C40 CITIES
CLIMATE LEADERSHIP GROUP

1.5°C

CASE STUDY: ACTION PRIORITISATION METHODOLOGY APPLIED FOR NEW YORK CITY'S 1.5 °C CLIMATE ACTION PLAN

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#ONENYC

BUROHAPPOLD ENGINEERING

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1 Introduction

This document serves as a case study of the methodology for 1.5°C: Aligning New York City with the Paris Climate Agreement ("1.5 Degrees Climate Action Plan") and the accompanying Excel workbooks for the purposes of communication with NYC stakeholders and C40 cities looking to develop similar plans to achieve the Paris Agreement for their respective cities. This case study covers the planning process and analytical approach to develop the 1.5 Degrees Climate Action Plan and describes the workbooks used by the New York City team to conduct the analysis and document outcomes. These workbooks include:

- Masterbook – reference document for action language for each workbook
- GHG Calculations and Prioritization Workbook – lists, analyzes and quantifies actions
- Visualization Workbook – aggregates the GHG potential data and illustrates the GHG reduction curve (can be included in the GHG Calculations and Prioritization Workbook)
- Benefits Workbook – compares the non-GHG impact of actions
- Cost Workbook – estimates and compares the costs of actions and sub-actions
- Feasibility Workbook – describes the current state of the action, the lead implementing agency for the action, and the funding and financing of the action

Context and Background

The C40 Cities Climate Leadership Group (C40) is a network of the world's megacities committed to addressing climate change. Acting both locally and collaboratively, C40 Cities are having a meaningful global impact in reducing both greenhouse gas emissions and climate risks. The Paris Agreement commits signatories to holding the increase in the global average temperature to well below 2°C above pre-industrial levels, and to pursue efforts to limit the temperature increase to 1.5°C above pre-industrial levels. C40's Deadline 2020[1] report presents a detailed pathway for what C40 cities need to do to play their part in converting the COP21 Paris Agreement into action. The Deadline 2020 report also outlines city-specific action pathways necessary to meet the target trajectories, clearly laying out the pace, scale and prioritization of action needed between now and the end of the century. Given the immediacy of this agenda, the C40 Steering Committee voted to revise its participation standards. By the end of 2020 each C40 city must have in place a climate action plan that aligns with the objectives of the Paris Agreement. Only through ambitious and pragmatic planning today will cities move rapidly towards the 2050 outcomes urgently needed. To help realize the targeted greenhouse gas (GHG) emissions reductions and support cities to prepare robust climate action plans C40 established a Climate Action Planning Technical Assistance Programme, building on C40's existing technical assistance programmes on Global Protocol for Community-scale GHG Emission Inventories (GPC) inventories and target setting.

The Technical Assistance Programme is initially supporting eight pilot cities in developing robust 1.5°C action plans, consistent with the goals of the UN Paris Agreement. New York City is one of the pilot cities and elected to receive the following scope of technical assistance:

- Prioritization of actions for accelerated implementation of the 1.5°C Climate Action Plan
- Development of a detailed implementation strategy for the prioritized actions
- Calculation of the projected emissions reductions by 2020 and beyond based on the 1.5°C Climate Action Plan
- Development of a case study on the methodology used to inform other cities' climate action planning efforts.

This document serves to satisfy the final point.

http://www.c40.org/researches/deadline-2020

2 1.5°C: Aligning New York City with the Paris Climate Agreement process

The 1.5°C: Aligning New York City with the Paris Climate Agreement process included eight steps, as described below. Note that the action planning process is an iterative process that includes feedback from stakeholders, initial simple analysis, and then detailed analyses to allow for input and consensus from stakeholders.

Figure 2.1: Climate Action Planning Process

STEP 1: IDENTIFY ACTIONS

Actions are the specific initiatives designed to support long-term mitigation strategies and achieve the desired GHG emissions reductions. They are by definition "actionable," meaning the necessary regulatory, financial, and organizational structures are in place to implement them, including responsible or lead stakeholders, supporting stakeholders, estimated costs, funding source, and timeframe. The impact of their implementation is also measureable. Actions are typically developed based on a city's existing experience pursuing GHG reduction strategies and the opportunities to build upon their successes and lessons learned, best practices from other cities, and input from stakeholders. For New York City, these strategies were developed as part of New York City's Roadmap to 80x50 ("Roadmap") and cover GHG emissions reductions related to the major sources of emissions: Energy, Buildings, Transportation and Waste. The actions to support realization of the identified strategies may be stand-alone (i.e., self-contained, capable of occurring on its own), while others may require sub-actions (i.e., more detailed projects, programs or activities that are related to the actions). With input from stakeholders and reviews of best practices, typically a large number of actions may be identified in STEP 1. For New York City, approximately 160 potential actions were listed. While sub-actions were not included in the public-facing 1.5 Degrees Climate

Action Plan for New York City, fleshing them out during the planning process helped estimate the action costs and assumptions for GHG impact calculations.

Complementing the major emission sources and categories defined in the 80x50 Roadmap, the New York City team used themes to organize and communicate the 1.5 Degrees Climate Action Plan Actions: Climate Change Leadership, Reduced and More Efficient Consumption, and Transition to Clean Energy Sources.

STEP 2: REDUCE NUMBER OF ACTIONS AND DEVELOP IMPLEMENTATION DETAILS FOR EACH ACTION

Through further discussions with stakeholders and an understanding of the order of magnitude of the GHG emission reduction potential, the City was able to narrow the list down to priority actions as well as to consolidate similar and/or overlapping actions. This allowed for a more streamlined and efficient evaluation of the actions, as priority actions were identified relatively early into the planning effort, and fewer revisions were needed for each action.
It is essential for the planning process to allow opportunities for stakeholders to review, edit, update and provide more detail for actions, which will help quantify and qualify the actions for prioritization. In the case of New York City, a template was created to help other agencies review, comment and edit actions and sub-actions. The agencies also provided additional inputs into assumptions for GHG calculations, cost, responsibility, timeline and benefits. Besides agencies' staff, other industry leaders and partners provided similar input.

STEP 3: IDENTIFY CRITERIA TO PRIORITIZE ACTIONS AND DEVELOP CRITERIA METHODOLOGY

Criteria analysis is a tool to help evaluate and then prioritize the actions in an Action Plan. While potential GHG emissions savings is one of the most important criteria, successful implementation of action requires a good understanding of its feasibility and its alignment with a city's other priorities (e.g. economic, health). For New York City, the following criteria were used:

- GHG emission reduction potential in total CO2e over a specific time-period– quantitative
- Cost/sum of sub-action costs (total and annual) – quantitative
- Benefit potential – qualitative and/or quantitative
- Feasibility – includes financial, technical and governance feasibility – qualitative

A number of additional criteria could be established as part of the planning process. However, schedule and budget may prohibit the level and detail of the criteria analysis so it is important to first establish what could be quantified and what could be qualified based on existing information.

Once the key criteria is agreed upon, cities need to establish methodologies for their analyses. The methodologies should have clear inputs and outputs, be consistent across criteria to the extent possible, and provide a framework that could improve over time. The methodologies should include steps for quantification of impact or approach for qualification where data does not exist. It is common for there to be gaps in available data for cities; therefore, as more data and information is available over time, the methodology should improve. For example, New York City has a significant amount of data on its air quality due to years of monitoring and measurement. This information allowed for the quantification of the air pollutant impacts of some actions, which would not have been possible a decade ago. If data is not available, the criteria assessment methodology should include literature reviews and all assumptions should be documented. The methodologies for the New York City 1.5 Degrees Climate Action Plan are described in later sections of this document.

STEP 4: EVALUATE ACTIONS USING THE CRITERIA AND RANK ACTIONS

Once the methodologies are established, the evaluation of each action's performance across the established criteria begins. The analysis for the actions in the New York City 1.5 Degrees Climate Action Plan is described in later sections of this document. A brief summary of the approach to each of the four criteria categories is below.

- GHG savings potential in the near- and long-terms (total metric tons of CO2e emissions by 2030)
- Non-GHG benefit potential, i.e., additional benefits (scored 1 through 5 and discussed in Benefits Section below) – in consideration of the following:
- Growth - quality jobs, economic innovation, workforce development and long-term societal savings
- Resiliency - resiliency, reliability and natural capital
- Equity - health and wellbeing, safety, affordability, access and community
- Sustainability – lead by example
- Necessary investment - capital, expense and operational costs to city and non-city
- Feasibility to implement - existing, expanded or new action
- City or non-city action
- Fundable vs difficult to fund project
- Capital or expense cost

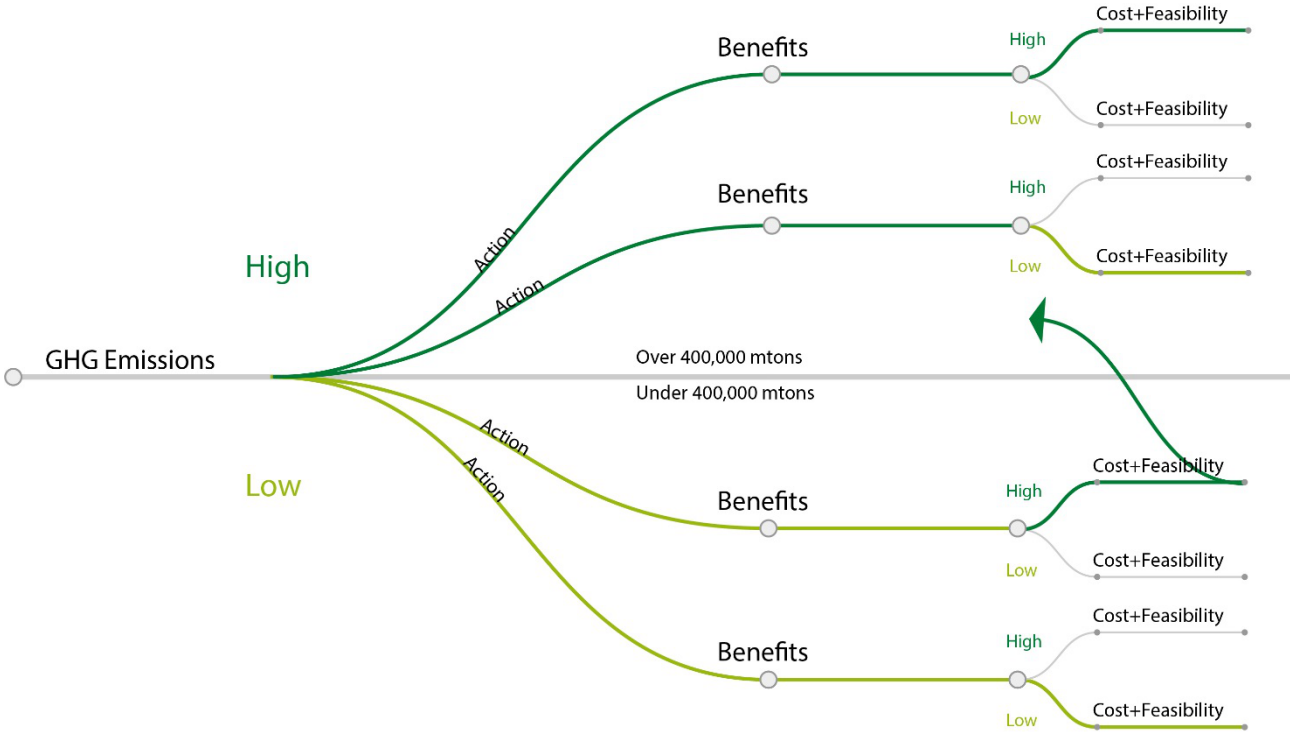

Figure 2.2: Prioritization process for ranking actions

Once the actions are evaluated based on the established criteria, cities can compare and rank (i.e., prioritize) the actions based on the evaluation results. This requires first ranking the criteria based on importance to the city (e.g., for New York City, or any GHG action plan, the most important criteria is the GHG emissions reduction potential). New York City ranked actions based on their performance across the four criteria categories in the following order: GHG savings potential, non-GHG benefit potential, cost, and feasibility.

As shown in the graphic above, actions were first organized based on their near-term GHG emissions reduction potential; those actions with the highest near-term GHG emissions reduction potential — more than 400,000 metric tons of CO2e by 2030 — were put into the highest ranking category, and those expected to result in 400,000 metric tons of CO2e or less, were organized into a lower priority category. Actions that do not have CO2e emissions values but are essential to realize, accelerate, and/or multiply the GHG emissions impact of the actions with high potential — often referred to as enabling actions — were included in the highest potential group. Once the actions were compared and organized by emissions reduction potential, they were ranked based on the results of their non-GHG benefit results, followed by estimated investment cost and implementation feasibility results.

For example, if there were four actions, Actions A, B, C and D, which save approximately 800,000, 600,000, 20,000 and 5,000 metric tons of CO2e emissions, respectively, then Action A and B were place in a higher priority group than Action C and D. Actions A and B were then ranked within the higher priority group by additional benefit performance while Actions C and D were ranked by additional benefit performance within their group. Any other actions that fell in the 50 percentile of the additional benefit rank were then compared by cost rank and feasibility rank.

STEP 5: REVIEW AND VERIFY ACTIONS WITH STAKEHOLDERS

Once the analysis is complete, the internal (agencies and staff) and external stakeholders need to review the assumptions, inputs and outputs of the analysis, action language and action prioritization. Some stakeholders may have more detailed information to improve the analysis (such as new data or completed studies) while others may have more critical actions that should be prioritized, including enabling actions such as regulatory changes.

It is important that the information presented to stakeholders is clear and detailed enough for them to comment. Scope of work, budget and project schedule should also be communicated to ensure that the stakeholder understands the level of examination and immediacy of the work.

STEP 6: FINALIZE ACTIONS

Once the prioritized actions and analyses are reviewed by stakeholders, the actions need to be updated and finalized for publication.

3 Analysis Workbooks

Masterbook

NYC established a master reference workbook that centralized the most up-to-date language to describe the actions and sub-actions as well as all of the outputs from the other workbooks. The existence of this Masterbook will support data management best practices, while eliminating miscommunications and repetition of analysis that could occur if reviews occur across different spreadsheets.

The information in the Masterbook should link to the other workbooks, as relevant, to ensure all workbooks are using the most up to date information. For example, if language describing an action is changed in the Masterbook, language will be updated in all of the other workbooks automatically, avoiding confusion and ensuring consistency.

Action	GHG Reduction by 2030 (mton) + enabling action score where applicable	Normalized Benefit Score	Feasibility Score	Total Cost
Action 1	1,200,000	34.8%	121.1	$
Action 2	4,000,000	89.3%	111.2	$1,200,000,000
Action 3	400,000	92.7%	322.2	$600,000
Action 4	1,500,000	76.3%	122.1	$100,000,000
Action 5	625,000	72.1%	322.2	$54,000,000
Action 6	1	36.3%	322.1	$200,000

Figure 3.1: Illustration of example pivot table ranking with the four criteria – GHG reduction potential, normalized benefit score, feasibility score and cost. Proxy values used for illustration purposes.

	GHG	Benefits		Feasibility					Cost	
Action	GHG Reduction by 2030 (mton) + enabling action score where applicable	Normalized Benefit Score	Risk Index	Type	Responsibility	Financing	Cost type	Feasibility Score	Total Cost	$/GHG
Action 1	1,200,000	34.8%	11%	200	20	2	0.1	322.1	$9,851,000	$0
Action 2	4,000,000	89.3%	0%	100	10	1	0.1	121.1	$600,000	$300
Action 3	400,000	92.7%	45%	100	20	2	0.1	312.2	$1,000,000	$1.5
Action 4	1,500,000	76.3%	15%	300	20	2	0.2	122.1	$648,000	$67
Action 5	625,000	72.1%	60%	100	10	1	0.1	322.1	$3,375,144,000	$86
Action 6	1	36.3%	89%	100	10	1	0.2	111.2	$4,404,335,422	N/A

Figure 3.2: Illustration of example action prioritization. Proxy values used for illustration purposes.

Greenhouse Gas (GHG) Prioritization and Projections Analysis Workbook

NYC's GHG prioritization workbook lists and analyzes the actions for the Action Plan. The workbook also includes all assumptions and calculations related to GHG emissions reduction evaluation.

The GHG Prioritization workbook includes the following tabs:

- Actions 2030 – the final actions listed in the Climate Action Plan. The tab includes the climate action identification number, sector, theme, action description, action type, whether or not GHG savings were calculated for the action (savings were not calculated for enabling actions), the enabling action score, where relevant, reduction parameters (i.e., assumptions that were used to calculate the GHG emission reductions), and the estimated 2030 emissions reduction (tCO2e).

- 2030 Projections – summary tab of the measurable projects which are linked from the individual action tabs. This is a projection of GHG emissions reduction from each action through 2030 (or any target date).

- It is important to distinguish the difference between the GHG emissions savings listed in the Actions 2030 tab and the GHG emissions savings in the 2030 Projections. The GHG emissions savings in the Actions 2030 tab is the total GHG emissions savings accumulated to 2030. This helps determine the total GHG emission savings for each action.. The GHG emissions savings in the 2030 Projections tab is a more complex calculation, which includes the savings compared to a BAU trajectory that took into account overlapping actions and reductions. This helps determine the annual GHG emission savings compared to a BAU until 2030.

- Enabling Action Scores – acknowledgement and inclusion of actions considered essential to enable major actions, or those that may have an accelerating/multiplying effect on other essential actions.

- Emissions Factors – the emission factors used for analysis.

- Numbered tabs – the analysis of GHG emission reduction potential for each action.

ACTIONS 2030

The Actions 2030 tab is the dashboard for the GHG Prioritization. This tab sets the structure and hierarchy to organize and evaluate actions, and therefore it should be created first. The City of New York included the following columns in this tab:

- Identification number – the identification number that was given to the action when it was created. For New York, these numbers were assigned during the development of the 80 x 50 Roadmap. It is recommended that the identification number for each action does not change. If any new action is created during the action planning process then a new action identification number should be created.

- Sector – categories of GHG emission sources used to organize goals, strategies and actions. New York City's 80x50 Roadmap, the sectors were buildings, energy, transportation and waste.

- Theme – an alternative set of categories to organize actions. Themes allow for a more dynamic and meaningful way to communicate the actions to wider audiences. New York City's action themes are 'Climate Change Leadership', 'Reduced and More Efficient Consumption', and 'Transition to Clean Energy Sources.'

- Action description – the explanation of the action.

- Action type – all actions were labelled as either major (its direct GHG emissions reduction can be calculated), moderate (calculated and included as part of a major action calculation) or enabling (enables, accelerates, or multiplies the impact of the major actions, but its direct emissions reduction potential cannot be measured).

- Enabling action score – the score given to enabling actions (1 – Essential for Major Actions; 2 – Accelerating/Multiplying Effect on Actions; and 3 – Good Practice).

- Reduction parameters – detailed assumptions for the major actions.

- Reduction to 2030 (tCO2e) – calculated GHG emission reduction potential for the action to 2030.

2030 PROJECTIONS

The 2030 Projections tab summarizes the GHG emission reduction potential over a given timeframe (e.g., 2015 through 2030) for each sector category (buildings, energy supply, waste, transportation). The data is linked from the individual action tab calculations (e.g., B1-B2, B3, B4a, etc.) and can be exported or directly linked to a data visualization workbook. Note that some actions with GHG emission reduction potential may overlap with other actions and this needs to be considered when adding up the total reduction potential of the sector category. The timeframe of an action (start and end dates) also needs to be considered when adding up the total reduction potential of the sector category (e.g., one action may reduce emissions for five years and another action may reduce emissions for ten years).

The City developed GHG emissions reduction projections for 2030 and 2050 for a number of scenarios based on a large set of assumptions. These assumptions are city-specific and need to be agreed upon by internal and external stakeholders, where appropriate. For New York City, the 2050 scenarios and their assumptions were created during the Roadmap to 80x50 process and included values agreed upon by agencies and stakeholders and augmented with specific studies. The same values were assumed for the 1.5 Degrees Climate Action Plan.

Projected Reductions

2015-2030 Reduction Summary

Combined Reductions (tCO2e)	2015	2020	2025	2030
Buildings				
Energy Supply				
Waste				
Transportation				
Total Reduction	0	0	0	0

TRUE

2015-2030 GHG Reductions

Combined Reductions (tCO2e)	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030
Buildings		0														
Energy Supply		0														
Waste		0														
Transportation		0														
Total Reduction	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0

Buildings Reductions (tCO2e)	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030
B1		0														
B2		0														
B3		0														
Total Buildings Reduction	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0

Energy Supply Reductions (tCO2e)	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030
E1		0														
E2		0														
E3		0														
Total Energy Supply Reduction	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0

Waste Reductions (tCO2e)	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030
W1		0														
W2		0														
W3		0														
Total Waste Reduction	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0

Transportation Reductions (tCO2e)	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030
T1		0														
T2		0														
T3		0														
Total Transportation Reduction	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0

Figure 3.3: Example of 2030 Projections workbook.

The first (baseline) scenario is Business-as-usual (BAU). New York City included the following variables and assumptions in its BAU scenario:

- Population growth and economic development (including building stock projections).
- Existing outcomes of city, state and federal policies and regulations (prior to 2015).
- Emission factors (modeled) – local, state and federal GHG initiatives, trends for electricity demand, natural gas prices, renewable energy costs.
- Buildings (modeled) – building turnover, updates to building codes, phase out of fuels such as heating oil, reduction in electricity consumption, etc.
- Transportation (modeled) – local and federal fuel economy standards, expansion of local public transportation, reduced carbon intensity of the BAU electric grid.
- Solid waste (modeled) – projected waste volumes (BAU) to incorporate population growth and employment trends, existing and future diversion rates (based on historical information).
- Additional assumptions were created for the other scenarios based on the Action Plan's identified strategies and actions.

ENABLING ACTIONS

Since enabling actions do not lend themselves to direct GHG emission reductions, their importance is evaluated and scored based on whether they are essential for the implementation of a major action, whether they accelerate or multiply the impact actions can have, or whether they are generally considered a good practice. For each of these considerations, an action received a score of '1' if the enabling action is 'Essential for Major Actions', a score of '2' if the enabling action has an 'Accelerating/ Multiplying Effect' and a score of 3 if the enabling action is 'Good Practice'. For the New York City analysis, scores of '1' and '2' were prioritized.

Each enabling action received a score and justification for the score. A more detailed analysis may consider the multiplying and accelerating impacts of each enabling action to potentially create a more accurate GHG emissions reduction value.

Example: Better communications about climate change and important policies/ programs/actions can accelerate our impact. Better training for the workforce can both 1) help realize the full potential of a particular action e.g. advanced building codes, and 2) accelerate and multiply emissions reductions. Advocating for improving the flexibility of in-city transmission and distribution systems will an impact by accelerating clean, distributed energy resources and smart technologies.

EMISSION FACTORS

Fuel emission factors are essential for GHG accounting and projection scenarios. Electrical, gas, steam, biofuel, oil, or any other applicable fuel type should be included in the emissions factor tab. A detailed emission factor and load model was created during the Roadmap for 80x50 process to determine several emission factors for New York City given regional economic and policy changes, introduction of new sources of power and retirement of power plants. Fuel Oil (#2 FO, #4 FO, and #6 FO), biofuel and steam were also included in the New York City plan.

The emissions factor related to electricity generation is especially critical to track over time as it changes as the fuel mix to generate electricity changes due to new power generation facilities, upgrades to existing ones, changes in fuel supplies, and retirements. For example, the New York City electricity grid's emission factor has decreased from 0.121 tCO2e/MMBTU (0.000414 tCO2e/kWh) in 2005 to a 0.0821 tCO2e/MMBTU (0.000280 tCO2e/kWh) in 2015 due to fuel switching and efficiency upgrades to existing plants, construction of new natural gas fueled power plants, and the introduction of more renewable energy sources. This is a 32 percent reduction in 10 years.

Any changes in emission factors for other fuels, such as the introduction of biomethane to the natural gas pipeline, should be included in the Emission Factors tab, if applicable. The Emission Factors tab allows the user to select the BAU Electricity Emission Factor and the Projected Emission Factor. The NYC worksheet includes four electricity emission factors and projections:

1. BAU – The BAU electricity emission factor.
2. BAU Early Nuclear Retirement – The BAU electricity emission factor with the assumption of Early Nuclear Retirement (modelled for the 1.5 Degrees Climate Action Plan).
3. Low carbon intensity grid alternative reference case (the 80x50 Scenario electricity emission factor in the NYC analysis).
4. Low carbon intensity grid alternative reference case with Early Nuclear Retirement (or the 80x50 scenario with Early Nuclear Retirement). The 80x50 Scenario electricity emission factor described above with early nuclear retirement.
5. The emission factors were developed through a modelling exercise. The model used a regional long-term electricity generation planning and simulation model that identifies the least-cost electricity resource mix and dispatch. It simulates the electricity market's least-cost resource

decisions through 2050 taking into consideration the impact of GHG reduction strategies on electricity demand across sectors. The least-cost resource decisions include retirement of existing generating units, construction of new generating units, and the dispatch of generation across the fleet of new and existing units. The model's selection of the least-cost resource mix is based on the database of existing generators, clearly delineated resource expansion options, inter-area transmission flow constraints, electric demand, fuel price forecasts, and environmental policies. For each of the emission factor scenarios the model generated a least-cost combination of generation capacity and dispatch that is specific to the emission factor scenario's set of these input parameters.

6. The 80x50 Scenario with Early Nuclear Retirement uses the same assumptions as the 80x50 Scenario with the exception of the earlier retirement of the Indian Point units and demand levels.

In order to perform the GHG prioritization and GHG projection analysis in the workbook, there needed to be an electricity emission factor selected in the worksheet to understand the potential savings of an action. Since the analysis includes assumptions until 2030, the savings of an action needed to be compared to a baseline, which was

Emissions Factor Calculations															
Baseline (tCO2e/ MMbtu)	2005	2006	2007	2008	2009	2010	2020	2021	2022	2025	2026	2027	2028	2029	2030
BAU early Nuclear Retirement	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Natural Gas	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
#2 FO	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
#4 FO	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
#6 FO	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Biofuel	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Steam	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Projected GHG emissions (tCO2e/ MMbtu)	2005	2006	2007	2008	2009	2010	2020	2021	2022	2025	2026	2027	2028	2029	2030
BAU early Nuclear Retirement	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Natural gas	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
#2 FO	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
#4 FO	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
#6 FO	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Biofuel	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Steam	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-

Figure 3.4: Illustration of emission factor tables used in 1.5 Degrees Climate Action Plan, including baseline emission factors and projected emission factors.

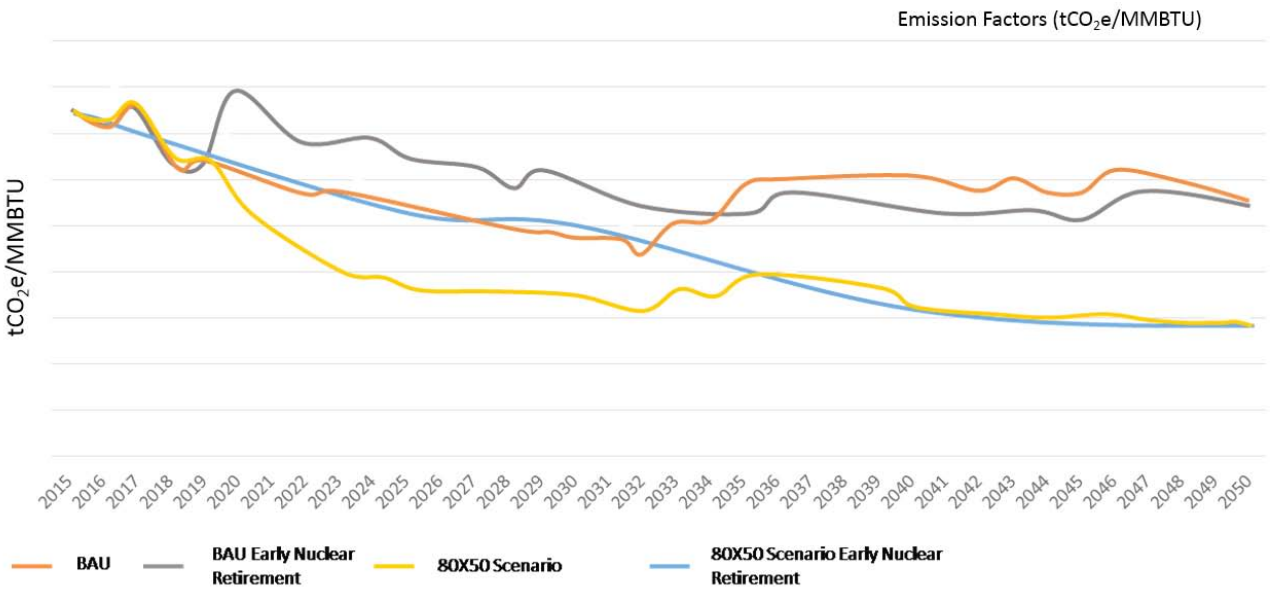

Figure 3.5: Example illustration of emission factors considered in New York City's 1.5 Degrees Climate Action Plan.

called the Business-as-usual (BAU) for the purposes of this action plan. NYC selected the BAU Early Nuclear Retirement Scenario to project GHG emissions and the impact of potential actions. This scenario allows the City to understand the GHG savings of a more aggressive electricity emission factor compared to the BAU by selecting 80x50 Scenario with Early Nuclear Retirement for the Projected GHG Emissions and keeping the BAU Early Retirement for the baseline.

MAJOR CLIMATE ACTIONS

A GHG emissions potential analysis was determined for each major action, including the assumptions used for the calculations. These assumptions were city specific, and were documented and recorded for each major action. The New York City 1.5 Degrees Climate Action Plan calculated two separate outputs in the Major Climate Actions calculations: Action GHG emission reduction potential for prioritization analysis and ranking, and Action GHG emission reduction potential for the 2030 projections.

Visualization Workbook

NYC also developed a Visualization workbook to illustrate the GHG reduction based on the calculated actions over a specific time period. Such a workbook could be included in the GHG prioritization workbook as a tab, be a standalone workbook (such as New York City's) or be part of a more detailed model/tool.

The Visualization Workbook was split into the following tabs:

- Visualization Mockup – dashboard featuring the BAU, short-term (near-term) action data, and chart of GHG trajectories.

- GHG Analysis Link – these are worksheets that 'link' data from the GHG Prioritization workbook.

VISUALIZATION MOCKUP

The workbook contains two dynamic charts: a visualization of the impact of short-term actions across different electricity emission factors scenarios and a visualization of the impact of short-term and accelerated actions across those same scenarios.

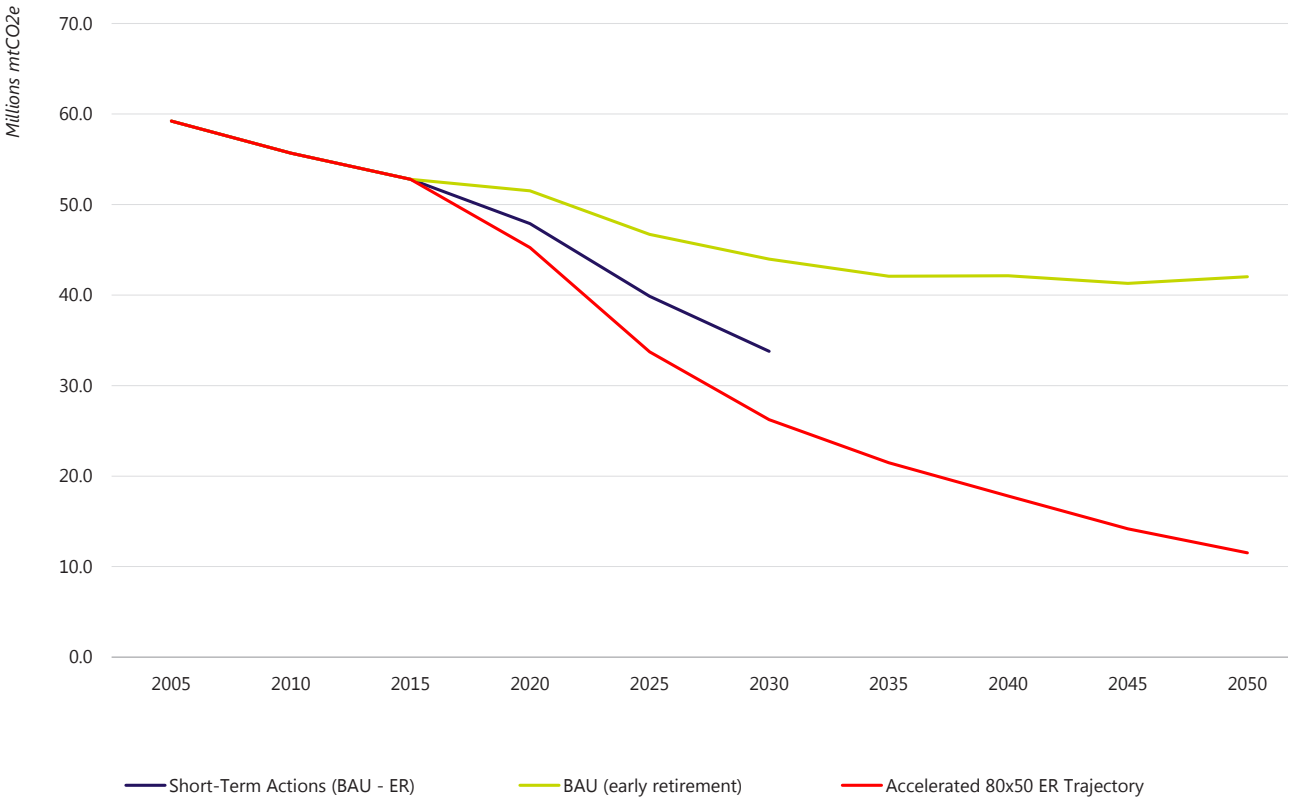

Figure 3.6: Scenario GHG projection curves used in the 1.5 Degrees Climate Action Plan.

GHG ANALYSIS LINK

The values in the GHG Analysis Link tab are linked from the GHG Prioritization workbook - 2030 Projections tab. These values are used for the Visualization Mockup.

Projected Reductions

2015-2030 Reduction Summary

Combined Reductions (tCO2e)	2015	2020	2025	2030
Buildings				
Energy Supply				
Waste				
Transportation				
Total Reduction	0	0	0	0

TRUE

2015-2030 GHG Reductions

Combined Reductions (tCO2e)	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030
Buildings	0															
Energy Supply	0															
Waste	0															
Transportation	0															
Total Reduction	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0

Buildings Reductions (tCO2e)	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030
B1	0															
B2	0															
B3	0															
Total Buildings Reduction	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0

Energy Supply Reductions (tCO2e)	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030
E1	0															
E2	0															
E3	0															
Total Energy Supply Reduction	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0

Waste Reductions (tCO2e)	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030
W1	0															
W2	0															
W3	0															
Total Waste Reduction	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0

Transportation Reductions (tCO2e)	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030
T1	0															
T2	0															
T3	0															
Total Transportation Reduction	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0

Figure 3-7: Illustration of the action-level data that is linked with the Greenhouse Gas (GHG) Prioritization and Projections Analysis Workbook.

Benefits Workbook

A benefits analysis evaluates the non-GHG emissions impact of actions. For the NYC 1.5 Degrees Climate Action Plan, the City's existing policy goals or "visions", as outlined in OneNYC , were used to frame the impact: Equity, Resiliency, Growth and Sustainability - categories across thirteen potential benefits (i.e., additional benefits) - Quality Jobs; Economic Innovation; Workforce Development; Long Term Societal Cost Savings; Resiliency: Flood & Sea Level Rise, Heat, Power Outage; Reliability; Natural Capital; Health & Wellbeing; Safety; Affordability; Access; Community; and Climate Leadership by Example. Through research, these impacts were assessed qualitatively and analyzed quantitatively to understand the potential impact on each of the thirteen benefit categories.

The evaluation of the potential additional benefits of the actions followed an evidenced-based qualitative approach using data from academic papers from peer-reviewed journals, industry reports, case studies and government research. To better assess the actions' additional benefits impacts, the analysis includes a consistent set of questions across the actions.
Framing questions helped to qualitatively assess the benefit potential for all actions and benefit scores were assigned given a qualitative scale [1-5] based on both responses to framing questions, expert input, and literature review as follows:

- **Score 5: Major Benefit –** where action has:
  - Multiple potential positive impacts according to framing question responses
  - Significant benefit to serve as a stand-alone rationale for an action
  - Strong justification in literature review or by agency experts
- **Score 4: Moderate Benefit –** where actions fall between 'major' and 'neutral'
- **Score 3: Neutral Benefit –** where no assessed correlation
- **Score 2: Moderate Risk or Co-harm –** where actions fall between 'major' and 'neutral'
- **Score 1: Major Risk –** where action has:
  - Multiple potential risks according to framing question responses (potential for risk or harm against objectives outlined in questions)
  - Significant potential to prevent implementation of action
  - Strong justification in literature review or by agency experts

This assessment was undertaken two times across all potential actions. The first contemplated the "best case scenario" in order to understand the full potential for benefits. The second contemplated the "worst case scenario" in order to understand the full potential for risks, or lost benefit opportunity.

Best Case Scenario: implementation of the action in such a way that maximized benefits and minimizes risks (inclusion and equity lens)

Worst Case Scenario: implementation of the action in such a way that minimizes benefits and does not adequately mitigate risks.

Framing questions for benefit assessment included:

ONENYC VISION: GROWTH

QUALITY JOBS

1. Could this generate new, quality jobs?
2. Could this lead to sustained, long-term job impacts?
3. Could this increase the median household income?
4. Could this increase access to quality jobs?

ECONOMY AND INNOVATION

1. Could this unlock private sector capital, technology adoption, and/or innovation?
2. Could this support growth in innovation industries, including green infrastructure; advanced manufacturing; advertising, media, and arts; biotechnology and life sciences; design; e-commerce; and technology and information?
3. Could this increase the share of private sector jobs in innovation industries?
4. Could this have a positive economic impact on local businesses and for residents?

WORKFORCE DEVELOPMENT

1. Could this improve workers' skills?
2. Could this increase the number of NYC public school graduates attaining professional certifications, or technical, associates or bachelor's degrees?
3. Could this increase the number of individuals receiving City-sponsored, industry-focused training? 4. Could this increase workforce participation?

LONG-TERM COST SAVINGS

1. Could this benefit health outcomes and productivity, leading to reduced citywide healthcare costs?
2. Could this mitigate the risk of property damage to city infrastructure?
3. Could this lead to long-term energy savings?
4. Could this improve economic output/productivity by decreasing transit times?
5. Could this improve economic output/productivity by improving

health and wellbeing?

ONENYC VISION: EQUITY

HEALTH AND WELLBEING

1. Could this improve outdoor air quality and reduce incidences of asthma, respiratory, and cardiac problems?
2. Could this improve indoor air quality, ventilation, or temperature control?
3. Could this increase the comfort and mental health of residents?
4. Could this lead to improvements in the quality of indoor spaces (e.g. reduction of toxins, integrated pest management, or mold)?
5. Could this reduce noise pollution?
6. Could this reduce light pollution?
7. Could this increase access to quality food?
8. Could this encourage active, healthy modes of travel? Would this shift lead to a significant increase in physical activity?
9. Could this bolster quality of life by saving time?
10. Could this improve access to green and healthy spaces or to community members?
11. Could this address health or environmental justice disparities?

SAFETY

1. Could this improve fire safety?
2. Could this improve safety during commutes and align with the goal of ending traffic deaths and injuries?
3. Could this increase access to essential services such as hospitals?
4. Could this mitigate rising temperatures in the city and not contribute to the urban heat island effect?
5. Could this increase public safety?

AFFORDABILITY

1. Could this reduce the energy cost burden for renters who pay a disproportionate amount of their monthly pre-tax income on energy?
2. Could this improve affordability for severely rent-burdened households?
3. Could this limit displacement of residents and small businesses when surrounding property values rise?
4. Could this increase energy price stability?
5. Could this address disparities in affordability?

ACCESS

1. Could this expand access to walking and biking paths, public transportation, clean energy, affordable housing, health, services, quality jobs, and other benefits?
2. Could this address historical disparities?
3. Could this increase nearby amenities and improve the walkability of the area?
4. Could this address environmental health disparities or promote environmental justice?

COMMUNITY

1. Could this increase community participation?
2. Could this build stronger communities?

ONENYC VISION: SUSTAINABILITY

LEAD BY EXAMPLE

1. Does this ensure the city is leading by example?
2. Could this influence actions led by another city, state, or federal entity?
3. Could this increase public awareness of climate change issues?
4. Could this lead to replicable legislation in other cities?

ONENYC VISION: RESILIENCY

RESILIENCY

1. Could this mitigate climate change risks and improve the city's adaptive capacity?
2. Could this strengthen social cohesion in communities and emergency preparedness and response networks?
3. Could this mitigate rising temperatures in city and mitigate the urban heat island effect?
4. Could this reduce heat risks for vulnerable populations?
5. Could this increase the percentage of residents with back-up generation?
6. Could this improve more rapid evacuation or emergency response?

RELIABILITY

1. Could this increase fuel diversity?
2. Could this reduce peak electricity demand?
3. Could this bolster energy reliability that is essential to keeping people safe during emergency events?
4. Could this increase the number of residents with backup generation?
5. Could this minimize disruptions to energy or mobility services during emergencies or natural disasters?

NATURAL CAPITAL

1. Could this increase ecosystem services by preserving and restoring land, protecting waterways, or preventing sewage discharges?
2. Could this contribute to preservation of greenfields, prime wildlife habitat, or wetlands?
3. Could this increase the amount of permeable surface cover?
4. Could this mitigate rising temperatures in city and not contribute to the urban heat island effect?

PRIORITIZATION METHODOLOGY

The benefit scores are combined into a single score for each action. Those actions that consistently provide non-GHG benefits are prioritized, while those that may have a negative impact are deprioritized. To take into account conflicting beliefs or lack of data to support claims around the impact of benefits, the analysis includes scores that take into account the differences between the best and worst-case scenarios and the potential of negative impacts by including risk indices.

First, the best-case scenario scores were summed across all benefits to calculate a "global score". This number provides a first indication of which actions perform the best. However, this cumulative score does not discount for any negative impacts the action may have on any benefits; therefore, the second step is calculation of the "benefits share." The benefit share is defined as the ratio between the amount of best case scenario scores that achieve a positive impact (>3) and the global score.

$$benefit\ share = \frac{count\ of\ best\ scenario\ scores\ (>3)}{count\ of\ best\ scenario\ scores\ (total)}$$

The "weighted score" is the product of the global score and the benefit share.

The weighted score is then divided the highest weighted score across all the actions to calculate a "normalized score." The normalized score spreads the final score values to be less clustered around certain values, thereby allowing for more differentiation to support ranking.

$$normalised\ score = \frac{weighted\ score\ (action\ X)}{\max weighted\ score\ \ (all\ actions)}$$

The action scores are accompanied by risk indices to take into account the potential for lower benefit performance due to conflicting or lack of data and for the negative impact on certain benefits. Overall, the risk indices are a measure of how much the final rank of each action is subject to uncertainty.

To take into consideration the risk reflected in conflicting and/or lack of data (i.e., difference between best and worst-case scenarios), the sum of the differences between best and worst case scenario scores by benefit and action are divided by the max difference).

$$risk\ index = \frac{\sum \square\ (best\ case\ scenario\ score - worst\ case\ scenario\ score)_{co-benefit\ 1,2,\ldots,i}}{Max\ difference}$$

To take into account risk related to negative impacts of the action, the differences between the neutral (3) and worst case scenario scores (only if below 3) are summed, and then divided by the max difference).

$$risk\ index = \frac{\sum \square\ (neutral\ case\ scenario\ score - worst\ case\ scenario\ score)_{co-benefit\ 1,2,\ldots,i}}{Max\ differnece}$$

The figure below illustrates the process of determining each action's final score and its risk index.

	Action 1	Action 2	Action 3	Action 4	Action 5
Best	5	5	3	2	5
Worst	5	1	2	2	3
Best	1	5	5	5	3
Worst	1	3	2	5	2
Best	3	5	5	3	5
Worst	2	5	1	2	2
Global Score	9	15	13	10	13
Benefit Share	0.67	1.00	1.00	0.67	1.00
Weighted Score	6.00	15.00	13.00	6.67	13.00
Normalized score	0.40	1.00	0.8666667	0.6666667	0.8666667
Sum of best-worst gap	1	6	8	1	6
Risk Index	0.125	0.75	1	0.125	0.75
Sum of neutral-worst gap	3	2	4	2	2
Risk Index	0.75	0.5	1	0.5	0.5

Figure 3.8: Example calculation of benefit score and risk index.

Cost Workbook

It is typical for actions plans to include an estimation of the cost of implementation, including both capital expenditure (CAPEX) and operating expenditure (OPEX). For each action, the costs incurred by New York City (all agencies) are divided into Capital, PS (staff expense) and OTPS (other expense), and the Non-City costs are categorized into those taken on by the private sector, NY State (and its agencies), and the ratepayer. Costs that fall in the 'ratepayer' category could be initially borne by the private sector or State, but is assumed that it will transfer onto the public ('ratepayer') over a period of time. The city's agencies and cost experts were consulted, and plans and research papers were studied in order to accurately estimate costs for each action.

The Agency Cost Matrix is split into the following Tabs:

- Summary Actions – A summation of action costs broken down by Capital, PS, OTPS and Non-City costs as well as Existing, New, City Existing, City New and Share of Costs.
- Summary Sub Actions – A summation of sub-action costs.
- Cost Inputs – All of the actions and sub-actions with costs and assumptions.

COST INPUT

This sheet includes the actions, sub-actions, the corresponding lead City agency, and the associated costs and assumptions behind them. Costs are divided up into the following categories:

- Capital costs - City
- PS costs - City
- OTPS costs – City
- Private – Non-City
- State – Non-City
- Ratepayer – Non-City (costs that fall in this category could be initially borne by the private sector or State, but is assumed that it will transfer onto the public ('ratepayer') over a period of time).

These estimates were derived after consulting with MOS staff, city agencies, cost experts, as well as reviewing research papers and relevant project plans.

Some of these costs are annual, and some costs are projected through 2030, in which case they are broken down into 'duration of sub-action' in order to calculate the 'sub-action's total cost'.
This sheet also includes the existing and new costs associated with each sub-action.

Feasibility Workbook

The feasibility analysis evaluates the chances for successful implementation by taking into account the ability to overcome potential obstacles: administrative/ operational, regulatory, and financial. Actions for which implementation is already underway tend to be more feasible, in that they had limited obstacles or already addressed those obstacles. Therefore, the feasibility assessment begins with the status of the action: is it existing/in the pipeline, an expansion of an existing action, or a new action. The following feasibility inputs may address potential operational and financial barriers, including responsibility (i.e., who has jurisdiction, is in position and ready to implement) and financing (i.e., is there a funding source available for each type of necessary investment). The feasibility criteria and scores could be different for other cities and it is up to the city to distinguish what criteria to use for the analysis. The feasibility analysis for New York City included the following criteria: action type/status, responsibility, financing, and cost-type:

1. Type/Status:
- Existing/In the pipeline
- Existing and will be expanded
- New

2. Responsibility:
- City lead
- Non-city lead

3. Financing:
- Financeable (it can be adopted fairly quickly with a number of precedents for financing a project of that scale).
- Financing barriers (it has very low or long-term (approximately 20+ years) returns, or it is difficult to finance, such as energy projects with multiple stakeholders or transmission projects requiring a significant amount of approvals and expense).

4. Cost-type
- Capital (includes capital projects and larger long term investments in facilities & infrastructure).
- Expense (includes labor and fees to keep an agency running but not towards a specific project).

Each action is associated with four categories and sub-categories (Figure 3.9).

ACTION	TYPE/STATUS		FINANCING	COST-TYPE
Action 1	Existing and will be expanded	Non-City	Non-Financeable	Capital
Action 2	New	City	Non-Financeable	Capital
Action 3	New	Non-City	Financeable	Expense

Figure 3.9: Feasibility analysis categories.

In order to prioritize one action against another, every action's:

- 'type' takes precedence over its 'responsibility'
- 'responsibility' takes precedence over its 'financing' component, and
- 'financing' component takes precedence over its 'cost-type' component,

Within 'type',
- 'Existing/In the pipeline' takes precedence over 'Existing and will be expanded,'
- 'Existing and will be expanded' takes precedence over 'New' actions.

Within 'responsibility',
- 'City' lead actions takes precedence over 'Non-city' lead actions.

Within 'financing',
- 'Financeable' actions takes precedence over 'Non-financeable' actions.

Within 'cost-type',
- 'Capital' costs takes precedence over 'Operating Expense' costs.

To take these prioritization hierarchies into consideration, a scoring methodology was devised, where each action gets one score from every main category (Figure 3.10).

For each action, the four scores are added up to produce a total score for each action. Actions with higher total scores are prioritized over actions with lower scores. It is important to note that these scores are simply a way of ranking actions, and the magnitude of the score doesn't have meaning. This scoring method just ensures that the action's 'type' has hierarchy over 'responsibility,' which has hierarchy over 'financing' condition, which has hierarchy over 'cost-type' condition. For example, all existing/ in the pipeline actions will be given priority over 'existing and will be expanded' and 'new' actions regardless of whether they are city or non-city actions, or can be financed easily or not, or they are capital or expense costs. This scoring system, order and even categories can be modified based on how a city wants to define 'feasibility'.

SCORE	TYPE
300	Existing/In the pipeline
200	Existing and will be expanded
100	New
Score	Responsibility
20	City
10	Non-City
Score	Financing
2	Fundable
1	Funding Barriers
Score	Cost-type
0.2	Capital
0.1	Expense

Figure 3.10: Scoring methodology for feasibility analysis.

Figure 3.11 illustrates an example of the scoring for three sample actions. In Figure 3.11, Action 1 is given the highest priority, and Action 3 is given the lowest priority.

Action	Type	Responsibility	Financing	Cost-type	Total
ACTION 1	EXISTING AND WILL BE EXPANDED	NON-CITY	NON-FINANCE-ABLE	EXPENSE	
SCORE	200	10	1	0.1	211.1
ACTION 2	NEW	CITY	NON-FINANCE-ABLE	CAPITAL	
SCORE	100	20	1	0.2	121.1
ACTION 3	NEW	NON-CITY	FINANCEABLE	CAPITAL	
SCORE	100	10	2	0.2	112.2

Figure 3.11: Example of feasibility analysis scoring.