other Scenario Elements Affecting Recommended Buildings Pathway			
Flexibility to Achieve 20% Energy Consumption Commitment by 2030	Enables the 20% energy consumption reduction commitment for buildings to be achieved in the second LL97 compliance period	Requires the 20% energy consumption reduction commitment for buildings to be achieved in the first LL97 compliance period	Can only achieve 15% reduction through the second LL97 compliance period

Figure 34: City Emissions Reductions Compliance Scenario Comparison

48 This level of emissions reductions is based on the implementation of some less certain EROs on top of the most certain EROs included in the most conservative emissions reduction potential. These less certain EROs consist of projects or activities that are planned, funded, and will be underway within one to four years (between the start of 2022 and the end of 2025).

49 This level of emissions reductions is based on the implementation of only the EROs that are deemed most certain to be delivered. These EROs consist of projects or activities that are planned, funded, and will be underway within a year (during 2022).

- **Reference case:** The reference case performs well against the policy compliance consideration by enabling the City to achieve the LL97 mandates and satisfy the emissions reduction and energy mandates and commitments, with the 20% energy consumption reduction commitment met by 2030. Pertinent to the feasibility consideration, the reference case manages risk by sourcing emissions reductions from all asset categories and electricity supply, and thereby not over-relying on interventions from any asset category or the electricity supply. The result is a feasible volume of projects in buildings over both LL97 compliance periods. In terms of the cost consideration, the reference case requires a lower investment as compared with meeting the 20% energy consumption reduction commitment by 2025. The reference case also provides a relatively balanced level of required investment across both the first and second LL97 compliance periods.
- **High case:** The high case performs well against the policy compliance consideration by enabling the City to achieve the LL97 mandates and satisfy the emissions reduction and energy mandates and commitments, with the 20% energy consumption reduction commitment met by 2025. Pertinent to the feasibility consideration, meeting the 20% energy consumption reduction commitment by 2025 requires a volume of projects that is infeasible during the first compliance period. In terms of the cost consideration, meeting this commitment on-time leads to the selection of additional higher-cost EROs in the first compliance period, which pushes the required investment appreciably higher with modest additional emissions reductions. Given the higher costs and only modest additional emissions reductions, this scenario is not recommended.
- **Low case:** The low case performs poorly against the policy compliance consideration by not achieving either the 2025 or the 2030 LL97 mandated emissions reductions. This is a result of only modest emissions reduction contributions from electricity supply and from non-building assets. Pertinent to the feasibility consideration, the assumed under-performance from electricity supply and non-building assets results in infeasible levels of investment and project execution in buildings to attempt to cover the gap, especially in the first compliance period. In terms of the cost consideration, significant additional investment would be required for buildings to fully make up the gap to ensure LL97 compliance in both compliance periods.

Figure 35 below depicts a comparative risk assessment of the scenarios.

Scenarios/Elements	Reference Case	High Case	Low Case
Policy Compliance	Recommended Near-term mandates and commitments achieved, except 20% energy consumption reduction target extended to 2030.	Recommended Near-term mandates and commitments achieved on time.	Not Recommended LL97 mandates and other near-term mandates and commitments not achieved.
Technical and Practical Feasibility	Feasible Buildings make a significant contribution to the Action Plan while better balancing the timing of interventions and investments across compliance periods. Electricity supply and all asset categories contribute emissions reductions to manage risk.	Infeasible Required building interventions and investments must be front-loaded into first compliance period.	Infeasible Project execution infeasibly front-loaded into first compliance period. Buildings alone cannot carry the City to LL97 compliance.
Cost	Recommended Comparatively lower investment, better balanced across compliance periods.	Not Recommended Comparatively highest total investment, heavily front-loaded into first compliance period.	Not Recommended Comparatively higher buildings investment, heavily front-loaded into first compliance period.

Figure 35: City Emissions Reductions Compliance Scenario Performance Against Plan Vision Considerations

Section 4: Required Implementation Support

DCAS Facilities Management building operators maintaining electric motors | Source: DCAS

Required Implementation Support

To support successful implementation of the Action Plan, DCAS recommends a set of initiatives focused on policy and operational changes. The initiatives are designed to put the City in the best position to achieve its ambitious emissions reduction agenda and mitigate climate change by changing key ways in which the City does business. The initiatives were developed in consultation with the Action Plan Advisory Board, Steering Committee, and energy management staff across the City, based on their experience with challenges that can impede emissions reduction efforts. The initiatives fall into the five broad categories presented below. Under each category, the main idea of each initiative is described along with the need(s) addressed and likely key partners for implementation. It is important to emphasize that the initiatives, which are separate but interconnected, relate to, and reinforce each other.

Category 1: Accountability Infrastructure

This category of initiatives is focused on strengthening accountability and transparency related to the City's emissions reduction efforts.

1a: Enhanced agency governance

Description: Under this initiative, agencies will be required to (1) incorporate emissions reductions into their missions, and (2) establish a senior-level staff person within each agency serving as the Agency Chief Decarbonization Officer (ACDO), who is responsible for directing the agency's overall emissions reduction efforts. ACDOs will be put in place at each of the individual agencies that cumulatively contribute to more than 90% of GHG emissions from City stationary assets, as well as agencies identified as critical to meeting the City's emissions reduction targets. The ACDOs will be charged with ensuring that agencies remain on track to meet individual agency decarbonization targets and contribute to overall City mandates and commitments. Their work will include helping agencies access required funding and staffing, performing project identification and delivery, and conducting workforce development and change management, among other activities. To support this initiative, the business title of DCAS' City Chief Energy Management Officer will change to City Chief Decarbonization Officer (CCDO). The CCDO will assume an expanded portfolio including overseeing the City's overall compliance with decarbonization mandates.

Need(s) addressed: This initiative will help agencies consistently prioritize emissions reductions and maintain a strong focus on integrating such into daily operations and capital planning.

Key partners: DCAS, Law Department, Mayor's Office of Climate & Sustainability, Mayor's Office of Operations, Office of Management and Budget, all agencies

1b: Enhanced public transparency regarding emissions reduction progress

Description: Under this initiative, the City will report each agency's emissions reduction progress to the public on an annual basis.

Need(s) addressed: This initiative will help all stakeholders, including agency heads and the public, understand and hold the City and agencies accountable for progress towards agency and City targets.

Key partners: DCAS, Mayor's Office of Climate & Sustainability, Mayor's Office of Operations, all agencies

1c: Ongoing performance tracking and recalibration against emissions reduction targets

Description: Under this initiative, the City will implement a system and processes to track agencies' progress towards individual and overall City emissions reduction targets and help agencies course correct as necessary. This performance tracking and recalibration initiative is intended to rebalance required emissions reductions across agencies and the City portfolio as necessary based on actual performance.

Need(s) addressed: This initiative will help the City ensure that agencies remain on track and implement corrective action if needed.

Key partners: DCAS, Mayor's Office of Climate & Sustainability, Mayor's Office of Operations, all agencies

Category 2: Human Capital

This category of initiatives is focused on ensuring essential energy staff are embedded across the City and into core City functions to enable emissions reduction work to move forward effectively.

2a: Placement of essential energy project planning, delivery, and maintenance staff across the City

Description: Under this initiative, the City will (1) continue to place energy project planning and delivery staff at agencies to implement projects on the ground, including staff focused on capital planning; (2) expand in-house commissioning and preventative maintenance teams at agencies to help them get the greatest benefit from existing and newly installed systems; and (3) explore the establishment of rotating teams to fulfill specific technical needs across the City, such as building controls design and solar panel maintenance.

Need(s) addressed: This initiative will help ensure that the City has the staff in place to implement projects at scale and appropriately commission and maintain equipment and systems to get the most out of each investment and fulfill highly specific technical needs.

Key partners: DCAS, Office of Management and Budget, all agencies

2b: Placement of essential support staff at key functional entities across the City

Description: Under this initiative, the City will embed energy-focused staff working under a common set of operating principles at key entities that support emissions reductions work across the City, such as budget management, procurement, and contracting activities. For example, these staff will help drive the review of energy-related project and staffing budget requests across all agencies (at Office of Management and Budget) and develop contracts and support procurements to serve common energy-related needs across agencies (at Law, Mayor's Office of Contract Services, and DCAS).

Need(s) addressed: This initiative will ensure that the City has staff with the specialized expertise and focus necessary to connect the City's emissions reduction work across a diverse set of functions and significantly accelerate it.

Key partners: DCAS, Law Department, Mayor's Office of Climate & Sustainability, Mayor's Office of Contract Services, Office of Management and Budget

2c: Expanded workforce development

Description: Under this initiative, the City will (1) develop and implement new and revised civil service titles for energy work and (2) bring together the major City entities involved in both recruiting and training energy staff to integrate and expand the City's overall energy workforce development efforts. The City is already working to create new titles for energy strategy development and project management work, and will identify and respond to other emerging needs, such as titles focused on building controls management.

Need(s) addressed: This initiative will help the City build the workforce required to achieve our ambitious emissions reduction and energy mandates and commitments by addressing staff and skill gaps.

Key partners: DCAS, Department of Buildings, Mayor's Office of Climate & Sustainability, Office of Management and Budget

Category 3: Project Implementation Support

This category of initiatives is focused on addressing funding and procurement barriers to delivering energy projects and realizing the greatest co-benefits from such projects.

3a: Comprehensive funding strategy, including collaboration with the state and utilities and efforts to align state of good repair and energy efficiency investments

Description: Under this initiative, the City will continue to collaborate with (1) the state and utilities to expand access to funding and other resources for project implementation and (2) City budget entities and agencies to develop clear guidance about how to differentiate, but align, energy efficiency and state of good repair investments⁵⁰ and size state of good repair work required to support energy efficiency work.

Need(s) addressed: The City will need to make significant investments to achieve our emissions reduction and energy mandates and commitments, including LL97, while facing budget constraints, which makes it essential that the City work with the state and utilities to secure current and future resources. In addition, given that energy efficiency work often requires state of good repair work to realize projects and/or energy savings, the City must ensure that it is planning for resources to meet both needs.

Key partners: DCAS, Mayor's Office of Climate & Sustainability, New York State Energy Research and Development Authority, New York State Public Service Commission, Office of Management and Budget, State regulatory and policy-making entities, utilities, all agencies

3b: Comprehensive contracting strategy, including establishment of new project implementation vehicles

Description: Under this initiative, the City will (1) develop a comprehensive LL97-associated contracting strategy to ensure the City can access necessary services and project delivery support, including expanding opportunities for robust minority-owned and women-owned business enterprise participation, and (2) establish critical recommended project implementation vehicles. The vehicles are expected to include, but are not limited to, a master agreement with multiple service providers who can offer turnkey engineering, procurement, and construction services.

⁵⁰ When possible, energy efficiency and state of good repair investments will support adjacent resiliency investments.

Need(s) addressed: This initiative will help the City close key gaps in project implementation capacity and realize a diversity of project delivery vehicles required to implement different project types at the necessary scale and pace.

Key partners: DCAS, Law Department, Mayor's Office of Climate & Sustainability, Mayor's Office of Contract Services, Office of Management and Budget, all agencies

3c: Environmental justice prioritization

Description: Under this initiative, the City will incorporate equity and environmental justice considerations into energy project site selection, prioritization, and staffing.

Need(s) addressed: This initiative will help ensure that climate change mitigation work benefits communities that are most vulnerable to climate change impacts across the five boroughs.

Key partners: DCAS, Mayor's Office of Climate & Sustainability, Office of Management and Budget, all agencies

Category 4: Integrated Capital Planning

This category of initiatives is focused on embedding consideration of emissions impacts into the City's capital planning processes to drive energy capital project throughput and impact.

4a: Emissions impacts evaluation

Description: Under this initiative, the City will (1) require agencies to evaluate the emissions impacts of capital projects upfront and (2) establish a defined process for integrating Action Plan energy projects into the four-year and 10-year capital plans.

Need(s) addressed: This initiative will ensure that the City and agencies are aware of the emissions impacts of their projects and changes in project timing and there is awareness and discussion of the carbon budget alongside fiscal budget.

Key partners: DCAS, Department of Design and Construction, Economic Development Corporation, Mayor's Office of Climate & Sustainability, Office of Management and Budget, School Construction Authority, all agencies

4b: Targeted capital planning improvements

Description: Under this initiative, the City will (1) take specific action to streamline capital project approvals for energy projects, including by establishing master Certificates to Proceed and developing clear policy guidelines on capital eligibility and (2) develop energy-efficient specifications and clear policy guidelines about when replacement in kind is not permitted to help the City move to lowest-emissions technologies.

Need(s) addressed: This initiative will help the City advance energy projects more quickly by eliminating common causes of project delays and move beyond replacement in kind by providing necessary tools and guidance.

Key partners: DCAS, Department of Design and Construction, Economic Development Corporation, Mayor's Office of Climate & Sustainability, Mayor's Office of Contract Services, Office of Management and Budget, School Construction Authority, all agencies

Category 5: Optimized Building Operations

This category of initiatives is focused on sustaining emissions reductions over time by improving the performance of existing equipment and systems and ensuring the effective operation of new equipment and systems.

5a: Advanced metering and controls

Description: Under this initiative, the City will continue work to (1) fully integrate planned utility metering upgrades, real-time metering installations, and submetering activities; and (2) develop and implement a master plan to upgrade controls across the City.

Need(s) addressed: This initiative will help set the City up to transform energy management across facilities by improving access to data from utility meters and controls. With this data, City staff will be best positioned to take actions that save energy and improve facility performance, whether that involves going out into the field or taking advantage of new remote capabilities.

Key partners: DCAS, Department of Design and Construction, Department of Information Technology, New York Power Authority, Office of Management and Budget, School Construction Authority, utilities, all agencies

5b. Advanced analytics

Description: The City will continue work to deploy new resources and technology, including machine learning capabilities, to target buildings for projects, improve automated diagnosis of energy conservation opportunities, and support measurement and verification at buildings to enable their best performance.

Need(s) addressed: This initiative will help the City leverage technology to improve energy management efforts, including identifying energy-efficient projects and other interventions to improve efficiency.

Key partners: CUNY Building Performance Lab, DCAS, Department of Design and Construction, Department of Information Technology, New York Power Authority, Office of Management and Budget, School Construction Authority, utilities, all agencies

1 Accountability Infrastructure

Strengthening **accountability and transparency** related to the City's emissions reduction efforts.

2 Human Capital

Ensuring **essential energy staff are embedded across the City** and into core City functions to enable emissions reduction work to move forward effectively.

3 Project Implementation Support

Addressing **funding and procurement barriers to delivering energy projects** and realizing the greatest co-benefits from such projects.

4 Integrated Capital Planning

Embedding **consideration of emissions impacts into the City's capital planning processes** to drive energy capital project throughout and impact.

5 Optimized Building Operations

Sustaining emissions reductions by **improving the performance of existing equipment and systems** and **ensuring the effective operation of new equipment and systems**.

Figure 36: Required Implementation Support Initiatives

Conclusion

Climate change is one of the most pressing issues facing New York City today. Without immediate, significant, and sustained reductions in greenhouse gas emissions, we face a future of irreversible warming that will increase the frequency and intensity of catastrophic events like coastal flooding, flash flooding, and heatwaves.

As a city at the forefront of climate action, New York has an important role to play in the global effort to reduce emissions. LL97 builds upon over fifteen years of sustainability planning and policy-making that have established New York City as a leader in mitigating climate change. The emissions reduction mandates put forth by the landmark LL97 legislation underscore the City's ongoing commitment to this work.

Balancing policy compliance, technical and practical feasibility, and cost considerations, this Action Plan provides the roadmap for achieving the emissions reductions required by LL97 for city government operations and other near-term policy mandates and commitments.

Among other critical interventions, this plan calls for:

- Scaling up investments in cost-effective emissions reduction opportunities.
- Achieving a 20% reduction in building energy consumption by 2030.
- Converting more municipal buildings' heating to electric power.
- Expanding solar installations on City properties to generate 100MW of solar power annually by 2025.
- Sourcing 100% of electricity used by city government from renewable sources by 2026.
- Investing in energy and emissions projects at wastewater and water treatment facilities.
- Purchasing electric vehicles and renewable fuels for the City's vehicle fleet.

To support Action Plan implementation, the City has dedicated nearly \$4 billion over the next 9 years to invest in its assets, facilities, and energy supply.

Above and beyond these financial resources, Action Plan implementation will require broad collaboration and bold action across City agencies, offices, and entities. To help facilitate this collaboration, DCAS will engage agencies in ongoing planning to support agency target achievement. In addition, DCAS will work with stakeholders across the City, State, and utilities to implement the policy and operational changes outlined in this plan.

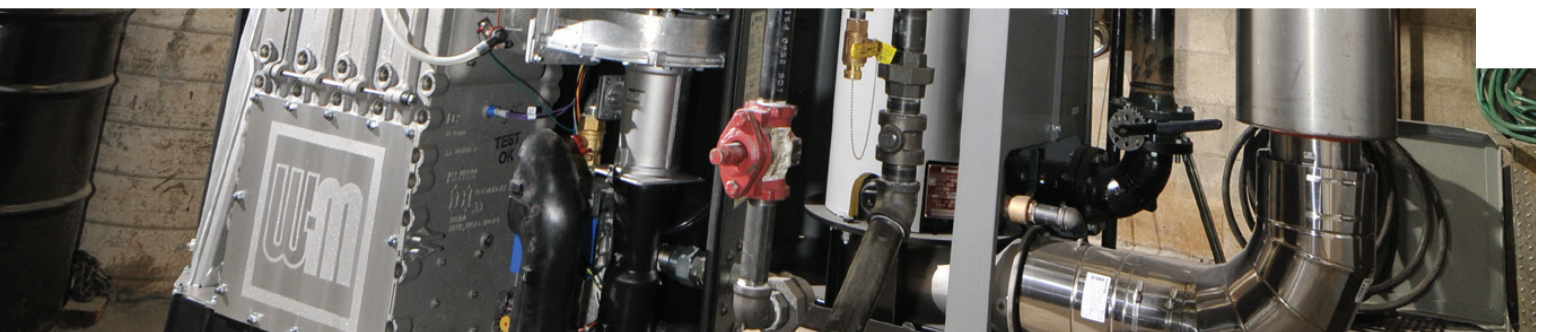
Successful implementation of the LL97 Implementation Action Plan will enable the City to move rapidly toward deep decarbonization and provide a model for what cities around the world can do to help secure the future of our planet.

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HVAC equipment at the Staten Island Ferry Maintenance Facility | Source: DCAS



Boiler Maintenance at Brooklyn War Memorial
Source: DCAS

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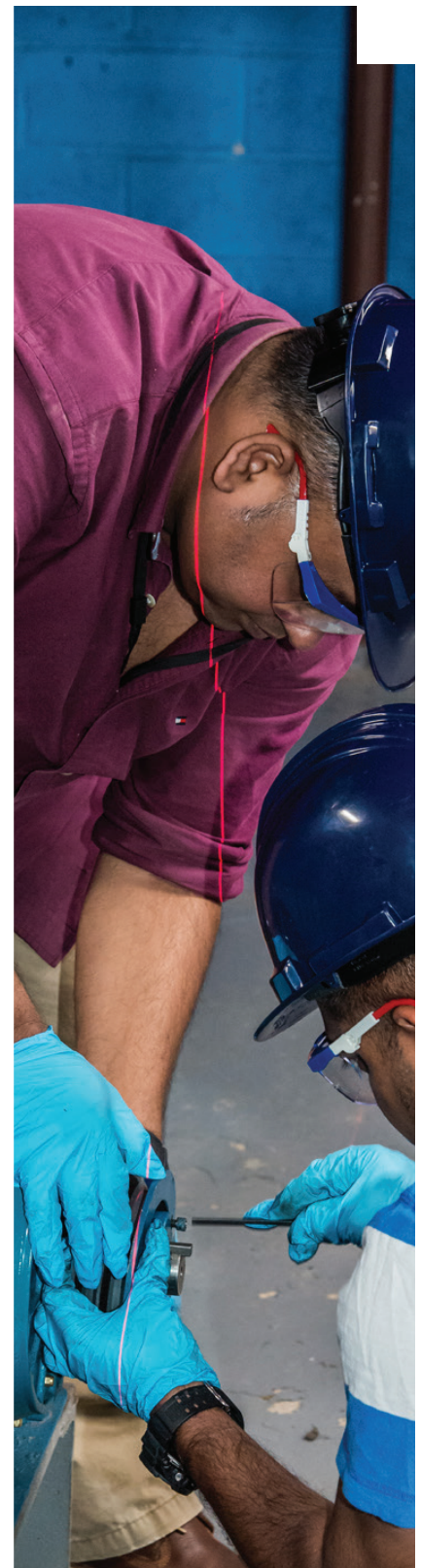
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NYC school building staff performing preventative maintenance on an electric fan motor.

Source: DCAS



DCAS FM Building Operators examining building electrical systems.

Source: DCAS

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**...and so many more.
Thank you.**

*Represents a staff person who is no longer at the agency but participated in the development of the Action Plan.

Appendix



Installation of solar panels on roof of Queens Wave Preparatory Elementary School | Source: DCAS

Section A - Glossary of Terms

Building electrification: Building electrification refers to phasing out gas, steam, and fuel oil powered heating/cooking equipment from building and converting building systems to completely electric energy consumption units.

Buildings: Subcategory within stationary assets that is functionally equivalent to the Buildings sector in the City Government Inventory. The buildings asset category includes all buildings either leased or owned by the City.

Bundle: A strategic grouping of Emissions Reduction Opportunities (EROs) that target specific facility systems. Bundles represent a group of similar project types that could be implemented across building typologies.

City emissions reduction scenario (scenario): City emissions reduction scenarios are defined as the combination of various emissions reduction contributions from non-building sectors and electricity supply, leaving a residual emissions reduction to be realized from the buildings sector. Scenarios reflect different groupings of policy and operational parameters under which the citywide and agency-level pathways are developed. The parameters for scenario development reflect (1) compliance with the City’s core emissions reduction and energy policy mandates and commitments, (2) technical and practical feasibility among and within City asset categories, and (3) cost, in terms of rate of spend and cost effectiveness.

City government operations: As defined by Local Law 97 of 2019, city government operations includes “operations, facilities, and other assets that are owned or leased by the City for which the City pays all or part of the annual energy bills.”

City portfolio: Unless otherwise specified in the context of the Action Plan, City portfolio refers to city government operations and is inclusive of all City asset categories including stationary assets—both buildings and non-buildings—and non-stationary assets.



Neighborhood in Manhattan
Source: Adobe Stock



Solar panel installation at Queens Rachel Carson Intermediate School | Source: DCAS

Climate Leadership and Community Protection Act (CLCPA): The CLCPA commits New York State to reaching net zero greenhouse gas emissions. This mandate covers all sectors of the economy and includes electricity and fuels that are imported from other states. The bill requires 40% emissions reductions in absolute terms from 1990 levels by 2030 and 85% emissions reductions by 2050. To reach the commitment of net zero emissions, the CLCPA allows for any remaining emissions beyond 85% to either be directly reduced or offset through projects that remove greenhouse gases from the atmosphere.

Core emissions reduction and energy mandates or commitments: Derived from review of relevant City plans, legislation, and executive orders to identify emissions and energy City objectives focused on city government operations or buildings. Mandates are codified by law, and commitments are policies described in published plans or mayoral announcements.

Emissions baseline year: For all city government related emissions reduction mandates, the City's baseline year for inventories emissions is 2006.

Emissions factors: Coefficients which allow for the conversion of activity data into GHG emissions. In the case of city government and citywide emissions accounting, emission factor refers to the conversion of a unit of electric, gas, fuel, or steam use into a unit of carbon dioxide (CO₂), methane (CH₄), nitrous oxide (N₂O), hydrofluorocarbons (HFCs), perfluorocarbons (PCFs), sulphur hexafluoride (SF₆) and nitrogen trifluoride (NF₃).

Emissions reduction opportunities (EROs): Operational interventions or equipment replacements and upgrades that lead to emissions reductions by improving facility energy performance.

Energy Conservation Steering Committee: Established in 2007, the Energy Conservation Steering Committee (ECSC) included: Mayor's Office of Long-term Planning and Sustainability (OLTPS), now the Mayor's Office of Climate and Sustainability (MOC&S); Mayor's Office of Management and Budget (OMB); New York City Economic Development Corporation (EDC), Department of Design and Construction (DDC); and Department of Citywide Administrative Services (DCAS). The ECSC produced a 2008 planning report to aid the City's achievement of its goal to reduce emissions 30% by 2017.

Heat, Light and Power (HLP) budget: DCAS works with the City's Office of Management and Budget to develop the City's Heat, Light, and Power budget, which covers electricity, natural gas, and steam each year. For 2021, heat, light, and power expenditures are expected to be \$777 million, with the City-funded portion \$714.7 million. Electricity represents over three-quarters of the budget in terms of total cost, and almost half of the budget in terms of total energy usage. This is also referred to as the City's utility energy budget.

Heat electrification initiative: Refers to the proposed citywide effort to replace existing boiler systems via electrification for the purpose of putting the City on a sustainable trajectory towards 80x50 and carbon neutrality.

Inventory of New York City Greenhouse Gas Emissions: Established by Local Law 22 of 2008, the Inventory of New York City GHG Emissions annually tracks the City's greenhouse gas emissions and their sources at both the Citywide and city government levels. The citywide Inventory tracks all emissions within the city limits while the City Government Inventory tracks only the emissions of city government operations.

Large-scale renewables (LSR): This refers to the commitment to power city government operations with 100% renewable electricity by 2025. On April 20th, 2021, Mayor Bill de Blasio announced New York City has signed a letter of intent in partnership with the New York State Energy Research and Development Authority (NYSERDA) committing the City to pursuing a joint purchase of large-scale renewable source of electricity delivered to the City which could include Canadian hydropower to the extent selected or its equivalent.

Lifecycle costs: Defined as the net present value (NPV) of costs over a project's useful life. Lifecycle costs are necessary to evaluate the relative cost-effectiveness of interventions.

LL97 compliance periods: Per Local Law 97 of 2019, city government operations must reduce emissions 40% by 2025 and 50% by 2030 from a 2006 baseline. Respectively, the interim and final compliance periods are thus, 2019 to 2025 to achieve 40% reductions and 2026 to 2030 to achieve 50% reductions.

LL97 Implementation Action Plan (Action Plan): The Action Plan puts forth a recommended scenario (reference case), which considers the electricity supply and emissions reduction actions in non-building City assets, and a recommended buildings pathway, which considers emissions reduction interventions in City buildings to comply with the City's LL97 emissions reduction mandates, as well as other City emissions reductions and energy mandates and commitments. The plan is based on methodology developed to identify and model emissions reduction opportunities for city government operations, with a specific focus on buildings.

LL97 Implementation Action Plan implementation periods: The Action Plan implementation periods are based on the LL97 compliance deadlines and reflect the publication of the Action Plan in 2022. The first Action Plan implementation period is 2022 to 2025 and the second implementation period is 2026 to 2030.

LL97 Pathways Model: The Excel-based model developed to evaluate and recommend City and agency-level pathways to achieve the required LL97 emissions reduction mandates.

Marginal abatement cost curve (MACC): The marginal abatement cost metric of cost per ton of carbon reduced enables the equivalent comparison of different EROs. Plotting the marginal abatement costs of various EROs with a y-axis of cost per ton of carbon reduced and an x-axis of annual carbon abatement produces the MACC, which ranks EROs from most cost effective to least cost effective. The costs represented in Action Plan MACCs include both lifetime costs and benefits.

Marginal abatement costs: A metric for demonstrating the combined upfront and lifecycle cost of reducing emissions, expressed as cost per ton of carbon emissions reduced. The metric is based on net present value of lifetime costs (both upfront project costs and operating costs) and annual carbon abatement. The marginal abatement cost metric enables examination of all EROs based on \$ cost per ton of carbon reduced over the lifetime of the ERO and sets up apples-to-apples comparison between EROs with different cost structures and lifetime impacts.

Near-term mandates and commitments: Refers mandates and commitments that must be realized by 2030.

Non-building stationary assets: Subcategory within stationary assets that includes four specific sectors (following the sector definitions within the City Government Inventory): Wastewater Treatment, Water Supply, Solid Waste, and Streetlights & Traffic Signals.

Non-stationary assets: Category consisting of two specific sectors within city government operations (following the sector definitions within the City Government Inventory): Transportation, which includes emissions from on-road vehicles, marine vessels and helicopters, and Fugitive Emissions, which includes fugitive HFC emissions from on-road vehicles.

Pathway: A pathway details the types and volumes of building emission reduction opportunities to be pursued in a given year to achieve (1) the remaining reductions required to meet LL97 mandates and (2) the emissions reduction and energy mandates and commitments. Pathway interventions are represented as a % of total portfolio square footage to be touched by a given bundle in one-year increments (see definition for bundle).

Planned energy efficiency projects: Planned energy efficiency or clean energy projects or activities for stationary assets that at the time the Action Plan was developed, have already been planned, funded, and have a start date in the four years between the beginning of 2022 and the end of 2025.

Prototype building energy model: A modeled property based on a real property or set of real properties within the City's buildings portfolio that is used in the Action Plan to represent a set of similar buildings within a given building type.

Recommended buildings pathway: A final recommended buildings pathway, which achieves the buildings target and is then carried forward into agency-level target setting and pathway development.

Reference case: The reference case refers to the recommended City emissions reduction scenario from which, the recommended buildings pathway is developed.

Relatively cost-effective EROs: Defined for the Action Plan as emissions reduction opportunities with a lifetime marginal abatement cost that is less than that of the estimated Large-Scale Renewables REC marginal abatement cost. Relatively-cost effective EROs are selected in order of lowest cost, to fulfill remaining emission reduction needs.

Stationary assets: Category consisting of five specific City Government Inventory sectors within city government operations (following the sector definitions within the City Government Inventory): Buildings, Wastewater Treatment, Water Supply, Solid Waste, and Streetlights & Traffic Signals.

Section B - Emission Reduction Opportunity Bundles

The development and use of ERO bundles are described in Section 2. This set of 11 ERO bundles are applicable to buildings and are applied across the building types modeled as a part of the Action Plan. Additional detail on the types of EROs included in each bundle is provided in Figure 37.

Bundle Name	Sample EROs In Bundle
Operational Interventions	
Bundle 0. Operational improvements	<ul style="list-style-type: none"> Reset pressure / temperature / humidity setpoints on system components Check monitoring sensors for proper calibration; repair failed controls Calibrate, relocate, or repair lighting sensors Clean ducts, vents, grills, coils, or valves in air distribution system
Structural and Mechanical Interventions	
Bundle 1. Lighting improvements	<ul style="list-style-type: none"> Install occupancy / vacancy sensors, lighting controls, and daylight sensors Replace lamps with LED lamps Replace interior fixtures with LED fixtures
Bundle 2. Mechanical system improvements	<ul style="list-style-type: none"> Add variable frequency drives (VFDs) to HVAC equipment Add demand control ventilation Adjust outdoor air balancing
Bundle 3. Lighting + mechanical system improvements	<ul style="list-style-type: none"> Effectively, combines, or stacks, the actions under Bundle 1 (lighting improvements) and Bundle 2 (mechanical system improvements)
Bundle 4. Boiler system improvements	<ul style="list-style-type: none"> Repair boiler Make heating distribution improvements Replace steam traps Upgrade, install, or replace thermostatic radiator valves (TRVs), thermostats, and control valves Add pipe insulation
Bundle 5. Lighting + mechanical system + boiler system improvements	<ul style="list-style-type: none"> Effectively, Bundle 5 combines, or stacks, the actions under Bundle 1 (Lighting improvements), Bundle 2 (mechanical improvements), and Bundle 4 (boiler system improvements)

Bundle Name	Sample EROs In Bundle
Bundle 6. HVAC replacement on top of Bundle 5 ⁵¹	<ul style="list-style-type: none"> ■ Do HVAC replacement ■ Replace boiler with more efficient unit ■ Add new HVAC controls <p><i>With these actions being taken on top of the actions in Bundle 5</i></p>
Bundle 7. HVAC replacement + building envelope improvements on top of Bundle 5	<ul style="list-style-type: none"> ■ Do HVAC replacement ■ Replace boiler with more efficient unit ■ Add new HVAC controls ■ Do building envelopment improvements ■ Increase wall insulation ■ Increase ceiling insulation ■ Weather-seal and/or repair window or door ■ Replace glazing with high-performance glazing <p><i>With these actions being taken on top of the actions in Bundle 5</i></p>
Bundle 8. Heat electrification + supporting energy efficiency	<ul style="list-style-type: none"> ■ Install high-efficiency variable refrigerant flow (VRF) system ■ Install right-sized back-up space heating system (where VRF cannot cost-effectively provide all building heating) ■ Install electric on-demand service water heating <p><i>With these actions being taken on top of the actions in Bundles 1 and 4</i></p>
Bundle 9. Heat electrification + building envelope improvements + supporting energy efficiency	<ul style="list-style-type: none"> ■ HVAC replacement + building envelope improvements from Bundle 7: Install high-efficiency VRF system; back-up heating system; electric on-demand service water heater; increase wall insulation; increase ceiling insulation; weather-seal and/or repair window or door; replace glazing with high-performance glazing [on top of] ■ Supporting EE from Bundle 4: Add demand control ventilation; adjust outdoor air balancing ■ Supporting EE from Bundle 1: Install occupancy / vacancy sensors and lighting controls; replace lamps with LED lamps; replace fixtures with LED fixtures
Clean Energy Interventions	
Bundle 10. Solar PV	<ul style="list-style-type: none"> ■ Rooftop and canopy solar PV

Figure 37: Detailed Description of Bundles of Emissions Reduction Opportunities Applicable to Buildings

51 Replacement of existing HVAC systems with a more efficient unit was considered within the ERO assessment (Bundles 6 and 7). The recommended Buildings Pathway does not include Bundles 6 or 7. Instead investments that electrify HVAC systems (Bundles 8 and 9) are prioritized, and earlier bundles (Bundles 0-5) are selected to fulfil any remaining emissions reduction needs from buildings.

Section C - Select Modeling and Methodology Assumptions

Section 2 describes the agencies that have assets evaluated for EROs within the Action Plan. Of the 24 agencies with assets evaluated for EROs within the Action Plan, the 19 agencies listed in Figure 38 below were allocated LL97 emissions reduction targets.

Agency				
BPL	DEP	DOHMH	EDC	NYPD
CIG	DHS	DOT	FDNY	NYPL
CUNY	DOC	DPR	HHC	QPL
DCAS	DOE	DSNY	HRA	

Figure 38: Agencies with Assets Considered in the Scope of the Action Plan

The emissions baseline for city government operations is described in Section 1. The 2019 Inventory of New York City Greenhouse Gas Emissions was the latest GHG inventory available during the development of the Action Plan and was used as the basis for establishing 2006 and 2019 emissions from city government operations across all asset categories.

City Asset Category	GHG Sector	2006 Annual Emissions (MTCO ₂ e)	2019 Annual Emissions (MTCO ₂ e)	Percentage Changed
Buildings	Buildings	2,487,097	1,970,109	(21%)
Building Stationary Assets Total		2,487,097	1,970,109	(21%)
Non-Building Stationary Assets	Streetlights and Traffic Signals	128,701	46,870	(64%)
	Wastewater Treatment	610,385	490,319	(20%)
	Water Supply	10,556	47,049	346%
	Solid Waste	286,168	91,326	(68%)
Non-Building Stationary Assets Total		1,035,811	675,565	(35%)
Non-Stationary Assets	Transportation	336,743	322,728	(4%)
	Fugitive and Process Emissions	11,381	12,569	10%
Non-Stationary Assets Total		348,124	335,297	(4%)
City Government Operations Total		3,871,032	2,980,971	(23%)

Figure 39: Emissions Baseline for Asset Categories based on 2019 City GHG Inventory

Building prototypes are described in Section 2 and represent 74% of the buildings sector's energy consumption. Schools were further segmented into three prototypes based on building systems, in consultation with DOE. Similarly, hospitals were further segmented into two prototypes based on annual energy consumption, and offices were further segmented into three prototypes based on vintage.

Modeled Building Prototype	% of Buildings Sector Energy Consumption	% of Building Sector Square Footage
K-12 School (3 prototypes)	32%	36%
College/University	12%	0.9%
Hospital (2 prototypes)	12%	0.5%
Office (3 prototypes)	5%	5%
Repair Services	4%	4%
Courthouse	2%	0.7%
Lodging/Residential	1.3%	1.9%
Library	1.3%	6%
Police Station	1.2%	3%
Fire Station	0.8%	6%
Urgent Care/Clinic/Other Outpatient	0.7%	0.7%
Pre-school/Daycare	0.6%	4%
Fitness Center/Health Club/Gym	0.5%	0.9%
Performing Arts	0.4%	0.3%
Medical Office	0.2%	0.5%
Modeled Sub Total	74%	70%
Other/Not Modeled	26%	30%

Figure 40: Energy Consumption and Square Footage in 2019 Represented by Major Building Types Modeled

Section D - Agency Targets

This appendix defines each agency's 2025 and 2030 emissions reduction targets. These targets provide agency leadership with their expected contribution to LL97 and the City's other emissions reduction and energy mandates and commitments to support ongoing agency planning and overall City compliance.

This appendix also describes the process for deriving agency targets and pathways from the reference case and City buildings pathway in collaboration with agency partners. The preliminary targets and pathways for buildings were set by assessing technically feasible interventions by building type and applying those interventions to an agency's portfolio on a least-cost basis, considering other requirements. The preliminary targets and pathways for non-building asset categories (i.e., non-building stationary assets and non-stationary assets) assumes that all available emissions reduction opportunities in the reference case that have a start date in the four years from the start of 2022 through the end of 2025 will be implemented. These targets and pathways were then refined according to feedback from individual agencies.

Finally, this appendix outlines future agency planning and implementation support. This includes performance tracking and target rebalancing, which will allow DEM to adjust targets in response to on-the-ground circumstances.

Agency Targets and Pathways

Figure 41 presents individual agency emissions reduction targets, as well as emissions reduction targets for the non-building asset categories. Agency targets will be achieved through a combination of demand-side interventions at agency facilities and supply-side interventions that are not within the control of individual agencies, specifically, the cleaning of the electric grid and procurement of large-scale renewables.



Installation of solar PV canopies at the New York Botanical Garden | Source: DCAS

City Assets Category	2006 Emissions Baseline (MTCO ₂ e)	2019 Emissions Status (MTCO ₂ e)	2025 Emissions Target (MTCO ₂ e)	2006 - 2025 % Change	2030 Emissions Target (MTCO ₂ e)	2006 - 2030 % Change
Buildings						
BPL	9,290	5,947	4,072	(56%)	1,208	(87%)
CIG*	131,307	117,425	89,598	(32%)	48,762	(63%)
CUNY	76,793	63,818	40,441	(47%)	14,728	(81%)
DCAS	138,771	92,313	73,722	(47%)	18,276	(87%)
DHS	36,025	26,997	19,482	(46%)	9,464	(74%)
DOC	123,926	101,671	114,553	(8%)	58,913	(52%)
DOE	858,811	740,129	654,415	(24%)	380,102	(56%)
DOHMH	21,015	18,861	10,700	(49%)	5,590	(73%)
DOT	35,316	31,152	23,211	(34%)	15,085	(57%)
DPR	64,009	44,337	31,829	(50%)	15,290	(76%)
DSNY	102,862	81,208	51,858	(50%)	18,746	(82%)
EDC	18,117	10,586	5,729	(68%)	1,343	(93%)
FDNY	40,935	32,461	29,142	(29%)	12,402	(70%)
HHC	350,392	251,736	200,862	(43%)	105,473	(70%)
HRA	46,325	22,910	18,244	(61%)	2,960	(94%)
NYPD	77,158	63,949	51,964	(33%)	19,179	(75%)
NYPL	27,350	19,788	13,831	(49%)	3,767	(86%)
QPL	9,146	7,948	5,796	(37%)	1,658	(82%)
Other Buildings*	319,549	236,871	195,936	(39%)	121,307	(62%)
Buildings Total	2,487,097	1,970,109	1,635,385	(34%)	854,253	(66%)
Streetlights and Traffic Signals						
DOT	128,701	46,870	34,737	(73%)	4,414	(97%)
Wastewater Treatment						
DEP	610,385	490,319	382,475	(37%)	187,463	(69%)
Water Supply						
DEP	10,556	47,049	26,009	146%	18,895	79%
Solid Waste						
DEP, DSNY, DPR	286,168	91,326	64,868	(77%)	49,800	(83%)
Non-Building Stationary Assets Total	1,035,811	675,565	508,088	(51%)	260,572	(75%)
Transportation						
DCAS Fleet	336,743	322,728	154,873	(54%)	137,079	(59%)
Fugitive and Process Emissions						
DCAS Fleet	11,381	12,569	12,569	10%	12,569	10%
Non-Stationary Assets Total	348,124	335,297	167,442	(52%)	149,648	(57%)
City Government Operations Total	3,871,031	2,980,971	2,310,915	(40%)	1,264,473	(67%)

*Other buildings encompass (1) agencies not listed, including OCME and FIT; and (2) incremental emissions reductions from CIGs exceeding the target specified above. CIGs contributing to the incremental reductions include the Met, AMNH, WCS, NYBG, Carnegie Hall, and the Brooklyn Museum.

Figure 41: Agency Emissions Baselines and Targets

Agency Pathways

To inform agency planning and support target achievement, agency pathways were developed containing bundles of emissions reduction opportunities. These bundles exist within the four intervention categories identified for the overarching City recommended buildings pathway.

- Planned energy efficiency projects: These are projects that are funded and planned to be initiated in the four years from the start of 2022 through the end of 2025, as of August 2021.
- Investment in on-site solar: Including rooftop and canopy solar PV.
- Heat electrification initiative: Electrification opportunities for agency buildings with heating systems reliant on fossil fuels.
- Additional energy efficiency projects: Additional relatively cost-effective emissions reduction opportunities as they become available across the 2022 to 2025 and 2026 to 2030 compliance periods.

Agency pathways delineate the number of emissions reduction opportunity bundles by year, as well as forecasted energy consumption and emissions by fuel type, impacted square footage, required investment by funding type, and personnel needs.

Methodology for Developing Preliminary Agency Targets and Pathways

Agency targets and pathways were developed in six steps: (1) accounted for agency emissions reductions achieved to date; (2) forecasted future agency emissions reductions; (3) allocated projects to agencies based on the building pathway interventions; (4) developed agency pathways; (5) developed agency targets; and (6) confirmed practical feasibility of agency targets and pathways.

1: Accounted for agency emissions reductions achieved to date.

1.1: Established agency emissions baselines based on the 2006 and 2019 Inventory of New York City Greenhouse Gas Emissions.

1.2: Estimated additional agency emissions achieved between 2019 and 2021 based on DCAS records of completed energy efficiency projects.

2: Forecasted future agency emissions reductions.

2.1: Forecasted future emissions reductions based on planned energy efficiency projects in agency portfolios.

2.2: Estimated additional future emissions reductions based on agency growth.

3. Allocated projects to agencies based on the building pathway interventions.

3.1: Based on the City's most recent solar readiness assessment, recommended investment in on-site solar at 123 facilities with high solar PV capacity. This intervention will enable the City to complete the installation of 100MW of solar PV on City property by the end of 2025.

3.2: Recommended investment in heat electrification in buildings with old and fuel oil-fired heating systems that are nearing or have already reached a need for replacement. This intervention will enable the City to complete heating system electrification projects in City buildings so as to steadily ramp up to a pace of 2% of City building square footage per year by 2030.

3.3: Estimated additional emissions reductions by distributing the recommended buildings pathway interventions, described in Section 3, and their associated emissions reductions among agencies. This distribution was done by applying the interventions within agency-specific marginal abatement cost curves (MACCs), which organize emissions reduction opportunities (EROs) for each agency in order from lowest to highest cost.

The process of developing agency-specific MACCs involved:

- a. Segmenting agency building portfolios based on building function, age, size, and energy system to identify major building types within each agency's building portfolio.
- b. Identifying EROs for each major building type and organizing those EROs into 11 ERO bundles.
- c. Developing building energy models to estimate hourly building energy consumption for each major building type and determine the energy and emissions reductions associated with each of the 11 ERO bundles.
- d. Organizing the results from the building energy models into agency-specific MACCs by plotting the marginal abatement potential and marginal abatement cost of each ERO bundle within an agency's building portfolio.

The ERO bundles associated with the recommended buildings pathway were selected for agencies with the lowest cost opportunities and those agencies were assigned the corresponding projects and emissions reductions.

4. Developed agency pathways.

4.1: Aggregated planned energy efficiency projects determined in step two (2), planned solar and heat electrification projects determined in steps 3.1 and 3.2, and additional cost-effective energy efficiency projects determined by the MACC analysis in step 3.3.

5. Developed agency targets.

5.1: Calculated the difference between emissions reductions achieved by the projects included in the agency pathway and the 2006 baseline.

6. Confirmed practical feasibility of agency targets and pathways.

6.1: Assessed feasibility of agency targets and pathways based on historic agency project metrics such as project volume, costs, and personnel requirements.

Agency Consultation Sessions

Initial emissions reduction targets and pathways were shared with agency partners and refined during agency consultation sessions. These sessions built upon agency engagement initiated during the LL97 Implementation Action Plan development process, during which over 100 agency stakeholders were briefed and consulted through 17 agency interviews, four meetings with the 74-member advisory board, four meetings with the 16-member Steering Committee, one meeting with all Action Plan stakeholders, and two surveys.

Key LL97 implementation partners were invited to participate in the agency consultation sessions, including all agencies with an emissions reduction target and pathway. To help facilitate collaboration within agencies, agency consultation session participants included energy staff embedded within agencies as well as capital planning, facilities management, and budget staff.

The agency consultation sessions unfolded in three parts: (1) Preliminary Agency Targets and Pathways Briefing, (2) target and pathway refinement period, and (3) Refined Agency Targets and Pathways Briefing.

1: Preliminary Agency Targets and Pathways Briefing

DEM briefed agency partners on the methodology for generating preliminary targets and pathways and introduced the process for refining targets and pathways. Following the Preliminary Targets and Pathways Briefing, DEM provided agency partners with their agency's preliminary targets and pathways, including key assumptions used to develop each.

2: Target and Pathway Refinement

Agency partners were asked to provide DEM with feedback on the technical and practical feasibility of their preliminary target and pathway to inform target and pathway refinement. To support this request, DEM provided agency partners with a detailed summary of individual agency targets and pathways, the methodology for generating preliminary targets and pathways, and supplemental information about the specific energy efficiency measures identified for each agency pathway. In addition, DEM provided agencies with a feedback form to gauge agency alignment with key emission reduction target assumptions (e.g., forecasted square footage and project timelines); preliminary emissions reduction targets; and preliminary pathways for target achievement. DEM also offered agency partners the option to meet individually with the LL97 Core Project Team during this period.

To support target and pathway refinement, DEM placed all feedback received from agencies in one of four categories:

- (1) Feedback on overall achievability of target and pathways for agencies, which informed overall rebalancing across the City as agency-level targets and pathways were adjusted.
- (2) Feedback on accuracy of specific model inputs with updated data provided by agencies, which allowed DEM to update inputs, and thereby targets and pathways.
- (3) Feedback on accuracy of model inputs generally, or without updated data provided by agencies, which DEM noted and will consider in future planning.
- (4) Feedback on LL97 implementation and/or required resourcing, which DEM noted and will consider in future planning.

The model refinement process drew on feedback in categories one (1) and two (2), which was used to make limited adjustments to model inputs and assumptions. This included modest changes to agency staffing levels, square footage growth, eligible building stock, and ERO bundles.

DEM limited the impact of updating these assumptions on other agency targets and pathways, as well as the Citywide emissions reductions. DEM also worked to ensure that in aggregate, refined agency targets and pathways do not impact the level of investment required to implement the Citywide pathway and achieve the City's other emissions reduction and energy mandates and commitments.

3: Refined Agency Targets and Pathways Briefing

To conclude the agency consultation sessions, DEM shared the refined agency targets and pathways, provided an overview of the methodology for target and pathway refinement, and discussed implementation, resources, and ongoing planning.

Ongoing Agency Planning

Following the agency consultation sessions, DEM plans to work with agency partners to support LL97 implementation on an ongoing basis and recalibrate agency targets and pathways as required.

LL97 Agency Planning and Support

Beginning in 2022, DEM will regularly meet with agency partners to support ongoing LL97 implementation. These meetings will address three key needs: (1) ensuring adequate agency resourcing from a funding, staffing, and procurement perspective; (2) facilitating agency portfolio and individual project-level planning and implementation, and (3) proactively addressing challenges and risks associated with Citywide and agency implementation.

Agency Performance Tracking and Target Rebalancing

On a yearly basis, DEM will benchmark measured Citywide, City asset category, and agency emissions against the LL97 targets to ensure that the City is on track to meet its emissions reductions and energy mandates and commitments. As needed, agency targets and pathways will be rebalanced based on actual performance and additional constraints or opportunities arising during the implementation period.



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