SECURING OUR FUTURE: STRATEGIES FOR NEW YORK CITY IN THE FIGHT AGAINST CLIMATE CHANGE

New York City Council
Speaker Corey Johnson

MARCH 2020

LETTER FROM THE SPEAKER AND COUNCIL MEMBERS

Dear New Yorkers,

Climate change is a global problem that impacts all of us. We have already seen its effects around the world, and right here in New York City: horrific fires in Australia and California; deadly heat waves across Europe; the catastrophic hurricanes that have wreaked havoc on our neighbors in Puerto Rico and the Caribbean; and Superstorm Sandy, which caused 43 deaths and $19 billion in damage in the five boroughs alone.

We must act now and take aggressive measures to adapt to and mitigate climate change. The science is indisputable—if we don't make changes now to reduce greenhouse gas emissions and halt global warming, our planet will suffer long-standing and irreversible effects.

Unfortunately, our federal government denies science and is callously looking to roll back important environmental protections nationwide. Not only is the Trump Administration postponing the U.S. Army Corps of Engineers study of coastal storm protections for New York and New Jersey, but the president of this country is also advising us to get out our "mops and buckets" rather than taking this problem seriously and helping us prepare for the future. The protection of our coastline is vital, and any delay in the study's completion puts millions of lives at risk.

While we will continue to fight the federal government to combat damaging policies, New York City must continue to move forward with a local blueprint to address climate change. Already, we have taken bold action. We passed groundbreaking legislation ensuring that sustainability is a core principle of government operations, reducing building emissions, and developing a streets master plan that focuses on safe, sustainable modes of transportation. New York City also remains committed to the principles of the Paris Agreement, and we have joined together with other cities and countries in a global effort to reduce greenhouse gas emissions 80% by 2050.

We will continue to do more. We need to build a more resilient city to withstand the rising sea level and extreme weather that is coming, and to protect both the neighborhoods that have already been hit hard and those that are at risk in the future. We need to transition from fossil fuels to clean, renewable energy. We need to transform ourselves into a circular economy, by designing waste out of our system. And we need to focus our efforts on building a robust pipeline for good paying green jobs.

This report lays out strategies that New York City can pursue in the fight against climate change. New York City is and always has been a leader. The actions we take together will inspire communities across the world, and help us usher in a greener, healthier, and more equitable future for our City and our planet.

Sincerely,

Corey Johnson
Speaker

Costa Constantinides
Chair, Committee on Environmental Protection

Ydanis Rodriguez
Chair, Committee on Transportation

Antonio Reynoso
Chair, Committee on Sanitation and Solid Waste Management

Justin Brannan
Chair, Committee on Resiliency and Waterfronts

Mark Levine
Chair, Committee on Health

TABLE OF CONTENTS

EXECUTIVE SUMMARY

It is indisputable that the Earth's climate is changing at an unprecedented rate. Scientific evidence shows steady rises in global temperature, hurricanes, ocean acidification, wildfires, and extreme heat events, as well as warming oceans, shrinking ice sheets, and sea level rise. The overwhelming consensus of the scientific community is that modern climate change is caused by human activities like burning fossil fuels and deforestation, which have resulted in significant increases in the amount of greenhouse gas emissions in the atmosphere.

In order to mitigate climate change, there must be collective action on a local, national, and global scale. According to the United Nations' Intergovernmental Panel on Climate Change, if global warming is not limited to 1.5°C above pre-industrial levels this decade, the impacts will be long-lasting and irreversible.

Coastal cities like New York City are particularly vulnerable to climate change, as their large populations are directly confronted by increasingly rising sea levels and intensifying storms. Within cities, frontline communities who have historically suffered disproportionately negative health and environmental effects face even greater impacts from climate change. As centers of economic growth, cities are also responsible for the majority of the world's greenhouse gas emissions, largely from energy consumption to power buildings and transportation.

Recognizing that cities are an integral part of the solution, New York City has positioned itself as a leader in the fight against climate change. In addition to pledging itself to the principles of the Paris Agreement, it has committed to achieve an 80% reduction in greenhouse gas emissions by 2050 (80x50), institutionalized sustainability as a core principle of government, and aggressively acted to reduce emissions from buildings and design streets so that they promote sustainable modes of transportation.

In order to achieve 80x50 and do its part to adhere to the commitments of the Paris Agreement, New York City must take bold steps to transition to clean energy and a circular economy. It must also adapt to the climate change that is already occurring and plan for a future where its infrastructure and buildings are resilient, its benefits are equitable, and its green, sustainable jobs employ a diverse workforce.

This policy paper lays out strategies that New York City can pursue in the fight against climate change. It includes four key areas of focus:

1. Resiliency
2. Energy and Emissions
3. Sustainable, Circular Economy
4. Green Jobs Pipeline

Within each area of focus, the paper identifies goals to achieve, and includes strategies within each goal for the City to consider.

Resiliency focuses on *planning* for climate change and *protecting* New York City today and in the future. Areas covered include coastal resiliency, cooling New York, greenscaping and sustainable surfaces, and citywide resiliency planning. Goals identified are:

- Protect the City's Coastal Areas
- Achieve Cooling Equity
- Cool the Public Realm
- Increase Green Infrastructure
- Use Sustainable Surfaces
- Plan for the Future
- Build Present Day Resiliency

Energy and Emissions focuses on concrete steps the City can take to *reduce greenhouse gas emissions* and support the transition from fossil fuels to a clean energy economy. Goals identified are:

- Transition from Fossil Fuels to Clean Energy
- Reduce Buildings Emissions
- Improve Indoor Air Quality
- Reduce City Transportation Emissions
- Improve Electric Vehicle Infrastructure

Sustainable, Circular Economy focuses on developing a system that *reduces waste* and pollution through innovative design, increased access to recycling, and support for groundbreaking, sustainability-focused work. Goals identified are:

- Increase Access to and Confidence in Recycling
- Divert Textile Waste from Landfill for Reuse and Recycling
- Increase City Support for Sustainable Businesses and Jobs
- Extend the Life of Building Materials
- Reduce Waste

Green Jobs Pipeline focuses on how the City can *create good-paying, sustainable jobs* that employ a diverse workforce, and that will be in high demand as the City achieves resiliency, clean energy, and circularity. Goals identified are:

- Build a Sustainable Workforce
- Increase Work-Based Learning Programs that Focus on Green Jobs
- Improve Access to Green STEM
- Build Student Interest in Green Jobs

The report includes strategies to achieve its identified goals and support equitable solutions for all New Yorkers. Key among these strategies include:

- *Develop a Five-Borough Coastal Resiliency Plan* to assess coastal vulnerability and consider optimal projects to protect neighborhoods.
- *Increase Cooling Assistance for Vulnerable Populations* to prevent against the increasing threat of heat-related deaths.
- *Expand Green Infrastructure in the MS4 Area to Reduce Flooding* in parts of the City that experience frequent stormwater management issues, as well as to provide needed cooling and air quality improvements.
- *Transform Rikers Island into a Renewable Energy Hub* to ensure that the future of Rikers Island advances our transition to renewable energy, decreases citywide emissions and localized air pollution, and creates green jobs for New Yorkers, particularly restorative justice and environmental justice communities.

- *Require Buildings to be Electrification-Ready* to ensure new buildings are "future proofed" to reduce emissions, as the State advances towards its commitment to a 100% carbon-free electric grid by 2040.
- *Achieve a 100% Zero Emissions School Bus Fleet by 2040* to provide a safer, cleaner mode of transportation that improves our environment and the quality of life for students, especially those in areas with high asthma rates.
- *Mandate Citywide Curbside Organics* separation and collection and provide quality education and outreach to New Yorkers to divert our food waste from landfill.
- *Focus Workforce Development on Green Jobs* in an effort to track the pulse of green jobs, quantify future need and identify qualifications, develop training opportunities, place workers in jobs, and promote a diverse workforce that includes frontline communities.

All strategies in this report represent actions that could help New York City adapt to, and mitigate, climate change. It is a blueprint of opportunities for the City to ensure resiliency, reduce emissions, achieve a circular economy, and create sustainable jobs.

GENERAL BACKGROUND

Climate Science Basics

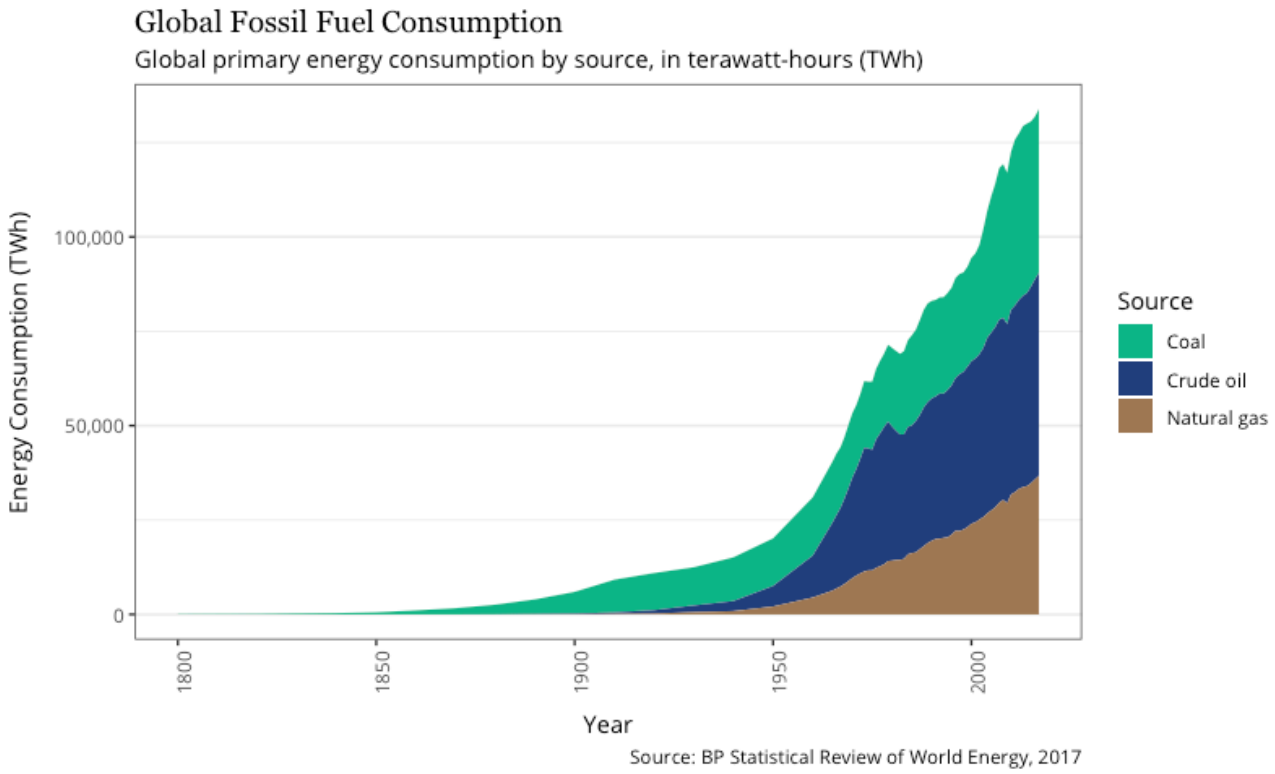
The overwhelming consensus of the scientific community is that climate change is real and human activities are the dominant cause.[1] Scientists have long understood that as the concentration of greenhouse gases (GHGs) in the atmosphere increases, the average global temperature on Earth rises.[2] This is due to a process known as the "greenhouse effect," whereby GHGs in the atmosphere trap heat radiating from the Earth's surface, causing the planet to warm.[3]

Since the Industrial Revolution, human activities have released a significant amount of GHGs into the atmosphere, largely though the burning of fossil fuels, but also through industrialized animal agriculture, deforestation, cement production, and other activities.[4] This has caused the atmospheric concentration of carbon dioxide (CO_2)—the primary GHG released by human activity—to increase by approximately 40% in the industrial era.[5]

Along with the increase in CO_2, the Earth's global average temperature has risen steadily. Although natural factors also influence the climate, scientists have concluded that the warming that has occurred since the 19th century cannot be explained by natural factors alone, and that the only credible explanation is human-caused ("anthropogenic") GHG emissions.[6] Without human activities, scientists have found, the influence of natural factors would have, in contrast, cooled the planet slightly over the past 50 years.[7]

The History of Fossil Fuel Combustion

Humans have long relied on fossil fuel combustion to produce energy, although large-scale combustion of fossil fuels did not begin until the Industrial Revolution.[152] Coal was essentially the only fossil fuel used prior to the 1860s, when crude oil consumption first began (natural gas use started several decades later, in the 1880s).[153] As global energy needs increased during the industrial era, the production and consumption of fossil fuels grew exponentially.[154]

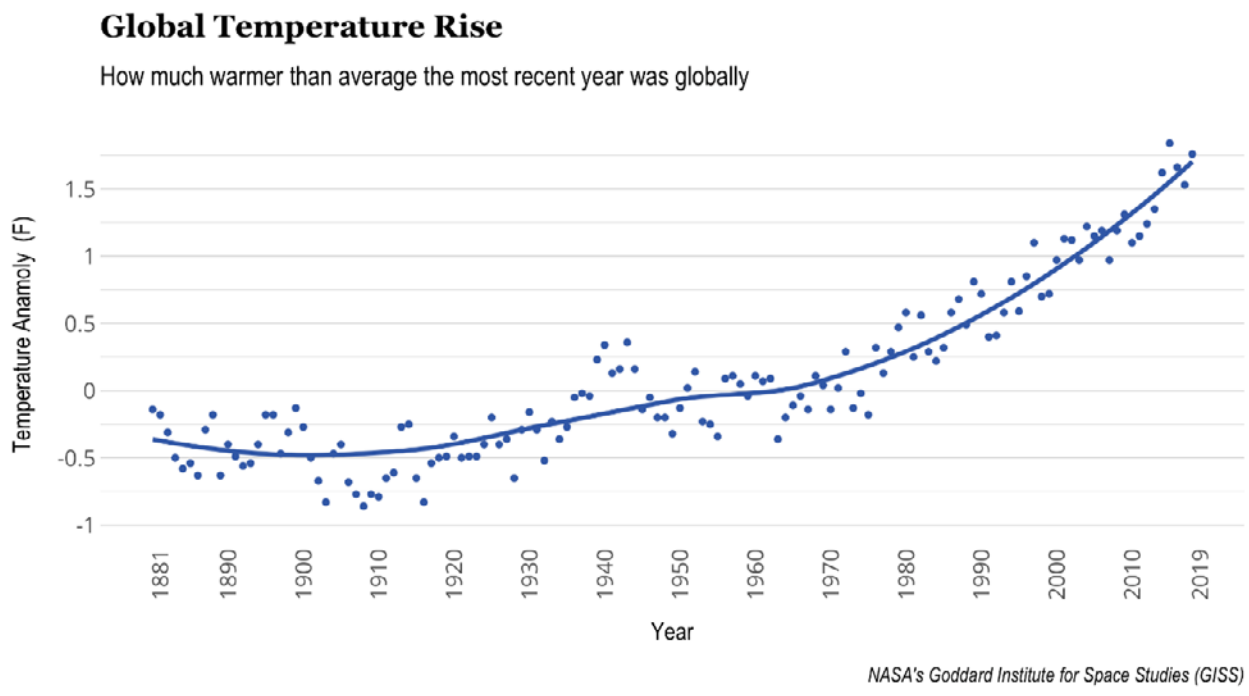


Source: Hannah Ritchie and Max Roser, Fossil Fuels, Our World in Data, (2020), available at https://ourworldindata.org/fossil-fuels.

Evidence of Climate Change

There is overwhelming evidence that the Earth's climate is changing at an unprecedented rate. For example:

1. Global Temperature Rise: Earth's average surface temperature has risen by approximately 1°C since the late 19th century, with 19 of the 20 warmest years on record occurring since 2001.[8]



Source: NASA, Climate Change: Vital Signs of the Planet, Global Temperature, available at https://climate.nasa.gov/vital-signs/global-temperature/.

What Is 1.5°C and Why Is It Important?

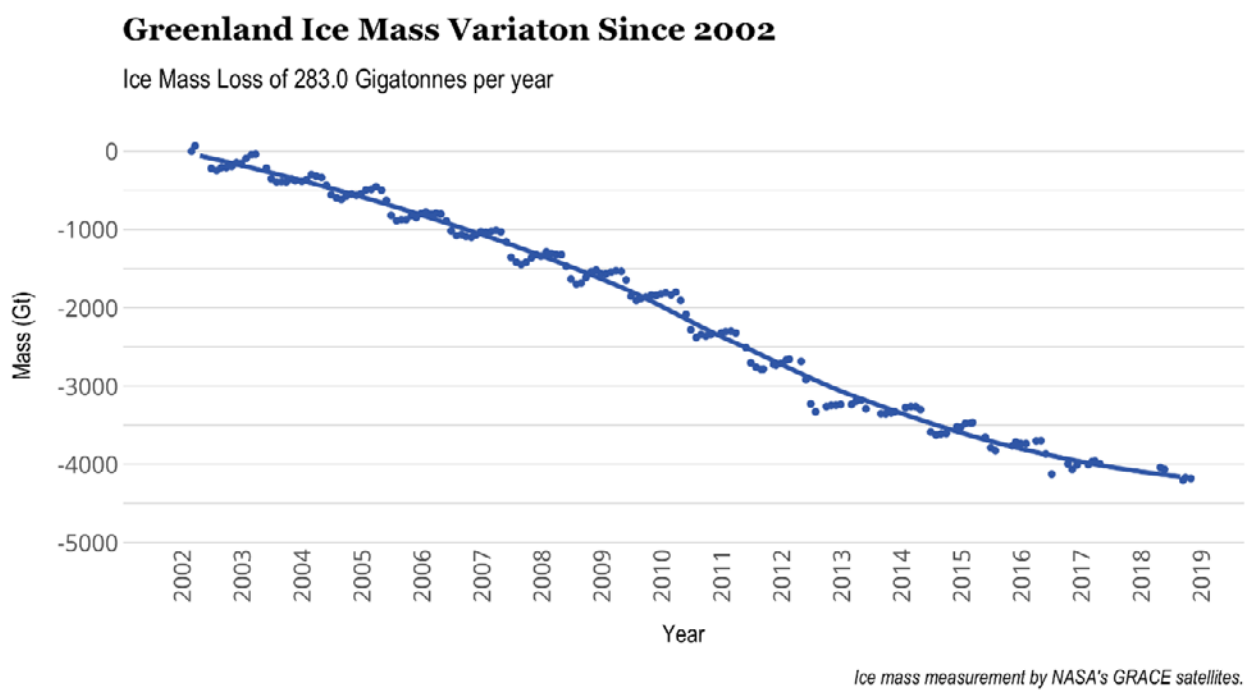
As discussed in greater detail below (see box discussing the Paris Agreement), countries around the world have set targets to limit global warming to 1.5°C above pre-industrial levels. Although there are serious climate impacts even at this level of warming, this threshold is significant, as any additional warming beyond 1.5°C will bring even worse impacts, threatening lives, livelihoods, and economies.[9] The Intergovernmental Panel on Climate Change (IPCC)—a U.N. body that assesses climate science—has concluded that there are major differences between 1.5°C and 2°C of warming , including the following:

- At 1.5°C, the Earth's coral reefs will decline by over 70%, but at 2°C, over 99% of all coral reefs will be lost.
- Insects are twice as likely to lose half of their habitats at 2°C as they are at 1.5°C.
- At 1.5°C, the Arctic Ocean is likely to be completely bare of sea ice at least once per century, but at 2°C, this increases to a likelihood of once per decade.
- At 1.5°C, over six million people currently living in in coastal areas will be vulnerable to sea level rise, but at 2°C, 10 million more people will be impacted by the end of this century.
- At 2°C, sea level rise will likely be one meter higher than at 1.5°C.
- Above 1.5°C, frequent and intense droughts, storms, and extreme weather events will increase in likelihood.[10]

Studies have found that under a "business-as-usual" scenario where anthropogenic GHG emissions continue to increase, there is a significant likelihood that global warming will reach 4°C or more by the end of this century.[11] A report by the World Bank finds that 4°C of warming could be "devastating," leading to the inundation of coastal cities, significant food security risk, and irreversible loss of biodiversity.[12] (See Appendix for further detail.)

According to a 2019 report by the United Nations Environment Programme (UNEP), to prevent warming beyond 1.5°C, global emissions need to be reduced by 7.6% every year between now and 2030.[13] Notably, if countries had acted 10 years ago, global emissions would have only needed to be reduced by 3.3% annually to keep warming to 1.5°C.[14] This illustrates a critical point: the longer we wait to address the problem of climate change, the more difficult and costly it will become to do so.

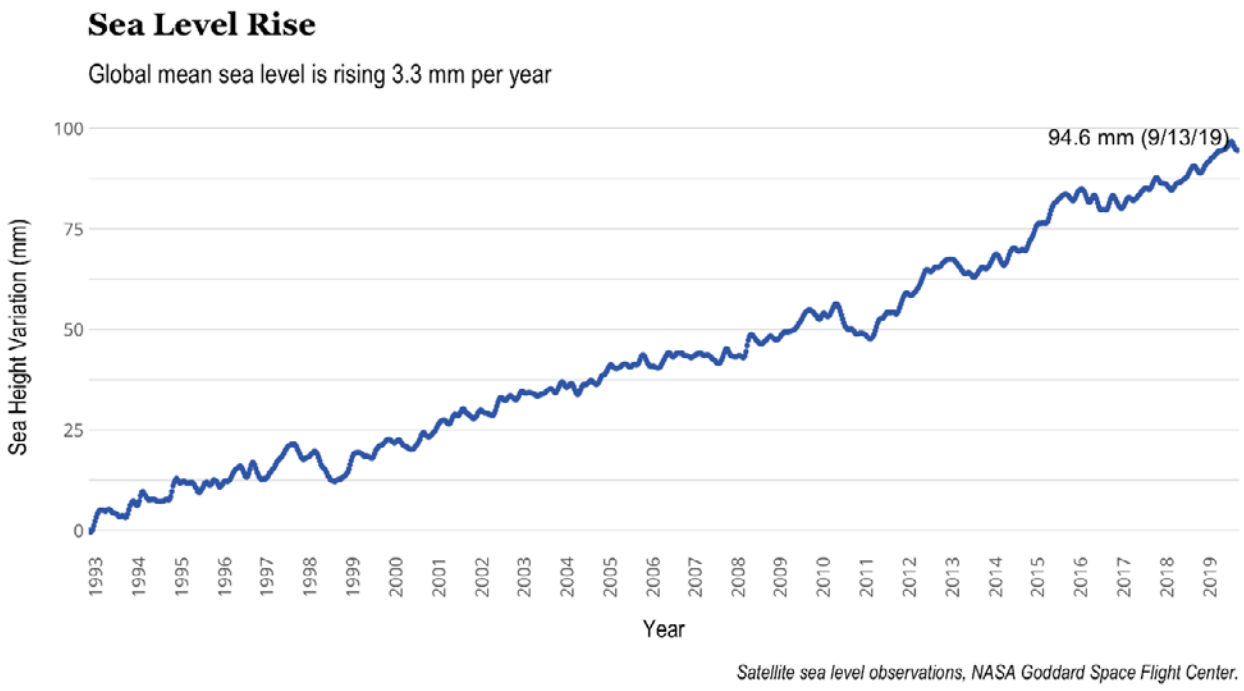
2. Warming Oceans: The Earth's oceans have absorbed more than 90% of all the excess heat energy trapped by GHGs.[15] As a result, the top 2,300 feet of the Earth's oceans have warmed more than 0.4°F since 1969,[16] and the surface layers of the oceans are warming 24% faster than they did several decades ago.[17]
3. Shrinking Ice Sheets: The Greenland and Antarctic ice sheets have shrunk. Between 1993 and 2016, Greenland lost an average of 286 billion tons of ice per year, and Antarctica lost approximately 127 billion tons of ice per year.[18] The rate at which Antarctica is losing ice mass has tripled in the last decade. [19]



Source: NASA, Climate Change: Vital Signs of the Planet, Ice Sheets, available at https://climate.nasa.gov/vital-signs/ice-sheets/.

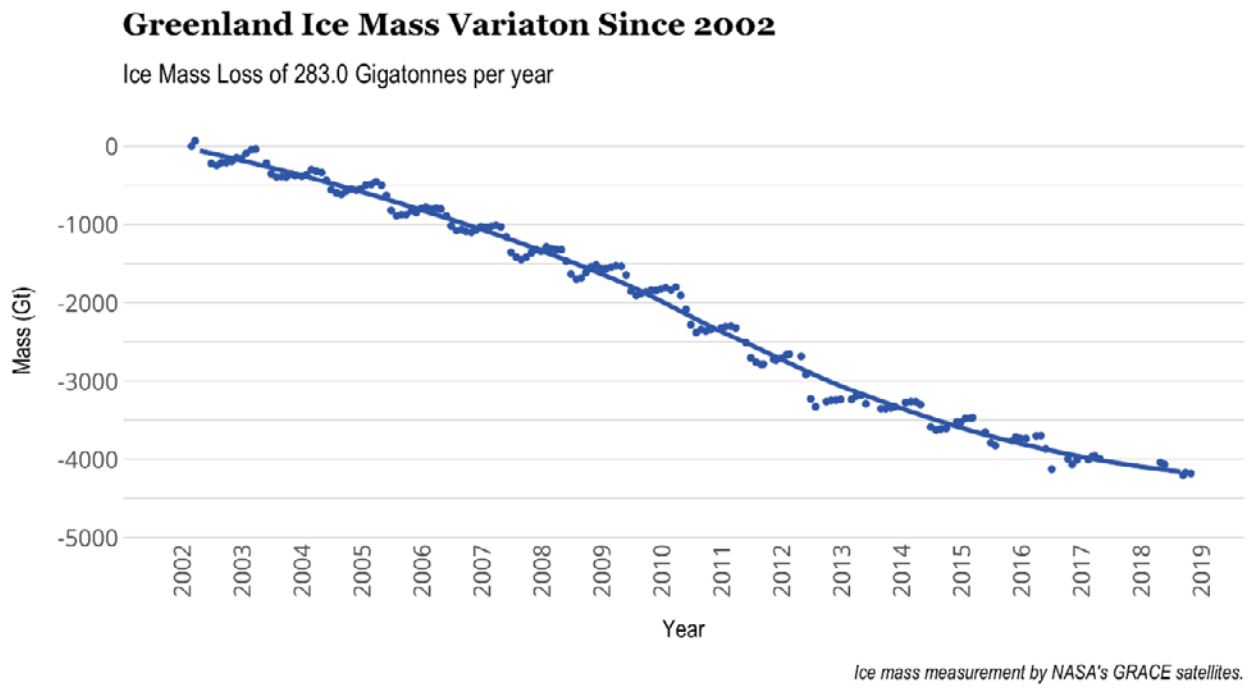
4. Glacial Retreat: Glaciers have receded across the globe, with about 400 billion tons of glacial loss annually since 1994.[20]
5. Decreased Snow Cover: Over the past five decades, the amount of spring snow cover in the Northern Hemisphere has decreased, and the snow that remains is melting earlier in the year than it has historically.[21]

6. Sea Level Rise: During the 20th century, the global sea level rose approximately eight inches.[22] Over the last two decades, the rate of sea level rise has increased dramatically. The rate of sea level rise over the past two decades is nearly twice that of the last century, and is increasing every year.[23]



Source: NASA, Climate Change: Vital Signs of the Planet, Sea Level, available at https://climate.nasa.gov/vital-signs/sea-level/.

7. Declining Arctic Sea Ice: Over the last four decades, the extent and thickness of Arctic sea ice has significantly declined.[24] September Arctic sea ice, which represents the annual seasonal low point, is declining at a rate of 12.85% per decade.[25]



Source NASA, Climate Change: Vital Signs of the Planet, Arctic Sea Ice, available at: https://climate.nasa.gov/vital-signs/arctic-sea-ice/.

8. Extreme Heat Events: Since 1950, the number of record high heat events in the United States has increased rapidly, and the number of record low temperature events has decreased.[26]
9. Wildfires: The rise in global temperatures has likely contributed to more frequent wildfires.[27] Over the past 60 years, the number of wildfires in the western United States has steadily increased, as has the average acreage burned in those wildfires.[28]
10. Ocean Acidification: The Earth's oceans absorb much of the CO_2 released into the atmosphere, creating carbonic acid.[29] As a result, the acidity of the ocean's surface waters has increased by about 30% since the beginning of the Industrial Revolution. Each year, the upper layer of the oceans absorbs about two billion tons of additional CO_2.[30]
11. Hurricanes: Since the 1980s, hurricanes in the North Atlantic Ocean have increased in intensity, frequency, and duration.[31] Although scientists are continuing to refine their understanding of the relationship between hurricanes and climate change, research indicates that global warming makes intense hurricanes more likely.[32] Today, a storm like Hurricane Harvey—which ravaged Houston in 2017—is approximately six times more likely than it was just two decades ago.[33]

Effects of Climate Change

As the Earth's temperature continues to rise, previously rare extreme weather events are now occurring with alarming frequency.[34] Although the science linking individual weather events to climate change is still developing,[35] recent examples of deadly heat waves, storms, and wildfires abound. In May 2015, intense heat waves in India caused the asphalt in New Delhi to melt and resulted in the deaths of at least 2,300 people.[36] In September 2017, Hurricane Maria devastated Puerto Rico and, according to independent researchers, caused nearly 3,000 deaths in the six months that followed the storm.[37] France's deadly heat waves in 2019 killed nearly 1,500 people and left Parisians seeking refuge in public water fountains.[38] In addition, during Australia's 2019-2020 bushfire season, uncontrolled fires burned millions of acres of land, killing dozens of people and perhaps as many as one billion animals.[39]

In the continental United States, the effects of climate change can be seen in every region. The Northeast is seeing an increase in heat waves, severe rain, and sea level rise.[40] The Northwest is seeing freshwater shortages, rising seas, erosion, flooding, increased ocean acidity, increased wildfire risk, insect outbreaks, and outbreaks of tree diseases.[41] In the Southeast, sea level rise, extreme heat, and decreased water availability continue to have negative economic and environmental impacts, while in the Midwest, heavy downpours, flooding, and extreme heat pose challenges to the agriculture and forestry industries.[42] In the Southwest, heat waves, drought, insect outbreaks, increased incidence of wildfires, freshwater shortages, and flooding and erosion in coastal areas can all be linked to climate change.[43]

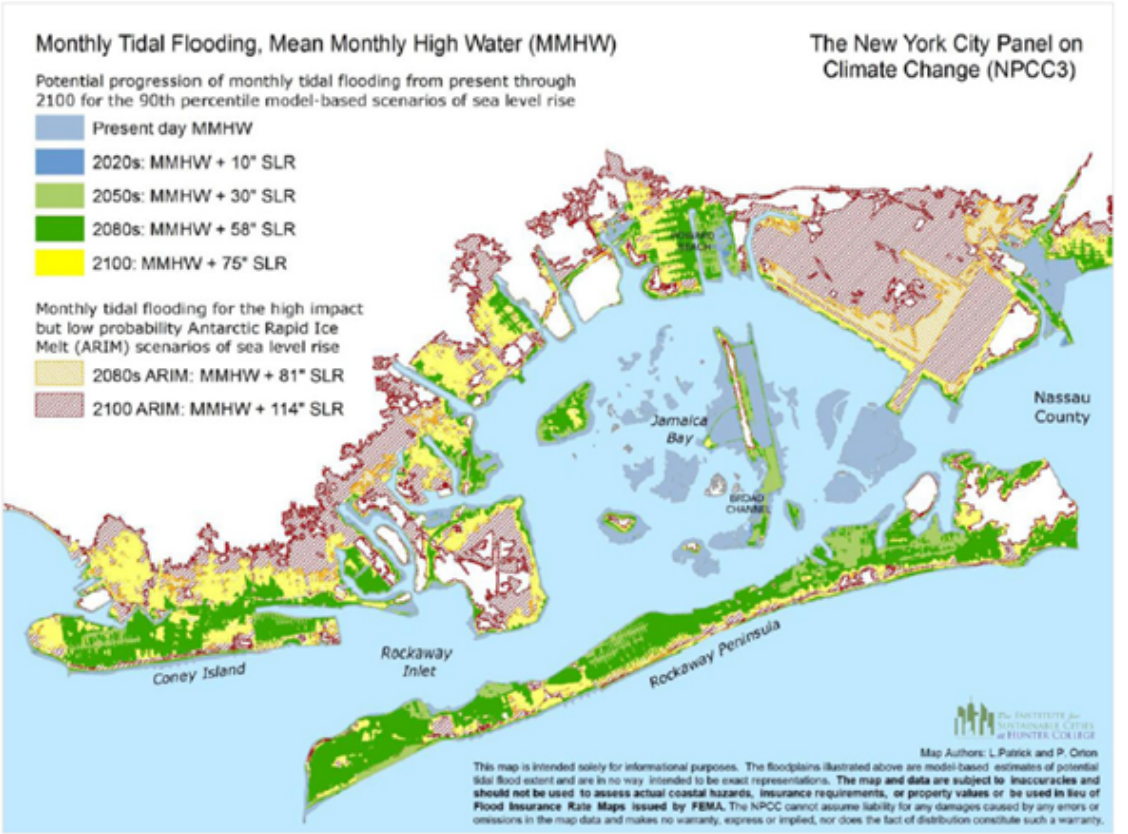
Coastal communities across the United States are at the forefront of climate change-linked sea level rise, with approximately 311,000 residential properties potentially at risk of "chronic inundation"—i.e., flooding at high tide at least 26 times per year—by 2045.[44] By 2100, scientists estimate that as many as 2.4 million residential properties and 107,000 commercial properties in the United States will be at risk of chronic tidal inundation.[45] These properties have a combined value of $1.07 trillion—roughly equivalent to Florida's entire gross domestic product—and house approximately 4.7 million people.[46] One recent study estimates that by 2100, high tide flooding of low-lying roads, freshwater systems, and properties may occur 182 days per year or more.[47] Furthermore, coastal communities along the eastern seaboard routinely face unexpected flooding during clear weather, a phenomenon known as "sunny day flooding," with Miami experiencing daily high tide records for over a week straight between late July and early August of 2019.[48]

New York State is projected to have approximately 143,000 residential properties at risk of coastal inundation by the end of the century—the third most in the country.[49] The East and Gulf Coasts of the United States are undergoing some of the fastest rates of sea level rise, with coastal flooding occurring approximately once every three months, up from once every one to five years in the 1950s.[50]

New York City's waterfront communities face significant threats from extreme weather events and high tides, and projections show that these communities will experience greater and more frequent damage from flooding because of climate-related weather events and sea level rise. Neighborhoods such as Broad Channel,

Howard Beach, Hamilton Beach,[51] Rosedale, Far Rockaway, Coney Island, Stapleton, Arrochar, and Midland Beach,[52] where eight New Yorkers drowned in Superstorm Sandy's floodwaters,[53] regularly experience tidal inundation, a trend that will only be exacerbated by continued sea level rise.

Projected Tidal Flooding in New York City



Source: Philip Ortan et al., New York City Panel on Climate Change 2019 Report, Chapter 4: Coastal Flooding, NPCC, (Mar. 2019), available at https://nyaspubs.onlinelibrary.wiley.com/doi/10.1111/nyas.14011.

Superstorm Sandy

On October 29, 2012, Superstorm Sandy approached New York City from the southeast, causing high winds and a 14-foot storm tide.[54] Sections of Lower Manhattan, Staten Island, Brooklyn, and Queens were inundated with seawater. The storm flooded approximately 17% of New York City's total landmass, or 51 square miles.[55] By the end of 2012, the New York City Department of Buildings (DOB) identified approximately 800 buildings that had been damaged or destroyed and nearly 70,000 housing units that were found to have suffered some amount of damage.[56] Superstorm Sandy caused an estimated 43 deaths and $19 billion in losses in New York City.[57]

Along with damage to residential and commercial property, the storm damaged critical city infrastructure and services. Nearly two million people lost power.[58] Con Edison's steam system was unable to service one-third of its customers for nearly two weeks.[59] Landline and internet service was disabled in some neighborhoods for up to 11 days.[60] Six hospitals and 500 buildings with doctors' offices, clinics, and other outpatient facilities were forced to close due to flooding.[61]

Climate change is expected to continue exacerbating extreme weather events, leading to stronger and more frequent storms like Superstorm Sandy.[62] By 2050, the City's annual precipitation is projected to increase by 4% to 11%, and sea levels are projected to rise by 11 to 21 inches.[63] As a result, a Superstorm Sandy-like extreme weather event in 2050 could cause approximately $90 billion in damages, compared to the $19 billion caused by Superstorm Sandy.[64]

THE ROLE OF CITIES IN ADRESSING CLIMATE CHANGE

As engines of economic growth, cities are responsible for over 70% of the world's CO_2 emissions.[65] This means that without aggressive steps to make cities greener, addressing the global climate crisis will be all but impossible.[66]

Moreover, cities are particularly vulnerable to the effects of climate change. Approximately 90% of the world's cities are coastal, leaving them exposed to inundation from sea level rise and powerful storms.[67] In addition, the high concentration of roads and buildings in urban areas can exacerbate extreme heat events[68] and make flooding from stormwater more likely.[69] As more and more people move to cities, the resiliency of city infrastructure will become more and more important. Today, over half of the world's population lives in urban areas.[70] By 2050, over two-thirds will.[71]

In the last three years, as the federal government has taken steps to roll back progress on combatting climate change (see Box on next page), it has become even more critical that local governments rise to the challenge.

What has the Trump Administration Done to Reverse Progress on Climate Change?

The Paris Agreement

In December 2015, world leaders came together and agreed upon a landmark international accord—the Paris Agreement—to combat climate change and ensure a low-GHG emissions future. Through the Paris Agreement, almost every country in the world committed to limiting the increase in the global average temperature to below 2°C above pre-industrial levels, and to pursuing efforts to limit the temperature increase to 1.5°C above pre-industrial levels, recognizing that this would significantly reduce the risks and impacts of climate change.[72]

To achieve these goals, the Paris Agreement requires all parties to put forth their best efforts to meet self-determined emission reduction targets known as "nationally determined contributions," to report regularly on their efforts, and to take part in a "global stocktake" every five years to assess collective progress toward the goals set forth in the agreement.[73] In addition, recognizing that many of the countries that contributed the least to climate change will suffer the most from its consequences, the Paris Agreement includes a plan for developed countries to provide financial support and other resources to help developing countries mitigate and adapt to climate change.[74] The Paris Agreement became effective on November 4, 2016. Since then, 189 of the 197 parties to the convention have ratified the agreement.[75]

Although the United States signed the Paris Agreement, President Trump has begun the process of withdrawing from the accord.[76] As a result of his actions, the United States is on course to become officially withdrawn from the Paris Agreement on November 4, 2020—one day after the next presidential election.[77]

U.S. Mitigation Efforts Rolled Back by the Trump Administration

In addition to withdrawing from the Paris Agreement, President Trump has rolled back many of the country's most critical rules and regulations previously established to mitigate the impacts of climate change and protect the nation's environment. As of December 2019, President Trump and Congressional Republicans have taken steps to roll back at least 95 environmental rules and regulations covering a wide range of topics, including air pollution and emissions, drilling and extraction, infrastructure and planning, animals, toxic substances, and water pollution.[78] Some of the Trump administration's most damaging and shortsighted decisions include:

- Repealing the Obama administration's Clean Power Plan, which aimed to reduce GHG emissions from power plants by 32%, and replacing it with the significantly weaker Affordable Clean Energy rule,[79] which is projected to reduce GHG emissions from the power sector by less than 1%;[80]

- Effectively reversing the Methane Waste Prevention Rule, an Obama-era regulation designed to prevent methane—a GHG that is 84 times more powerful than CO_2[81]—from being released into the atmosphere during oil and gas drilling;[82]
- Revoking California's power to set more stringent emissions standards for motor vehicles;[83]
- Revoking an Obama-era executive order aimed at cutting the federal government's GHG emissions by 40% over 10 years;[84]
- Lifting a ban on fossil fuel exploration in the Arctic National Wildlife Refuge;[85]
- Repealing a rule that required state and regional transportation agencies to track GHG emissions from motor vehicles;[86]
- Revoking resiliency standards for federal infrastructure projects located in or near floodplains;[87]
- Loosening offshore drilling safety regulations adopted after the Deepwater Horizon oil spill;[88]
- Reinterpreting the Endangered Species Act to make it more difficult to protect wildlife from the long-term effects of climate change;[89] and
- Scaling back protections for tributaries and wetlands regulated under the Clean Water Act.[90]

In addition, in a step that is of particular importance to New York City, in February 2020, the U.S. Army Corps of Engineers "indefinitely postponed" a study commissioned after Hurricane Sandy to evaluate measures to protect communities in the New York-New Jersey harbor region from severe storms and flooding.[91]

Many of the actions noted above have been challenged in court and remain the subject of ongoing litigation. The primary challengers of the Trump administration's environmental rollbacks have been environmental groups, city governments, and state attorneys general. For instance, in August 2019, New York State led a coalition of 23 states and six municipalities—including the City of New York—in filing a lawsuit in federal court challenging the Trump administration's rollback of the Clean Power Plan.[92]

Fortunately, cities like New York are well positioned to take a leadership role in addressing the climate crisis. Throughout history, cities have been centers of innovation and creativity.[93] That ingenuity can be harnessed to develop new ways to make cities more sustainable and resilient. In addition, as cities work to develop more efficient ways of living and getting around, the density of urban areas can be an asset.[94]

New York City Efforts

New York City has already taken significant steps to combat climate change. For instance, the City Council has passed several substantial climate laws over the past 15 years, including local laws on the following topics:

- GHG Emissions: Through a series of local laws enacted between 2008 and 2019, the City has committed itself to reducing citywide GHG emissions to 40% below 2005 levels by 2030, and to 80% below 2005 levels by 2050.[95]

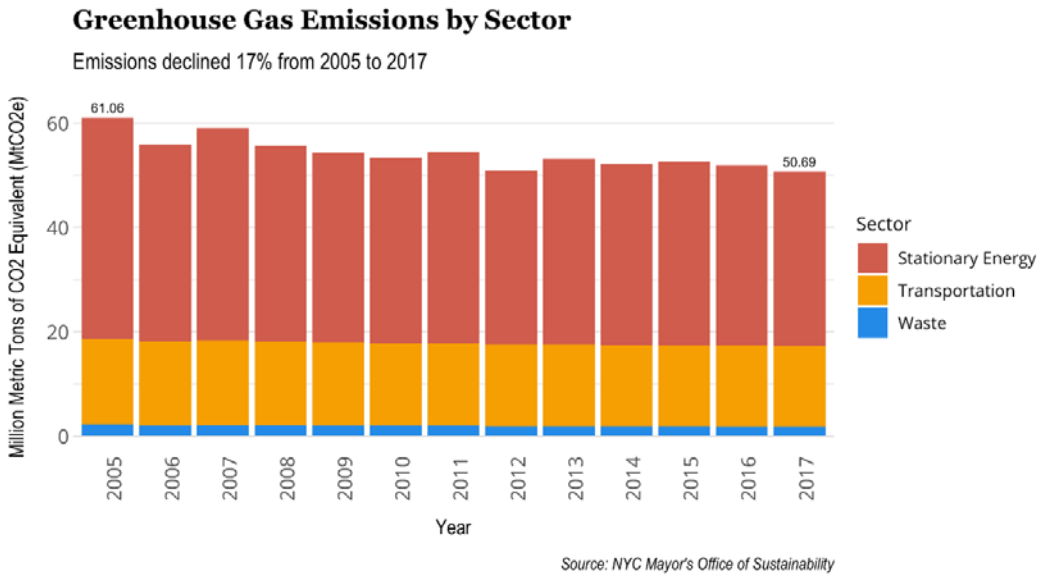
The City has also committed itself to reducing GHG emissions from government operations to 40% below 2006 levels by 2025, and to 50% below 2006 levels by 2030.[96]
In addition, Local Law 97 of 2019 requires certain buildings in the City—specifically, buildings larger than 25,000 square feet—to reduce their GHG emissions to 40% below 2005 levels by 2030, and to 80% below 2005 levels by 2050.[97] This law also requires the highest-emitting buildings to begin reducing their emissions by 2024.[98]

GHG Emissions in NYC

Pursuant to Local Law 22 of 2008, the Mayor's office must produce annual reports regarding the City's GHG emissions (known as the "Inventory of NYC GHG Emissions.") These reports allow policymakers to understand where the City's GHG emissions are coming from and to track the City's progress in reducing them. The Inventory of NYC GHG Emissions tracks all direct and indirect GHG emissions from:

- **Stationary energy:** energy used by buildings and other stationary sources, as well as fugitive emissions from natural gas distribution within city limits;
- **Transportation:** on-road transportation, railways, marine navigation, and aviation within city limits; and
- **Waste:** wastewater treatment within city limits, and solid waste generated within the city.

As the following chart indicates, New York City's citywide GHG emissions decreased by approximately 17% between 2005 and 2017:



Source: NYC Mayor's Office of Sustainability, Inventory of NYC GHG Emissions, available at https://nyc-ghg-inventory.cusp.nyu.edu/#inventories.

- Renewable Energy and Energy Efficiency: The City Council has also passed several local laws to promote energy efficiency. For instance, Local Law 85 of 2009 established the New York City Energy Conservation Code (NYCECC), enabling the City to enforce a more stringent energy code than the State.[99] Meanwhile, Local Law 84 of 2009 required property owners of buildings larger than 50,000 square feet to benchmark their buildings' energy and water use,[100] and Local Law 133 of 2016 expanded this requirement to include buildings larger than 25,000 square feet.[101]

  In addition, the City Council has passed local laws encouraging, and in some cases requiring, the installation of renewable energy systems, including:

  - Local Law 24 of 2016, requiring the Department of Citywide Administrative Services (DCAS) to identify rooftops in the city that are appropriate for solar energy systems, and to submit a biennial report on the installation of those systems;[102]
  - Local Laws 230 and 232 of 2017, creating programs to encourage the use of solar energy throughout the city;[103]
  - Local Law 233 of 2017, creating an Office of Alternative Energy within DOB;[104]
  - Local Law 248 of 2017, requiring the City to create a long-term energy plan with specific recommendations for renewable energy sources and energy efficiency measures that could feasibly be developed and integrated by the City;[105]
  - Local Law 107 of 2018, requiring that all City-owned buildings be powered by green energy sources by 2050;[106]
  - Local Law 96 of 2019, allowing building owners subject to Local Law 97 (which, as noted above, applies to buildings of 25,000 square feet or more) to obtain loans to finance energy efficiency improvements and the installation of renewable energy systems;[107] and
  - Local Laws 181 and 183 of 2019, requiring the City to conduct feasibility studies on renewable energy and storage systems for City-owned buildings.[108]

- Sustainability and Resiliency: The City Council has also taken steps to ensure the city is sustainable and resilient going forward. For instance, Local Law 17 of 2008 required the Mayor to establish an Office of Long-Term Planning and Sustainability tasked with creating, and updating every four years, a sustainability plan for the city,[109] and Local Law 84 of 2013 required the Office of Long-Term Planning and Sustainability to include resiliency measures in its plans.[110] This Office works to minimize the City's contributions to climate change from the waste, transportation, energy, and building sectors.

  Local Law 42 of 2012 established the New York City Panel on Climate Change (NPCC), which is required to convene regularly for the purpose of producing a report on the future of climate change in the city, and the New York City Climate Change and Adaptation Task Force, which is required to review the projections of the NPCC and develop proposals for adaptation.[111]

What is the New York City Panel on Climate Change (NPCC)?
The NPCC is an advisory board of researchers with expertise on issues pertaining to climate change. Per Local Law 42 of 2012, the NPCC's main goal is to provide an authoritative source of actionable information on future climate change, and its potential impacts, to support City policy and decision-making, namely through climate analysis and transdisciplinary assessment every three years.

NPCC's 2019 report, *Advancing Tools and Methods for Flexible Adaptation Pathways and Science Policy Integration*, made the following findings:

- Trends in annual temperatures and precipitation increases are in line with previous NPCC projections for the 2020s (2010–2039);
- If emissions remain high, sea levels may rise even faster than previously anticipated due to Antarctic Ice Sheet destabilization; and
- New maps provide a new understanding of flood risks due to sea level rise.[112]

The report also explored new methods for incorporating equity into climate change vulnerability assessments and community adaptation planning. In addition, the report analyzed new ways to track and measure climate impacts and adaptation.[113]

Pursuant to Local Law 84 of 2013, Mayor de Blasio released a comprehensive strategic plan in April 2019 to "secure our city's future against the challenges of today and tomorrow."[114] The plan, known as *OneNYC 2050*, sets forth several ambitious goals for combating climate change and ensuring a sustainable future for New York City, including:

- Committing to carbon neutrality and 100% clean electricity by 2050, and to a carbon-neutral City fleet by 2040;
- Requiring buildings to cut their emissions, as per Local Law 97 of 2019;
- Amending the NYCECC to require more stringent energy efficiency requirements to ensure that buildings do not leak large amounts of air;
- Building new infrastructure to connect New York City to zero-emission Canadian hydropower;
- Reducing waste and carbon-intensive consumption by ending unnecessary purchases of single-use plastic foodware, processed meat, and beef; and
- Aligning the City's efforts with the United Nations' (U.N.) Sustainable Development Goals (see Appendix) and submitting a Voluntary Local Review to the U.N., which will monitor New York's advancement toward those goals.[115]

New York State Efforts to Address Climate Change

New York State has also taken several important steps to address climate change. For instance, New York, together with eight other northeastern and mid-Atlantic states, is a member of the Regional Greenhouse Gas Initiative (RGGI), the first mandatory market-based program in the U.S. to reduce greenhouse gas emissions. Together, the nine RGGI states set a cap on the total CO_2 emissions from power plants in the region. Since 2005, power plants subject to RGGI have seen their CO_2 emissions decrease by more than 45%.

The State has also taken significant action on its own to help mitigate and adapt to climate change. Most significantly, on July 22, 2019, New York State enacted the Climate Leadership and Community Protection Act (CLCPA). CLCPA is an historic piece of climate legislation that includes some of the most ambitious emissions reduction targets in the country. Under CLCPA, New York State must reduce its statewide GHG emissions to "net zero" by 2050,[116] which means reducing GHG emissions in absolute terms to at least 85% below 1990 levels, and offsetting any remaining emissions through projects that remove GHGs from the atmosphere.[117] As an interim target, CLCPA requires New York State to reduce its emissions in absolute terms to 40% below 1990 levels by 2030.[118] These mandates cover emissions from all sectors of the economy and include emissions from fuels that are imported from other states.[119]

CLCPA also requires 100% of the state's electrical energy to come from renewable sources by 2040, with an interim goal of 70% by 2030.[120] In addition, the law requires the installation of offshore wind facilities capable of producing 9,000 MW of energy by 2035, solar facilities capable of producing 6,000 MW of energy by 2025, and energy storage systems capable of storing 3,000 MW of energy by 2030.[121]

To implement these measures, CLCPA establishes a 22-member body (the Climate Action Council) to develop a "scoping plan," which will set forth recommendations for reducing emissions across all sectors.[122] The Climate Action Council must prepare and approve the first scoping plan by 2021 and update the plan every five years.[123] CLCPA then requires the New York State Department of Environmental Conservation (DEC) to promulgate rules and regulations to ensure that the State meets its emissions targets. The Climate Action Council's scoping plan will inform these regulations.[124]

CLCPA also includes environmental and climate justice provisions. Specifically, it establishes a Climate Justice Working Group to advise the Climate Action Council on its scoping plan, and work with the DEC to create and implement a strategy to improve air quality in communities affected by local air pollution.[125] In addition, CLCPA requires the State to prioritize projects that both reduce GHG emissions and eliminate pollutants in historically disadvantaged communities, and requires disadvantaged communities to receive at least 35% of the overall benefits from the State's spending on clean energy and energy efficiency projects.[126] The Climate Justice Working Group will develop criteria for qualifying as a disadvantaged community for these purposes.[127]

Environmental & Climate Justice

Any equitable response to climate change must include measures dedicated to environmental and climate justice. Environmental justice (EJ) and climate justice both speak to the disproportionate effects faced by majority-Black, Brown, and low-income communities, resulting from environmental racism, classism, and climate change. These include policies that produce and sustain inequities between different racial and income-class groups, as they relate to things like pollution, availability of green space, and access to healthy food. Although the two terms are similar and intersect, they are unique:

- Environmental Justice: The Environmental Protection Agency (EPA) defines EJ as "the fair treatment and meaningful involvement of all people regardless of race, color, national origin, or income with respect to the development, implementation, and enforcement of environmental laws, regulations, and policies."[128] This definition was conceived after the EPA's Environmental Equity Workgroup released a 1992 report confirming that "racial minority and low-income populations bear a higher environmental risk burden than the general population."[129] EJ also includes equity in the distribution of environmental benefits, including amenities such as open space and parks.[130] According to the EPA, EJ will be achieved when everyone enjoys "the same degree of protection from environmental and health hazards and equal access to the decision-making process to have a healthy environment in which to live, learn, and work."[131]

- Climate Justice: This term refers more specifically to the disparate effects of climate change on majority-Black, Brown, and low-income communities. Though no community is immune to climate change, these communities often experience the brunt of its effects. As U.N. Secretary-General António Guterres has noted, with climate change, "as is always the case, the poor and vulnerable are the first to suffer and the worst hit."[132]

To ensure that climate change is equitably addressed through a social justice lens, advocates have focused on achieving a "just transition." According to the Climate Justice Alliance, a just transition is a "vision-led, unifying and place-based set of principles, processes, and practices that build economic and political power to shift from an extractive economy to a regenerative economy."[133] A just transition means transforming our production and consumption cycles to be holistic and waste-free,[134] and provides the framework for achieving climate and environmental justice.

New York City is not immune to environmental and climate injustice. From 2000 to 2010, Black residents represented nearly half of those affected by heat-related deaths in the city,[135]

despite representing only about a quarter of the city's overall population.[136] Climate change is likely to make this problem worse. According to one study, by 2080, heat waves could kill as many as 3,331 New Yorkers annually.[137]

EJ communities are often disproportionately located near sources of pollution.[138] In New York, the largest sources of pollution are often in manufacturing districts, known as "M-zones," and the closer a community is located to an M-zone, the greater the impact of pollution. A review of major M-zones in NYC shows a higher percentage of minority populations than borough or city averages living in M-zones in every county except Manhattan.[139] Furthermore, a study that examined the relationship between asthma and air pollution in the Bronx found that people living near areas of noxious land use were 66% more likely to be hospitalized for asthma, 30% more likely to be poor, and 13% more likely to be minority than persons living farther away from those areas.[140]

New York State EJ Program

DEC houses an Office of Environmental Justice (OEJ), which "works to address environmental issues and concerns that affect primarily low-income and minority communities through grant opportunities, enforcement of environmental laws and regulations, consultation, guidance, and enhancing public participation."[141] OEJ offers competitive grants to tax-exempt not-for-profit organizations to support communities as they develop and implement solutions to address EJ issues.[142] OEJ also administers Operation ECO-Quality (ECO-Quality), an initiative that works to promote good health and quality of life by communicating directly with small to mid-size regulated facilities within EJ areas to "determine what leads to non-compliance, educating them on best management practices and pollution prevention, and bringing them into compliance with Environmental Conservation Laws and Regulations."[143]

DEC defines potential EJ areas as U.S. Census block groups of 250 to 500 households that meet or exceed at least one of the following statistical thresholds:

1. At least 51.1% of the population in an urban area reported themselves to be members of minority groups;
2. At least 33.8% of the population in a rural area reported themselves to be members of minority groups; or
3. At least 23.59% of the population in an urban or rural area had household income below the federal poverty level.[144]

New York City Council Legislation

The City has taken several important steps toward addressing EJ and climate justice, including the enactment of Local Law 64 of 2017, which established an Environmental Justice Interagency Working Group (IWG) consisting of representatives from various City agencies.[145] Local Law 64 of 2017 requires the IWG to conduct a comprehensive EJ study every five years identifying the locations and boundaries of EJ areas within the city, describing environmental concerns affecting these areas, and identifying data, studies, programs, and other resources that are available and that may be used to advance EJ goals.[146]

In addition, Local Law 60 of 2017 requires the IWG to develop a comprehensive Environmental

Climate Justice at the Federal Level

The Green New Deal (GND) is a non-binding federal resolution introduced in February 2019 by Senator Ed Markey and Representative Alexandria Ocasio-Cortez that sets forth the following five goals for the country: (1) achieving net-zero GHG emissions; (2) establishing millions of high-wage jobs and ensuring economic security for all; (3) investing in infrastructure and industry; (4) securing clean air and water, climate and community resiliency, healthy food, access to nature, and a sustainable environment for all; and (5) promoting justice and equality.[149]

The GND calls for the accomplishment of these goals through a 10-year national mobilization effort that includes:

- building smart power grids (i.e., power grids that enable customers to reduce their power use during peak demand periods);
- upgrading all existing buildings and constructing new buildings to achieve maximum energy and water efficiency;
- removing pollution and GHG emissions from the transportation and agricultural sectors;
- cleaning up existing hazardous waste and abandoned sites;
- ensuring businesspersons are free from unfair competition; and
- providing higher education, high-quality health care, and affordable, safe, and adequate housing to all.[150]

The first proposed legislation under the Green New Deal umbrella was introduced in November 2019 by Senator Bernie Sanders and Representative Alexandria Ocasio-Cortez. The bill, entitled the Green New Deal for Public Housing Act, would commit up to $180 billion over a decade to upgrade 1.2 million federally-owned homes.[151]

Justice Plan (EJ Plan) that provides guidance on incorporating EJ concerns into City decision-making.[147] This law established an EJ Advisory Board, consisting of Mayoral and Speaker appointees, all of whom must have EJ qualifications. The Advisory Board will make recommendations to the IWG concerning ways to promote EJ, hold public hearings to fact-find, and closely consult the IWG during the development of the EJ Plan.[148] The EJ Advisory Board began meeting in January 2020.

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RESILIENCY AND PLANNING FOR CLIMATE CHANGE

Goals & Strategies

COASTAL RESILIENCY

Goal: Protect the City's Coastal Areas

- Develop a Five-Borough Coastal Resiliency Plan
- Call on the Federal Government to Continue the New York/New Jersey Harbor and Tributaries Study
- Call on the Federal Government to Pro-Actively Fund Resiliency
- Increase the Resiliency of New Construction
- Revitalize FloodHelpNY
- Call for a Tri-State Regional Commission

COOL NEW YORK

Goal: Achieve Cooling Equity

- Develop a Comprehensive Cooling Plan
- Increase Cooling Assistance for Vulnerable Populations
- Ensure Building-Specific Cooling Centers
- Better Measure Heat-Related Deaths

Goal: Cool the Public Realm

- Increase the Use of Cool Roofs
- Use Public Shade Structures

GREENSCAPING AND SUSTAINABLE SURFACES

Goal: Increase Green Infrastructure

- Expand Green Infrastructure in the MS4 Area to Reduce Flooding
- Fill Empty Tree Pits
- Create Sustainable Playgrounds
- Create Green Ends
- Green Bus Stops

Goal: Use Sustainable Surfaces

- Initiate a Comprehensive Sustainable Pavement Testing Program
- Reduce Impervious Areas on New Development Projects
- Increase the Amount of Reclaimed Asphalt

CITYWIDE RESILIENCY

Goal: Plan for the Future

- Consider Climate Change in Capital Planning
- Utilize the Climate Resiliency Design Guidelines
- Conduct Vulnerability Assessments for Critical City Infrastructure and Buildings
- Improve the Collection of Real-Time Local Climate Data

Goal: Build Present Day Resiliency

- Increase Funding for the Office of Long-Term Planning and Sustainability
- Designate Chief Resiliency Officers
- Develop Civic Engagement for Sustainability Projects in Every Community District

The New York City Panel on Climate Change (NPCC) is an advisory body formed by local law to regularly review and report on scientific climate data. The City Council stated that the panel's purpose is to "help the City prepare an intelligent response to climate change."[155]

In the NPCC's most recent report, it considered the city's likelihood of experiencing extreme temperatures, heavy downpours, drought, sea level rise, and coastal flooding.[156] The NPCC reviewed existing climate science data, and developed and tested new methods for observations and projections.[157] Its projections for sea level rise, precipitation, and future temperatures all indicate increasing multi-hazard risks—some of which may exacerbate the impacts or severity of others—to the city over the rest of this century, and should be used to inform the City's planning efforts. Ensuring resiliency means we should plan to build intelligently today so that we are not vulnerable tomorrow.

It also means, as discussed in greater detail in the citywide resiliency subtopic, that not only the physical vulnerabilities of communities should be considered in planning, but also the social vulnerabilities of communities. The impacts of poverty or insufficient infrastructure, for example, can severely hamper a community's ability to survive or recover from the impacts of climate change. Social vulnerability is a critical factor in determining the sufficiency of any measures taken to protect a community.

The following section addresses the major climate change impacts identified by the NPCC—including sea level rise, extreme heat, and heavy downpours—and proposes strategies to address the social and physical vulnerabilities of communities. The section is organized into subtopics on coastal resiliency, protecting the public health by mitigating and adapting to rising temperatures, greenscaping and sustainable surfaces, and citywide resiliency. Although the strategies that follow have been divided into these subtopics, each strategy's benefits may mitigate multiple hazards. Further, the strategies and goals are meant to complement and reinforce each other, with an emphasis on an integrated approach to resiliency planning.

COASTAL RESILIENCY

New York City is essentially an archipelago on the edge of the Atlantic Ocean. As measured by the National Oceanic and Atmospheric Administration (NOAA), the city has approximately 520 miles of coastline.[158] That is more shoreline mileage than the islands of Guam, American Samoa, and the U.S. Virgin Islands, combined.[159] It is also more shoreline mileage than the cities of Miami, Boston, Los Angeles, and San Francisco, combined.[160] Water and coastline are defining features of New York City.

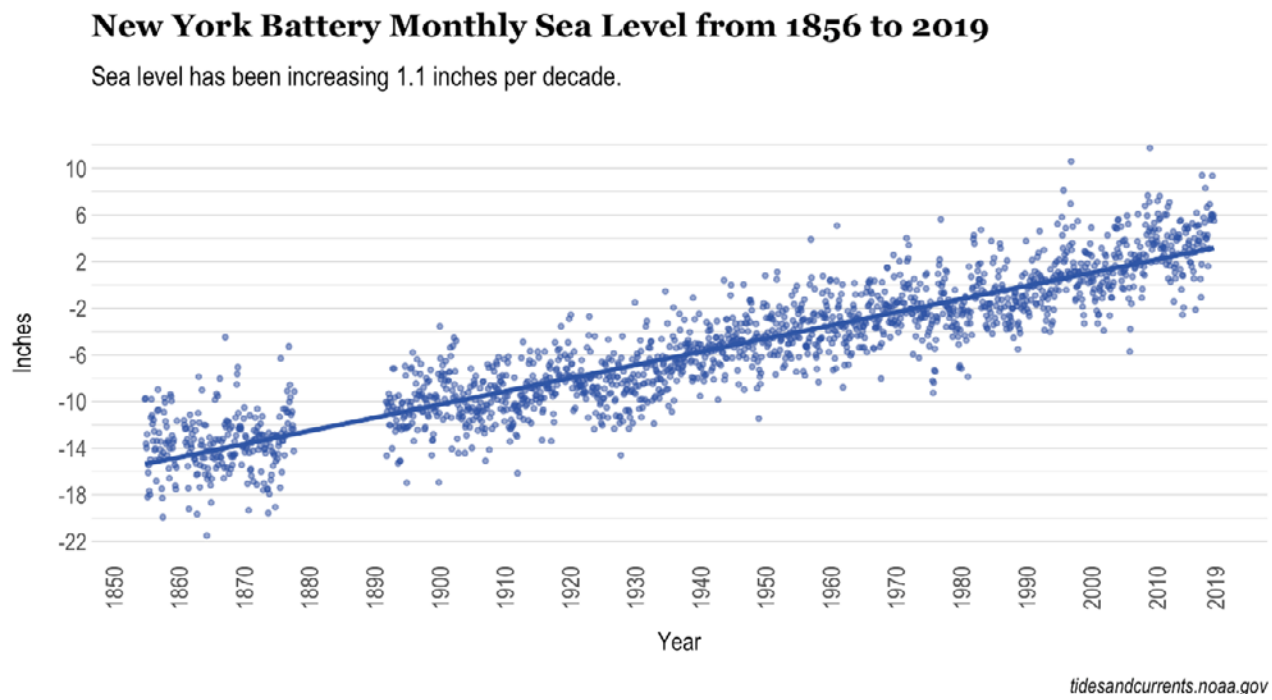
These very features make us particularly vulnerable to the impacts of tides, coastal storms, and sea level rise. While the events of Superstorm Sandy clearly demonstrated these vulnerabilities, climate change will exacerbate the risks posed to our city. Over time, these risks will become more severe, more frequent, and affect larger geographic portions of the city.

Sea level rise is a global phenomenon and is not unique to New York City. While it is often popularly described as a single number by which water levels will rise, in reality the precise local impact may vary.

Sea Level Rise in New York City

The NPCC evaluated the question of local impact for the New York City area through a review of recent scientific literature and climate change data in its 2019 report. It

found that the city lies in an area that experiences sea level rise higher than global averages due to enhanced thermal expansion, ice losses from the Antarctic Ice Sheet, and past ice mass losses.[161] Compounding that, the NPCC identified several additional factors that could have significant local impact. First, ocean circulation could slow down due to decreased North Atlantic salinity,[162] causing additional thermal expansion that would push water mass shoreward.[163] Second, as Arctic and Antarctic ice is lost, there is a reduction in its gravitational attraction, causing water to congregate farther from it.[164] Some of this gravitational weakening in the northern hemisphere may result in a lower-than-average local sea level rise.[165] However, the conclusion of the NPCC was that the "net effect of all these processes drives New York City sea level rise above the global average."[166]



Tide measurements taken at The Battery in Lower Manhattan demonstrate a long-term trend of local sea level rise, from 1850 to 2020. The New York City Panel on Climate Change noted that New York City's historic trend, which has increased measurably since 1990, has been nearly double the mean global rate.[167]

Given the local conditions identified by the NPCC, the use of New York City-specific data and projections, rather than global or national trends, is crucial for local planning. The work of the NPCC, and the projections that follow, have been a key influence on the development of the coastal resiliency strategies proposed in this section.

The NPCC calculated sea level rise projections[168] as estimated ranges of 10th, 25th, 75th and 90th percentile increases, relative to the sea level during a 2000–2004 base period.[169] In addition to

these projections, the NPCC's most recent report also evaluated the Antarctic Rapid Ice Melt (ARIM) scenario, which is an upper-end, but low-probability, projection based on advances in the understanding of ice sheet behavior. ARIM signifies an increase in long-term risk and so was not projected to fall outside the ranges of the NPCC's general projections until the 2080s.[170]

Sea level rise (relative to baseline)	Low estimate (10th percentile)	Middle range (25th–75th percentile)	High estimate (90th percentile)	ARIM
2020s	+2 in.	+4-8 in.	+10 in.	-
2050s	+8 in.	+11–21 in.	+30 in.	-
2080s	+13 in.	+18–39 in.	+58 in.	+81 in.
2100	+15 in.	+22–50 in.	+75 in.	+114 in.

Source: New York City Panel on Climate Change 2019 Report Chapter 3: Sea Level Rise, Table 3.1 and Table 3.2 (2019), available at: *https://nyaspubs.onlinelibrary.wiley.com/doi/10.1111/nyas.14006*

What If the ARIM Projection is Correct?

The NPCC has suggested that if climate change begins to follow the ARIM projections, then portions of the neighborhoods below might be permanently inundated with water by the 2080s if no coastal protections are put in place:

- Coney Island;
- Red Hook;
- Howard Beach;
- The Rockaway Peninsula;
- The east and west coasts of Staten Island;
- The Lower Manhattan waterfront; and
- The areas around Gowanus Canal, Newtown Creek, and Pelham Bay.[171]

The sea level rises projected above would have multiple impacts on both the natural and built environment of the city.

The impacts of sea level rise on the city's built environment would most directly appear through coastal storm flooding, regular tidal flooding, or land inundation. Under the ARIM scenario, which projects 114 inches (9.5 feet) of sea level rise, the permanent loss of land to inundation would occur by 2100 in some low-lying areas.[172] The more likely scenarios are the middle range projections (25th to 75th percentile) that, while projecting significantly less sea level rise than the ARIM scenario, still mean that the city could face monthly tidal flooding of some areas by the 2050s.[173]

Such tidal flooding already occurs in a few city neighborhoods such as Broad Channel, Hamilton Beach, and Howard Beach, among others.[174] Recorded data by NOAA from The Battery in Lower

Manhattan, shows 12 flood days in 2018, with a record high of 15 days in 2017.[175] NOAA projects that in the 2030s there will be 20-40 flood days, and by the 2050s there will be 50-135 flood days, annually for The Battery.[176] This means that, in the future, for over a third of the year Lower Manhattan might suffer tidal flooding. The projected impacts are citywide and will touch every borough and the majority of community districts, as detailed more fully in the Citywide Resiliency subtopic below.

For the city's natural environment, salt water can be harmful to freshwater-dependent life, and greater submergence and wave attenuation can erode both beaches and marshes.[177] As with other aspects of climate change, the reduction of natural features, such as beaches or salt marshes, which had previously functioned as protective barriers, could accelerate or exacerbate the impacts of future climate change-related events.[178]

New York City's Floodplain

Even in neighborhoods not at immediate risk for tidal flooding, the increased danger from coastal storm surges, as experienced during Superstorm Sandy, is a significant hazard as sea levels rise. The risk of coastal flooding is often described in terms of the 100-year and 500-year floodplains.[179] The 100-year floodplain, also known as the Special Flood Hazard Area (SFHA), denotes a 1% chance of flooding in that area in any given year.[180] Similarly, the 500-year floodplain, which is outside the SFHA but is not outside the risk of being flooded, denotes an area with a 0.2% chance of annual flooding.[181]

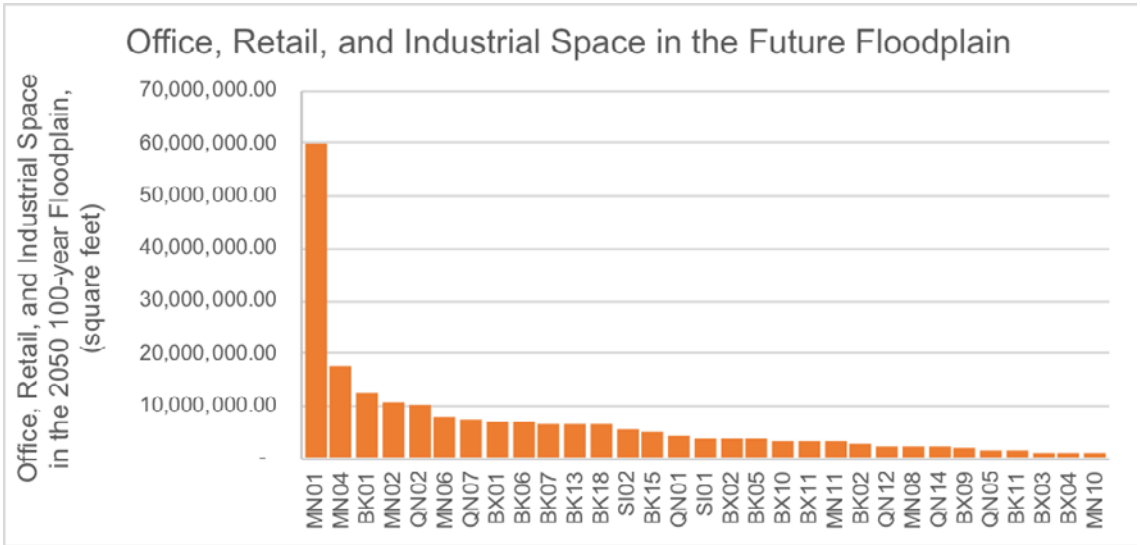
It should be emphasized that the term "100-year flood" does not mean that such a flood could only happen once during that time-period. Rather, it means the probability of a flood in that location in any given year. For example, the year after Superstorm Sandy and each year since, the 100-year floodplain has still had a 1% chance of another flood.

New York City has the largest population within the 100-year floodplain of any major American city,[182] and a significant portion of the city's major infrastructure is also within that floodplain.[183] Approximately 400,000 residents and 71,500 buildings (including 57,400 1-4 family residences) are in the floodplain.[184] LaGuardia Airport (LGA) is in the floodplain today, and Kennedy International Airport (JFK) is projected to be in the floodplain within a decade.[185] Over half of the city's electricity-generation capacity, 88% of our steam-generating capacity, 10% of our healthcare facilities, all of our wastewater treatment plants,[186] and a significant percentage of the Hunts Point Food Distribution Center, a key link in our city's food network, are within the 100-year floodplain as well.[187]

Critical Infrastructure in the Special Flood Hazard Area (SFHA)

Hunts Point, pictured here, contains critical facilities threatened by sea level rise—including the food distribution center and a wastewater treatment plant. A coastal protection system and energy resiliency strategy were proposed for Hunts Point during the Rebuild by Design competition. While the City's Economic Development Corporation has committed to following through on an energy resiliency project, no project for coastal protection has been advanced.[188] *Picture source: Google.*

Office, Retail, and Industrial Space in the Future Floodplain (by square feet per community district)[189]



A homeowner in the current 100-year floodplain with a typical (30-year) mortgage has a 26% chance of being flooded at least once during the life of that mortgage.[190] Sea level rise will only exacerbate these risks. Researchers affiliated with the National Aeronautics and Space Administration's (NASA) Goddard Institute for Space Studies, and several local universities, estimate that by the 2080s, today's 500-year flood might occur as often as every 100 years, and today's 100-year flood might occur as often as every 15 years.[191] A home located in an area where flooding could be expected every 15 years would have about an 87% chance of being inundated at least once over the life of an owner's mortgage.[192] This demonstrates the necessity of ensuring that the city's buildings are resilient both for today and in the future.

Buildings constructed in New York City are expected to have long useful lives. To provide just one example, construction of the David N. Dinkins Manhattan Municipal Building was completed in 1914, and it remains in active use today, over a century later.[193] Even smaller residential stock, such as brick row houses built circa 1930 and 1940 in southern Brooklyn—now within the 500-year floodplain—remain in use.[194] One analysis, based on Primary Land Use Tax Lot Output (PLUTO) data, put the median age of the city's multiple-dwelling residential buildings at almost 90 years old.[195] Based on historical trends, it is reasonable to expect that an average residential or commercial building constructed today, regardless of size, will be in useful operation by the 2080s, or even into the 2100s.

What is the Flood Risk for a Building that Lasts 90 Years?[196]

500-year floodplain: over 16% chance of being inundated at least once.

100-year floodplain: almost 60% chance of being inundated at least once.

15-year flood frequency: over 99.8% chance of being inundated at least once.

A building or any capital project that is designed, or site selected, without consideration of the entirety of its useful life is especially vulnerable to the impacts of climate change. As found firsthand in the aftermath of Superstorm Sandy by New York City's Build It Back program, it can be significantly more difficult to make an existing building resilient than to build a new building that is already resilient, particularly when elevation is required.[197] Efforts such as the Climate Resiliency Design Guidelines, prepared by the then-Mayor's Office of Recovery and Resiliency, have advanced this idea and seek to incorporate future climate projections as non-binding guidance into the City's planning and design processes.[198] The strategies in this section would advance those ideas further and cement them more directly into the City's operations.

Investing in Resiliency

The concept of coastal resilience is one of *preparedness*. It is as much about ensuring that people survive a flood event and that infrastructure remains intact, or immediately recovers after a flood event, as it is about preventing flood events in the first place. It is a recognition that both "hard" protections, such as sea walls and bulkheads, and "soft" (or "living shoreline") protections, such as wetlands,

dunes, beaches, oysters, and reefs, should be implemented where appropriate. But it is also a recognition that water is an ever-present fact in New York City, and reducing the potential of negative impacts, should flooding occur, can be as important as stopping it at the shore.

Investing in resilience can also be financially prudent. A study by the National Institute of Building Sciences' Multihazard Mitigation Council considered the cost-effectiveness of various hazard-specific mitigation approaches. Several of these were of particular relevance to New York City. One mitigation approach examined was requiring new construction to be built to higher elevations (the study considered the impact of elevating four feet above the requirement of the International Code Council's (ICC) 2015 standard of Building Flood Elevation (BFE) + 1 foot).[199] It estimated that if all new residences in the 100-year floodplain were built to BFE + 5 feet, then a potential benefit-cost ratio of 5:1 would be realized for every dollar spent on such elevation, with the greatest benefit-cost ratio generally found at BFE +2 feet or BFE + 3 feet.[200] For single-family dwellings in the coastal surge zone (designated V or VE by FEMA), the benefit-cost ratio for elevation increased to 7:1.[201] While these benefits would vary locally, they do speak to the general concept that resilience should be viewed as an investment.

The National Institute of Building Sciences' study also looked at the return on federal risk mitigation grants, including FEMA and U.S. Department of Housing and Urban Development (HUD) grants. Although hurricane surge was not studied, hurricane winds were, and a positive benefit-cost ratio was found for all such federal grants, with an average ratio of 7:1.[202] Considering the additional federal funding for resiliency projects that New York City would likely need, this study supports the idea that investing in resiliency can be cost-effective and ultimately saves money.

Snapshot of Current Major Coastal Resiliency Projects in NYC[203]

- **East Shore Seawall/Staten Island Levee Project:** Funded by the U.S. Army Corps of Engineers (USACE), New York State, and the City, with a projected cost of $615 million, this project will create a 5.3 mile embankment and elevated promenade with a boardwalk from Fort Wadsworth to Oakwood Beach, Staten Island, north of the Living Breakwaters project. It is currently in the planning phase, with the first contract for work set to be awarded by the end of 2020, and the project completed by 2025.
- **Tottenville Living Breakwaters:** Funded by HUD's Community Development Block Grant - Disaster Recovery Assistance program and New York State, with a projected cost of $74 million. The project area is in the waters of Raritan Bay from Wards Point to Butler Manor Woods and will consist of approximately 3,200 feet of near-shore breakwaters located between 790 and 1,800 feet from the shore. In-water construction is estimated to start in mid-2020.

Snapshot of Current Major Coastal Resiliency Projects in NYC[203]

- **East Rockaway Inlet to Rockaway Inlet and Jamaica Bay:** Funded by USACE, a Draft Report and Tentatively Selected Plan was released in August 2016 and included a storm barrier across Jamaica Bay inlet. The plan was revised with the storm barrier moved to the New York/New Jersey Harbor and Tributaries (NY/NJ-HAT) study. The recommended plan, which was approved on August 22, 2019, includes a beach fill with a reinforced dune; new and rehabilitated groins, berms, floodwalls, and bulkheads; and natural and nature-based features like living shorelines. Construction is set to begin in 2020.
- **East Side Coastal Resiliency** (originally part of the "Big U,"[204] which was a resiliency plan developed to protect Lower Manhattan): Funded by HUD and the City with a projected cost of $1.45 billion, this project is an integrated coastal protection system from Montgomery Street to East 25th Street that stretches 2.4 miles and will raise the East River Park with flood protection alignments close to the water's edge. Construction is expected to begin in spring 2020 and to be completed by 2025.
- **Lower Manhattan Climate Resiliency** (part of the "Big U"): This proposed $10 billion build-out of Lower Manhattan is expected to add approximately 500 feet of fill to include the Financial District and the South Street Seaport. It is currently in the planning stages. While funding sources are unknown, it will need to receive approximately $9.5 billion in federal funding to proceed.
- **Brooklyn Bridge-Montgomery Coastal Resilience** (part of the "Big U")**:** Funded by HUD and the City, with a projected cost of $200 million, this is a plan to install a combination of flood walls and deployable flip-up barriers to form a 10-foot shield and to elevate almost one mile of the East River Esplanade up to two feet. It is expected to break ground in 2021 and be operational in 2024.
- **Rockaway Beach Dune Project:** Funded by USACE and the City with a projected cost of $600 million, this project will consist of a reinforced dune and tapered groin field combined with a system of berms, floodwalls, and nature-based features over five miles of the Rockaway Boardwalk. Construction is set to begin in 2020.
- **Breezy Point Double Dune System:** Funded by HUD and FEMA at a cost of $58 million, this project will continue the existing dune line on the Atlantic side of Breezy Point. It is currently in the design phase.
- **Battery Park City Resiliency:** Funded by bonds issued by the Battery Park City Authority, with a projected cost of $134 million, this project will create an integrated and continuous flood barrier from The Battery to Chambers Street, around Battery Park City. Construction is set to begin in 2020, and is projected to be completed in 2023.

Snapshot of Current Major Coastal Resiliency Projects in NYC[205]

- **City Raised Shorelines Project:** Part of the City's $20 billion climate resiliency program, it will address the following neighborhoods—Old Howard Beach, Queens; Mott Basin, Queens; Norton Basin, Queens; Coney Island Creek, Brooklyn; Gowanus Canal, Brooklyn; Canarsie, Brooklyn; and East River Esplanade, Manhattan. All projects are expected to be completed by the end of 2020.
- **Red Hook Integrated Flood Protection System**: The Office of Emergency Management (OEM) installed interim measures—Hesco flood barriers and Tiger dams—at a cost of $1 million in 2017. The project is currently in the design phase and will include the area around the Atlantic Basin in Red Hook.
- **Sea Gate T-Groin:** Completed in June 2016 at a cost of $28 million, this USACE project was funded through the federal Disaster Relief Appropriations Act of 2013. Four T-groin structures, narrow extensions built out into the water perpendicular to the shore to reduce some types of beach erosion, were constructed west of 37th Street and 70,000 cubic yards of sand were added to Sea Gate Beach.

As an example of potential federal investments, the U.S. Army Corps of Engineers (USACE) began a multi-year New York/New Jersey Harbor and Tributaries (NY/NJ-HAT) study to assess regional risk of tidal flooding and to propose potential projects to remediate those risks. That study represented an important potential partnership with both federal and state actors to ensure regional resilience. However, in February 2020, four years into its planned six-year period, USACE suspended the study indefinitely.[206]

USACE was expected to release a feasibility report in 2020, but as part of an interim report released in 2019 USACE issued a series of proposals, including the construction of surge gates, floodwalls, levees, and several potential harbor barrier concepts.[207] USACE presented these proposals as a series of alternatives for future actions:

- Alternative 1 proposed a "no action alternative" in which no action would be taken as a result of the study. Under this alternative, USACE anticipated that the study area will continue to experience damages from coastal storms, and that the damages may increase as a result of more intense storm events."[208]
- Alternative 2 proposed a Sandy Hook to Breezy Point storm surge barrier, with a potential length of over 30 miles.[209]
- Alternative 3a proposed five storm surge barriers, one each at Arthur Kill, Throggs Neck, Pelham Bay, Verrazzano-Narrows, and Jamaica Bay, respectively.[210]
- Alternative 3b proposed eight storm surge barriers, one each at Arthur Kill, Gowanus, Kill Van Kull, Pelham Bay, Flushing Bay, Newtown Creek, Westchester Creek/Bronx River, and Jamaica Bay, respectively.[211]

- Alternative 4 proposed seven storm surge barriers, one each at Gowanus, Pelham Bay, Flushing Bay, Newtown Creek, Westchester Creek/Bronx River, Hackensack, and Jamaica Bay.[212]
- Alternative 5 proposed only shoreline-based measures, and as such was predicted to have no adverse impacts to geology and soils beyond the footprints of those measures. However, wetlands in those areas could be impacted.[213]

The USACE study, while extensive, had been criticized for certain limitations, including that the proposed barriers, whether storm surge barriers or shoreline barriers, did not sufficiently take future sea level rise into account.[214] Additionally, organizations concerned with the health of the Hudson River Estuary had raised concerns that the estuary ecosystems might be impacted by the construction of storm surge barriers, and that such impacts should be given greater consideration.[215] Additional conversations on how best to protect the city could have addressed those concerns. However, the suspension of the study intervened, and has been criticized for preventing further conversation or research.[216] It remains important to examine the entire shoreline of New York City for potential vulnerabilities and to put protective measures in place.

COASTAL RESILIENCY–GOALS AND STRATEGIES

Goal: Protect the City's Coastal Areas

KEY STRATEGY: DEVELOP A FIVE-BOROUGH COASTAL RESILIENCY PLAN TO PROTECT THE CITY

The City Council will consider legislation requiring the development of a five-borough coastal resiliency plan, to protect all vulnerable areas of the city against the effects of climate change. New York City has 520 miles of coastline and, while progress toward making the city more resilient since Superstorm Sandy has occurred, only a relatively small number of coastal protection projects are currently being designed and built. Most of these projects are in areas that were directly impacted by that storm. However, the next storm may not impact the same communities, and there has been no comprehensive study of the entire New York City coastline to prepare for that possibility. The City should commit to studying the entire coastline for existing and projected vulnerabilities. In doing so, the City should consider both "hard" and "soft" coastal storm protection projects that make all five boroughs more resilient in the face of coastal storms, sea level rise, and tidal flooding, as well as increased precipitation, which can exacerbate flooding.[217] These measures could include the introduction of oyster beds or natural wetlands to absorb wave action and flooding, as well as raised land or barriers where a natural project is not feasible.

The NY/NJ-HAT study focused on protections for the entire harbor, and one of its proposed alternatives centered on shoreline protections. However, at the time of its suspension, that study was only evaluating segments of the city's coastline for such protections. Additionally, as discussed below in the Citywide Resiliency subtopic, a majority of the city's waterfront community districts have measurable social vulnerabilities, and that combined physical and social vulnerability reinforces the idea that the entire shoreline should be considered. The plan proposed here would provide that broader scope.

The development of such a plan would be a multi-year process because of the number of communities facing climate risk, the importance of the study being grounded in the NPCC's climate change projections, the technical feasibility of implementation, and the critical role of community engagement. Consideration could be given to adopting a phased approach wherein the most vulnerable neighborhoods are engaged first, with successive deadlines to work with additional communities on localized plans to address vulnerabilities.

Strategy: Call on the Federal Government to Continue the U.S. Army Corps of Engineers' New York/New Jersey Harbor and Tributaries Study

As a city comprised of islands and low-lying neighborhoods, we are vulnerable to coastal storm surge, which is likely to intensify in strength and become more frequent as a result of climate change. Without the federal government as a partner, ambitious and necessary projects could not come to fruition. In January 2015, USACE found in its North Atlantic Coast Comprehensive Study that the New York/New Jersey harbor region was a high flood risk area in need of further study.[218] The resulting New York/New Jersey Harbor and Tributaries (NY/NJ-HAT) Coastal Storm Risk Management Feasibility Study began shortly thereafter. An interim report, released in February 2019, found that "[r]ecurring impacts from coastal flooding has resulted in significant economic, environmental, and community impacts in the NY/NJ-HAT study area."[219] The report proposed alternative solutions as a subject of continued study.[220]

In February 2020, USACE announced an indefinite postponement of the NY/NJ-HAT study's draft Integrated Feasibility Report and Environmental Impact Statement, both of which had been planned for release in late summer of 2020.[221] The reason provided was that the study did not receive federal funding and that therefore activities related to the study were "suspended until further notice."[222]

The protection of the harbor is vital to the lives of millions of New Yorkers, with any delay in the study's completion extending the vulnerability of the entire harbor. The City Council calls for the study to be funded and completed in a timely manner.

Strategy: Call on the Federal Government to Proactively Fund Planning and Construction of Coastal Resiliency Projects through FEMA and HUD

Major coastal storm protection projects should be funded with the help of the federal government. However, the federal government is generally reactive to disasters rather than a partner in planning. FEMA primarily funds disaster relief and/or recovery projects in

response to disasters and HUD requires specific Congressional allocations in response to disasters in order to fund projects. Yet, FEMA, as the administrator of the National Flood Insurance Program (NFIP), has a vested interest in proactively funding projects to protect against future risks, thus preventing potential future flood insurance claims. The federal government must be more proactive in supporting coastal storm protections, including by removing restrictions in the Stafford Disaster Relief and Emergency Assistance Act on providing pre-disaster mitigation funds.[223] Such funds could fill a gap by supporting resiliency projects smaller in scope than those managed by USACE but which nevertheless would protect vulnerable communities.

Strategy: Increase the Resiliency of New Construction

New York City has incorporated flood-resistant design standards into the Building Code, but in doing so relied on the Flood Insurance Rate Maps, which do not take into account anticipated sea level rise.[224] However, the NPCC's projections now reflect a greater understanding of the potential future sea level rise, and the Climate Resiliency Design Guidelines have recommended taking such sea level rise into account for the anticipated lifespan of a building. Therefore, the City Council will consider legislation to amend the Building Code to require a context-dependent additional one-to-two feet of freeboard beyond what was required after Superstorm Sandy—the technical term for the additional safety factor above the flood line above which finished floors and critical systems of buildings should be placed. This freeboard height was identified by the National Institute of Building Science as being the most cost-effective height (see discussion on "*Investing in Resiliency*," above, in the Coastal Resiliency background). It would also accommodate sea level rise projections, and provide additional safety and flood insurance savings for New Yorkers, while instituting a reasonable, uniform standard.

Strategy: Expand and Revitalize the FloodHelpNY Program

FloodHelpNY[225] is a partnership between the Mayor's Office of Resiliency, the Governor's Office of Storm Recovery (GOSR), and the Center for NYC Neighborhoods to help homeowners affordably protect themselves from future flood risks. Its goal is to connect homeowners with resiliency experts such as engineers, surveyors, and counselors to provide resiliency audits and advice on how to lower their risk and flood insurance premiums. Eligible homeowners may also receive elevation certificates, which can potentially be used to lower flood insurance premiums. Unfortunately, this program has been funded using federal funds (distributed through GOSR) that will soon expire. Moreover, since it is a pilot program, only a limited number of neighborhoods were eligible to participate.[226] The Special Flood Hazard Area (SFHA), which is the 100-year floodplain, includes neighborhoods in each borough that are not currently eligible. This program should be continued using City funding if necessary, and expanded to make any home in the SFHA eligible to apply, with sufficient funding to provide services to more families across those vulnerable areas.

Strategy: Call for the Creation of a Tri-State Regional Commission and Adaptation Trust Fund for NY, NJ, and CT

Flooding from rising sea levels and tides is a regional problem that should be managed accordingly. New York, New Jersey, and Connecticut should create a regional commission to coordinate coastal planning, protection, mobilization of resources, and development of common standards for region-wide resiliency projects. The Regional Plan Association notes there is poor inter-governmental coordination between the three states.[227] Without a coordinated effort, addressing issues like ecological restoration and water management will be challenging. A Regional Resilience Commission could: 1) have an adaptation trust fund as a dedicated source of funding[228] to invest in coastal resiliency projects for the region; 2) have the legal authority to designate areas for resiliency efforts; and 3) have a coordinated plan regarding how to manage rising sea levels and tides for the tri-state area.

COOL NEW YORK – PROTECTING THE PUBLIC HEALTH BY MITIGATING & ADAPTING TO RISING TEMPERATURES

Extreme heat can be deadly. It results in more deaths annually than extreme cold or any other type of extreme weather event.[229] Older adults and persons with certain health conditions are particularly vulnerable to an extreme heat event, but the availability of adequate cooling is important for every New Yorker.[230]

Quantifying heat-related deaths is difficult, and there is some variation in numbers among sources because—aside from heat stroke—high heat is more often a contributing, rather than direct, cause of mortality.[231] However, even with these limitations, it is clear that there are significant impacts on health and mortality from extreme heat.

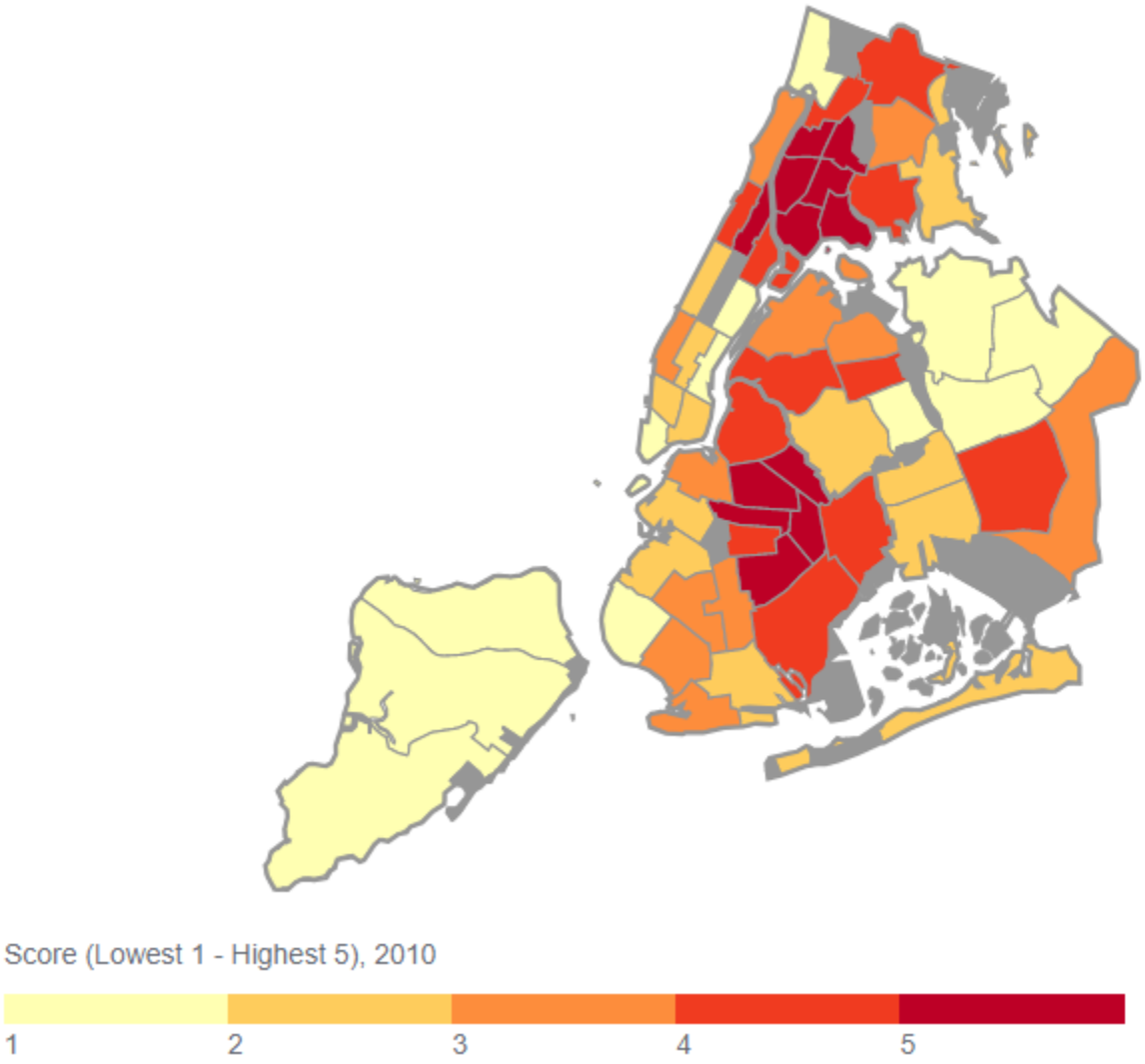
The most direct cause of heat-related death is heat stroke, the term for the life-threatening form of hyperthermia, which is a condition that occurs when the body's core temperature reaches or exceeds approximately 104°F.[232] Not every form of hyperthermia is deadly, and a person may pass through earlier stages before reaching a life-threatening condition, but in its most extreme form of heat stroke, the body is no longer able to control its temperature.[233] Consequently, organs of the body, and particularly the brain, begin to shut down.[234] Even if a person survives, permanent damage is possible.[235] While heat stroke may be popularly associated with athletes and strenuous exercise, in reality passive exposure to a hot, humid environment can be sufficient to cause heat stroke in any person.[236]

According to a commonly-cited number, New York City averages about 13 heat stroke fatalities per year, most likely based on an average of the years 2000-2011.[237] However, that number varies widely for individual years, with 45% of the heat stroke deaths occurring in heat waves that occurred in 2006 and 2011. [238] The 2006 heat wave lasted for 10 days, three of which exceeded heat indices of 100°F, while the 2011 heat wave lasted for four days, and peaked at a heat index of 110°F.[239]

The majority of heat-related deaths in the city are likely not direct and are instead instances where heat was a contributing factor in individuals with an underlying condition.[240] Such instances are more difficult to determine conclusively, as it may be difficult to distinguish in individual cases whether a deceased person's underlying chronic condition was exacerbated by extreme heat. Accordingly, statistical models are sometimes used to try to find the number of "excess deaths"—which is "the number of deaths due to natural causes above the number expected for the time of year."[241] Between 1997 and 2013, the Department of Health and Mental Hygiene (DOHMH) estimated an annual average of 94 excess deaths associated with extreme heat events; for 2013 another DOHMH estimate found 140 such excess deaths.[242] These numbers are estimates and the actual number of heat-related deaths may be higher,[243] however, they provide a sense of scope, particularly relative to the number of heat stroke deaths.

Additionally, heat-related deaths are not distributed evenly among the city's population. In the period from 2000 to 2012, Black people were disproportionately represented among those impacted, making up almost half of all heat-related deaths.[244] It is possible that poverty also plays a role in contributing to heat-related deaths. In 2013, in only 12% of the heat-related deaths was the person known to have an air conditioner (41% did not have an air conditioner and for 47% it was unknown), while 59% could not be confirmed to have a fan.[245]

Department of Health and Mental Hygiene (DOHMH) Heat Vulnerability Index Map



Heat vulnerability summarized at the community district level, with a score range from 1 (lowest risk) to 5 (highest risk). Based on an index developed between DOHMH and Columbia University that took into account temperature data along with topographical, demographic, and social factors.[246] Note that the lowest risk score does not mean that there is no risk.

A study by researchers at the University of Bristol found that increasing global temperatures could lead to thousands more heat-related deaths in the city,[247] and that as many as 2,716 heat-related deaths could be prevented from heat events that could be expected to occur once every 30 years if the global temperature increase is kept to 1.5° C instead of 3° C.[248] Similarly, a peer-reviewed study published in *Environmental Health Perspectives* found that, on our current course, as many as 3,331 New York City residents may succumb to heat-related deaths annually by 2080.[249] However, the Centers for Disease Control (CDC) describes all heat-related deaths as preventable, if proper cooling measures are taken in time.[250] The need for such cooling measures will grow as temperatures increase.

In fact, the average daily maximum summer temperature in New York City has been increasing since 1900.[251] The NPCC has projected that heat waves—defined by the National Weather Service as three or more days of temperatures at or above 90˚ C—are going to be longer, hotter, and more frequent, particularly where exacerbated by the urban heat island phenomenon.[252]

What is an Urban Heat Island?

As described by the U.S. Environmental Protection Agency (EPA), the term "urban heat island" refers to the elevated temperatures in urban and suburban areas as compared to rural areas.[253] The warming is an example of local climate change, caused by the thermal properties of development and the impact of buildings. Certain infrastructure can be put in place to ameliorate urban heat islands, including vegetation, shade structures, permeable surfaces, and cool roofs.[254]

According to the EPA: "On a hot, sunny summer day, the sun can heat dry, exposed urban surfaces, such as roofs and pavement, to temperatures 50–90°F (27-50°C) hotter than the air, while shaded or moist surfaces… remain close to air temperatures. Surface urban heat islands are typically present day and night, but tend to be strongest during the day when the sun is shining. In contrast, atmospheric urban heat islands are often weak during the late morning and throughout the day and become more pronounced after sunset due to the slow release of heat from urban infrastructure. The annual mean air temperature of a city with 1 million people or more can be 1.8-5.4°F (1-3°C) warmer than its surroundings. On a clear, calm night, however, the temperature difference can be as much as 22°F (12°C)."[255]

The NPCC's middle-range projection for the 2020s is for 2 to 4 heat waves per year, lasting 4 to 6 days each, with an average temperature of 92.5°F to 94.5°F.[256] By the 2080s the NPCC's middle-range projection is for 3 to 5 heat waves per year, lasting 6 to 15 days each, with an average temperature of 94.2°F to 97.1°F.[257] For its highest end projection for the 2080s, NPCC projects as many as 75 days per year above 90°F, and 27 days above 100°F.[258]

COOL NEW YORK – PROTECTING THE PUBLIC HEALTH BY MITIGATING & ADAPTING TO RISING TEMPERATURES - GOALS AND STRATEGIES

Goal: Achieve Cooling Equity and Reduce Heat-Related Deaths

Strategy: Develop a Comprehensive Cooling and Public Communication Plan

In light of the serious health risks associated with heat exposure, the City should be doing as much as possible to provide New Yorkers with information and methods to stay cool. While there are public cooling centers available during extreme heat events, there is concern that the Office of Emergency Management (OEM) provides insufficient advance notice of the locations of such cooling centers prior to a heat event, and does not establish permanent cooling centers.[259] Furthermore, while it is recognized that it is important to maintain minimum temperatures during the winter months, there has not been a similar focus on habitability during extreme heat events, particularly for vulnerable populations. In addition, it is important to address overcooling, which wastes energy and taxes the grid.

The City Council will consider legislation requiring the City to establish a comprehensive plan to ensure that the cooling needs of residents are met on high heat days. This plan could include requiring the Department of Health and Mental Hygiene (DOHMH), along with OEM, to identify and adopt best practices for providing residents with information regarding the dangers of heat exposure, and sufficient advance notice of the locations and availability of cooling centers. It could also include requiring the Office of Long Term Planning and Sustainability and DOHMH to develop measures to prevent large office buildings from overcooling in summer months and straining the grid, which can cause power outages. The City has previously done this for individual cases of heat emergencies, but should consider proactive measures in the face of rising temperatures.

KEY STRATEGY: INCREASE COOLING ASSISTANCE FOR VULNERABLE POPULATIONS

A primary reason New Yorkers cite for not owning or using air conditioning is cost.[260] The Low Income Home Energy Assistance Program (LIHEAP) is a federally-funded grant program administered by the State and the City to assist with costs associated with heating and cooling. However, availability of cooling assistance is currently limited, and can only be used to purchase an air conditioning unit or fan for a unit where an individual meets certain income qualifications, and has a documented medical condition that is exacerbated by heat, among other requirements.[261] Further, this assistance is not available to subsidize any utility costs associated with an air conditioning unit or a fan.[262]

To make cooling more accessible to the most heat-vulnerable New Yorkers, the State should: (i) supplement LIHEAP funding; and (ii) make a greater percentage of LIHEAP funding available for cooling, including for assistance with utility costs associated with cooling. Furthermore,

the City could provide funds to supplement the LIHEAP allocation so that vulnerable residents have access to cooling. This could include people with serious health conditions, people with disabilities, seniors, and New York City Housing Authority (NYCHA) residents, who are among the City's most heat-vulnerable. The Human Resources Administration (HRA) administers the funds allocated by the federal LIHEAP program, and the agency's existing infrastructure could be used to administer any additional funds.

Strategy: Ensure Building-Specific Cooling Centers for Vulnerable Populations

Any plan to keep all New Yorkers cool should provide pathways for vulnerable residents of City-owned or contracted buildings to escape high temperatures. To that end, the City should work to ensure that cooling centers are available in buildings that house vulnerable populations and are owned by the City or operated by City-contracted organizations. This could include adult care and assisted-living facilities, supportive housing, shelters, and detention centers. At a minimum, this could include cooling in an area large enough to serve all vulnerable residents, which has not been consistently provided in many of these spaces.[263]

Strategy: Better Measure Heat-Related Deaths

Although the City has identified heat-vulnerable areas and tracks some instances of heat-related health complications, more robust data is imperative to ensure that the City has an effective approach to addressing heat-related deaths and illnesses. Currently, DOHMH publishes data regarding heat-related deaths on its Environmental Health Portal, but the metric used is under-inclusive, leaving out deaths caused by conditions exacerbated by heat exposure.[264] Further, this portal has not been updated since 2017. Additionally, the City's Heat Vulnerability Index, which identifies the most at-risk neighborhoods during extreme heat, has not been updated since 2010 and has a low spatial resolution, only providing information at the community district level.[265] The City Council will consider legislation requiring DOHMH to re-evaluate its metrics to ensure that all heat-related deaths are appropriately counted. The legislation could also require regular public reporting and updates in aggregate form, as well as more granular data to assist in better targeting resources to reduce heat-related deaths and illnesses.

Goal: Cool the Public Realm

Strategy: Increase the Use of Cool Roofs

Expand Cool Roof Requirements

The City Council will consider legislation expanding reflectivity or "cool roof" requirements to reduce the urban heat island effect. More cool roofs will lower the amount of heat absorbed by the roofs of buildings, helping the roof structure to last longer while also reducing the indoor temperature and the amount of energy used to cool a building. Legislation could broaden the applicability of the current law and narrow the existing exceptions. Specifically, pursuant to Local Law 21 of 2011, new buildings and existing buildings, where a roof covering has been altered or replaced, must comply with the Building Code's reflectivity (i.e., cool roof) requirements.[266] This could be expanded to extend roof reflectance requirements to buildings where other exterior

work is occurring. Furthermore, the current law includes surface area exceptions that could be reduced or eliminated. For example, the current law does not apply to existing buildings where the area of the roof being recovered or replaced is less than 50% of the roof area and less than 500 square feet. Existing exemptions could also be narrowed for roof materials made of glass, metal, clay, concrete tile, plastic, or rubber, as many of these materials can be developed to incorporate levels of reflectance with a cooling effect.

Expand the Cool Roof No-Cost Installation Program

During the Bloomberg administration the City established the NYC CoolRoofs program, which provides select buildings with cool roof installations at no cost or low cost, with priority given to not-for-profits and affordable housing.[267] The City should fund an expansion of the program to include more roof types and capture more homes in heat vulnerable and EJ communities by: (i) including pitched roofs (currently the program seems to be limited to roofs that are "flat" even though Local Law 94 of 2019 established reflectance requirements for roofs with a pitch over 17%); (ii) expanding beyond roofs in good condition to include those where the City could provide the additional service of remediating simple blisters, cracks, or peeling paint at no cost or low cost prior to applying the cooling coating; and (iii) ensuring that the program is available for roofs constructed from the full range of materials to which the cool roof coating can be applied (bitumen, EDPM rubber, and smooth aluminum have been mentioned as acceptable materials, but the full range of practicable materials is unclear). Additionally, the Department of Buildings could be required to document the presence, or lack thereof, of a cool roof whenever conducting an inspection of such roof, and if present, the materials used should be documented as well. Tracking cool roofs will help the City target resources, enforce existing requirements, and measure the effectiveness of this program in reducing the heat island effect.

Strategy: Use Public Shade Structures

The planting of street trees and other greenery in public spaces is one of the most effective ways to combat the urban heat island effect, by providing shade as well as evaporative cooling. However, once planted, trees may take decades to grow before providing the most benefit, and some sites are unsuitable for street trees or plants due to space constraints, soil conditions, underground utilities, or other limitations. Where underground planting is not feasible, the City could provide shade on sidewalks or pedestrian plazas using awnings or other structures. Cities in the Mediterranean region have used awning-like structures to provide shade in public places for thousands of years.[268] New York City could use the provision of public shade as an opportunity to create a signature piece of design in the public realm. The City should use shade structures at a variety of different scales in our public plazas and parks, and on streets, where tree cover is not feasible.

GREENSCAPING AND SUSTAINABLE SURFACES

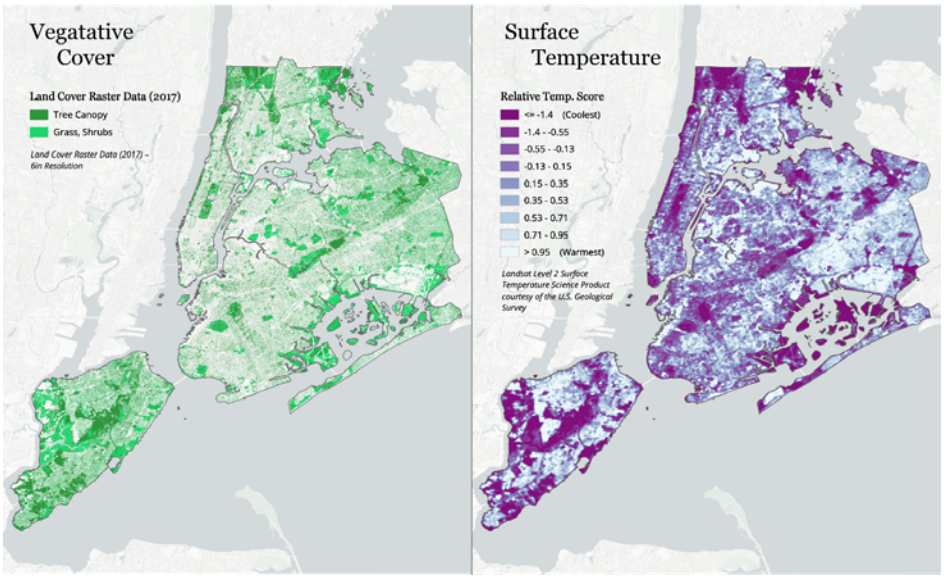
Greenscaping and Tree Canopy

Improving the landscape and streetscape of New York City through the building of green infrastructure is an important part of a sustainable future. Typical green infrastructure such as trees and soil provide a vast array of sustainability benefits, including stormwater runoff management,[269] the reduction of the urban heat island effect through shading and evapotranspiration,[270] noise mitigation,[271] air purification through the uptake of CO_2, and removal of fine particulate matter from the air.

Tree canopy cover also provides physical and psychological benefits to human health. Proximity to trees improves mental and physical well-being; reduces morbidity and mortality in urban residents (likely due to trees providing psychological relaxation and stress alleviation); stimulates social cohesion; and supports physical activity.[272] A person's proximity to trees has also been linked to reductions in childhood obesity rates; decreased cognitive fatigue; improved worker attitudes on the job; reduced stress; and reductions in feelings of anger, depression, and anxiety.[273] Furthermore, trees are extremely effective at carbon absorption and sequestration, with some environmental scientists asserting that planting one trillion trees would be sufficient to draw down approximately one decade-worth of anthropogenic carbon emissions.[274]

Because tree canopy cover provides a multitude of environmental benefits, ensuring that tree canopies are distributed evenly is an EJ concern.[275] In New York City, industrial and low-income areas often have the lowest percentages of canopy cover.[276] A more equitable distribution of trees, as well as a general increase in overall tree cover across the city, can help to mitigate the harmful health effects of urban living that are often compounded in these areas.[277]

Vegetative Cover as Compared to Surface Temperature



In the Vegetative Cover map the darker colors indicate greater vegetative cover (whether tree or grass), while in the Surface Temperature map the darker colors indicate cooler temperatures, as measured by a Landsat satellite. A correlation can be observed between the darker colors in both maps.[278]

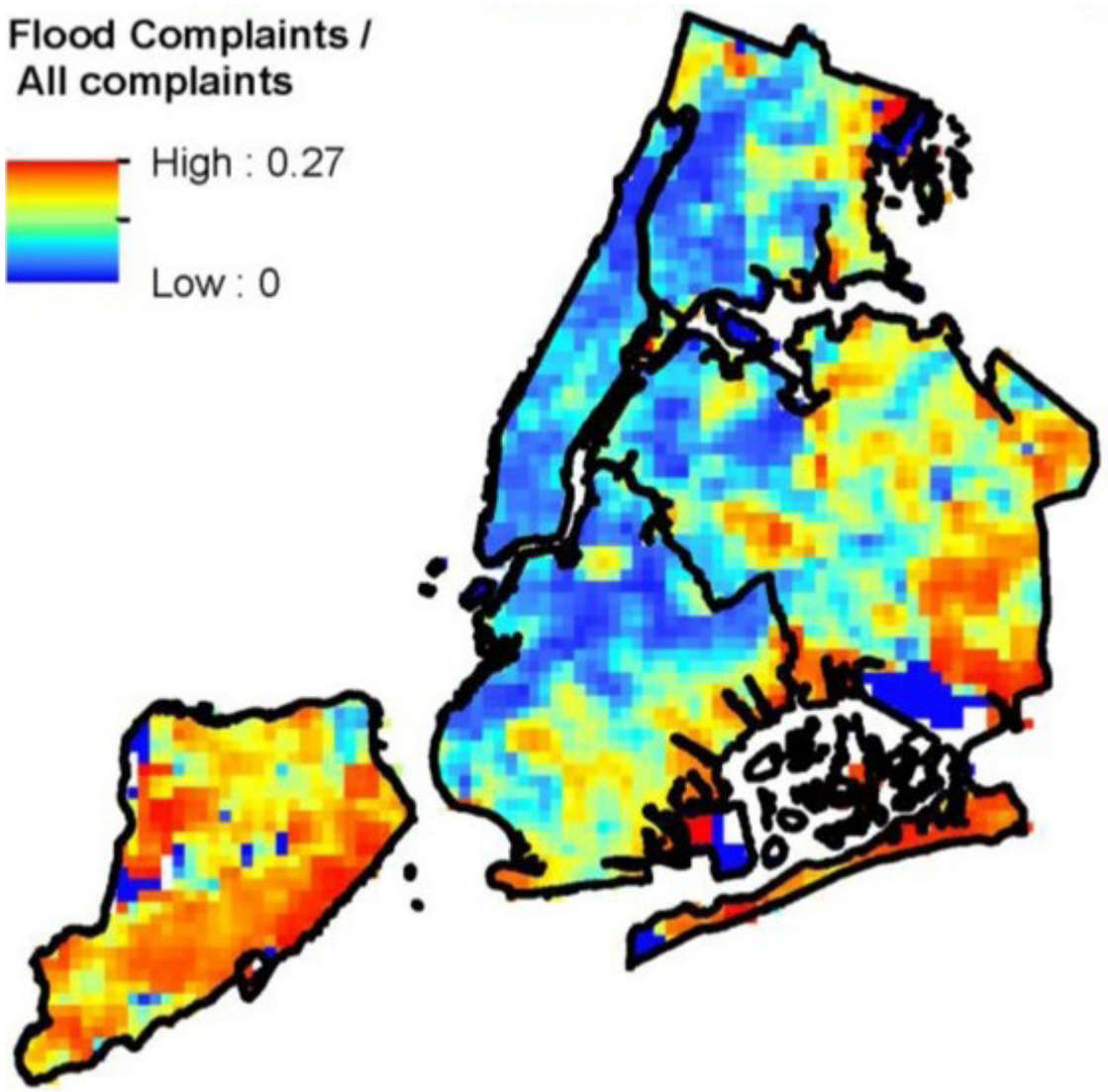
The relationship between ambient air temperature and canopy cover is well-established by science.[279] In New York City, the neighborhoods with the highest ambient heat levels correlate with the neighborhoods with the lowest amount of canopy cover, while the areas with the highest levels of canopy cover show up as significantly cooler in satellite images (see maps above in "Vegetative Cover as Compared to Surface Temperature").

Urban heat islands develop from the replacement of vegetation with asphalt and concrete, which absorb, rather than reflect heat. Urban heat islands can increase energy demand, air conditioning costs, air pollution, GHG emissions, and heat-related illnesses and deaths.[280] Increasing the amount of green infrastructure in New York City would reduce the urban heat island effect. Vegetation absorbs the energy from sunlight without re-emitting it as heat. As a result, surface and air temperatures remain cooler, reinforcing the cooling effect of water evaporating from leaves, flowers and stems.[281] Reducing the urban heat island effect by increasing green infrastructure will provide a multitude of environmental and health benefits.

New York City's interactive tree map tries to quantify the benefits of an important form of green infrastructure—trees. It includes statistics for stormwater retention, carbon sequestration, and the amount of airborne pollutants removed, on a per-tree basis for all mapped street trees in the city.[282] According to the Department of Parks and Recreation (DPR), New York City's trees intercept over a billion gallons of stormwater, reduce over 600,000 tons of carbon dioxide, and remove 635 tons of air pollutants from the atmosphere annually.[283]

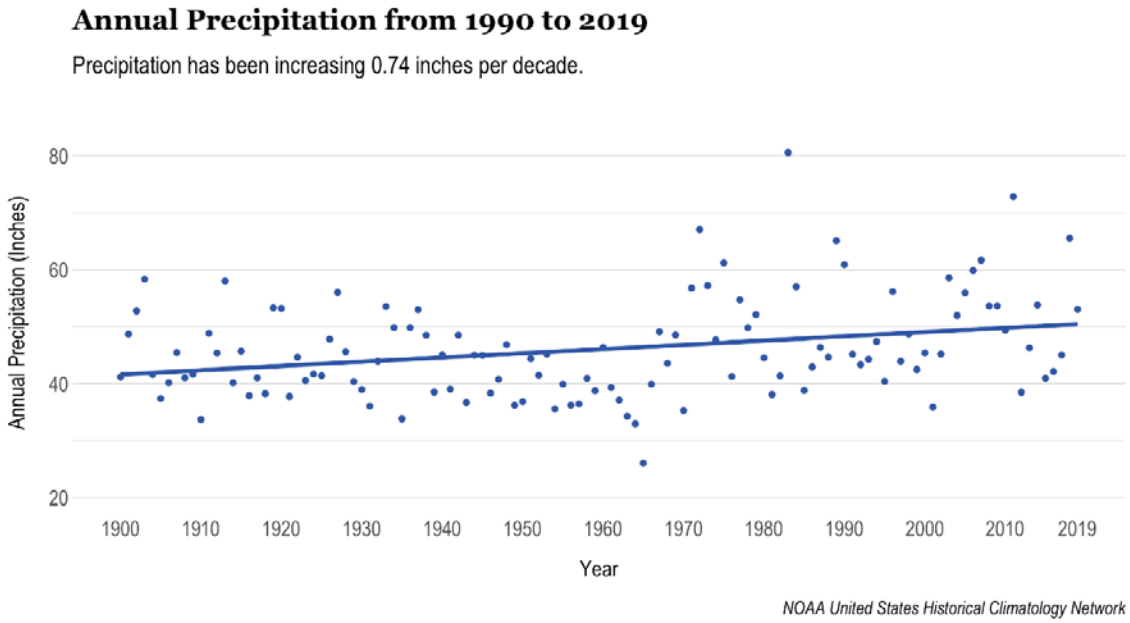
Climate Change and Downpour Flooding Risks
Sea level rise and coastal storm floods are not the only processes through which parts of New York City can become inundated. Even today, videos abound online of New York City streets and subway stations flooding as a result of downpours.[284] Localized flooding already regularly occurs during rainfalls in which the local stormwater management system becomes overwhelmed, or poorly-maintained systems become clogged.[285] There are neighborhoods where residents report that street flooding from downpour water alone has become "a new normal" after any rainstorm.[286]

311 Street Flooding Complaints 2004 – 2015



The New York City Panel on Climate Change studied 311 call data from 2004 to 2015, adjusted it for potential bias, and found higher volumes of street flooding complaints in several areas of the city. A number of causal factors were discussed, two of which were local rainfall patterns differing and the type of sewer system present. The areas in Brooklyn and Queens with the greatest number of complaints were largely in the municipal separate sewer system (MS4), discussed below.[287]

In fact, this experience and perception of New Yorkers comports with the climate data that has been collected. Annual precipitation has increased in New York City by approximately nine inches since the year 1900 (see chart on "Annual Precipitation from 1990 to 2019"), with the year-to-year variability increasing significantly since 1957—making the wettest years during the second-half of the 20th century significantly wetter than any from the first-half of the 20th century.[288]



As depicted by the chart "Annual Precipitation from 1990 to 2019," precipitation can be highly variable, and so statistically significant statements on extreme precipitation events can be difficult to make. As such, in 2015 the NPCC observed that there has been a "small but not statistically significant trend toward more extreme precipitation events in New York City since 1900."[289] Additionally, while the NPCC has cautioned that it is not possible to attribute any individual extreme weather event to climate change, some large-scale trends can be attributed to anthropogenic climate change, and those trends can exacerbate the impacts of extreme weather events when they occur.[290] For example, researchers have observed a connection between temperature and downpours, such that "a warmer atmosphere… is likely to increase rates of heavy downpours with climate change."[291] As a result, the NPCC stated in its 2015 report that downpours "are very likely to increase in frequency and intensity."[292]

In 2019, the NPCC reaffirmed its earlier analysis and projections that, at the high estimate, the number of annual heavy rainfall days may increase by the 2080s from 13 to 18 days of at least one inch, from three to five days of two or more inches, and from 0.3 to 0.7 days of four or more inches of rainfall.[293]

The NPCC also noted that the rainfall that causes urban flooding in our region is "typically temporally and spatially concentrated and is most often caused by thunderstorms."[294] This is an important point because the city covers a large geographic area, and our main weather stations are far apart, so rainfall measurements are necessarily more limited in geographic coverage (the most often relied upon being in Central Park). In fact, the NPCC directly connected this limitation in coverage

to planning concepts, saying that "when using rainfall projections for design purposes such as in the New York City Climate Resiliency Design Guidelines… it is important to recognize that smaller areas can experience higher rainfall rates than larger areas."[295]

When planning for neighborhoods with a measured, or even simply apparent, greater instance of flooding—such as the areas identified in the map on "311 Street Flooding Complaints 2004 – 2015," above—both public and private actors should not rely on generalized city rainfall rates alone. Instead, consideration should be given to the local experience and factors such as the area's permeability, or how well a material allows water to pass through. The NPCC noted that the effects of impervious surfaces, through which water cannot penetrate, "are likely to have larger impacts on the frequency and intensity of flash floods than does climate change."[296] In analyzing 311 data, the NPCC found that additional factors to consider when determining an area's risk of localized flooding include proximity to the coast and the type of sewer system, whether combined or separate, as discussed below.[297] Further factors were identified in the New York City 2019 Hazard Mitigation Plan, such as irregular topography, soil infiltration rate, and soil storage capacity.[298]

Factors such as sewer coverage, including the presence of catch basins or drains, or the percentage of a neighborhood's land area that is impervious, are largely under the City's control. In planning both public stormwater management infrastructure and private development, these factors should be given serious consideration.

New York City's Stormwater System

New York City has two types of sewer systems. Approximately 60% of the city is covered by a combined sewer system, where sewage and stormwater are mixed and conveyed through the same pipe, and approximately 40% of the city is covered by a separate sewer system, in which sewage and stormwater are conveyed through separate pipes.[299]

In a combined sewer system, both the runoff and sewage flow through the pipe to one of New York City's wastewater treatment plants, where pollutants are removed from the water before it is returned to our local waterways.[300] However, during a heavy downpour, the combined flow of stormwater and sewage may increase beyond the capacity of a wastewater treatment plant. In such cases, the untreated combined flow is discharged directly into a nearby waterway, which is known as a combined sewer overflow (CSO).[301] In a municipal separate storm sewer system (MS4), during a downpour, the storm sewers send runoff directly into local waterways and therefore present no additional volume burden on the wastewater treatment plants.[302] However, while MS4 areas do not create CSOs, they also do not treat the stormwater and so pollutants such as oils, chemicals, and sediments picked up from the street are carried along and discharged into the waterway.[303] These distinctions are important to understanding the actions the City has taken and the work that still must be done to protect our neighborhoods.

To manage these stormwater flows, the City uses a mix of "gray" and "green" infrastructure. Gray infrastructure refers to "traditional infrastructure such as sewers, tunnels, and wastewater treatment plants," which are used to store water pending its eventual treatment.[304] Green

infrastructure, which includes green roofs, rain gardens, permeable pavement, and subsurface detention systems, "slows down, absorbs, and filters stormwater runoff before it can enter the sewer system or local waterbodies."[305]

New York City and the Clean Water Act
The federal Clean Water Act regulates the discharge of pollutants in waterways within the United States and establishes water quality standards.[306] To meet its obligations under the Clean Water Act and applicable New York State laws, New York City has entered into a series of agreements with the New York State Department of Environmental Conservation (DEC).

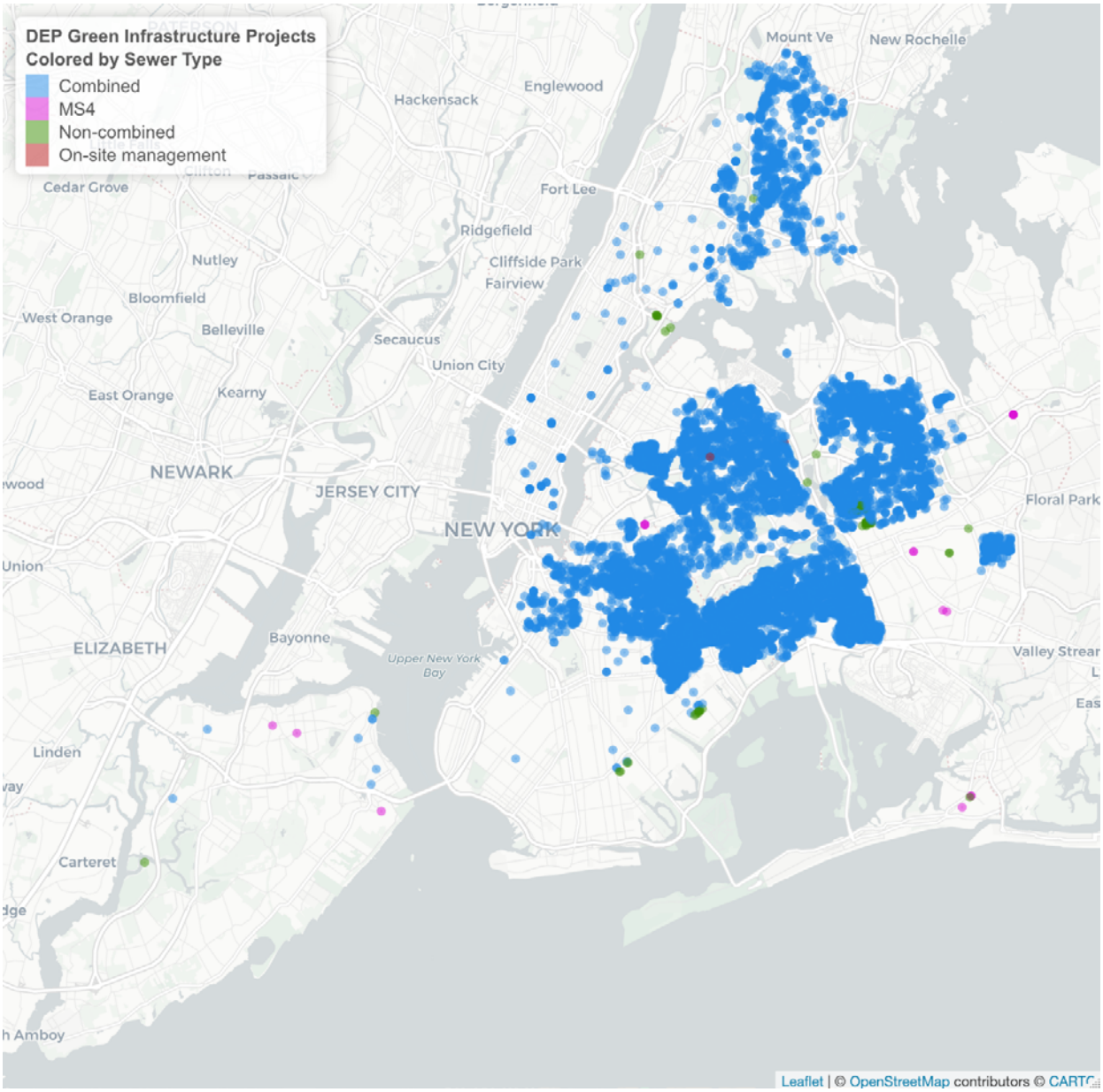
For the CSO area, the first administrative consent order between the Department of Environmental Protection (DEP) and DEC was agreed to in 1992.[307] Since then, there have been several updates and modifications, with the most recent in 2018.[308] Among the most significant are the 2005 and 2012 orders.

The 2005 order required the construction and improvement of gray infrastructure—combined sewer related facilities, including retention facilities, outfall and sewer improvements, separate sewers, pumping stations, and related infrastructure—as well as the development of Long-Term Control Plans.[309]

Under the 2012 order, gray infrastructure projects that were deemed to be the least cost-effective were replaced with more cost-effective gray infrastructure alternatives.[310] Additionally, a 20-year commitment to green infrastructure was made by incorporating elements of the 2010 New York City Green Infrastructure Plan.[311] The order described green infrastructure as "green roofs, trees and tree boxes, blue roofs, permeable pavement, rain barrels and cisterns, rain gardens, vegetated swales, picket wetlands, infiltration planters, and vegetated sidewalk swales and median strips."[312] A series of benchmarks for green infrastructure construction was established. New York City committed to controlling the equivalent of stormwater generated by one inch of precipitation on 1.5% of the impervious surfaces citywide in combined sewer areas by December 31, 2015; a total of 4% by December 31, 2020; a total of 7% by December 31, 2025; and a cumulative total of 10% by December 31, 2030.[313] The 2030 goal of 10% of the impervious surface of the combined sewer area would be 7,875 acres.[314] According to DEP's 2018 annual report, it greened 591 acres from 2010-2018.[315]

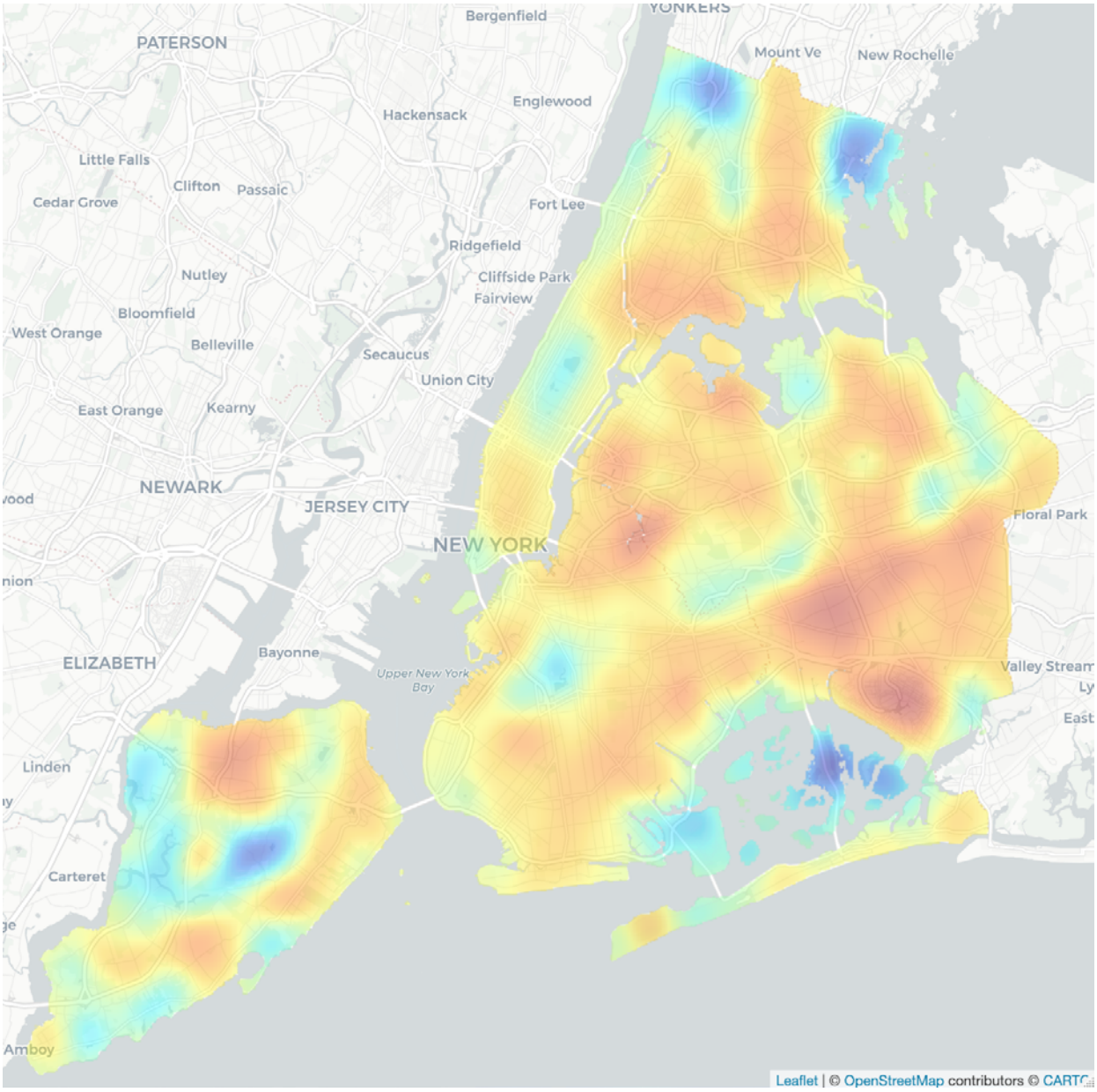
For the MS4 area, New York City received its first MS4 permit from DEC in 2015, which expanded the City's obligations to reduce pollutant discharges.[316] As part of that permit, a Stormwater Management Program Plan was submitted, as well as implementation and progress reports.[317] While management of stormwater in the MS4 area is often discussed using volumetric terms such as million gallons, the goal under federal law is to "reduce the discharge of pollutants to the maximum extent practicable."[318] If that reduction could be achieved by controlling pollutants at their source so that they never enter a storm sewer, rather than by a volume reduction alone, then it would be consistent with the permit.[319] However, the difficulty of complete source control means that some level of volume reduction is also necessary. In the CSO area, the use of green infrastructure is currently helping to reduce volume, as described above, but an equivalent green infrastructure goal has not been established for the MS4 area and similar measures have not been put in place.

Current and Planned Green Infrastructure Projects (by Sewer Type)



This map of Department of Environmental Protection (DEP) green infrastructure projects demonstrates that almost all of the projects are being built in the CSO area (blue dots). Only a handful of projects are in the MS4 area (light purple dots). For example, the area bounded by the Van Wyck Expressway, Grand Central Parkway, and Kennedy Airport in Southeast Queens is almost entirely in the MS4 area; it is almost entirely without green infrastructure projects. In addition to comparison with the adjacent Temperature Variation map, this map should also be compared with the "311 Street Flooding Complaints 2004 – 2015" map, above, between which it can be seen that some areas of the city with the most flooding complaints, such as southeast Queens, are not receiving green infrastructure. Source: NYC Open Data Portal, "DEP Green Infrastructure"

Temperature Variation Across New York City



This map of temperature variation across the city shows the generally hotter and cooler areas of the City. It is presented here for purposes of comparison with the adjacent 'Green Infrastructure Projects' map, particularly for the area of southeast Queens. That area, along with neighboring southwestern Queens, has some of the hottest relative temperatures in the city, but green infrastructure, and its potential cooling benefits, is not being introduced equally across the area.

GREENSCAPING AND SUSTAINABLE SURFACES – GOALS AND STRATEGIES

Goal: Increase Green Infrastructure Throughout New York City

KEY STRATEGY: EXPAND GREEN INFRASTRUCTURE IN THE MS4 AREA TO REDUCE FLOODING

The City is currently investing in green infrastructure in the CSO area, but has not been making the same investment in the municipal separate storm sewer system (MS4) area. Green infrastructure in the MS4 area would help with stormwater volume reduction and prevent pollutants from reaching nearby waterways,[320] in addition to providing needed cooling, air quality improvements, and local stormwater management. This is particularly important to neighborhoods such as those in southeast Queens, that have suffered from local flooding problems and that are in a consistently hotter region of the City, but which have received few green infrastructure projects. The current and planned green infrastructure projects in southeast Queens, as shown above, currently stop at the Van Wyck Expressway, with few projects east of that area. In order to make more neighborhoods resilient in the face of increasing precipitation and other climate change impacts, the City should expand the use of green infrastructure in the MS4 area. Such expansion should be in addition to the current CSO green infrastructure program, so that all neighborhoods can enjoy the benefits of infrastructure such as green roofs, rain gardens, bioswales, vegetation, permeable surfaces, and similar investments.

Strategy: Fill Tree Pits Throughout New York City

Despite a 2008 Zoning Text Amendment requiring street tree planting in all zoning districts and a planting strip between the sidewalk and the curb in lower-density areas,[321] there remain unfilled tree pits throughout the five boroughs. And the City's tree canopy is not evenly distributed, with industrial and low-income areas often having the lowest percentages of tree canopy cover (see discussion on "*Greenscaping and Tree Canopy*," above, in the Greenscaping background). Yet, trees can reduce stormwater volume, lower ambient temperature, and foster both mental and physical well-being.

The City Council will consider legislation requiring the Department of Parks and Recreation (DPR) to work to fill empty tree pits throughout the city. Tree pits could be revitalized with a newly-planted tree or, where not feasible due to underground infrastructure, the City could plant other types of appropriate vegetation such as shrubs, flowers, and grass.[322] The City could also use mobile tree planters where digging in the ground may be problematic. For EJ communities that have historically lacked appropriate green infrastructure, DPR could prioritize plantings in empty pits, and consider the opening of new pits for trees or appropriate vegetation.

Furthermore, the City must reduce the amount of time it takes to plant trees. According to DPR, tree planting requests submitted to DPR currently may take over a year to fulfill.[323] To address this delay and achieve the goal of filling tree pits throughout the city, DPR should work to plant trees in the next planting season, so that no more than one planting season elapses before a request for a street tree is resolved.

Strategy: Create Sustainable Playgrounds

DPR's current design guidelines for playgrounds include giving consideration to sustainable design strategies such as using lighter colored surfaces and protecting existing trees, as well as a suggestion to plant larger trees to provide shade near play areas.[324] However, these are only guidelines and are not necessarily followed or inclusive. Therefore, the City Council will consider legislation to require DPR to adhere to sustainability measures in playgrounds.

Sustainability measures could include planting trees as protective barriers on the borders of playgrounds and play areas that are adjacent to highly-trafficked roadways. Exposure to fine particulate matter air pollution has been linked to cognitive side effects and developmental delays in children,[325] and the presence of trees has been linked to reductions in airborne levels of fine particulate matter.[326] Furthermore, planting trees as protective barriers around playgrounds will furnish important shade and reduce noise, providing a calmer area for children and their families. Similarly, as discussed in the Cool New York section above, mitigating the urban heat island through the use of lighter-colored surfaces (as opposed to black rubber mats heating up many existing play areas), or certain permeable surfaces, would provide additional benefits to both park goers and the surrounding community.

Strategy: Turn New York City's Dead Ends into Green Spaces

New York City has hundreds of dead ends, which often lack green infrastructure and may even be a harbor for garbage and rodents.

A Tale of Two Dead Ends:

Albemarle Road in Brooklyn, Facing the B/Q Tracks

Albermarle Road is bisected in Brooklyn by the tracks for the B/Q trains. Facing west, the dead end is largely concrete. The only vegetation is weeds and the contents of unmaintained small planters. Graffiti and an abandoned cone are also visible. Facing east, grass, flowers and trees are used to green the dead end.

Albemarle Road (Facing West) – Source: Google

Albemarle Road (Facing East) – Source: Google

The City Council will consider legislation requiring the City to conduct an assessment of dead ends, analyzing conditions and determining the feasibility of converting these areas into a bioswale or similar green space that would support the planting of trees and other vegetation. Identified areas would be transformed into green spaces, which would capture stormwater, improve air quality, and beautify neighborhoods.

Strategy: Green Bus Stops

The City's bus stops present opportunities to cool passengers and beautify neighborhoods. For example, green roofs and the vegetation comprising such roofs, help to combat the urban heat island effect by providing greenery that lowers surface and air temperatures.[327] Recently, the City of Utrecht in the Netherlands announced that bus stops will be receiving green rooftops covered in succulents, which supports pollinator populations, and are also capable of storing rain water, capturing dust particulates from the air, and providing cooling.[328] Philadelphia has also implemented a similar project.[329] New York City should pilot the use of green roofs on bus shelters.[330] The City should also greenscape neighborhoods by installing tree pits and planting trees near bus stops to provide shade to riders where a bus shelter is not available.

Goal: Use Sustainable Surfaces Throughout New York City

Strategy: Initiate a Comprehensive Sustainable Pavement Testing Program

The City Council will consider legislation requiring DEP and the Department of Transportation (DOT) to establish an expansive program to test the effectiveness and durability of sustainable pavements throughout the city. This should include both cool pavements, where coloration or materials are used to mitigate the urban heat island effect, and permeable pavements, which can be used to reduce stormwater runoff and mitigate heat.[331]

For permeable pavements, Local Law 80 of 2013 required a modest pilot program which, by the timelines established in that law, was to be completed in early 2016.[332] As of this writing, it has been delayed multiple times and, while some test sites have been implemented, DOT's most recent public estimate for the pilot's completion is 2021.[333] In the meantime, several cities, such as Boston and Chicago, have completed pilots and are now implementing targeted permeable pavement programs. As discussed above, annual precipitation has been increasing in New York City since at least 1900, and the severity of downpours is projected to grow in the future. Meanwhile, the NPCC found that an area's permeability may play an even larger role in localized flooding than climate change (see discussion on *"Climate Change and Downpour Flooding Risks"* in the Greenscaping background). Therefore, after a half-decade delay, the limited scope of that original pilot is no longer sufficient to meet the needs of today's sustainability goals.

Cool pavements should be studied for all public paved areas, including roads, interior pathways, parking lots, and playground surfaces. Consideration should be given to testing on surfaces with differing levels of traffic to help determine where pavement materials can be successfully maintained. Additionally, all materials and colorations should be considered for their ability to lower street surface temperatures.

Strategy: Reduce Impervious Areas on New Development Projects

The City Council will consider legislation requiring new and redeveloped sites over a certain size to reduce the impervious areas by a certain amount as compared to preexisting conditions. This can be done through the installation of permeable pavements, green roofs, or other green infrastructure that mitigates stormwater runoff. The legislation could include a "best practices" document to support compliance. Reducing the number of impervious surfaces at development sites will decrease runoff from increased precipitation and help lower temperatures.

Strategy: Increase the Percentage of Reclaimed Asphalt Pavement (RAP)

Pursuant to Local Law 71 of 2011, asphaltic concrete must contain 30% RAP, and heavy-duty asphaltic concrete must contain 10% RAP.[334] RAP is asphalt pavement that has been processed for reuse in asphaltic concrete.[335] A 2011 U.S. Department of Transportation (U.S. DOT) report determined that 30% RAP asphalt mixtures have similar long-term performance to pavements with no RAP.[336] Subsequently, U.S. DOT has done extensive testing on RAP asphalt pavement mixtures, including pilot programs of RAPs over 30%.[337] The City Council will consider legislation establishing a pilot project to determine the extent of local use of RAPs over 30%, looking at its strength, durability, supply chain, and potential best practices and locations for use. Depending on the results of that pilot, consideration should be given to amending Local Law 71 of 2011 to require higher percentages of RAP.

CITYWIDE RESILIENCY

This section draws upon the climate change risks described above to present an integrated approach to resiliency planning. Further, this section acknowledges that the vulnerabilities of communities will vary. The risks that climate change presents are not evenly distributed, physically or socially.

Some areas of the city, due to their location or physical qualities like topography, vegetation, and urban land use, are more exposed to impacts of climate change such as heat waves, coastal storm surge, sea level rise, and increased precipitation. These factors describe an area's *physical vulnerability*. Similarly, the degree to which a community exhibits certain social conditions, including high poverty, high numbers of individuals living with disabilities, or poor housing quality, may affect that community's ability to prevent human suffering and financial loss in the event of disaster. These factors describe an area's *social vulnerability.*[338]

Knowing the physical and social vulnerability of a community can help in planning processes, both for prioritizing areas with the greatest need and for tailoring solutions to the actual needs of its residents. Analyses of some of these vulnerabilities are below.

Social Vulnerability

The Centers for Disease Control produces a Social Vulnerability Index (SVI). Each census tract is given an index score between 0 and 1; the score reflects the tract's percentile rank within, in this case, New York State.[339]

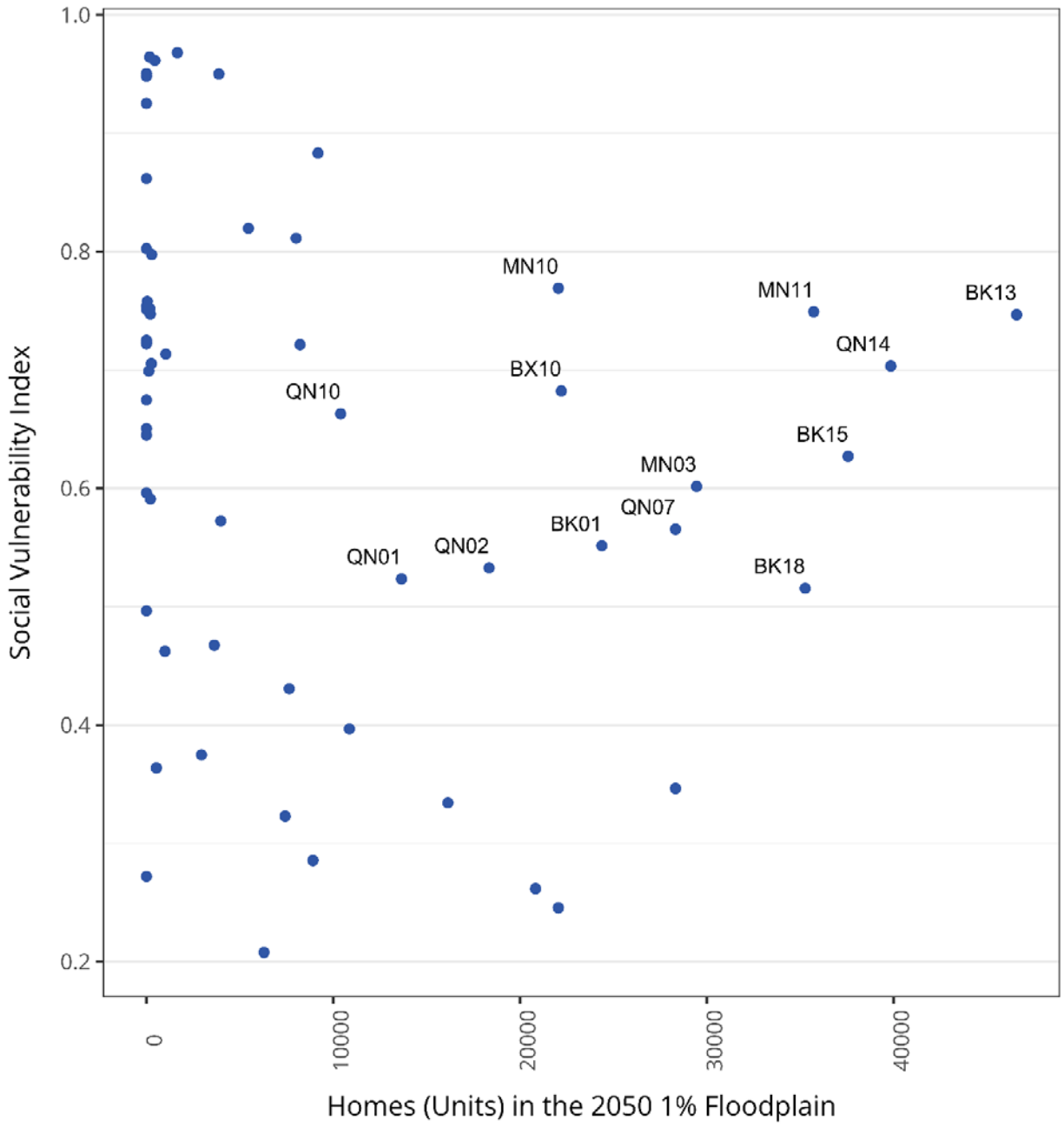
To apply this index to a more understandable geographic area in New York City, the census tracts were sorted by the community district in which they are located, and the average SVI for the whole community district was calculated. After doing so, it was found that the average score for all community districts is 0.64, ranging from the least socially vulnerable community district, Staten Island CB 3, with a score of 0.21, to the most socially vulnerable, Bronx CB 5, with a score of 0.97.[340]

Comparisons Between Social Vulnerability and Physical Vulnerability

This social vulnerability information can be combined with information on physical vulnerability for a more holistic analysis of a neighborhood. For example, the most socially vulnerable community district as identified by the SVI, Bronx CB 5, also received the highest risk score from DOHMH's Heat Vulnerability Index (see "Department of Health and Mental Hygiene (DOHMH) Heat Vulnerability Index Map" in the Cooling New York background). Both indexes take into account social vulnerability factors, but, as discussed earlier, the Heat Vulnerability Index also considers temperature and topographical information, for a fuller risk analysis.

For an example of combining the SVI with physical vulnerability factors, the adjacent chart compares the social vulnerability of a community district to the number of residential units that will possibly be in the 100-year floodplain in that community district by the year 2050.

Social Vulnerability Index vs. Residential Units in the 2050 100-Year Floodplain (by Community District)



A comparison of the social vulnerability of a community district to the number of residential units that will possibly be in the 100-year floodplain in that community district by the year 2050. The higher on the y-axis, the more socially vulnerable the community district. The further to the right on the x-axis, the more residential units in the future floodplain. Those community districts with the highest combined risks of social vulnerability and physical vulnerability to future coastal flood are mostly in the upper right quadrant, and have been identified by their borough and community district number.

Another example is a comparison of social vulnerability to possible future tidal flooding. Using the 90th percentile projections for 2050, as discussed above in the Coastal Resiliency section, there are three neighborhoods that may face extensive high-tide flooding. All are in Queens and located around Jamaica Bay: Broad Channel; Howard Beach and Hamilton Beach; and Arverne and Edgemere, in the Rockaways. Table 1 shows the population of these neighborhoods, as well as the SVI score and the number of homes potentially impacted by high tide flooding in 2050.[341]

Table 1

Neighborhood	Population	SVI	Homes impacted by Tidal Flooding
Broad Channel	28,243	0.439	1,755
Arverne/ Edgemere	57,276	0.887	3,523
Howard Beach/ Hamilton Beach	29,296	0.490	982
	14,815	**0.605**	**6,260**

By 2080, under the 90th percentile projections, the list would add Lower Manhattan, near the Financial District, mostly along the East River between South Street Seaport and The Battery, as well as Belle Harbor and Breezy Point, Red Hook, Gowanus, Coney Island and Brighton Beach, Sheepshead Bay and Manhattan Beach.[342] Table 2 summarizes these communities.

Table 2

Neighborhood	Population	SVI	Homes impacted by Tidal Flooding
Broad Channel/Belle Harbor/Breezy Point	38,910	0.503	10,768
Arverne/ Edgemere	65,152	0.881	13,637
Howard Beach/Hamilton Beach	29,296	0.490	2,950
Financial District	49,495	0.219	2,576
Red Hook/Gowanus	21,808	0.484	1,287
Coney Island/Brighton Beach	86,020	0.744	23,260
Sheepshead Bay/Manhattan Beach	34,852	0.536	6,495
	325,533	**0.551**	**60,973**

All of the communities at highest future risk for high tide flooding are within the community boards subject to future coastal flood risk, with the exception of Hamilton Beach and Howard Beach.

However, using these combined social and physical analyses of the future flood risk with sea level rise, from both coastal storms and high tides, there are 22 community districts that contain areas that are particularly vulnerable to such risks:

- Jamaica Bay and Lower New York Bay
  - Brooklyn CB13 (Coney Island)
  - Brooklyn CB15 (Sheepshead Bay/ Manhattan Beach/Gerritsen Beach)
  - Brooklyn CB18 (Canarsie)
  - Queens CB10 (Howard Beach)
  - Queens CB14 (The Rockaways)
- The East River
  - Brooklyn CB1 (Greenpoint/Williamsburg)
  - Brooklyn CB6 (Red Hook/Gowanus)
  - Brooklyn CB7 (Sunset Park)
  - Queens CB2 (Long Island City)
- The Manhattan Central Business District
  - Manhattan CB1 (Lower Manhattan)
  - Manhattan CB2 (West Village)
  - Manhattan CB3 (Lower East Side)
  - Manhattan CB4 (East Midtown)
  - Manhattan CB6 (West Midtown)
- Hell Gate & Long Island Sound
  - Bronx CB1 (Mott Haven)
  - Bronx CB2 (Hunts Point)
  - Manhattan CB10 (Harlem)
  - Manhattan CB11 (East Harlem)
  - Queens CB1 (Astoria)
  - Queens CB7 (Flushing)
- Kill Van Kull and Arthur Kill
  - Staten Island CB1 (North Shore)
  - Staten Island CB2 (West Shore)

This information is provided for illustrative purposes, but the community districts identified here represent a majority (58%) of the 38 waterfront community districts. This suggests both that a citywide plan to approach such risks is needed and that it could be developed in stages, beginning with higher priority vulnerable communities, followed by the remaining coastal communities across the city.

As was done here for heat and flood risks, other risks, such as from increasing precipitation, should be similarly analyzed with consideration of socially vulnerable communities. Any comprehensive future planning should consider both categories of vulnerability—physical and social—as well as the variety of possible climate change impacts.

CITYWIDE RESILIENCY—GOALS AND STRATEGIES

Goal: Plan for the Future

Strategy: Consider and Address Climate Change Impacts in Capital Planning

The City Council will consider legislation requiring climate change to be evaluated and considered as part of capital planning. The Ten-Year Capital Strategy is a planning

document that proposes how to spend billions of dollars in capital funds over the coming decade to improve infrastructure.[343] The most recent strategy identified four guiding principles, including sustaining the City's financial responsibility; promoting forward-looking, holistic capital planning; advancing a more equitable City; and considering community perspectives in capital planning and decision-making. While responding to climate change was an identified goal and "addressing citywide resiliency goals, and restoring and protecting our waterfront" was listed as one of six investment priorities, it is critical that climate change be formalized as a permanent paramount consideration.

Any proposed investment in new infrastructure or facilities requires serious evaluation for potential risks and must ensure that resiliency is factored into both the siting and the estimated costs. Furthermore, existing infrastructure or facilities that need to be refurbished or replaced provide opportunities to consider heat mitigation, relocation, stormwater management, investment in flood protections, or other resiliency measures. Larger impacts on the surrounding environment should also be considered, such as by ensuring that infrastructure and facilities do not further contribute to the urban heat island effect and instead mitigate it wherever possible. Each agency represented in the Ten-Year Capital Strategy should address the specific climate change impacts its infrastructure and facilities will face, and detail how the capital plan mitigates those impacts.

Strategy: Utilize the Climate Resiliency Design Guidelines for All City Capital Projects

- Institutionalize the Climate Resiliency Design Guidelines for All City Capital Projects
- Implement a Resiliency Scoring System for All City Capital Projects

Institutionalize the Climate Resiliency Design Guidelines for All City Capital Projects

It can be difficult to make existing infrastructure or buildings more resilient (see discussion on "*New York City's Floodplain*," above, in the Coastal Resiliency background). New construction and alterations, however, can be the best opportunities during which to ensure resiliency. The most recent Climate Resiliency Design Guidelines were released by the Mayor's Office of Recovery and Resiliency in 2019 as guidelines for planners on how to consider increasing heat, precipitation, and sea level rise in the design of infrastructure and buildings. For example, when evaluating flood risk, the guidelines recommend considering sea level rise and the lifespan of a building when determining the needed elevation. Similarly, when evaluating the potential for higher temperatures in the future, the guidelines recommend design criteria for heating, ventilation, and air conditioning (HVAC) systems based on projected future temperatures. It has proved to be an invaluable resource not only for City capital projects, but also for design practitioners in the private sector who want to incorporate resilient features based on climate change projections into their projects. Currently, however, the use of the guidelines is discretionary. The City Council will consider legislation mandating the use of the guidelines in all City capital projects and

requiring them to be published and updated on a regular basis.

Implement a Resiliency Scoring System for All City Capital Projects

To ensure that the Climate Resiliency Design Guidelines are followed to the greatest extent possible, the City Council will consider legislation mandating that the City develop a scoring system to rate capital projects on their resiliency, along with setting a minimum required score that all projects must meet. This should be required early in the planning and design process, so that every project considers the vulnerabilities and risks of a 2080 New York City, as well as those that exist today.

Strategy: Conduct Vulnerability Assessments for All Critical City Infrastructure and Buildings

Existing City assets should be evaluated for resiliency both now and in the future. For example, there are schools, libraries, firehouses, police precincts, healthcare facilities, roadways, all of the City's wastewater treatment plants, and other public buildings within the 100-year floodplain.[344] These are existing structures that provide vital community services and must continue to be able to do so in the future. Furthermore, climate risks, including heat and intense precipitation, will affect the city's ability to deliver important services. Therefore, the City Council will consider legislation requiring the City to conduct a full assessment of all critical municipal infrastructure and buildings, informed by future climate projections. This assessment should also consider the conditions of critical resiliency systems, such as emergency generators, and the ability of such infrastructure or buildings to maintain habitable conditions for at least 72 hours in an emergency, particularly if serving vulnerable persons.

Strategy: Improve the Collection of Real-Time Local Climate Change Data

Climate science is built on a foundation of data. The collection of additional data would improve projections and help the City to better understand the social equity impacts of climate change. The NPCC's work has highlighted the importance of local data collection to inform local climate modeling. The 2019 report also demonstrated the necessity of collecting data from geographically diverse locations within the city.[345] For example, while the temperature gauge at Central Park has the longest historical record of temperature data for New York City going back to the 19th century, gauges that were added at the city's airports in 1970 have shown geographical temperature variation, with two of the gauges experiencing higher summer maximum temperatures than the other, and potentially different temperature trend lines.[346]

The City should collect more granular, real-time climate data, in geographically diverse parts of the city, to better inform future climate science projections. In cooperation with local academic institutions and the NOAA, which operates our current weather stations, the City should establish additional measurement locations. By increasing the number of measurements taken, the City can identify climate impacts that would otherwise go unobserved when there are longer gaps between data points. Additionally, any information collected should be made public in real-time, so that localized temperature spikes, heavy downpours, or other climate impacts could be more quickly identified and addressed. In doing so, the City may look toward eventually

developing a climate change resilience indicator and monitoring system, based on the vision laid out in NPCC's 2019 report;[347] however, in the meantime, particular focus should be given to increasing and improving the collection of data useful for refining climate models.

Goal: Build Present Day Resiliency

Strategy: Increase Funding for the Office of Long-Term Planning and Sustainability

Since being codified into local law,[348] the Office of Long-Term Planning and Sustainability[349] has been granted, by the Charter, the power and duty to "develop and coordinate the implementation of policies, programs and actions to meet the long-term needs of the city, with respect to its infrastructure, environment and overall sustainability citywide, including but not limited to the categories of housing, open space, brownfields, transportation, water quality and infrastructure, air quality, energy, and climate change; the resiliency of critical infrastructure, the built environment, coastal protection and communities; and regarding city agencies, businesses, institutions and the public,"[350] as well as to "develop measurable sustainability indicators,"[351] and to increase public awareness of sustainability.[352] A significant portion of the funding supporting that work is through grants that will soon expire;[353] yet the need for this office's expertise will only grow. It is crucial that this important office has the resources it needs to fight climate change and serve New Yorkers in the years ahead. The City should significantly increase the Office's headcount and funding to ensure a truly sustainable future.

Strategy: Designate Chief Resiliency Officers

Agencies with large capital budgets, such as the Department of Transportation, the Department of Environmental Protection, the Department of Housing Preservation and Development, Health and Hospitals, the Department of Citywide Administrative Services, and the School Construction Authority, should each have a designated Chief Resiliency Officer. In order to protect the tens of billions of dollars invested in their infrastructure and buildings, and to ensure the continuation of the public services they provide, it is vital that the resiliency and sustainability of all their assets—both current and planned—be a primary focus. Chief Resiliency Officers could ensure that focus, as well as facilitate coordination with other agencies to achieve the City's larger resiliency goals. The City should ensure that every appropriate agency, such as those listed above, has a Chief Resiliency Officer.

Strategy: Develop Civic Engagement for Sustainability Projects in Every Community District

The Civic Engagement Commission (CEC) should establish a participatory process to identify, in each community district, spaces, projects, developments, or retrofits that can be implemented to demonstrate what sustainability means in practice. There is concern that the move toward sustainability will engage and benefit neighborhoods and communities that are already well resourced. This CEC-driven proposal could ensure that the City is focused on an equal distribution of sustainable projects, so that no district is overlooked.

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349 The Office of Long-Term Planning and Sustainability (OLTPS) does not seem to have a public facing existence any longer, despite being required to exist pursuant to the Charter. A December 4, 2014 press release claims that Mayor Bill de Blasio merged OLTPS with the Mayor's Office of Environmental Coordination to create a new Mayor's Office of Sustainability. However, no corresponding change in law or executive order was issued. Attempts to reach OLTPS's former website (previously *available at* nyc.gov/oltps) redirect browsers to the website for the Mayor's Office of Resiliency, which is not part of the Mayor's Office of Sustainability, though according to an organizational chart on the City's website (*available at* https://www1.nyc.gov/assets/home/downloads/pdf/reports/2014/NYC-Organizational-Chart.pdf), both offices report to the Office of Policy and Planning, which the Green Book states was created in 2018 (see: http://a856-gbol.nyc.gov/GBOLWebsite/GreenBook/Details?orgId=8885). Again, despite Charter §8(f) indicating that such changes should be made by executive order ("…the mayor may, by executive order, at any time, create or abolish bureaus, divisions or positions within the executive office of the mayor as he or she may deem necessary to fulfill mayoral duties") no executive order creating or merging such offices, under the current administration, was found.

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ENERGY & EMISSIONS

Goals & Strategies

ENERGY GRID

Goal: Transition from Fossil Fuels to Clean Energy

- Work with the State to Get the Transmission Capacity Needed to Bring Clean Energy to New York City
- Call on Con Edison to Invest in Grid Infrastructure in order to Eliminate Fossil Fuels from NYC's Energy Grid by 2050
- Call on State to Increase Oversight of Con Edison
- Revive and Repurpose the City's Public Utility
- Transform Rikers Island into a Renewable Energy Hub
- Enable a District-Scale Geothermal System
- Create a Database of Subsurface Conditions to Support Better Engineering of Geothermal Heat Pumps
- Develop an Affordable Housing Renewable Energy Project
- Establish a District-Scale Clean Energy Project
- Review Regulatory Barriers to Battery Storage

BUILDINGS

Goal: Reduce Buildings Emissions

- Require Buildings to be Electrification-Ready
- Benchmark Buildings at 10,000 Square Feet
- Create a "Greening your Neighborhood" Program
- Reduce Emissions While Creating and Preserving Green, Affordable Housing

AIR QUALITY

Goal: Improve Indoor Air Quality

- Ensure Building HVAC Maintenance
- Create an Online Dashboard for Community Air Quality and Monitoring Initiatives
- Use Materials and Construction Techniques that Improve Indoor Air Quality

TRANSPORTATION

Goal: Reduce City Transportation Emissions

- Achieve a 100% Zero Emissions School Bus Fleet by 2040
- Reconsider Zoning Requirements for Parking, Zero Emission Vehicles, and Car Shares
- Expand Bike Share Programs
- Increase Bike Parking
- Call on New York State to adopt a Low-Carbon Fuel Standard
- Call on the Federal Government to Increase Fuel Economy Standards
- Call on the Federal Government to Strengthen Emission Standards
- Call on the Federal Government to Prioritize Public Transit and Other Sustainable Modes in Federal Transportation Funding

Goal: Improve Electric Vehicle Infrastructure

- Expand the Availability of Electric Vehicle Chargers
- Call on the Public Service Commission to Adopt an Order that would Require the Utilities to Contribute to Electric Vehicle Infrastructure Costs for Parking Lots

Climate change is the most critical and urgent issue facing our world, as climate scientists around the globe concur that we have until 2030 to curb greenhouse gas (GHG) emissions to avoid potentially catastrophic global temperature increases. While climate change has always existed, GHGs resulting from human activity have accelerated warming and need to be curbed to maintain relative climate stability.

New York State and the City are working to reduce GHG emissions by over 80% by 2050 to help avoid the most drastic effects of climate change. The State's goal is an emissions reduction of 85% from a 1990 baseline by 2050 (85x50) and the City's goal is 80% from a 2005 baseline by 2050 (80x50). The only way to accomplish this is to aggressively transition off of fossil fuels and on to renewable energy.

Rethinking the way we achieve clean energy is one of the most complex challenges for the City to address, for numerous reasons, including:

- significant State preemption in the energy sector;
- challenging costs of transitioning off of fossil fuels and its infrastructure and onto clean and renewable energy;
- inadequate renewable energy transmission from outside the city;
- inadequate grid improvements to handle intermittent renewable energy generation;
- inadequate battery storage for renewable energy;
- lack of strong accountability mechanisms for utilities;
- inequitable access for low-income residents to renewable energy; and
- lack of training for a green energy workforce.[354]

Despite these obstacles, the City has made significant strides toward transitioning to clean energy, and there is much more to be done to ensure that New York City fulfills its emissions reduction goals and eliminates its dependence on fossil fuels.

ENERGY GRID

Greening Our Energy and Grid: Necessity and Challenges

One of the most significant drivers of GHGs is human activities that burn fossil fuels like coal and oil.[355] These activities release large amounts of carbon dioxide (CO_2) and other GHGs into our atmosphere, further accelerating climate change.[356] According to the Environmental Protection Agency (EPA), electricity production generates the second largest share of GHGs in the United States.[357]

In 2018, 41% of the electricity generated in New York State came from fossil fuels (oil and gas plants), 32% from nuclear power, and 21% from hydropower.[358] In the upcoming years, there will be additional issues associated with these power sources.[359] For example, Indian Point Energy Center, a nuclear power plant that currently generates 2.1 GW of power, is scheduled to close in 2021.[360] Additionally, there are no plans to build new hydroelectric plants in the near future.[361]

Renewable energy sources such as wind, solar, and biomass account for only approximately 5% of New York State's electricity.[362] In short, there is currently a very limited supply of renewable energy available to New Yorkers. Also, there is significant opposition to investing in new fossil fuel infrastructure, given the immediacy of the climate emergency and the related time-bound targets to reduce GHG emissions.

The transition from fossil fuels to renewable energy creates challenges to operating power grids and energy systems to meet the energy needs required to handle base, intermediate, and peak loads. The power created by

renewable energy generation is intermittent, as wind can blow at a variety of speeds and cloud variation alters the feed to solar photovoltaic systems.[363] Safeguarding grid stability requires a diverse mix of electrical sources. Clean or renewable electricity sources such as hydropower and geothermal power can easily imitate traditional coal-fired or nuclear power,[364] and geothermal power is most efficient when it is allowed to run continuously and without interruptions.[365] Power sources that are flexible, reliable, and able to ramp up are essential to creating a network that is dependable given the cost and bandwidth to operate such a grid.[366]

Buildings and vehicles can electrify to end on-site energy generation from fossil fuel combustion, but the electricity itself, if not coming from a green source, can still contribute to producing unsafe levels of GHGs in our atmosphere when the energy is produced. It is imperative that fuel switching for buildings work in conjunction with the decarbonization of electricity generation.[367]

Know Your Watts

Kilowatts and kilowatt-hours are what you see on your electric bill, and are the metrics most commonly used to describe your energy use.

Kilowatts and kilowatt-hours: One kilowatt (kW) = 1,000 watts, and one kilowatt-hour (kWh) = one hour of electricity use at a rate of 1,000 watts.[368]

Megawatts: One megawatt (MW) = 1,000 kW = 1,000,000 watts. A typical coal plant is approximately 600 MW in size.[369] Con Edison services New York City and Westchester, with a peak capacity of 13,200 MW.[370] In New York City alone, the peak is around 11,500 MW.[371]

Gigawatts: One gigawatt (GW) = 1,000 MW = 1 billion watts. The total capacity of electricity-generating plants in the United States in 2012 was around 1,100 GW.[372]

Terawatts: One terawatt (TW) = 1,000 gigawatts.[373]

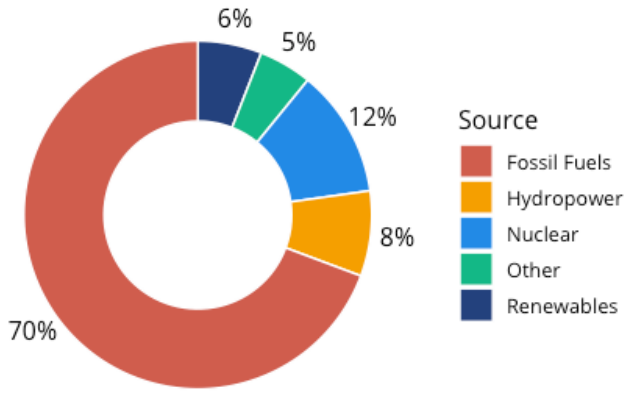
Goal: Transition from Fossil Fuels to Clean Energy

According to the U.S. Energy Information Administration, the five main sources of renewable energy are biomass, geothermal, hydropower, solar, and wind.[374] Together, these energies have thus far grown to comprise 14% of New York State and 7% of New York City energy consumption as of 2017 (see figures below).

Approaching renewable energy projects at the district or community level allows individual

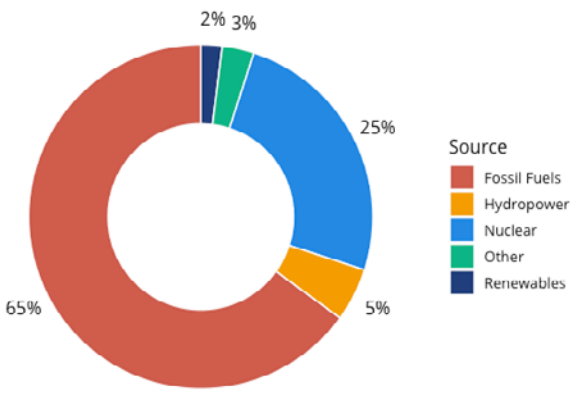
actors to take advantage of economies of scale in order to achieve goals that would be difficult at the individual building or home level.[375] Whether individuals are collaborating to purchase energy from renewable sources, as in the community choice aggregation model, or embarking on renewable projects more directly via district scale geothermal, heat storage, or community solar type models, participants may reap the benefits of coordination, allowing them to more efficiently reduce GHG emissions and incentivize development of renewable energy resources.[376]

New York State
Energy Consumption, 2017



Source: Energy Information Administration, State Energy Data System

New York City
Energy Consumption, 2017



Source: NYC Mayor's Office of Sustainability

New York City Energy Plans and Studies

Local Law 248 of 2017 created a long-term energy plan for the City, and established a New York City energy policy advisory subcommittee.[377] The plan will include a review of the current energy supply, a summary of the current citywide energy demand, a projection of the future citywide energy demand over the next four years, an estimate of renewable energy sources integrated into the energy supply, an accounting of energy efficiency measures that have been deployed, and specific recommendations for renewable energy sources and energy efficiency measures that could feasibly be developed and integrated by the City. The plan will also include an assessment of the replacement of gas-fired power plants[378] and an inventory of City land where large-scale renewable energy generation is feasible.[379] The first plan is due by December 31, 2021, and will be updated every four years thereafter.

Local Laws 181 and 183 of 2019 require feasibility studies on renewable energy and storage for City-owned buildings. Local Law 181 mandates a study on the installation and use of each available types of utility-scale energy storage systems in each City building.[380] Local Law 183 requires a study identifying the types of City-owned buildings where solar water heating and thermal energy systems may be appropriate and cost-effective.[381] Both studies must be completed and reported on by April 30, 2021.

Local Law 182 of 2019 requires the City to conduct a feasibility study on the implementation of one or more community choice aggregation (CCA) programs for energy purchasing by April 30, 2021.[382] The law requires a preliminary report to the Mayor and the Speaker by March 1, 2020. If it is determined that CCA is feasible, then an implementation plan must be submitted by December 31, 2021. CCA is a potential long-term tool to dictate greater renewable energy in our energy mix by allowing individuals to collaborate to purchase energy from renewable sources. CCA can increase procurement of renewable energy sources in municipalities by combining purchasing power to demand energy from renewable sources on an aggressive timeline. CCAs also allow municipalities to enter power-buying agreements in which electricity is purchased in bulk at a lower fixed rate.

Improving grid flexibility and stability will require using a wide range of options. McKinsey & Company conducted a study on New York's decarbonization strategy in the power sector,[383] and created a model to suggest what investment and system changes need to occur to meet the State's decarbonization goals for the energy sector and for the maintenance of grid reliability. [384] The model suggests that by 2040, demand for power will rise. It is projected that New York State's electric load will increase by one-third, which amounts to an additional 51 terawatt-hours (TWH), and more than 60% of New York State's electricity will come from wind and solar power.[385] The following is the chart of projected electrical generation for 2040: [386]

Projected electricity generation 2040	
Offshore Wind	70.9 TWH
Onshore Wind	26.2 TWH
Utility-Scale Solar	31.6 TWH
Distributed Solar	8.3 TWH
Hydro	30.3 TWH
Nuclear	21.8 TWH
Power to Gas	4.7 TWH
Natural Gas	0 TWH
Coal	0 TWH
New Transmission	19.6 TWH
Other (includes biofuels, flexible loads, and oil)	2.7 TWH

This model predicts that green-energy sources like offshore wind, onshore wind, and solar will largely replace conventional fuels and provide more than 60% of New York State's electricity by 2040.[387] However, the electric grid is not able to function without significant baseload power on the system, which is the minimum amount of power needed at any given time.[388] The supply of electricity must be balanced with demand; if not, actions must be taken to reduce the electric load.[389]

Role of New York State in Energy Governance

New York's Reforming the Energy Vision and Clean Energy Standard:

Governor Cuomo launched the Reforming the Energy Vision (REV) as a part of the 2015 New York State Energy Plan to reform energy consumption in the state. The REV is the State's stragegy to build a clean, more resilient, and affordable energy system for all New Yorkers.[390]

The recently-adopted Climate Leadership and Community Protection Act (CLCPA) (see Background section) updates some REV goals, which include the following: cutting GHG emissions 85% by 2050; 100% clean electricity by 2040; nine gigawatts of offshore wind energy by 2035; six gigawatts of distributed solar by 2025; and three 3 gigawatts of energy storage by 2030. The Governor delegated responsibilities to the New York State Public Service Commission (PSC), the New York State Energy Research and Development Authority (NYSERDA), the New York Power Authority (NYPA), and the Long Island Power Authority (LIPA) to implement the REV goals.[391]

The Clean Energy Standard (CES), administered by NYSERDA, is intended to combat climate change, reduce air pollution, and ensure an energy mix that is diverse, reliable, and low carbon.[392] The goal of CES is to have 70% of New York's electricity coming from clean energy sources by 2030.[393] The CES creates two mechanisms that require utilities, electric companies and any other load-serving entity (LSE) to assist the State in reaching the clean energy goal - the renewable energy standard and the zero-emissions credit.[394] The renewable energy standard requires every LSE to purchase renewable energy credits associated with new renewable energy sources for their retail customers. The zero-emissions credit is designed to help struggling nuclear plants in the state remain open until 2029.[395] It requires nuclear power plant owners contract with NYSERDA to sell the zero-emissions attributes of the electricity they produce. LSEs are then required to purchase a certain amount of these attributes each year.[396]

New York State Public Service Commission (PSC) has exclusive regulatory authority over gas and electric utility companies in New York.[397] PSC crafts the regulatory changes needed to achieve the environmental goals of the Governor. The Department of Public Service is the staff arm of the commission and "represents all ratepayers and the public interest in Commission proceedings."[398]

New York Independent System Operator (NYISO) is a not-for-profit corporation that manages New York's power grid and energy markets.[399] New York City's electric distribution system is controlled almost entirely by the utility company Con Edison, which serves all of the city except for the Rockaway peninsula.[400] PSC is mandated by State law to establish a statewide energy storage goal for 2030.[401] The goal established in 2018 is 1,500 MW of energy storage by 2025, expanding to 3,000 MW by 2030.[402] A NYISO reliability requirement imposed by the New York State Reliability Council, a not-for-profit responsible for preserving electric service reliability in the state, obliges 80% of the city's peak electricity demand from power that is generated in-city to ensure energy consistency.[403]

Role of New York State in Energy Governance

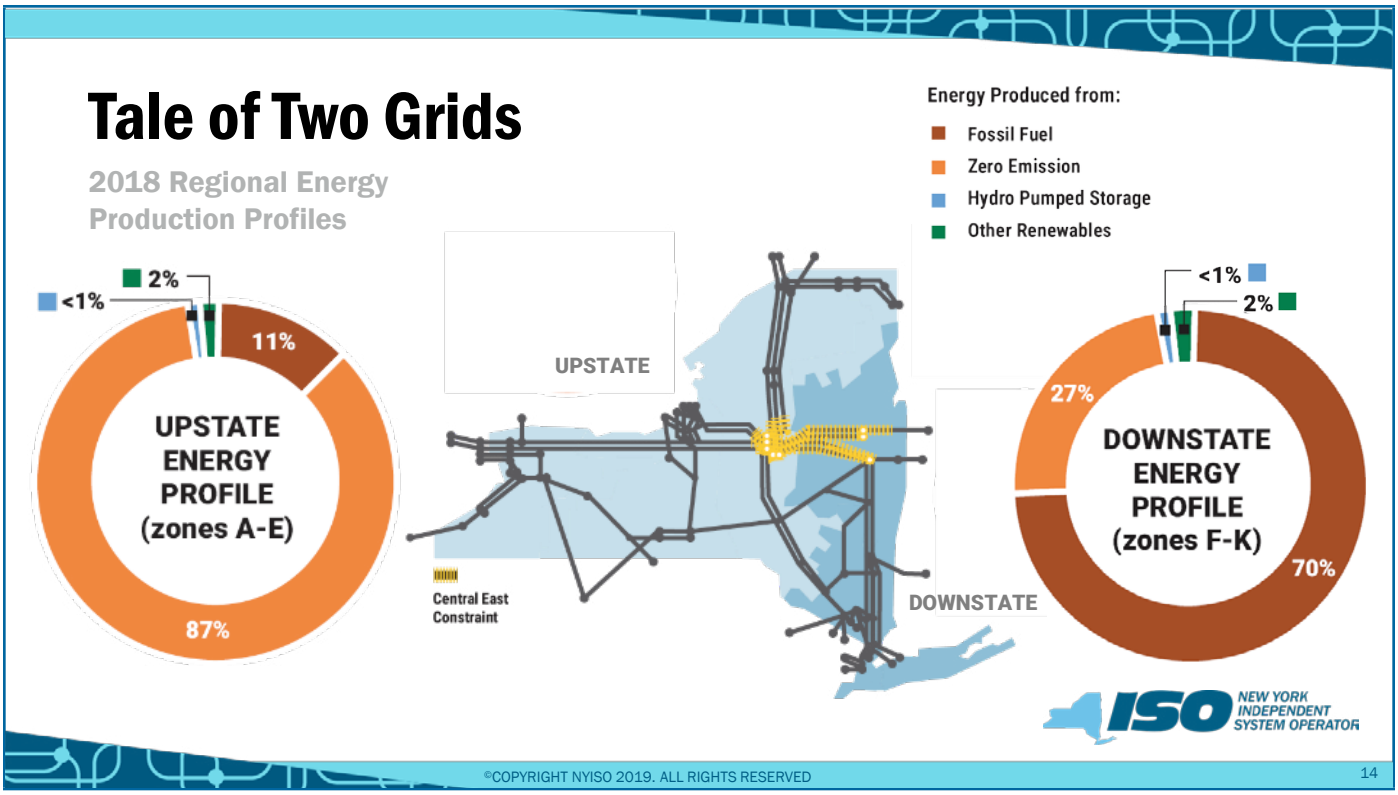
New York State Energy Research and Development Authority (NYSERDA) manages implementation of the State's REV, and works collaboratively to develop, invest, and foster the conditions for investments in the State's clean energy economy, advance large-scale clean energy and help expand energy efficiency and renewable energy use.[404] Its programs consist of clean energy competitions that award grant money, providing rebates to individuals buying electric cars, educating and financing transitions to solar energy, and much more.

New York Power Authority (NYPA) assists the REV initiative through the implementation of programs that are intended to revolutionize the way New York consumes energy, including providing for the installation of charging stations for electric cars, assisting schools in the transition to solar energy, enhancing energy efficiency in government buildings, and overall revitalizing infrastructure for a greener grid.[405]

Strategy: Work with the State to Get the Transmission Capacity Needed to Bring Clean Energy to New York City

We need more clean and renewable energy transmitted to the city in order to meet GHG reduction and renewable energy goals. The Climate Leadership and Community Protection Act (CLCPA) requires that a minimum of 70% of statewide electrical generation be secured by renewable energy systems by 2030. However, the City will likely not be able to meet this goal unless the State builds the transmission capacity for us to obtain this clean energy. That is because New York City has limited land available for its own large-scale renewable energy generation. Furthermore, the NYS Reliability Council requires the city to meet over 80% of its peak energy demand from power that is generated in-city, a requirement that currently is met by power plants using fossil fuels. While the City must work to replace these dirty plants and expand renewable energy generation, the State needs to significantly increase the amount of renewable energy transmitted to the city if it is to fully transition from fossil fuels to a clean grid.

In his 2020 State of the State plan, Governor Cuomo announced that the State will develop a plan "for authorizing and building new transmission capacity to bring clean and renewable power to areas that need additional electricity capacity, prioritizing using existing rights of way."[406] The City Council supports this necessary step and calls on the State to fulfill this commitment and meet resulting infrastructure needs with executive budget allocations necessary to meet these goals. Further, while the State has committed to generate 9,000 MW of offshore wind power by 2035, there is still no plan regarding how much of this energy will be allocated to which municipalities. The City Council will advocate for at least half of this wind power to go to New York City.[407] The City Council also calls on the State to ensure that new transmission lines are developed to connect upstate-generated renewable energy to New York City.[408]



Strategy: Call on Con Edison to Invest in Grid Infrastructure in Order to Eliminate Fossil Fuels from New York City's Energy Grid by 2050

Intermittent power sources, such as solar and wind, require a grid capable of energy storage and two-way transmission to allow intermittent sources to resemble a stable baseload power source. Without these grid upgrades, there is a risk of continued and expanding reliance on fossil fuels like natural gas.[409] Con Edison should invest in the grid upgrades necessary to eliminate fossil fuels from its energy grid by 2050. This should include a plan for the grid to utilize new energy generated by offshore wind industries.

Strategy: Call on State to Increase Oversight of Con Edison

Con Edison has a history over the past 20 years of failing to meet the city's demand for electricity, due to a raft of systemic failures that have led to an array of service outages.[410] This includes several power outages just last year, affecting customers in sections of each of the five boroughs.[411] Major outages also occurred in 1999, 2003, 2006, and in 2012 in the aftermath of Superstorm Sandy.[412] The City Council calls on PSC, which has exclusive regulatory authority over gas and electric utility companies in New York, to expand its enforcement capacity to ensure that utilities throughout New York State adhere to PSC standards and rate case agreements. A rate case is the formal process that occurs every three years which determines the amount that Con Edison and other regulated utilities can charge customers

for electricity, gas, water and steam service.[413] Currently, the only real vehicle for Con Edison's accountability is through the rate case, and while PSC has had Con Edison's proposed rate cases modified, it always ultimately approves them. In October 2018, PSC announced that it was creating an Office of Investigations and Enforcement (OIE), as well as a Director position. It is unclear thus far how the OIE will use its enforcement powers. The Director job posting stated that OIE "will utilize 'full penalty powers' granted by the state's Public Service Law, and will focus on consumer protection, electric and gas utility emergency preparations and response, gas safety, and commission orders related to 'reliability, merger conditions [and] service quality.'"[414] The OIE should be staffed with enforcement officers throughout the state, not just a director, and should measure Con Edison rate case commitments against their actual spending and performance.

Strategy: Revive and Repurpose the City's Public Utility

The New York City Public Utility Service (NYCPUS) (see Box) is a public utility that was created by the City that is currently dormant. In the future, it could serve as an electrical corporation for the purposes of building, acquiring, and/or operating infrastructure to generate clean energy. The City should explore opportunities to revive NYCPUS to build, acquire, and/or operate infrastructure to generate in-city renewable energy for sale to utilities or other customers.[415] This could include building and operating large-scale renewable energy generation and battery storage facilities. NYCPUS might also acquire some or all of the City's existing power generation facilities and redevelop them into renewable energy or battery storage facilities.[416]

New York City's Public Utility

New York City has its own public utility, which has been dormant since 2012. The New York City Public Utility Service (NYCPUS) was created in 1982 to allow residential electricity customers in New York City to access cheap hydroelectric power from the Niagara Falls area.[417] In 1957, the Niagara Redevelopment Act (NRA) authorized the Federal Power Commission (now the Federal Energy Regulatory Commission (FERC)) to issue a license for the Power Authority of the State of New York (now the New York Power Authority (NYPA)) to generate hydroelectric power from the Niagara River.[418] The license for the Niagara Power Project required that 50% of the project's power "give preference and priority to public bodies and nonprofit cooperatives within economic transmission distance."[419] The law did not define "public body." Pursuant to this license, NYPA entered into contracts for this "preference power" with rural electric cooperatives and municipalities that owned their own distribution facilities, who organized themselves into the Municipal Electric Utilities Association (MEUA).[420] Most of these contracts were set to expire in 1985 or 1990.[421]

New York City's Public Utility

Anticipating the expiration of MEUA contracts, municipalities formed public utilities, of which NYCPUS was one, to contract to purchase NYPA preference power.[422] Because many municipalities did not own and operate power distribution facilities themselves, NYCPUS and other municipal distribution agencies (MDAs) entered into lease agreements with private utility companies—Con Edison in New York City—to use their facilities to distribute preference power purchased by the MDA.[423] At the time, City officials believed having a leasehold interest in facilities from a private utility was sufficient for NYCPUS to be considered a "public body" pursuant to the law.[424]

Local Law 78 of 1982, approved by voters in a public referendum, established NYCPUS and authorized it to "establish, construct, lease, purchase, own, acquire, use and/or operate facilities within or without the territorial limits of the city, for the purpose of furnishing…any service similar to that furnished by any public utility company…"[425] The law further provided that the City "will not acquire or build any electric or gas transmission or distribution facilities which are parallel to, or duplicative of electric or gas transmission or distribution facilities of any utility companies within the city, nor take any action to impair any agreements, franchises, rights or obligations of any utility company within the city including, to provide safe, adequate and efficient service to conduct its business in the city and protect its assets" unless authorized by further law and referendum.[426] It also provided that the City would not exercise its power to acquire by condemnation facilities of a public utility company[427] "unless specifically authorized by further local law and public referendum."[428] The City entered into a lease agreement with Con Edison, essentially using NYCPUS as a pass-through for NYPA preference power—as the public body, NYCPUS would purchase preference power at low rates and pass it on to customers through Con Edison's existing distribution and billing systems, with no disruption to Con Edison's physical infrastructure or business.[429] Recipients of this preference power would remain Con Edison customers.

NYCPUS's potential as a conduit for cheap upstate power for residential customers was never fully realized. After the old NYPA contracts expired, downstate utilities struggled to acquire any upstate power at all, owing to the State and NYPA's reluctance to alter the status quo of NYPA power allocations that favored upstate utilities.[430] Furthermore, after the MEUA filed a complaint alleging that downstate MDAs did not qualify as public bodies under the NRA and NYPA was therefore in violation of its Niagara license agreement in allocating preferential power to them, FERC and federal courts determined that NYCPUS and other MDAs were not public bodies.[431] The court ruled that NYCPUS's lease agreement with Con Edison did not give the City enough meaningful control over its power distribution system to qualify as a public body for the purposes of receiving preference power.[432]

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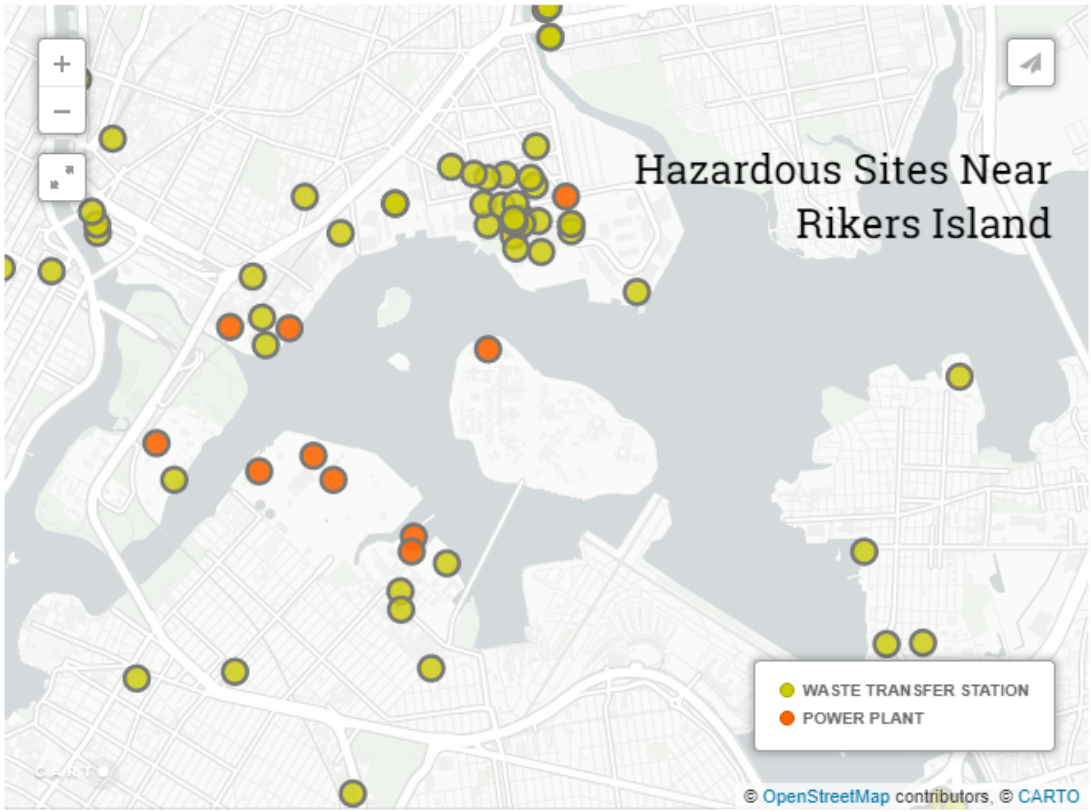
NYCPUS eventually became a conduit for NYPA power for economic development purposes, rather than residential electricity. In 1985, amidst upstate-downstate jostling for Niagara power allocation, NYPA agreed to reallocate eight megawatts of power that it had been allocating to neighboring states to downstate utilities, including NYCPUS, but for the express purpose of "economic development" and creating jobs, rather than residential use.[436] In 1995, management of NYCPUS was transferred to the Economic Development Corporation (EDC) and reserved for economic development. Power was resold to businesses at discounted rates, to encourage businesses to move to New York City and create jobs, and to remain in the City and invest.[437]

In 2005, State legislation created the Energy Cost Saving Benefit (ECSB) program, which consolidated three NYPA power programs aimed at supporting businesses, including the Municipal Distribution Agency Power program that allocated power to entities like NYCPUS.[438] In 2012, ECSB was allowed to sunset and was replaced with today's ReCharge New York program, which provides low-cost NYPA power to businesses and not-for-profits in the city directly.[439] Consequently, NYCPUS is no longer used to purchase low-cost energy in the city.[440]

Renewable Rikers

In October 2019, the City Council passed a historic plan to permanently close the Rikers Island complex for the purposes of incarceration, following decades of human rights abuses. For many New Yorkers, Rikers Island is a symbol of brutality, inhumanity, and everything that is wrong with our criminal justice system. With the facility closing by 2026, there are over 400 acres of land on the island that could be utilized to make this city a greener and more sustainable place for everyone.

The shuttering of the jail facilities on Rikers Island is an opportunity to not only offer restorative justice to communities that have long borne the brunt of New York City's incarceration system, but also to address the environmental racism that has long placed polluting infrastructure in these same communities. By creating large-scale renewable energy generation and storage, the City could retire some of the dirty "peaker" plants that are used to provide energy on days when there is peak energy use in the city. There are four peaker plants powered by natural gas within approximately one mile of Rikers Island and in low-income communities of color. Shutting down these facilities and replacing them with clean, renewable energy generated at Rikers Island would decrease air pollution in some environmental justice communities (see Background section) and provide these neighborhoods with new opportunities for positive infrastructure, like parks and housing. Meanwhile, the City would be further reducing GHG emissions and creating green jobs.



KEY STRATEGY: Transform Rikers Island into a Renewable Energy Hub

In January 2020, the City Council held a hearing on three pieces of legislation that would advance the City toward transforming Rikers Island into a hub for renewable energy and green jobs. One bill would require the City to transfer control of the Island from the Department of Correction. Other bills would require that the City study the island for its renewable energy and storage capacity, and as a potential location for the creation of a new wastewater treatment facility, which could replace older plants currently sited in more residential areas in northern Queens, the South Bronx, and Upper Manhattan. The City Council will work to pass this legislation and ensure that the future of Rikers Island advances our transition to renewable energy, decreases citywide emissions and localized air pollution, and creates green jobs for New Yorkers, particularly restorative justice and environmental justice communities.[441]

Rendering by FX Collaborative.

Geothermal Energy

Geothermal energy is the constant internal heat found beneath the Earth's surface, which can be used for electrical generation or to assist with heating and cooling.[442] This renewable energy source can be tapped into and utilized in a range of ways, from large, utility-scale geothermal power plants to small-scale

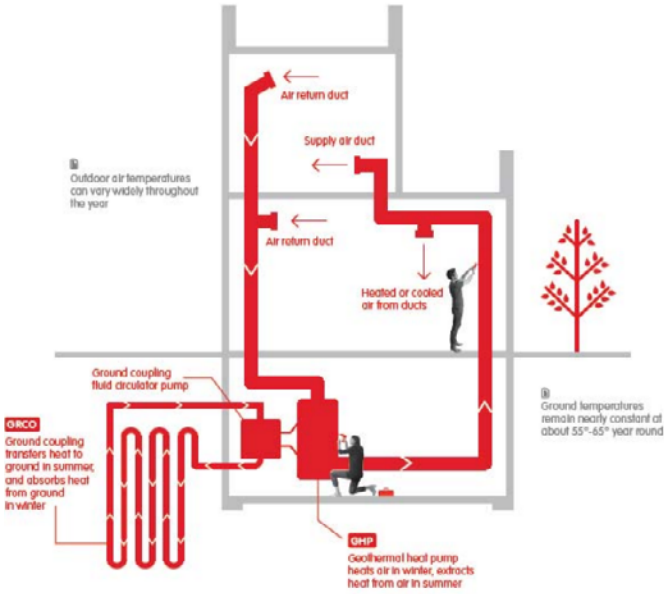
geothermal heating and cooling systems installed in individual buildings or building complexes.[443] A study cited by the EPA found that geothermal heat pumps "are the most energy efficient, environmentally clean, and cost effective space-conditioning systems available, with the lowest carbon dioxide emissions."[444]

In New York City, utility-scale geothermal energy generation is not feasible as below-ground temperatures are only a moderate 55-65°F.[445] However, geothermal or "ground source" heat pumps can be used in the city through smaller-scale applications for thermal regulation of individual buildings or a series of buildings.[446]

Geothermal heating and cooling systems transfer heat between the underground and buildings above ground. This system generally consists of a "ground coupling" system of underground looping pipes used for heat exchange, a heat pump, which transfers heat energy to and from the ground coupling, and air ductwork that circulates heat in the building.[447] In the winter, the ground's higher ambient temperature is used to partially warm the air, thereby reducing the energy that is required to heat spaces to a comfortable temperature.[448] In the summer, the process is reversed and the pump moves heat from the indoor air into the ground around the heat exchanger, subsequently reducing the energy that is required to cool the space.[449] These heat pumps provide buildings that do not have full electrification with a renewable energy option for their heating and cooling needs.

According to the United States Department of Energy, geothermal heat pumps are more than three times more efficient than conventional heating systems.[450]

Figure: Basic Layout of a Geothermal (Ground-Source) Heating and Cooling System[451]



Strategy: Enable a District-Scale Geothermal System

A district-scale geothermal system enables a consortium of building owners to transition from fossil fuel to renewable energy to meet their heating and cooling load needs. Creating a geothermal district brings economies of scale, making geothermal energy more cost-effective. The City Council will consider legislation requiring the City to create a district-scale geothermal project, which can utilize the existing geothermal screening tool to assess where a district-scale pilot would be cost-effective.[452] The bill could establish criteria for choosing a site for the project district and require that geothermal energy be provided to participating buildings through energy power purchase agreements with building owners. As it is cheaper to drill once or twice to connect 20 homes, a district-scale system would reduce drilling costs of geothermal through developing economies of scale.

Strategy: Create a Database of Subsurface Conditions to Support Better Engineering of Geothermal Heat Pumps

Geothermal energy provides an under-utilized opportunity for the City's buildings to reduce their emissions. Installing heat pumps and converting water heaters are important in order to reduce energy consumption and GHG emissions from buildings. In addition to large-scale production to green the energy grid, there needs to be building-level advances to reduce this major source of emissions in the city. The City Council will consider legislation requiring DEP to create a database showing geological logs of the city's geothermal bores and locations of geothermal energy system installations.[453] The database could also include locations of water wells, including unused privately-owned wells. This would complement the existing geothermal screening tool that shows if geothermal energy is cost effective for a given building address.

Strategy: Develop an Affordable Housing Renewable Energy Project

Building GHG emissions in the city are largely created by the on-site burning of fossil fuels, which provide heating and hot water for buildings. Buildings can transition from fossil fuel combustion for heating and hot water needs and reduce emissions through electrification sourced by clean, renewable energy. Such transition should include the City's affordable housing stock. Currently, some affordable housing developments, such as at Sendero Verde in East Harlem and Haven Green in Little Italy, are being designed to utilize clean energy advancements and passive house standards, which are building design principles "used to attain a quantifiable and rigorous level of energy efficiency."[454] However, there is currently no affordable housing project that fully operates on renewable energy. The City should develop a renewable energy project at an affordable housing development. This project could include 100% building electrification along with building-scale heat pumps, solar thermal, solar photovoltaic, and small wind and/or wastewater recovery systems with battery storage to supply all of the energy for heating, hot water production, cooling, and electricity for an affordable housing development.[455] The City should consider siting this project in an environmental justice community.

Strategy: Create a District-Scale Clean Energy Project

A district-scale energy system (also known as district heating and cooling) can utilize one or more energy sources such as river source heat exchange, ground source geothermal, and solar thermal to provide heating and cooling to a network of buildings. Rather than limiting such systems to building level, a district-scale system could connect multiple buildings with thermal energy distributed through underground pipelines to meet their collective heating, cooling, and hot water needs with clean, renewable sources. Some district energy systems are also connected to clean electricity generation and storage infrastructure, and can thus also provide power.[456] The City Council will consider legislation creating a district-scale clean energy project, which will bring together a network of buildings to provide heating, cooling, and hot water needs without fossil fuels. The City should study the potential impact on communities and determine where to best utilize an integrated system of river source, geothermal, solar thermal, and/or building

wastewater energy, along with energy storage, to supply heating and cooling for a network of buildings. The focus of the project should include a New York City Housing Authority (NYCHA) development, ensuring our public housing residents are not left behind in the transition to clean, renewable energy.

Battery Storage

In order to achieve 80x50, the City must work aggressively to replace GHG-emitting fossil fuels with a comprehensive combination of sources of renewable energy whenever possible. The disparity between peak production of intermittent renewables and peak demand is one of the biggest impediments to large scale rollout of renewable energy generation, because it requires energy storage to line up demand and supply.[457] Peak energy usage generally occurs during the evening hours when most people return home from work.[458] Also, peak solar energy production tends to occur during the day when sunshine is the strongest,[459] and onshore wind-based energy production peaks with high wind speeds, which is less correlated with a specific time of day.[460]

Energy storage will play a vital role in meeting our energy and climate goals. Battery storage helps governments overcome the intermittent nature of power generation from renewable sources, an obstacle to large-scale implementation.[461] Storage helps integrate clean energy into the grid, reduces costs associated with meeting peak electric demands, and increases efficiency. It also helps systems to stabilize supply during peak electric usage and to keep critical systems online during an outage.[462]

In the 2018 State of the State, Governor Cuomo set a goal of 1,500 MW of energy storage by 2025. The PSC furthered that goal to 3,000 MW of energy storage by 2030. In April 2019, the NYSERDA outlined the details of the incentive structure and design, which will be used to support the achievement of its goals.[463]

In April 2018, a working group composed of the City University of New York Smart Distributed Generation Hub (DG Hub), DOB, the Fire Department of the City of New York (FDNY), and Con Edison, released a report titled "Energy Storage System Permitting and Interconnection Process Guide for New York City Lithium Ion Outdoor Systems."[464] It provides a general overview of the necessary approvals, required documents, submission instructions, and fees, as well as general safety guidelines for the siting of batteries, fire protection, and best practices in the event of chemical spills.[465] In October 2019, the FDNY adopted a new rule pertaining to battery storage, 3 RCNY 608-01, entitled "Outdoor Stationary Storage Battery Systems."[466]

Battery storage is slowly expanding in the city. A combined solar and battery storage microgrid was completed in 2017 at the Marcus Garvey Apartments, a 625 unit complex in Brooklyn.[467] The project aimed to reduce power costs, improve grid reliability, and provide an alternative power source in case of power disruptions from the larger grid.[468] This project was also the first to utilize lithium batteries under new City rules.[469] In October 2019, PSC approved a utility-scale battery storage project at the Ravenswood Generating Station (RGS) in Long Island City, Queens.[470] If this project is implemented, it would be the largest battery storage facility thus far in the state.[471]

Strategy: Review Regulatory Barriers to Battery Storage

Reducing barriers to battery storage will make in-city renewable energy generation more viable and will increase the likelihood of meeting the city's GHG emissions reductions goals. In 2012, the zone green text amendment to the New York City Zoning Resolution made it easier to build new green buildings and retrofit older buildings. Since then, new technologies such as battery storage and smart grid systems have advanced. To ensure a sufficient amount of safe and reliable battery storage in commercial and residential areas, more information is needed on how current FDNY rules, zoning, and other regulations can allow for this expansion, as well as the amount of time it takes for applicants to go through the permitting process. The City should undertake a review of the regulatory and other barriers to new energy efficiency and renewable energy technologies, such as battery storage.

BUILDINGS

Goal: Reduce Buildings Emissions

In New York State, energy uses in residential and commercial buildings are responsible for 45% of GHG emissions.[472] Most of these emissions come from burning natural gas and oil for space heating, cooling, water-heating, and cooking.[473] In New York City, the majority of GHG emissions come from our buildings, which are responsible for two-thirds of citywide emissions.[474] Since buildings have long useful lives, a large majority of New York City's buildings will continue to be in use in 2050. A key way to reduce building-sector GHG emissions is by retrofitting a majority of the existing buildings.[475]

In April 2019, the City Council passed the groundbreaking Local Law 97 of 2019, which requires buildings that are 25,000 square feet or larger to reduce their carbon emissions to levels that achieve, in aggregate, reductions of by 40% by 2030, and then by 80% by 2050. The worst performing buildings—the highest-emitting 20% of buildings in each occupancy group—will have to act by 2024 to reduce their emissions.[476] Ultimately, this Local Law is expected to result in a 7% reduction in GHG emissions in the city overall.

Local Law 97 also created the Office of Building Energy and Emissions Performance (OBEEP) within DOB to oversee the implementation of this legislation, as well as future bills and policy around building emissions. The law also mandated the creation of an advisory board, which has already started to convene. Further, Local Law 97 requires a study of carbon trading and an implementation plan, which should ensure that environmental justice communities are not left behind. The study and implementation plan are due on January 1, 2021.[477]

Local Law 97 includes some flexibility related to the needs of buildings. Adjustments to the building emissions limit may be available if a building cannot comply with the emissions limit in some scenarios. This includes if the building is designated as a landmark, if the building makes an effort to purchase greenhouse gas offsets or renewable energy credits, or if the building participates in available grant and incentive programs. A building may also apply

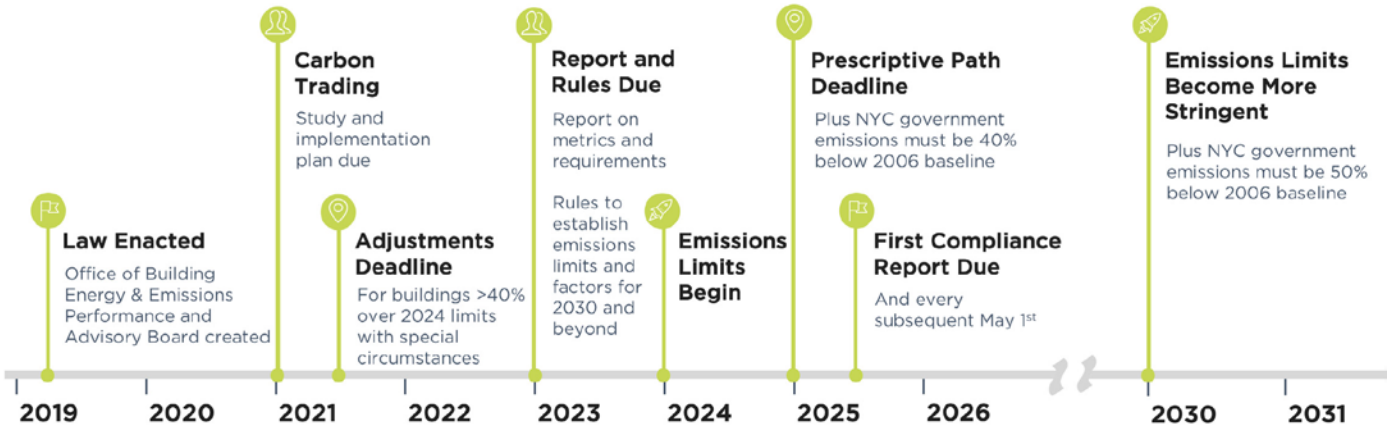
for a percent reduction if that building is 40% over its GHG emissions limit.

The legislation also allows rent-regulated accommodations and houses of worship to comply with a list of lower-cost prescriptive measures, such as insulating pipes and repairing heating system leaks, instead of complying with the absolute emissions limits.

To assist with implementation of Local Law 97, the City Council also passed Local Law 96 of 2019, which authorized the use of Property Assessed Clean Energy, or PACE loans.[478] PACE loans allow buildings to receive long-term financing with minimal upfront costs for energy efficiency projects. The OBEEP will also publish a list of federal, state, city, private, and utility loan, grant, and incentive programs.

Ultimately, Local Law 97 will also create a huge demand for clean, renewable energy. By mandating these emission reductions, the State's commitments to 50% renewable electricity by 2030, and 100% by 2040, we expect the market to expand and welcome new technology and innovation. Buildings will be able to take advantage of the cleaner grid to comply with this bill.

Implementation Timeline for Local Law 97 of 2019



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Additional Recent City Laws on Building Energy & Emissions:

- Local Law 132 of 2016: requires owners of buildings of 25,000 square feet or more, and for tenant spaces (other than dwelling units) 5,000 gross square feet or larger, to install **submeters**.[480]
- Local Law 133 of 2016: requires property owners of buildings of 25,000 square feet or more to **benchmark** their buildings' energy and water use annually using the ENERGY STAR Portfolio Manager tool.[481]
- Local Law 31 of 2016: requires City-owned buildings to be designed and constructed as **low energy intensity buildings**. The City must produce an annual report with information about capital projects subject to the law's design and construction requirements, and a triennial report containing recommended practices for designing and constructing low energy intensity buildings.[482]
- Local Law 32 of 2016: updates Local Law 86 of 2007, which imposes **green building standards for certain capital projects**.[483]

Along with reducing our energy consumption and making the investments necessary to green our electrical grid, the City can reduce emissions from on-site power generation by constructing buildings that use electricity for heating, cooling, hot water, and stoves.[484]

Electrification is already encouraged in the revision of the New York City Overlay of the Enterprise Green Communities Criteria (EGCC). All developments that are constructed using funds from the Department of Housing Preservation and Development must comply with the EGCC New York City Overlay or LEED v.4.[485] This Overlay is currently undergoing revision, with the latest proposed amendments offering points to achieve an EGC certification where a development is constructed to be all-electric-ready or all-electric.[486]

Developers in New York City are beginning to shift away from fossil fuels, toward electrification. For example, the first phase of the 80 Flatbush Avenue development project will contain two buildings: 489 State Street, which is a new school building that will be built to passive house standards* and 100 Flatbush Avenue, which will contain office space and housing.[487] The housing portion will be all-electric and will contain induction cooktops, heat pump dryers, no parking, or gas utilities.[488] This phase of the project is expected to be completed by 2023.[489]

KEY STRATEGY: Require Buildings to be Electrification-Ready

The City Council will consider legislation requiring new construction or buildings undergoing extensive renovations to be fully electrification-ready, so that they do not need to rely on fossil fuels to provide heating and cooling needs.

These buildings should be designed and built to be net zero-ready. This means "future-proofing" buildings, so the electrical infrastructure[490] is in place to meet all energy needs. It also means a building will not have to burn fossil fuels on-site. Electrifying systems is critical to reducing emissions as the State advances toward its commitment to a 100% carbon-free electric grid by 2040.

New York City Energy Conservation Code

Roughly every three years, the International Code Council (ICC), an association of engineers, builders, property owners, government officials, and other relevant stakeholders, updates a model energy code known as the International Energy Conservation Code (IECC).[491] This regularly-updated code governs the "design of energy-efficient building envelopes and installation of energy efficient mechanical, lighting, and power systems through requirements emphasizing performance."[492] New York State then adopts this code (with some modifications specific to the State), and the City is, in turn, required to ensure that its own local energy code is at least as stringent as the State's code.[493] Upon enactment of Local Law 85 of 2009, New York City adopted the State Energy Code, with New York City-specific amendments, known as the New York City Energy Conservation Code or NYCECC. The last revision to the NYCECC went into effect on October 3, 2016.[494] The NYCECC is comprised of New York City-specific changes to the current New York State Energy Conservation Code (NYSECC), and the New York Stretch Code developed by the New York State Energy Research and Development Authority, as required by Local Law 32 for the year 2018.[495] By State law, all local government energy codes, including the NYCECC, must be more stringent than the NYSECC. The new NYSECC, and thus the new NYCECC, will go into effect on May 12, 2020.[496]

Strategy: Benchmark Buildings at 10,000 Square Feet

Local Law 133 of 2016 requires owners of buildings 25,000 square feet or more to benchmark their buildings' energy and water use annually. It also applies to City-owned buildings 10,000 square feet or more. The City Council will consider legislation expanding the benchmarking law to all buildings 10,000 square feet or more, in order to provide both building owners and the City with important data regarding energy and water use for smaller buildings.

Strategy: Create a "Greening your Neighborhood" Program

The NYC Retrofit Accelerator provides personalized support to help building owners make energy efficiency upgrades, particularly for buildings 25,000 square feet or more, that burn heavy heating oils, or are participating in an New York City Department of Housing Preservation and Development (HPD) or NYC Housing Development Corporation (HDC) program.[497] An expanded program that brings customized package options to building owners, specifically small and mid-sized buildings, will increase building owner awareness and utilization of energy efficiency and emissions reducing retrofit opportunities. The City already knows a lot about what work is needed, by building type, to improve energy efficiency and reduce carbon emissions. In New York City, there are a number of different building types that are essentially required to implement the same types of retrofits, making it easy to package information and disseminate this information to homeowners. This includes the city's affordable housing stock. The City should expand their retrofit support and create a robust outreach program that informs building owners about what retrofits they can make, what contractors could do the work, how much it would cost upfront, how much it would save in the long term, and what federal, state, and utility incentives are available to help offset costs. In addition to this outreach, which can include door-to-door recruitment, the program could include a climate and community development fund to assist affordable housing developments with any remaining costs after all incentives have been utilized. This way, the City can ensure that residents in affordable housing get the benefits of emissions reduction and energy efficiency improvements.

EnergyFit NYC Pilot

One example of the kind of programs that homeowners could be connected to is the 2016 Pratt Center EnergyFit NYC pilot, an energy efficiency program for one-family and two-family attached homes developed with support from the City Council.[498] EnergyFit NYC helped small homes get the information and support needed to make energy efficiency retrofits.[499] The program included a standardized package of upgrade measures by building type and ultimately helped complete 32 retrofits in six months.[500]

Strategy: Reduce Emissions While Creating and Preserving Green, Affordable Housing

As the City works to reduce carbon emissions, it must make certain that affordable housing is included. Environmental justice communities and affordable housing must be a priority focus of City efforts. The City's most recent Housing New York Plan aims to build or preserve 300,000 homes by 2026.[501] In the past few years, HPD created a public/private partnership that has the capacity to create and preserve 20,000 affordable units per year, and is aiming to increase this capacity to 25,000 affordable units per year.[502]

HPD has a Green Housing Preservation Program (GHPP), which helps finance energy efficiency and water conservation improvements, rehabilitation work to improve the physical health of buildings, and reduce building expenses and GHG emissions.[503] By doing so, the program preserves affordable housing for low and moderate-income households, while supporting efforts to make sure that affordable housing and low-income communities are not left behind on clean energy. The City should increase funding for the GHPP, and expand this program to proactively identify and target buildings in the city with the lowest emission performances for the development or preservation of affordable housing, as appropriate. Strengthening this program could help retrofit and improve building conditions and reduce GHG emissions, while continuing to help the City create and preserve affordable housing for New Yorkers.

Air Quality

Climate change increases harmful air pollutants and poses risks to human health, including asthma and other respiratory problems. Reducing emissions and fighting climate change will improve air quality and help eliminate some of the risk factors that contribute to poor health outcomes.

In 2015, air pollution was responsible for more than 30,000 deaths in the United States.[504] The rate of deaths was higher in areas with lower incomes and higher concentrations of Black residents.[505] Pollution causes respiratory problems in adults and children across New York City, [506] but particularly in the South Bronx and southeast Queens.[507] Persons with chronic health problems, the elderly, and children are particularly at risk for heart attacks or strokes after exposure to pollution.[508] Furthermore, particulate matter and ground level ozone, which are exacerbated by global warming, have been linked to premature death, developmental harm, wheezing and coughing, shortness of breath, cardiovascular harm, and lung tissue redness and swelling.[509]

In New York City, the Department of Health and Mental Hygiene (DOHMH) estimates that fine particulate matter – an air pollutant that is 2.5 microns or smaller in size – caused an average of more than 2,000 deaths between 2009-2011.[510] The World Health Organization estimates that 235 million people currently suffer from asthma, with 383,000 deaths worldwide from asthma in 2015.[511] In New York City, childhood asthma results in thousands of emergency room visits each year, disproportionately impacting communities of color.[512] While there is no one cause of asthma, there are several risk factors that make a person susceptible to its development, including indoor allergens, outdoor allergens, tobacco smoke, chemical irritants, and air pollution.[513]

The relationship between air pollutants and climate change is reciprocal, as air pollutants contribute to climate change and the effects of climate change may also exacerbate air pollution.[514] Many air pollutants are referred to as "short-lived climate forcers" (SLCFs), which contribute to climate change despite their short lifetime.[515] These SLCFs include ground-level ozone and black carbon, which is a component of particulate matter.[516] Additionally, ground level ozone is "not emitted directly into the air, but is created by chemical reactions between oxides of nitrogen (NO_x) and volatile organic compounds (VOC),"[517] and climate change and the higher temperatures associated with it can cause increases in ground-level ozone and particulate matter air pollution in some locations.[518] The existence of other SLCFs, including nitrogen oxide and sulfur dioxide, also harms the atmosphere.[519] For example, high amounts of sulfur oxides in the atmosphere can harm trees and plants by damaging foliage and decreasing growth, and is one of the components of fine particulate matter.[520]

Improved air quality and reduction of pollutants in New York City can reduce the effects of climate change while also keeping New Yorkers healthy.

Goal: Improve Indoor Air Quality

Strategy: Ensure Building HVAC Maintenance

Poorly maintained air systems can trigger or exacerbate asthma, which caused over 100,000

hospitalizations in New York City in 2016.[521] Additionally, a dirty filter can increase energy costs and damage heating, ventilation, and air conditioning (HVAC) equipment, leading to early equipment failure.[522] The Mechanical Code currently contains a requirement for the maintenance of air filters in central heating and air-conditioning systems,[523] providing that air filters must be kept free of excess dust and combustible material, and requiring that filters are replaced or cleaned when the resistance to airflow has increased to twice that of the original resistance.[524] However, the creation of a preventative maintenance program would help enforce these provisions more effectively and ensure owners have a plan in place to improve air quality in their buildings. The City Council will consider legislation requiring building owners of residential and commercial buildings with HVAC systems to create preventive maintenance programs for them to adhere to, and to keep those maintenance programs available for inspection by DOB or DOHMH if a complaint is made about air quality in a building.[525]

Strategy: Create an Online Dashboard for Community Air Quality and Monitoring Initiatives

The New York City Community Air Survey has monitored and measured pollutants in the city since 2008, utilizing about 100 monitors placed throughout the five boroughs.[526] The City also maintains an Environmental and Health Data Portal that provides information to New Yorkers about items such as Outdoor Air and Weather, and Environmental Sustainability.[527] However, the Portal does not track ongoing infrastructure projects or the effects of such projects on the environmental health of communities.

The City should take a holistic approach to improving outdoor air quality, particularly in environmental justice communities. While the city's air quality has improved over the past decades, more needs to be done. The City Council will consider legislation requiring DOHMH and DEP to create an online dashboard that would be a one-stop resource for New Yorkers to find out about their air quality. The dashboard could show potential infrastructure projects that would improve air quality, including new tree plantings and changes in traffic routes, as well as enforcement action that the City has taken in each neighborhood to curb emissions-producing activity, such as truck idling. These efforts should be mapped, and allow for community members to submit feedback, including ideas for air quality-improving infrastructure projects.

Strategy: Use Materials and Construction Techniques that Improve Indoor Air Quality

In 2012, the New York City Green Codes Task Force proposed various methods to improve air quality in developments by performing certain tasks during construction that would prevent materials from absorbing moisture, and by ventilating a structure before occupancy to ensure low concentrations of air contaminants such as formaldehyde, VOCs, and carbon monoxide.[528] The DOB should consider incorporating the construction materials and methods proposed by the Green Codes Task Force, as well as requiring the use of materials that meet the minimum standards of the City's Environmentally Preferable Purchasing guide into the next Building Code revision.

Divesting from Fossil Fuels

As part of the global movement for fossil fuel divestment, public and private institutions around the world are moving their money out of companies that focus on coal, oil, and gas extraction and into companies with more sustainable business models.[529]

For many of these institutions, the primary argument for divesting from fossil fuels is a moral one.[530] Research shows that in order to meet international targets under the Paris Agreement to keep global warming below 2°C above pre-industrial levels and avoid the most catastrophic effects of climate change, between 67% and 80% of existing fossil fuel reserves will need to remain in the ground.[531] Yet, as one recent study confirms, "no major oil company" is investing in a manner that is consistent with this goal.[532] To the contrary, fossil fuel companies continue to invest large sums of money into finding and developing new oil and gas reserves.[533] One study, published in September 2019, found that since the start of 2018, the major fossil fuel companies have approved approximately $50 billion in new development projects that undermine the Paris targets.[534] By pursuing a business strategy of perpetual extraction, fossil fuel companies significantly increase the risk that the world will continue on its path toward irreversible, catastrophic climate change.[535] Recognizing this, many institutions have concluded that it is simply not acceptable to remain invested in the fossil fuel industry.[536]

In addition, there is also a growing body of evidence that divesting from fossil fuels makes good financial sense. For instance, one recent study found that if the New York State pension system had divested from fossil fuels 10 years ago, it would have been worth $22 billion (approximately 10%) more today.[537]

In the past few years, major steps have been taken at the State and City levels to advance fossil fuel divestment.[538] Furthermore, several major financial institutions have also announced plans to begin moving away from fossil fuel investments. For instance, in December 2019, Goldman Sachs announced plans to stop financing new Arctic oil and gas exploration and new coal-fired power plants that do not utilize carbon capture technology.[539] In addition, in January 2020, BlackRock—the world's largest private asset manager—announced that it would divest from thermal coal producers as part of a larger effort to put sustainability at the heart of its investment strategy.[540] The following month, JPMorgan Chase announced that it would stop financing new oil and gas exploration in the Arctic and significantly curtail its financing of coal production.[541]

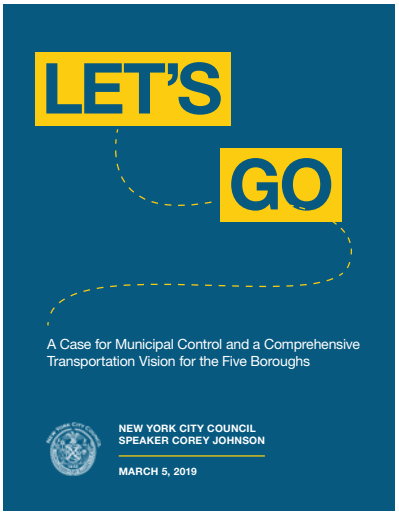
While public and private institutions around the world are taking steps to divest from fossil fuel companies, the U.S. government spends nearly $15 billion per year subsidizing fossil fuel production,[542] and over $600 billion per year subsidizing the fossil fuel industry as a whole.[543] Multiple provisions in the U.S. federal tax code directly subsidize domestic fossil fuel production. The three most significant direct subsidies are percentage depletion, the immediate expensing of intangible drilling costs, and the manufacturing deduction, which collectively cost approximately $4 billion per year.[544]

TRANSPORTATION

Transportation Emissions

As of 2015, 29% of the city's total GHG emissions came from vehicles, representing about 15.5 million tons of CO_2 equivalent[545] and the second largest source of climate warming emissions in the city after buildings. Within the transportation sector, vehicles that consume gasoline are the primary source, accounting for 80% of transportation-based emissions.[546]

With respect to City government operations, transportation contributed 12% of total GHG emissions in 2017.[547] On-road diesel emissions were the main source of transportation-based emissions (45%), followed by gasoline (27%), and diesel for marine transport (27%).[548]



Let's Go!

In March 2019, Speaker Corey Johnson unveiled a report titled, *Let's Go: A Case for Municipal Control and a Comprehensive Transportation Vision for the Five Boroughs*. The report outlined Speaker Johnson's vision to reduce car dependence and break car culture in New York by having the City take control of its mass transit system "so that we can establish and implement our own transportation priorities."[549] The Let's Go report also outlined other initiatives promoting sustainable transportation and prioritizing green infrastructure in transportation projects.

Beginning with the Speaker's Let's Go report and State of the City address in March 2019, and building on that effort with the passage of the Streets Master Plan bill this past October, walking, biking, and transit will become safer, easier, and more efficient in New York City. These efforts support the City's sustainability goals by making low- and zero-emission transportation the natural choice for many trips. In particular, the Streets Master Plan—by requiring 150 miles of bus lanes, 250 miles of protected bike lanes, one million square feet of pedestrian space, and other improvements to our streets and public space over a five-year period beginning in 2021—will further reduce the transportation-related GHG emissions of New Yorkers while making our streets safer, more enjoyable, and more sustainable. Our air quality will improve, noise related to traffic will decrease, and New Yorkers will be able to get around faster and more reliably on foot, bike, and bus.

New York City's Vehicle Fleet

The City operates over 30,000 vehicles, representing the largest municipal fleet in the United States.[550] Of these, approximately 11,000 are sedans and SUVs. According to the City, this fleet is "the greenest in the nation,"[551] as it includes 17,446 alternative fuel vehicles as of 2017.[552] A more recent brochure issued by the Department of Citywide Administrative Services (DCAS) indicated that over 20,000 vehicles in the City's fleet were now using some type of cleaner alternative fuel or design.[553] As of Fiscal Year (FY) 2019, 2,662 of these vehicles were electric vehicles (EV).[554] In addition to the vehicles in the City's fleet, the Department of Education's (DOE) Office of Pupil Transportation has contracts with approximately 65 companies to operate about 9,000 buses in 8,500 school routes.[555]

On February 6, 2020, during his State of the City 2020 speech, Mayor de Blasio outlined plans to electrify the City's fleet by 2040 and to have 4,000 EVs by 2025.[556] Following this speech, the Mayor issued Executive Order (EO) No. 53, mandating the 2040 goal. The EO also requires DCAS to issue a Clean Fleet Design and Electrification Plan that will outline alternative fuel, fuel efficiency, and electrification requirements for all City fleet units by type.

Goal: Reduce City Transportation Emissions

Moving toward a zero emissions vehicle (ZEV) fleet requires more aggressive action by the City. Further, concerted strategies to make mass transportation, walking, and biking safer, more efficient, accessible, and enjoyable will help promote sustainable modes of travel.

The Department of Education's Office of Pupil Transportation contracts with approximately 65 companies to provide bus service for about 150,000 students.[557] The school bus fleet includes around 9,000 vehicles operating 8,500 routes.[558] Spending for pupil transportation comprises 5% of DOE's overall budget, with approximately $1.3 billion allocated for FY 2019,[559] and New York State reimburses the City for approximately 50% of the cost of student transportation.[560] While these contracts were recently renegotiated by the City, none require the use of electric school buses.

Local Law 61 of 2009 imposes a 16 year age limit on all diesel fuel-powered school buses contracted for by the City.[561] In December 2018, the City Council held a hearing on legislation that would modify the age limits on school buses from 16 to 10 years, and require replacing school buses with all electric school buses by September 1, 2040.[562] At the time, the de Blasio administration opposed the bill.[563] While the de Blasio administration has since voiced its support for a goal of a fully ZEV fleet by 2040, this does not appear to include school buses, which are not City-owned, but rather privately-owned and contracted by the City.[564] However, the technology for EV school buses appears to be readily available,[565] and the City can align spending priorities to phase in a fully ZEV fleet over the next decade.

KEY STRATEGY: Achieve a 100% ZEV school bus fleet by 2040

The City Council will consider legislation that will replace diesel school buses with zero-emission school buses by 2040. This transition could be phased in as existing buses meet their age limitation. This timetable could replace more than 9,000 diesel buses with cleaner modes of transportation and improve the quality of life for students, especially those in areas with high asthma rates.

Clean Sanitation Vehicles

For some vehicles, the electric technology is already available; for example, school bus fleets are now ready to transition from fuel and diesel to electric buses. However, some vehicles are still in the development and test phases of electrification. For heavy-duty sanitation vehicles, the electric truck technology is still being developed and companies are just now starting to release models. In May 2019, Mack Trucks, the company that sells the City the majority of its sanitation trucks, unveiled the Mack LR Battery-Electric Vehicle (BEV) and announced that a demonstration model will begin operating in NYC in 2020.[566]

Commercial waste trucks currently run on diesel fuel and travel more than 23 million miles per year to collect New York City's commercial waste and recyclables.[567] Almost 50% of private sanitation vehicles operating in the City are 10 years old or older, and 9% of trucks are at least 20 years old.[568] Sanitation trucks used by the Department of Sanitation (DSNY), in contrast, are an average of approximately six years old.[569]

In December 2013, the City Council passed legislation that became Local Law 145 of 2013,[570] which requires all commercial waste carters licensed by the Business Integrity Commission (BIC) to install Best Available Retrofit Technology (BART) or be equipped with an EPA-certified 2007 engine in all heavy-duty commercial waste hauling vehicles by January 1, 2020. "BART" refers to technology verified by the EPA or the California Air Resources Board (CARB) to reduce pollutant emissions [571] and has been approved for use by the Commissioner of DEP.[572] The 2007 EPA engine standards are defined in the Code of Federal Regulations.[573] Trade waste vehicles that are mandated to comply with Local Law 145 of 2013 have diesel as their fuel type and gross vehicle weight of more than 16,000 pounds.

Additionally, Local Law 199 of 2019 established commercial waste zones in the city and allows the DSNY Commissioner to regulate environmental, safety and health standards for private waste haulers contracted by the City.[574] These include traffic safety standards and environmental and safety requirements for vehicles used in the collection, removal, transportation or disposal of trade waste.[575]

MTA Fleet

New York City Transit and the Metropolitan Transit Authority (MTA) Bus Company currently utilize 5,710 buses to transport 2.4 million riders each day.[576] The average age of an MTA bus is 7.8 years, with about 22% still operating on the road after 12 years.[577] In an effort to improve bus service, the MTA announced in January 2018 that it implemented a three-year pilot program for 10 electric buses, with the goal of reducing emissions and modernizing its fleet, and to have a fleet consisting entirely of electric buses by 2040.[578] This is an important step forward by the MTA.

Strategy: Reconsider Zoning Requirements for Parking, ZEV, and Car Shares

The New York City Zoning Resolution requires parking for many types of development in the city. The City should consider zoning changes to reduce or eliminate the overall requirements for parking where appropriate, to reduce automobile-dependency, and to make housing, commercial, and industrial space easier and less expensive to build. Where parking is required, the changes could consider set asides for car share and spaces that have EV chargers available. Further, zoning changes could mandate that a percentage of required parking be EV-ready and include EV infrastructure. Parking requirements for many building types and sizes can be relatively low, so a minimum threshold could be created before triggering this requirement.

Encouraging Biking

Biking, which produces zero emissions, can be a fun and easy way to get around the city. Along with the plans articulated in the 2019 Let's Go report and Streets Master Plan for additional bike lanes, the City can take several steps to make biking easier, safer and more convenient for New Yorkers.

Bike Parking

DOT's bike corral program, which installs bike parking racks in a curbside lane rather than on a sidewalk,[579] requires that there be a local maintenance partner to keep the corral clear of snow and debris. It also requires that bike corrals proposal be presented to the local community board. Local partners can be businesses, community groups, or individual volunteers, but are most commonly Business Improvement Districts (BIDs). The City has piloted secure bike parking in Lower Manhattan,[580] and, as of December 2019, in Brooklyn[581] at Atlantic Terminal.[582]

Strategy: Increase Bike Parking

As biking becomes increasingly popular, and as the Streets Master Plan covers more areas of the city in safe and connected bikeways, there needs to be a commensurate increase in safe and secure bike parking. This is especially true for transit hubs, commercial areas, and dense residential areas where there are a significant number of bikes and limited room in apartments to store them. The City should increase the availability of safe and secure bike parking, including in plazas and along parks, next to subway stations, and on-street, including by utilizing bike corrals.[583]

Bike Share

Citi Bike, which does not use City funds for its operation, is currently undergoing a major expansion, doubling its service area and tripling the number of bikes to 40,000. As a result, the Bronx will have Citi Bike for the first time, all of Manhattan will be covered, and the service area will expand further into Queens and Brooklyn. The expansion has already come to Bushwick and Ridgewood in anticipation of the MTA's L-train project. Pedal assist bikes associated with the program, which were removed in April due to technical and safety problems, have already returned.[584] Despite Citi Bike's successes and the current expansion, many communities still lack access and there is no clear timeline for further expansion.

Strategy: Expand Bike Share Programs

Bike share programs are an important and sustainable form of public transportation. The City should work to expand these programs to unserved neighborhoods. Expanding bike share programs throughout the city is an issue of equity, environmental justice, and access.

Low-Carbon Fuel Standards

Dramatically reducing transportation emissions will require bold action on multiple fronts. In addition to expanding access to mass transit and taking steps to encourage walking and biking, the State will also need to promote the use of cleaner vehicles and fuels.[585] A low-carbon fuel standard (LCFS) can help achieve this latter goal. An LCFS is a market-based policy designed to reduce the amount of carbon-intensive fuels produced or imported in the State and encourage the development of cleaner alternatives. It works as follows:

First, a State board determines the "carbon intensity" of each type of fuel (gasoline, diesel, biodiesel, electricity, etc.) based on the amount of carbon dioxide emitted throughout the entire lifecycle of the fuel, from production to delivery. Next, fuels produced or imported in the state with a carbon intensity that is lower than the

target set by the board will generate "credits," while fuels with a carbon intensity that is higher than the target will generate "deficits."

Finally, at the end of each year, fuel companies must have generated or obtained enough credits to outweigh their deficits in order to be in compliance with the law. If a company does not meet the standard, it can purchase credits from companies with an excess supply. It can also buy credits from entities that are cutting emissions with green infrastructure such as EV charging stations or direct air capture and air-to-fuel technologies.[586]

An LCFS encourages fuel companies to make their products less carbon-intensive–for example, by blending biofuels into the gasoline and diesel they sell.[587] In addition, an LCFS requires producers of more carbon-intensive fuels to subsidize the production of less carbon-intensive fuels and the development of green infrastructure. These subsidies can hasten the expansion of green alternatives to fossil fuels, making the emissions reductions required by CLCPA easier to accomplish.

Strategy: Call on New York State to Adopt a Low-Carbon Fuel Standard

The Council supports legislation by State Senator Kevin Parker and Assembly Member Carrie Woerner (S4003A/A5262A) that would require DEC to establish an LCFS for New York State.[588] This LCFS would require a 20% reduction in the carbon-intensity of transportation fuels produced or imported in the State by 2030, "with further reductions to be implemented based upon advances in technology as determined by the commissioner."[589]

Strategy: Call on the Federal Government to Increase Fuel Economy Standards

In 2012, the Obama administration implemented improved fuel economy standards for cars and light trucks that were to be built between 2017 and 2025.[590] The Trump administration has signaled that it intends to roll back those standards,[591] and the City must advocate for these standards to be maintained.

Strategy: Call on the Federal Government to Strengthen Emission Standards

Governed by the Clean Air Act, emissions standards set limits on the amount of pollution a vehicle or engine may emit. Stricter standards would make low-emission vehicles (LEVs) and zero-emissions vehicles ZEVs more attractive as a tool for improving air quality. The Trump administration has announced its intent to eliminate California's ability to set emissions rules that are stricter than the federal standards. New York is among 14 states that follow California vehicle emissions standards, and New York City has joined with 23 other states and cities in suing the EPA over its decision to lower vehicle emissions standards.[592]

Strategy: Call on the Federal Government to Prioritize Public Transit and Other Sustainable Modes in Federal Transportation Funding

In the first three years of the Trump administration, over 70% of all discretionary transportation grants went to highway, road, and bridge projects.[593] Grants for transit projects have fallen from nearly 28% to 8.5%, rail projects from 15.7% to 9.2%, and bike and pedestrian projects from 10.5% to 0% of federal discretionary grant funding. The City should advocate for a reprioritization of federal

transportation spending toward sustainable modes, which would likely increase the City's access to funding for mass transit, rail, bike, and pedestrian projects. As part of this call for the reprioritization of federal funding, the City should advocate for the reauthorization of, and increased funding for, specific grant programs (such as the Low- or No-Emission Bus Program) that help to catalyze municipal investment in electric transit infrastructure and other sustainable transportation projects.

Electric Vehicle Infrastructure

In tandem with expanding mass transit use and alternative forms of transportation, the City can reduce transit-related emissions by making EV a viable alternative to gas-powered vehicles. This requires expansion of EV charging infrastructure.

As of 2012, the electric grid in New York City had enough capacity to charge up to 230,000 vehicles without any major upgrades, "provided most charging occurs off-peak."[594] This is an indication that there may be a lack of capacity during peak hours, which is generally from noon to 8:00pm–a time when many New Yorkers are at work, commuting home, or running errands. It is unclear what the current capacity is for EVs, and whether it has changed over the past seven years.

In New York City, there are currently 9,772 EVs that are registered with the NYS Department of Motor Vehicles, and only 467 public charging stations that are registered with NYSERDA, representing a total of 1,077 outlets.[595] Many of the public charging stations are available for customer use only, for employee and guest use only, or are only available during certain business hours, even though they are advertised as public charging stations.

City, State and Federal Government Actions to Support Electric Vehicles and Electric Vehicle Infrastructure

New York City

Local Law 160 of 2016 established an EV charging station pilot program, which required the City to install 25 publicly-accessible EV charging stations, with at least two in each borough.

The 2015 OneNYC report included a plan to have at least 250 EV chargers by 2017.[596] Additionally, the Mayor introduced the Clean Fleet Plan in December 2015, which announced that 2,000 City-owned vehicles would be replaced with EVs by 2025.[597]

The 2019 OneNYC report set goals to reduce the City fleet size by 1,000 vehicles, downsize 250 SUVs to electric sedans, and operate 2,500 EVs at City agencies with a goal of at least 4,000 EVs by 2025.In early 2019, DOT proposed rules for curbside EV charging, which followed Mayor de Blasio's announcement of a partnership with Con Edison to create a program to install 120 level 2 EV chargers at curbs, to launch in 2019.[598] The rules specify that persons with parking permits may not park in on-street EV charging spots.[599]

Law 122 of 2013 established an Electric Vehicle Advisory Committee, which is to meet twice per year and make annual recommendations on ways to promote EV usage, until 2020.

Local Law 77 of 2003 requires diesel powered off-road vehicles on City construction projects to be powered by ultra-low sulfur diesel fuel.

New York State

In 2013, Governor Cuomo announced the new program under the existing Charge NY program to accelerate market adoption of EVs. The new program, known as the Electric Vehicle-Enabling Technology Demonstration Program, offers $2 million to fund research and demonstration projects related to EVs.[600] The Charge NY program was a result of the Multi-State ZEV Task Force, which was formed in 2013. Eight states (California, Connecticut, Maryland, Massachusetts, New York, Oregon, Rhode Island, and Vermont) entered into a Memorandum of Understanding committing to coordinated action to implement statewide ZEV programs.[601]

Subsequently, in 2018, the Governor launched Charge NY 2.0, a $4.2 million expansion plan to install additional high-speed EV charging stations along the New York State Thruway, which will allow EV owners to drive the entire thruway without having to exit to recharge.[602]

The NYSERDA has created the New York Truck Voucher Incentive Program, which offers purchase vouchers for all-electric trucks and buses.[603] This program provides up to $60,000 for the purchase of all-electric class 3 to class 8 vehicles in any air quality non-attainment zone in New York State (which would include New York City).[604]

NYSERDA also has an Alternative Fuel Vehicle Recharging Tax Credit, which is a State income tax credit for 50% of the cost, up to $5,000, available for the purchase and installation of commercial charging stations.[605] NYSERDA also offers a drive clean rebate for electric cars–up to $2,000 for new car purchases or leases.[606]

Governor Cuomo also announced a four-prong EV initiative in his 2020 State of the State address. First, a blue ribbon EV technology task force will be convened. The task force will be led by Dr. M. Stanley Whittingham, a Nobel Laureate in Chemistry for his work on lithium-ion batteries, and will be co-chaired by NYSERDA.[607] The task force will "develop an action plan for New York's EV economy, encourage further research and development in the State, and make recommendations to the Governor on how best to expand the transportation innovation economy in New York State."[608]

Second, PSC has proposed a "make-ready" initiative that would direct utilities to build and subsidize the grid infrastructure needed to enable the installation of chargers.[609] NYPA and NYSERDA will ensure that 10 or more fast-charging locations are available in each of the Regional Economic Development Council regions (Capital Region, Central New York, Finger Lakes, Long Island, Mid-Hudson, Mohawk Valley, New York City, North Country, Southern Tier, and Western New York) by the end of 2022, that every travel plaza on the New York State Thruway has charging stations by the end of 2024, and that at least 800 chargers are installed statewide over the next five years.[610]

Third, $100 million in Green Bank financing will aim to attract EV-sector manufacturers, suppliers or fleet owners, and businesses in the EV charger industry to New York to allow those businesses to relocate to or expand in New York. [611] Finally, the State will support electrification of upstate transit systems in the five largest upstate and suburban transit authorities.[612]

Federal

The federal government offers a tax credit of $2,500 to $7,500 per new EV purchased, depending on the size of the vehicle and its battery capacity.[613] This tax credit will be available until 200,000 qualified EVs have been sold in the United States by each manufacturer, at which point the credit will begin to phase out for that manufacturer. Currently, no manufacturers have been phased out yet, but Cadillac, Chevrolet, and Tesla are beginning a phase out, with lower tax credits through March 2020.

Construction vehicles are subject to EPA standards that were adopted to reduce emissions from non-road diesel engines. The EPA has also adopted requirements for in-use diesel fuel to decrease sulfur levels. Fuel that complies with these requirements, known as Ultra Low Sulfur Diesel Fuel, is required to be used in New York City per Local Law 77 of 2003.

Goal: Improve Electric Vehicle Infrastructure

In May 2018, Governor Andrew Cuomo announced that the State would fund a $250 million initiative, titled Evolve NY, to help expand EV infrastructure in New York.[614] The initiative is designed to expand EV fast charging along key corridors, create new New York City airport charging hubs, and establish "EV model communities" to "test and scale new EV infrastructure and service business models that will encourage more residents to transition to driving EVs."[615] Governor Cuomo also announced a four-prong EV initiative in his 2020 State of the State Address (SEE BOX).

New York City has also set a goal of having 20% of the vehicles sold in the city be electric by 2025.[616] EV sales in the city were less than 1% in 2017.[617] In order to achieve this goal, the City has committed $10 million in capital investments to support fast-charging infrastructure. Additionally, the City announced that the utility company Con Edison has plans to invest up to $25 million in innovative EV strategies and infrastructure.[618]

Strategy: Expand the Availability of Electric Vehicle Chargers

According to the recent Department of Public Service (DPS) *Staff Whitepaper Regarding Electric Vehicle Supply Equipment and Infrastructure Development*, in order to meet the State goal of 850,000 EVs in the State by 2025, New York City needs to be equipped with 39,190 EV chargers, including 22,344 workplace chargers, 13,924 public Level 2 chargers, and 921 public Direct Current Fast Charge (DCFC) charging stations.[619] Additionally, the DPS has proposed that Con Edison and other public utilities cover 90% of the costs for parking structures that do not have an access fee to install EV charging infrastructure, and 50% of the costs for parking structures that have an access fee.[620]

In order to expand the availability of EV chargers and make it easier for drivers to utilize EV over gas-powered vehicles, the City Council will consider legislation:

- To update Local Law 130 of 2013 to require EV chargers for all lots with 10 or more spots by 2030, and remove the "group M exception," which has exempted retail uses from the requirement to install EV infrastructure.
- To study the feasibility of adding to the existing Link NYC infrastructure—which replaced many pay phones across the city with new public Wi-Fi structures called "Links"—to install EV chargers.

Strategy: Call on the Public Service Commission to Adopt an Order that Would Require the Utilities to Pay for EV Infrastructure in Parking Lots

The Department of Public Service (DPS) proposed the establishment of a "Make-Ready Program" that would require utilities, including Con Edison, to install the infrastructure and cover up to 90% of the costs for EV Level 2 and light-duty DCFC charging stations that do not charge an access fee and are publicly accessible.[621] It would also require Con Edison to cover up to 50% of the costs for those that are non-publicly accessible.[622] PSC should adopt an order that would implement the DPS proposal.

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SUSTAINABLE, CIRCULAR ECONOMY

Goals & Strategies

Goal: Increase Access to and Confidence in Recycling

- Ensure Data-Driven Progress Toward Zero Waste
- Track Commercial Recyclables
- Mandate Citywide Curbside Organics Separation and Collection
- Beneficially Reuse Organics End Material from Anaerobic Digesters
- Study Bioplastics for Optimal Waste Management
- Create Extended Producer Responsibility for Mattresses

Goal: Divert Textile Waste from Landfill for Reuse and Recycling

- Divert All Household Textile Waste from Landfill
- Expand RefashionNYC to All Eligible Buildings
- Recycle or Reuse All Commercial Textile Waste
- Create Textile Sorting and Storage Facilities

Goal: Increase City Support for Sustainable Businesses and Jobs

- Partner to Hold Roundtables on Sustainable Businesses
- Support Sustainable Small Businesses
- Local Industry Focus: NYC's Sustainable Fashion Industry

Goal: Extend the Life of Building Materials

- Recycle Construction and Demolition Materials
- Create a Building Material Database
- Pilot a Lifecycle Analysis of Construction Projects
- Increase the Use of Recyclable Carpet

Goal: Reduce Waste

- Reduce Single-Use Plastics
- Reduce Junk Mail
- Implement a Conscious Consumerism Campaign
- Use a Trash Wheel to Clean the City's Waterways

An economy that is circular refers to a system aimed at minimizing waste and maximizing resources.[620] Waste, and in particular landfilled waste, should be considered a design flaw of our system. To achieve a circular economy, we must reduce the amount of waste we create, reuse or recycle what we are unable to reduce, and support growth of the market for products and services that are designed to significantly reduce negative impacts on the environment.

The standard approach to production has typically been: take, make, use, and dispose. Raw materials—often generated through resource-intense and high-impact processes—are transformed into products, which are purchased by consumers who ultimately throw them out. This linear consumption model is not sustainable.

The circular economy promises a system in which waste, pollution, and other harmful effects can be reduced or eliminated through innovative design. To be successful, the City must have a clear understanding of the materials people use and how these materials are reused or disposed of. Collecting appropriate data and accurately analyzing our waste stream is an essential part of this process, as it allows us to identify inefficiencies and find opportunities for innovation and change.

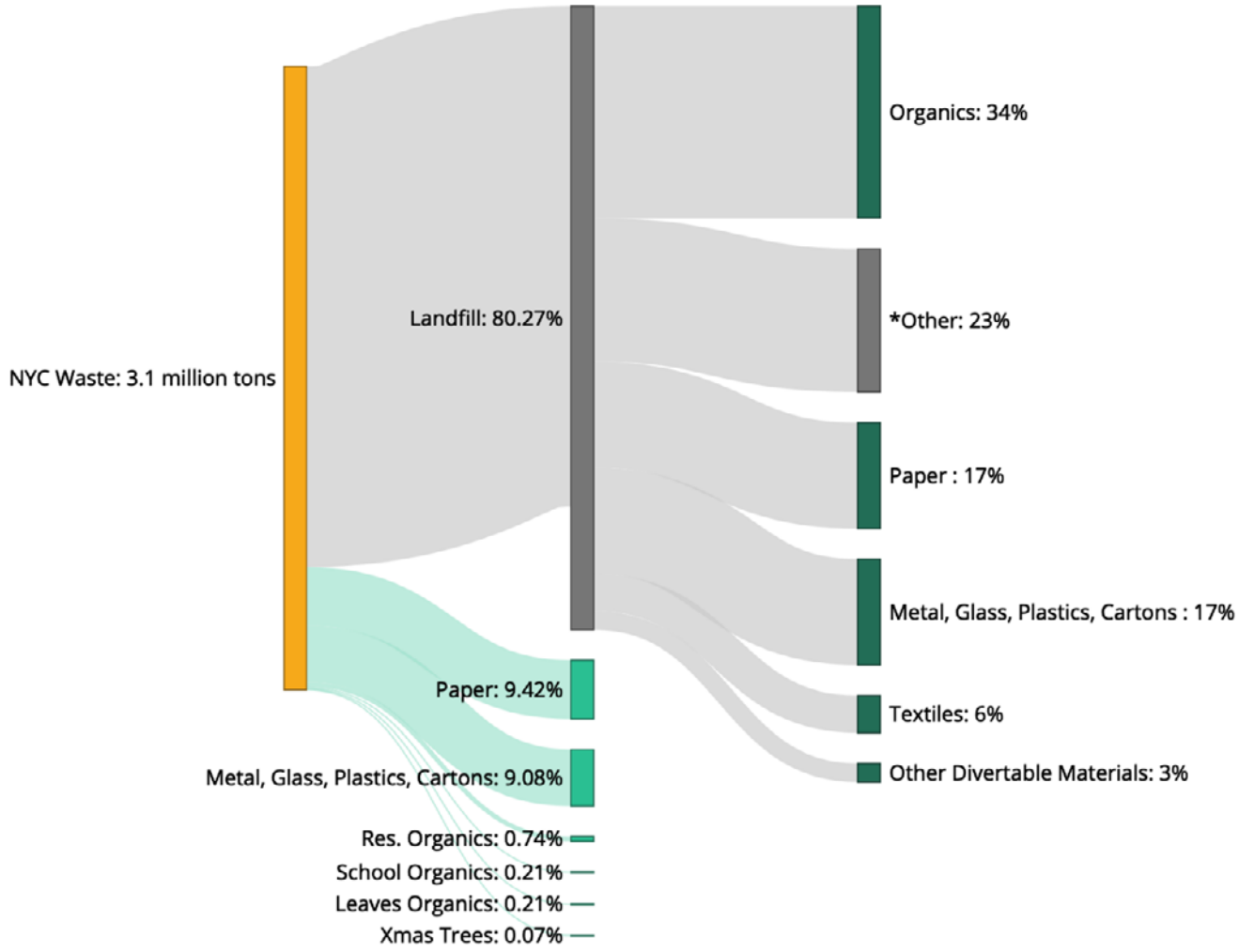
Goal: Increase Access to and Confidence in Recycling

Advancing Toward Zero Waste

New York City is part of a growing movement of cities across the world with goals to achieve zero waste.[621] In April 2015, Mayor de Blasio released *OneNYC: The Plan for a Strong and Just City*[622] (OneNYC).[623] OneNYC included a commitment to send zero waste to landfill by 2030.[624] Zero waste is an ambitious and important goal, requiring a focus on both increased waste diversion from landfill and decreased waste generation from residents and businesses.

Currently, residents are required to source separate materials that the New York City Department of Sanitation (DSNY) collects curbside, including metal, glass, plastic, paper, and corrugated cardboard [as seen in box on next page]. In March 2018, DSNY released the 2017 Waste Characterization Study (2017 Study). According to the 2017 Study, residential curbside collections totaled 3.1 million tons, with 2.5 million tons disposed of as refuse.[625] This means that city residences are recycling about 20% of their household garbage. To achieve zero waste, the City must not only advance existing work to ensure that all materials that have a path to diversion are properly separated from the refuse stream, but it must also create viable paths to diversion for materials that currently do not have one.

NYC's Residential Waste Composition & Potential for Landfill Diversion



DSNY Monthly Tonnage Data, 2017 NYC Residential, School, and NYCHA Waste Characterization Study
*Other: Items that currently have no or limited options for beneficial reuse

Strategy: Ensure Data-Driven Progress Toward Zero Waste

Despite the City's commitment to sending zero waste to landfill by 2030, about 80% of residential waste is not being diverted.[626] If we are to significantly decrease waste going to landfill, the City must create and implement a comprehensive plan for diversion. This plan must also include data collection to measure the City's success.

The City Council will consider legislation requiring the City to develop a plan to achieve zero waste and to periodically report on its progress toward that goal. This legislation could include measures to increase current diversion rates by material and to eliminate materials from the waste stream that are not easily recyclable. The report could also include recommendations related to extended producer responsibility, product design and creation, and consumption and use of materials. Additionally, the plans to increase diversion rates should

include specific initiatives for the New York City Housing Authority (NYCHA), which annually generates over 90,000 tons of recyclable or compostable refuse.[627]

Strategy: Track Commercial Recyclables

Historically, there has been a lack of clarity about what happens to recyclable materials after a private carter picks up the material from a commercial business and brings it to a transfer station. The City Council will partner with the National Resources Defense Council to study the issue, provide data, and inform policies to ensure that recyclable materials from commercial businesses are handled properly and do not end up in landfill.

Organics

Reducing food waste is essential, but there will always be some portion of our waste that is comprised of food scraps. Organic waste should be handled in a way that supports a circular economy. This includes source separating all organic material, and collecting and processing it so that the material can be eventually beneficially reused.

When sent to landfill, organic waste decomposes and generates methane, a potent greenhouse gas (GHG).[628] According

to the Environmental Protection Agency (EPA), methane accounts for 10% of GHG emissions in the United States.[629] For New York City, solutions that prevent organic waste from ending up in landfill will help achieve climate targets, including the Local Law 66 of 2014 requirement that the City reduce its GHG emissions by 80% by 2050, compared to 2005 levels (80x50).[630]

Organic waste can be diverted from landfill by converting it into fuel or compost. According to the 2017 study, the biggest opportunity for the City to divert waste from landfill is to capture organic material.[631] In 2017, a considerable amount of waste was suitable for either organics or recycling collection, but was instead discarded as refuse by residences, schools, and NYCHA communities. For residences, 34% of refuse was suitable for organics collection.[632]

Organic waste can be transformed through traditional composting methods as well as through anaerobic digestion. Biosolids produced during anaerobic digestion can be used as fertilizer and the methane released can be captured, turned into biogas, and used as energy.[633] Anaerobic digestion uses bacteria to break down organic material in a process that is faster than traditional composting.[634] The City

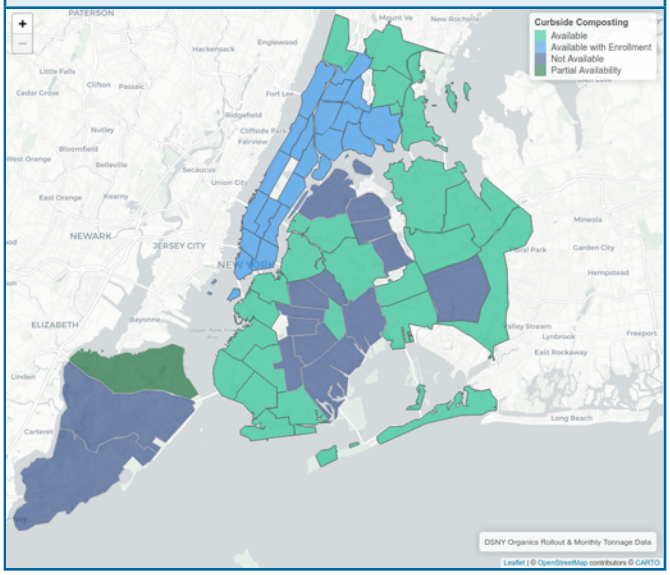
uses anaerobic digester eggs at the Newtown Creek Wastewater Treatment Plant (Newtown Creek) in Brooklyn.[635] Newtown Creek currently processes 130 tons of liquefied food waste, approximately 3% of the city's daily food waste, and expects to produce 190 to 275 million cubic feet of natural gas for local electricity generation in 2020.[636] All of the City's wastewater treatment plants have anaerobic digesters, but Newtown Creek is currently the only one accepting food waste.[637]

In October 2013, the City Council passed Local Law 77 of 2013, requiring the DSNY Commissioner to establish voluntary pilot programs for organic waste collection for residences and schools.[638] Previously, composting in the city existed only through not-for-profits, farmers' markets, at neighborhood composting sites in locations such as community gardens, and the Department of Parks and Recreation.[639]

DSNY rolled out the residential organic waste curbside collection pilot program incrementally across the city since Local Law 77 was enacted. The 2018 update to OneNYC reaffirmed that all residents would have access to compost their food and yard waste through either curbside collection or nearby drop-off locations by the end of 2018.[640] However, the City was not successful in meeting that goal. The DSNY halted expansion of the organics program in the spring of 2018, and the DSNY Commissioner Kathryn Garcia stated that it needed time to increase efficiencies and streamline the program.[641]

With the expansion of the organics program frozen since 2018, many districts still do not have access to curbside organics. In areas where organics pick-up is available, only 10% of the organic waste produced by residents is source separated and collected.[642] This is, in part, because individual participation is not mandatory and building management approval is sometimes required for participation.[643]

Availability of Residential Curbside Organics Collection, as of March 2020



Key Strategy: Mandate Citywide Curbside Organics Separation and Collection

The City Council will consider legislation providing all New York City residents with access to organics recycling. As the expansion is rolled out, the source separation of organic waste should become mandatory. In districts that currently have organics collection, bins would be given to each building that receives DSNY pick-up, as opposed to the current practice that sometimes requires building management approval for program participation. DSNY should also begin to

expand pick-up in other districts, providing an organics bin for each residence. Expanding access to residential organics pick-up will reduce waste sent to landfill, curtail resultant GHG emissions, and allow for the eventual beneficial reuse of food waste.

Importantly, success of the program will require New Yorkers to understand how to properly source separate their organic waste. To that end, the City should implement an education campaign that includes a discussion of the benefits of source separating organic material, including reduced rodent visibility. The City-provided brown organics bins are much more protective against rodents than traditional garbage bins and bags, and removing food scraps from garbage bags could reduce rat visibility around homes.[644]

Strategy: Beneficially Reuse Organics End Material from Anaerobic Digesters

As the amount of organic material collected by DSNY increases, the use of in-city anaerobic digesters should be expanded and encouraged. As mentioned above, anaerobic digestion produces biosolids that can be used as fertilizer and the methane released can be captured, turned into biogas, and used as energy.[645] Thus both biosolids and biogas can be beneficially reused. Further, processing organics locally reduces transportation-related emissions, as organic material does not need to be trucked out of the city.

Biogas, composed primarily of methane and carbon dioxide, can be used to produce electricity and heat.[646] The City Council will consider legislation mandating the use of this gas locally and prohibiting burning off the gas during the digestion process. Biosolids—the end material of anaerobic digesters—can be beneficially reused by, for example, land application. Land application supplies nutrients, replenishes soil organic matter, and can be used on agricultural land, forests, rangelands, or disturbed land in need of reclamation.[647] The City Council will consider legislation requiring the City to beneficially reuse a percentage of biosolids, thereby diverting this material from landfills.

Strategy: Study Bioplastics for Optimal Waste Management

Bioplastics—a term that covers a range of different plant-based plastics—are marketed as an "eco-friendly" alternative to conventional plastics, but data suggests that bioplastics come with their own costs and complexities.[648] As a fundamental matter, some bioplastics are not compostable, while others are. Of those bioplastics than can be composted, some must be processed at industrial facilities, while others may be processed in traditional compost heaps. As for bioplastics that cannot be composted, only some can be recycled. Bioplastic waste that ends up in landfill contributes to the release of methane into the atmosphere and must be minimized.

The overall complexity of the bioplastic market demands equally complex bioplastic waste management. As part of a responsible waste management plan, the City Council will consider legislation that requires a study of the City's current bioplastic waste management actions and its efforts to address the specific problems of bioplastic waste. The study could include a detailed assessment of the different types of bioplastics in the market, the options for management of such bioplastics, and the need for

increased consumer and business education on the proper methods of bioplastic waste disposal.

Case Study: Mattresses

To adequately reduce our waste, the City must create pathways for materials that have traditionally been landfilled to be recycled. Mattresses are largely created through the use of virgin materials, sold to consumers, and, in the case of New York City residents, disposed of through curbside collections by DSNY and sent to landfill.[649]

The vast majority of the components of a typical mattress can be recycled. The Mattress Recycling Council (MRC), an industry expert in the recycling of mattress components, asserts that more than 80% of a used mattress's components can be recycled, including the steel, foam, cotton, and wood materials that constitute it.[650] Many mattress companies already offer to take back old mattresses[651] and recycle them,[652] and California, Connecticut, and Rhode Island have already instituted successful mattress recycling programs in their states, recycling a combined total of 28,000 tons of mattresses in 2018.[653]

Landfilling mattresses represents a missed opportunity for the City, which could be recycling the materials for use in other products in support of a circular economy. In addition, recycling mattresses reduces carbon emissions, diverts chemicals from landfill, creates recycling jobs, and could potentially save the City money.

Connecticut Mattress Recycling Results

The production of mattresses from virgin materials causes GHG emissions. One report estimates that by recycling more than 130,000 mattresses in Fiscal Year (FY) 2016, Connecticut achieved a GHG emission savings of 4.2 million kilograms of carbon equivalent, which is comparable to annual emissions of 875 passenger vehicles.[654] Additionally, it saved about 48.7 megajoules of fuel energy.[655]

Strategy: Create Extended Producer Responsibility for Mattresses

The City Council will consider legislation requiring original manufacturers of mattresses to be responsible for the recycling or donation of their mattresses.

Pursuant to this legislation, a company with its brand name on the mattress, or that manufactured a mattress sold, offered for sale, or distributed in the city, could be responsible for the recycling or donation of that mattress. All manufacturers/brand owners could register[656] and submit a plan to DSNY for facilitating reduction, recycling, or reusing in a sustainable way, their education and outreach efforts, and a targeted annual collection rate.[657] These companies could also have their mattresses recycled or donated through a collection program created by DSNY, and they would reimburse the City for the cost of picking up the mattress and ensuring recycling or donation. To maximize participation in the program, this legislation could also require mattress companies to take back used mattresses from consumers upon delivery of a new one.

Extended Producer Responsibility

Extended Producer Responsibility (EPR) has been defined as "a policy approach under which producers are given a significant responsibility—financial and/or physical—for the treatment or disposal of post-consumer products."[658] Such an approach may encompass the disposal of hazardous products that may be expensive or difficult to recycle or reuse. The European Union, Canada, and states such as Maine and California have adopted notable EPR laws.[659] In 2008, New York City enacted Local Law 13, which established a citywide manufacturer extended producer responsibility program for e-waste. On May 28, 2010, New York State enacted the Recycling Act, expressly preempting Local Law 13 and establishing a statewide EPR program.[660] Starting in 2015, disposal of e-waste in curbside refuse collection was prohibited by State law. Between DSNY's 2013 and 2017 Waste Characterization studies, e-waste in NYC refuse has declined by 60%.[661]

Goal: Divert Textile Waste from Landfill for Reuse and Recycling

Nearly all textiles can be recycled,[662] and citywide infrastructure and programs currently exist to reuse and recycle textiles. These initiatives have provided some success in diverting textiles from landfill.[663] The voluntary and decentralized process, however, undermines the potential.[664] By addressing textile waste, the City can mitigate environmental harms and support burgeoning innovations and markets that are developing within the sustainable and circular fashion industry.

There are many opportunities for textile industries—including fashion—to move toward circularity. Globally, the consumption of textiles continues to increase dramatically, largely due to the "fast fashion" business model, which means that textile waste is trending upward, while most other forms of waste are decreasing. Moreover, post-consumer textiles and other forms of textile waste have market value, which is expected to grow with the advent of new business models and emerging technologies, and this value can only be realized if textiles stop ending up in landfill.

The Environmental Impact of Our Clothes

Textile production by conventional methods is intensely resource-dependent and environmentally destructive.[665] After disposal, natural and partially-natural fibers act similarly to food waste when buried in landfills, releasing methane while they degrade.[666] Further, due to chemical-dependent processes of producing clothing from natural fibers, the practice of landfilling or incinerating textile waste releases toxins into the environment.[667] Additionally, although less environmentally taxing by many indicators, the production of virgin synthetic fibers relies on fossil fuels,[668] and once tossed into a landfill, synthetic fibers can take up to a thousand years to degrade.[669]

Meanwhile, our appetite for new clothing has trended upward over the past few decades. Worldwide, consumers buy some 80 billion new clothing pieces each year, amounting to a 400% increase from 20 years ago.[670] From 2000 through 2014, municipal textile waste grew by 71%.[671] In comparison, for the same period, municipal plastic waste grew by 30%.[672] Per person, textile waste increased by 51%, while by the same measure, waste like glass, paper, and paperboard actually decreased.[673] It is estimated that globally, consumers waste $460 billion each year by throwing away garments that could continue to be worn.[674]

The overwhelming majority of textiles are incinerated or landfilled.[675] Only 15% of used clothing is recycled or donated in the U.S. and approximately 10.5 million tons are sent to landfill each year.[676] Furthermore, clothing utilization—the amount of times a garment is worn before it is disposed of—has dropped around the world.[677]

Local rates reflect national trends. Clothing and textiles account for over 6% of New York City's residential waste stream, or about 193,000 tons annually.[678] According to DSNY, the average city household threw out 125.2 pounds of textiles in 2017.[679] Should trends continue, municipal textile waste per person will more than double in less than 15 years, despite the fact that overall municipal waste per person is projected to decrease over the same period.[680]

Thus, although residential textile waste comprises 6% of municipal solid waste, that rate is only representative of volume and does not reflect, as discussed in the adjacent box, the true environmental cost of throwing these items away.[681] A host of environmental costs could be mitigated or avoided altogether if textile waste was managed more efficiently to incentivize a circular textile economy.[682]

Considering GHG emissions alone, the EPA estimates that diverting the annual total of textile waste from landfill to recycling programs would equate to removing 7.3 million cars and their carbon dioxide emissions from the road.[683] Additionally, encouraging consumers to buy more durable clothes and to care for them more responsibly can significantly reduce the environmental impacts of garments.[684] According to the clothing retailer H&M, consumer use determines over one-third of the environmental impact of an average garment.[685] The Ellen MacArthur Foundation reports that GHG emissions would be reduced by 44% per garment on average if it were worn twice the number of times.[686]

Mandatory Textile Recycling in France

As an example, mandatory textile recycling in France has increased post-consumer textile collection and recycling rates threefold since 2006.[687] This has led to a post-consumer textile recovery rate of up to 90%, of which 50% can be directly reused.[688]

Strategy: Divert All Household Textile Waste from Landfill

The City Council will consider legislation ensuring that textiles are not disposed of with household trash. Residents who wish to dispose of textiles (i.e., household linens, clothing, and shoes) would have to avail themselves of the textile waste collection infrastructure. This infrastructure is currently composed of over 1,100 public-facing, drop-off/collection sites across the city, (each of which is mapped on the DSNY website),[689] and an additional 1,422 semi-private bins located in residential buildings.[690] Combined, these sites include: (i) on-street drop-off bins at farmers' and green markets and in certain retailers; and (ii) in-building collection services through the City's refashionNYC program. Additional methods of disposal include donations to charity, textile reuse and swap events, and organizations that pick up used textiles. Residents could also consign their clothing in secondhand markets or mail back their clothing through a growing number of mail-back programs.[691]

The City should assess ways to expand the existing infrastructure to accommodate additional textiles, including through additional drop-off locations and bins, as well as textile collection and pick-up services. The City should also enhance the usability of its online textile-collection locator to enable users to input a zip code and type of textile they wish to dispose of in order to find the locations and options for textile collection nearest them. Furthermore, DSNY could pilot curbside pick-up of residential textile waste to capture this waste and reduce the burden on residents to find alternative methods of disposal.

Strategy: Expand RefashionNYC to All Eligible Buildings

Through refashionNYC, the City currently contracts with not-for-profits to perform textile waste collection at apartment buildings with more than 10 units, office buildings, commercial businesses, schools, and other institutions.[692] The City provides eligible buildings with the appropriate number of large or small bins. Participation through refashionNYC is voluntary, and the program has been successful. The City should expand refashionNYC to all eligible buildings.

Strategy: Recycle or Reuse All Commercial Textile Waste

Currently, DSNY rules require the separated collection of commercial textile waste only when it comprises at least 10% of the business' waste stream in a given month.[693] This rule is difficult to implement and enforce. To simplify compliance and enforcement, the City Council will consider legislation requiring the collection of all commercial textile waste for sorting and recycling or reuse. All commercial businesses and their private carters could be required to separate textile waste and to send it to textile sorting/recycling facilities or to verify that they have identified a market that will sustainably manage the waste without landfilling or incinerating.

Job and Market Potential in Textile Recycling

Establishing citywide textile recycling will provide new local business and job opportunities. For example, over the next five years, the growth in the secondhand apparel market is expected to more than double, from $24 billion per year to $51 billion.[694] Collection of secondhand garments through the proposed recycling programs could provide easy access to this "waste" for existing businesses and new entrepreneurs in the clothing resale market. This may be simply to resell collected items as secondhand clothing, or to utilize the textiles for textile-to-textile recycling. Cutting-edge technologies have increased textile manufacturers' ability to recycle pre- and post-consumer textile waste. For example, textile producer Lenzing uses pre- and post-consumer cotton waste to create TENCEL™ Lyocell fibers in a closed-loop process.[695] The clothing company For Days breaks down old t-shirts into pulp that is blended with organic cotton to make new clothing.[696] And, in partnership with H&M, the Hong Kong Research Institute of Textiles and Apparel has developed a fiber-to-fiber method for recycling polyester clothing.[697]

The task of textile sorting is also labor intensive, and will require workers to sort clothing according to its fiber content. The New York State Department of Environmental Conservation (DEC) reports that over 6,700 jobs would be created statewide if each resident recycled one additional pound of textiles per week.[698] France created 1,400 full-time jobs to implement textile sorting in support of its nationwide textile recycling program.[699]

Strategy: Create Textile Sorting and Storage Facilities

The City Council will consider legislation requiring DSNY to assess the need for, and potential utility of, local textile recycling facilities. These facilities could be used to sort and store collected textiles for the purpose of distribution to appropriate markets, including up-cycling markets; secondhand clothing markets; recycling markets for various materials, including recyclers of polyester, nylon, wool, cashmere, and cotton; and down-cycling markets for insulation and industrial rags. DSNY could contract with local textile recyclers to process textile waste and to realize its potential for reuse. To gain a more accurate picture of long-term lease space and contracting needs, program metrics (e.g., tonnage collected, state of available markets) could be used to inform recycling operations for the city's textile industry.

Goal: Increase City Support for Sustainable Businesses and Jobs

The move toward sustainable and circular practices and products presents an enormous opportunity for innovators and entrepreneurs. Studies and surveys continue to show that eco-consciousness is driving many consumers' purchase decisions. One study on corporate social responsibility, which surveyed a demographically representative sample of 1,000 Americans, found that those surveyed considered social- and eco-conscious brands far more favorably. For example, when considering brand loyalty, 88% of the survey respondents reported that they would be more loyal to such brands, while 87% expressed a willingness to purchase products that were socially or environmentally beneficial.[700]

Americans also seem willing to reward or punish a company based on its values and actions. For example, 87% of those surveyed said that they would purchase a product because the company advocated for an issue about which they care, and 76% would refuse to purchase from a company upon learning that it supported an issue contrary to their beliefs.[701] A similar survey, which examined the attitude of more than 1,100 American consumers, reported that people are also willing to pay more for products that were ethically sourced. Specifically, 52% of survey participants said that they would pay more for ethically-sourced food and drinks, and 45% expressed a willingness to do the same for ethically-sourced apparel and footwear.[702] Nearly a third of respondents stated that they would pay up to 5% more for these products, while just under a third would be willing to pay up to an additional 20%.[703] It is important for the government to partner with local businesses to assist them in both capitalizing on these new consumer attitudes and supporting the City's and the State's climate change goals.

Strategy: Partner to Hold Roundtables on Sustainable Businesses

Evolving consumer attitudes, together with innovations in waste reduction, energy efficiency, and the circular supply chain, are significant drivers of changes to the way businesses operate. In partnership with the Association for a Better New York (ABNY), the City Council will convene a series of roundtables where business leaders can share their best practices as they transition toward sustainability and circularity. These roundtables will be industry-specific, starting with the fashion and food industries, and will include small, medium, and large businesses.

There are numerous local stakeholders who have already implemented their own best practices to address climate change, but they typically work in silos. These roundtables will provide businesses with the opportunity to share their knowledge. By collaborating with other businesses in the supply chain and by sharing innovations, there is an opportunity for more local businesses to implement these best practices, which are both good for the environment and cost-effective. Collaboration will facilitate the growth of sustainable businesses in the city and provide our local players with a competitive edge in the new circular economy.

Strategy: Support Sustainable Small Businesses

The City Council will consider legislation requiring Small Business Services (SBS) to provide guidance to the city's small businesses on ways to reduce their environmental footprint. SBS could provide education, trainings, and share best practices with small businesses concerning strategies to improve efficiency, reduce waste and GHG emissions, and capitalize on environmental innovations. SBS could also assess current regulations to ensure that they do not hinder small businesses' ability to innovate towards sustainability and circularity. Ongoing input from small businesses themselves would be important to this process.

In Europe, various jurisdictions have taken this approach to cut red tape. For example, in 2007, the European Commission launched a program to reduce the administrative burdens of compliance with European Union regulation by over 25%.[704] Furthermore, member states such as Denmark instituted and convened

an advisory task force and a business forum to reduce the cost of compliance on businesses.[705]

Local Industry Focus: NYC's Sustainable Fashion Industry

The fashion industry is a crucial element of New York City's local and global identity, and the City has devoted numerous resources to ensuring that it continues to thrive. What has been overlooked thus far, however, is that this industry also represents a clear example of a sector that, with increased circularity, could significantly reduce its environmental impact. Given that garment manufacturing still represents approximately a third of all of New York City's manufacturing jobs,[706] and in view of this work being highly skilled and often paying livable wages,[707] it is crucial for this industry to become sustainable and for circular businesses to be fully supported.

Concern for the environment has caused a significant shift in the fashion industry at large. Leading brands and retailers are now incorporating business practices and products to address sustainability. Industry players representing all aspects and components of the supply chain have committed to various environmental targets, including those set in the United Nations' Fashion Industry Charter for Climate Action.[708] According to industry leaders surveyed for the State of Fashion 2020 report, sustainability is viewed as both "the single biggest challenge and the single biggest opportunity for the industry in 2020."[709] Some brands are leading the way, investing heavily in sustainable and circular textile development, new business models, and innovative technologies to ameliorate the impact of the industry on climate change.

Current Economic Development Corporation Funding Initiatives for Fashion

Recognizing the important role that the fashion industry plays in New York City, the Economic Development Corporation (EDC) has created different funding opportunities to support the City's fashion industry. These include:

- Made in NY: A label made available to fashion businesses who qualify to advertise their products as locally produced.[773]
- Fashion Manufacturing Initiative: In partnership with the Council of Fashion Designers of America (CFDA), EDC offers grants and funding opportunities to support local manufacturing and job development.[774]
- Fashion Future Graduate Showcase: An online and physical exhibition of designs from graduates of fashion colleges and design institutions in the City.[775]

Recommerce

Embracing the idea that waste can be a valuable resource, brands such as Patagonia,[710] Eileen Fisher,[711] and The North Face[712] have established secondary labels to sell used clothing. Under these "recommerce" models, brands take back clothing from customers, clean and repair the clothing, and then resell the items under a "renewed" label. Some brands even conduct this process in-house. Other brands, including Eagle Creek, Mara Hoffman, and Toad&Co, use the cleaning, repair, and resale services of companies like the Renewal Workshop, which employ sew technicians and other garment workers

to refurbish post-consumer apparel.[713] This approach to resale expands on secondhand clothing business models followed in thrift and consignment stores and through online platforms such as Thread Up.[714]

Textile Innovation

Cutting-edge, lab-based developments in materials generation and recycling hold promise for a more sustainable fashion future. Lab-grown leather,[715] fur, wool,[716] and silk[717] offer a path forward for fashion materials with expanded design possibilities and drastically reduced environmental impacts. Emerging cellulosic fibers utilize waste from other industries to make new textiles that, once they are eventually discarded, degrade more quickly than synthetic fibers.[718] Chemical recycling technologies transform waste into textiles over and over again.[719] Brands such as Stella McCartney have partnered with startups like BoltThreads to develop sustainable alternatives to conventional fashion materials.[720] Notably, much of this innovation has taken place in other localities, despite the fact that New York City offers the unique opportunity for development of new materials and technologies in close proximity to designers and feedstock (i.e., textile waste).[721] In addition, there are opportunities for investment and resource growth in this important new sector of the fashion industry.[722]

Support New York City's Sustainable Fashion Industry

The global fashion industry is transforming as it takes steps to mitigate its impact on climate change. Traditional approaches to fashion, where clothes are designed and manufactured through a linear supply chain and where the end of life of a garment is often not considered, are becoming a thing of the past. For New York City's fashion industry to remain robust into the future, the City should offer supports that are informed by developments in the sustainable and circular economy.

To secure the sustainability of the future of the city's fashion industry, the City should:

- Support the creation of a textile innovation lab to attract and support local textile research, development, and testing. This space could provide scientists and fashion designers with the tools necessary to develop new textile materials and ingredients through fermentation, polymers, and synthetic biology research, as well as to explore chemical and mechanical textile recycling capabilities. Adjoining office and conference room spaces could facilitate collaborative materials development and industry-wide education to advance sustainable solutions throughout the textile supply chain.
- Support the creation of a repair and renewal workspace. This space could employ sew technicians, dry cleaners, and other skilled garment workers to repair, clean, and refurbish worn, damaged, or returned items so that the clothes can be resold.
- Conduct a comprehensive report on the state and future of the fashion industry in New York City. The most recent analysis was conducted nearly a decade ago[723] and does not capture the market and consumer trends that are currently reshaping the industry.
- The EDC should prioritize providing assistance to local innovators who demonstrate a commitment to sustainability through their design and business practices.

Example of Green Fashion Label from the German Government

The German government has developed an initiative to certify sustainable fashion garments. Through this program, called the "Green Button," the government requires brands to meet 46 social and environmental standards, which are evaluated by independent bodies, before they are permitted to use the green button label. To avoid "greenwashing," the independent body tasked with certification evaluates the entire company, not just the brand's individual products.[724]

Goal: Extend the Life of Building Materials

Construction and Demolition Materials

Construction and Demolition (C&D) materials account for 25% to 45% of the total solid waste stream nationwide and for more than 60% in New York City.[725] The DSNY estimates that approximately 40% of the city's C&D materials are recycled, driven by cost savings.[726] There is currently no mandate for diversion of C&D material in the city.

Source separation generally yields the highest recycling rate and the best price for materials. The best opportunity for separation is during demolition and excavation.[727] However, site logistics in a dense area like New York City can make it difficult to accommodate multiple roll-off containers due to space constraints.[728] Construction sites can either source separate their materials or work with a transfer station off-site to sort the materials for a beneficial reuse.

C&D waste is managed almost exclusively in the city by private transfer stations and processors. Usually, a hauler provides contractors with containers of various sizes for the materials and then that hauler takes the containers to a waste transfer station and/or processing center. Transfer stations and processing centers can separate C&D materials to be recycled or reused, and the rest of the material is sent to a landfill.[729]

In November 2017, the DEC, through regulations, began requiring reporting about C&D waste.[730] Solid waste facilities, including transfer stations and processors, must now maintain a daily log of waste received—identifying waste type, quantity, and where it was generated—as well as recyclables removed from the facility.

Carpet

Recycling carpet is historically complicated since its markets are immature, and carpets are only fully-recyclable when the fibers can be separated from the backing and decontaminated. Carpet tile is considered to be much easier to reuse and recycle than other types of carpet, and it has a higher value on the recycling market.[731] Its modular design is also beneficial because tiles can be replaced without disposing of the whole carpet. In contrast, commercial broadloom, which is still used in many businesses and residences, is harder to recycle in part because the glue binding the fibers is a contaminant.[732] Increasing carpet recycling is important to help achieve zero waste.

Strategy: Recycle Construction and Demolition Materials

City Council will consider legislation requiring certain C&D materials to be recycled for beneficial reuse.

New York City could replicate steps other cities have taken to reduce the amount of C&D materials sent to landfill. For example, Oakland, California requires projects to recycle 100% of asphalt and concrete and 65% of all other materials.[733] Similarly, Seattle, Washington prohibits certain construction materials from landfilling, including asphalt paving, bricks, concrete, and metal.[734]

In some cases, the space to properly source-separate material for recycling on a New York City construction site is limited. To address this issue, there could be opportunities to secure additional permits from the Department of Transportation (DOT) to use street parking to facilitate recycling. C&D materials could also be separated and recycled at a waste transfer station or waste processing facility. Requiring certain materials at each construction site to be recycled would reduce the amount of waste sent to landfill and the need for new materials to be created. The legislation could also require that the City collect better data regarding the amount of C&D waste created and the amount being recycled to ensure that any mandate will be successfully implemented.

Strategy: Create a Building Material Database

Existing standards to measure GHG emissions for building materials can be a model for the City. This includes the International Organization for Standardization's (ISO) ISO 14000, which is a step-by-step approach for companies and government agencies to continuously measure and improve their environmental management efforts.

The City Council will consider legislation requiring the Department of Buildings (DOB) to create a building material database to rate common construction materials used and sold in New York City. This rating could be based on the material's sustainability, looking at factors like recyclability and GHG emissions from production. By utilizing this database, New Yorkers who purchase building materials can make more informed decisions about the environmental cost of materials.

Strategy: Pilot a Lifecycle Analysis of Construction Projects

The City Council will consider legislation requiring the DOB to develop and pilot a tool that would assess the lifecycle of construction projects. This tool could analyze the energy use and environmental impacts during the life of the project. The analysis could include the amount of GHG emitted during the extraction process of raw materials; manufacturing and transportation of finished materials; maintenance of the new structure; energy efficiency; potential for long-term preservation of buildings; and recyclability of construction and demolition materials.

The most effective method to reduce the environmental impact of construction waste is to prevent its generation as much as possible.[735] The lifecycle analysis tool could be used to inform architects, engineers, and contractors about construction techniques and materials that are more sustainable, efficient, and reusable and to ensure that new buildings in the city are built sustainably.

Strategy: Increase the Use of Recyclable Carpet

The City Council will consider legislation requiring the use of carpet tiles, or something of similar recyclability and reusability, in commercial buildings. Since carpet tiles are more easily recycled than other types of carpet, this will prepare the city for a future in which more carpet is recycled, rather than sent to landfill.

Goal: Reduce Waste

Single Use Plastics

Cheap production costs, durability, and broad functionality mean that plastics are a common feature of our lives. More than 320 million tons of plastics are consumed each year, and more plastics have been produced in the last decade than ever before.[736] Additionally, the use of plastics is expected to double over the next two decades.[737] While plastics last for decades or even centuries,[738] they are often single-use products. 95% of plastic packaging, for example, is used only once, and merely 14% of it is collected for recycling, despite plastics recycling being mandatory.[739] The World Economic Forum predicts that, under a business-as-usual scenario, **there will be more plastic in the ocean than fish by 2050**.[740] Followed by Japan and the European Union, the United States is the largest generator of plastic packaging waste on a per-capita basis.[741]

The Great Pacific Garbage Patch

Most plastics are also less dense than seawater, meaning that pieces of plastic float around the ocean and break down into smaller particles (microplastics)[742] that are consumed by fish and aquatic birdlife.[743] The ubiquity of plastics, their buoyancy, and our struggle to properly dispose of them means that there is now a land mass, known as the Great Pacific Garbage Patch, floating between the coasts of California and Hawaii. And 99.9 % of this patch, which is twice the size of Texas,[744] is composed of plastics.[745] Reducing the use and disposal of single use plastics will create significant environmental benefits, and is necessary to achieve a goal of zero waste in the future.

Strategy: Reduce Single-Use Plastics

The City Council will consider a package of legislation reducing the use of single-use plastics in New York City. This package of bills could include a broad study to determine the best way to reduce the distribution of single use plastics, including packaging. It could also include legislation that could reduce the ubiquity of specific single-use items, including straws, cups, utensils, and other food-ware.[746]

Mass Mailings

As a large percentage of junk mail in New York City is sent to be recycled without ever being opened, mass paper mailings create a significant expense for collecting and recycling

material that is not ever used.[747] Eliminating unwanted junk mail for New York City residents can therefore play a key role in supporting a circular economy by helping to effectively manage resources, minimizing both resource input and the creation of needless, expensive waste. Moreover, it is estimated that the energy used to produce, deliver, and dispose of junk mail produces more GHG emissions than annual emissions from 2.8 million cars,[748] and that the energy used to create and distribute junk mail in the United States for only one day could heat 250,000 homes.[749]

In New York City, paper represented almost 10% of the residential curbside aggregate discards in the year 2017,[750] all of which must be carried away at the City's expense. In addition, with New Yorkers receiving an estimated two billion pieces of junk mail annually,[751] only 32% of this junk mail is actually recycled. This results in 180 million pounds of junk mail going to landfill, costing the City more than $12.5 million annually.[752] However, the proliferation of junk mail continues. According to the United States Postal Service (USPS) Inspector General, advertising mail can generate nearly $20 billion in revenue for the USPS in a single year, and the USPS has expressed that it wants this "good news story" for mass paper mailings to continue.[753] The USPS even encourages and promotes the use of these mass mailings by providing a tool on its website (including a video) for businesses to plan and prepare mailings to targeted groups using the latest census data and by charging a much lower postal rate on mass mailings than on first-class mail.[754]

Strategy: Reduce Junk Mail

Benefits can be achieved at many levels by implementing a strategy both to facilitate the ease and efficiency of a mass-mailings opt-out for New Yorkers, and also to effectively educate the public about the various options available to stop unwanted paper mailings. Reducing unwanted mass mailings will save New York City the expense of collecting and recycling unused materials, as well as help conserve the Earth's forest resources and decrease GHG emissions from the production of paper. As the existing City website on opting out of paper mass mailings is limited in scope, cumbersome to use, and not widely known among New York City residents, an opt-out tool needs to be developed and publicized that incorporates both a greater ease of use and also an opportunity to opt out of additional kinds of paper mailings.

Conscious Consumerism

Conscious consumers consider the social, environmental, ecological, and political impacts of their spending habits. Consuming consciously does not require consumers to stop purchasing new goods and services; rather, it encourages them to think about how their consumption impacts the society-at-large. Shopping sustainably, considering the resources required for the manufacture and supply of commodities, and reusing and recycling products are all ways that a person may consume more consciously.

Fast-growing urban consumption is a key driver of climate change.[755] Urban consumption can have a significant impact on GHG emissions beyond a city's geographic borders by influencing global supply chains, since a product or service purchased by an urban

consumer has already generated emissions along the many links of the chain.[756] The production, processing, and consumption of commodities also requires extraction and use of natural resources. Commodities that we consume are responsible for up to 60% of global GHG emissions and between 50% and 80% of total land, material, and water use.[757]

The use of the commodities themselves also creates pollutants and waste.[758] For example, Unilever, a global business that creates more than 400 brands in 190 countries,[759] estimates that almost 70% of its carbon footprint depends on which products customers choose and on whether they use and dispose of them in a sustainable way.[760] Emissions in large cities throughout the world, as measured by what is consumed within the cities, will nearly double by 2050 if left unchecked.[761]

Cities are able to reduce GHG emissions, even beyond their city boundaries, by encouraging conscious consumption. A C40 Cities Climate Leadership Group report notes that changes in consumption in major cities will largely rely on consumer patterns and individual behaviors, as well as structural changes across supply chains and industries.[762] Cities can promote more conscious consumption by educating consumers on how to properly source separate and recycle materials, the benefits of reusing and recycling products, and how to shop more sustainably. By reusing and recycling products and shopping more sustainably, consumers in New York City would help reduce GHG emissions, prevent waste, keep products and materials in use, and create many health and economic benefits for city residents.

Strategy: Implement a Conscious Consumerism Campaign

The City Council will consider legislation implementing a conscious consumerism campaign to educate consumers and businesses on consumption practices that will benefit the consumer, businesses, and the environment. In addition to educating consumers on how to effectively recycle and reuse items, the campaign could include information about purchasing products and services that are ethically-sourced,

The Power of Conscious Consumerism

Keeping electronic goods and household appliances for longer (i.e. seven years, which is the optimum lifetime of laptops and similar electronic devices) instead of purchasing new products, will result in a total emissions reduction of 33% for appliances by 2050.[768]

Individual dietary change is the consumption category with the greatest potential for emissions reductions.[769] A report by the C40 Cities Climate Leadership Group,[770] entitled *The Future of Urban Consumption in a 1.5° C World*, estimates that if people in the C40 cities change their food consumption habits by 16 kilograms of meat per person per year, then food emissions could be cut by 51% by 2050.[771]

If all of the C40 cities reduce the number of new clothing and textile items by eight items per person per year, and half of the waste is reduced in the supply chain, then emissions in the clothing and textile category can be cut by 47% by 2050.[772]

the carbon footprint of companies, and about reducing an individual's carbon footprint. The goal would be to educate consumers about the connection between the goods and services they purchase and the environmental impact of the production, use, and disposal of those goods and services. [763]

Garbage on streets and in waterways can be frustrating to residents and can be expensive to clean up. Garbage in waterways can carry pathogens and toxins, which can put human health at risk when swimming or eating seafood that was exposed to those toxins. Dirty waterways also impact local wildlife that can mistake trash for food, which can lead to death because of suffocation, infection, or starvation.

Strategy: Use a Trash Wheel to Clean the City's Waterways[764]

Trash Wheels are sustainably-powered machines that can be placed in waterways to catch waste as it flows into the machine.[765] The first trash wheel collected more than one million pounds of trash in two and a half years.[766] In five years, trash wheels in Baltimore have collected approximately 11 million cigarette butts, 850,000 plastic bottles, 627,000 plastic bags, one beer keg, and one guitar. [767] The City should conduct a study in collaboration with experts in the field of marine waste and the city's waterways and deploy a trash wheel in New York City. The study could examine:

- The state of waste in the city's waterways;
- Case studies from Baltimore and other places with a trash wheel or similar apparatus;
- Effect of waste on environment/marine life and any risks to environment/marine life posed by a trash wheel;
- Proper disposal of items picked up by the trash wheel (recycling, landfill);
- Cost estimates;
- Timeline and build-out; and
- Effect of trash wheel on marine traffic.

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GREEN JOBS PIPELINE

Goals & Strategies

Goal: Build a Sustainable Workforce

- Focus Workforce Development on Green Jobs
- Facilitate a Conference on NYC Green Job Development
- Call for Offshore Wind Development Projects to Prioritize Green Jobs for Environmental Justice Communities
- Green Training and Certification for Home Improvement Contractors

Goal: Increase Work-Based Learning Programs that Focus on Green Jobs

- Create Additional CTE Programs Dedicated to Green Jobs
- Increase Green Job Focused Internships and Work-Based Learning Experiences for High School Students

Goal: Improve Access to Green STEM and Climate Change Education

- Expand Green STEM to All DOE Schools
- Expand Green STEM in After-School Programs
- Implement Climate Change Education in All New York Public Schools

Goal: Build Student Interest in Green Jobs

- Strategy: Increase Resources for Students Interested in Green Jobs

The move toward a sustainable and circular economy, new energy efficiency mandates, emissions reductions targets, resiliency planning, and other legislative and policy measures designed to fight climate change, all drive the growth of "green" jobs. In this landscape, workers require adequate training and skills to match newly created employment opportunities. It is also important for them to have an understanding of the environmental impacts of their work product and processes, so workers currently in a particular field can adapt to mitigation strategies developed for their industry.

New York City's passage of the package of bills known as the Climate Mobilization Act[776] exemplifies how new environmental regulations are driving a demand for green jobs. Modelling and analysis demonstrate that the enactment of Local Law 97, which sets strict greenhouse gas (GHG) emissions limits for most of the City's large-building stock, will drive both the retrofit market and the demand for skilled workers in this field.[777] Projections indicate that this law is expected to create at least 20,000 jobs over the next 10 years.[778]

Implementing policies and legislation that are able to both address climate issues and create new jobs is good governance. However, it is essential that resources and support are available to ensure a trained workforce is ready to fill these positions. Furthermore, as the move toward sustainability and circularity gains momentum, it is vital that the diverse population in New York City is able to fully capitalize on these workforce opportunities. This is especially true for frontline communities, who have historically suffered disproportionately negative health and environmental health effects from policy decisions that were not focused on their best interests and did not include their voice in the decision making process.[779] A just transition from a fossil fuel economy to a circular economy means sustainable jobs for these frontline communities.

Green jobs are good jobs. Not only do they assist in preserving the environment, strengthening the resiliency of the city, and making the city more habitable for residents, green jobs also often provide better salaries than their non-green counterparts. In its research on clean energy jobs, the Brookings Institution found that for clean energy workers, their mean hourly wages were 8% to 19% higher than the national average.[780] Furthermore, clean energy workers at the lower end of the salary scale were earning $5 to $10 more per hour than counterparts in other industries.[781]

Research from the Brookings Institution showed that, despite being paid more than their colleagues in other sectors, workers within the clean energy industry have lower educational requirements to enter into these jobs.[782] According to this research, for 50% of workers in the clean energy sector, a high school diploma is their highest level of education, and they earn more than similarly-educated workers in other fields.[783] The low educational entry point into these kinds of green jobs is useful in New York City, as half of the City's workforce does not have a bachelor's degree.[784]

Although there are many benefits of green jobs, a majority of the currently existing positions tend to be filled by a homogenous demographic. When compared to other occupations, "[t]he clean energy economy workforce is older, dominated by male workers, and lacks racial diversity."[785] Less than 20% of the clean energy production and energy efficiency sectors are female, and less than 10% of this workforce is Black.[786] New York City can increase the number of green jobs and diversity in the sector through a focus on workforce development and student pathways.

Defining a "green" job

As sustainability and environmental protection become policy priorities for legislators, activists, and business leaders, the concept of "green" jobs is becoming more pervasive. Despite its ubiquity today, the term has only existed in academic research for the past 15 years, and much debate continues to thwart a unanimous definition.[787]

The most common definition used in data analysis comes from the Bureau of Labor Statistics (BLS). According to the BLS, green jobs are either:

a. "[j]obs in businesses that produce goods or provide services that benefit the environment or conserve natural resources;" or
b. "[j]obs in which workers' duties involve making their establishment's production processes more environmentally friendly or use fewer natural resources."[788]

While the BLS definition provides a useful standard measure to track green jobs, it also deliberately avoids making judgements on the quality of these jobs, such as wages, benefits, or career opportunities.[789]

Given the gaps within the BLS classification, this paper adopts the definition provided by the International Labor Organization (ILO). Under the ILO description, green jobs preserve or restore the environment and can be in traditional sectors such as manufacturing and construction, or in new and emerging fields such as renewable energy and energy efficiency.[790] Additionally, under the ILO definition, a green job is also "decent"[791] work, meaning that it "involves opportunities for work that is productive and delivers a fair income, security in the workplace and social protection for families, better prospects for personal development and social integration, freedom for people to express their concerns, organize and participate in the decisions that affect their lives and equality of opportunity and treatment for all women and men."[792]

WORKFORCE DEVELOPMENT

In order to fully capitalize on the job growth potential caused by new environmental policies, whether that be through greening buildings, moving to renewable energy, planting trees, or making infrastructure more resilient, it is important to ensure that there is a ready pipeline of workers able to fill green job positions. In some instances, this will require elemental training and education to provide a solid foundation into a green career pathway. In other cases, incumbent workers will simply require upskilling to learn new efficiency or sustainability measures that supplement their existing expertise.

According to the International Labor Organization (ILO) as we move to a more sustainable economy, workers will require both technical skills, which are specific to each industry, and core, soft skills that offer a general understanding of sustainable development and environmentalism.[793] As detailed in the graphic

below,[794] the ILO also provides examples of the workforce sectors that are likely to change, due to a shift toward sustainability, and what types of occupations are expected to be created for both medium-skill level (MSL) and high-skill level (HSL).

SECTOR	NATURE AND EXTENT OF OCCUPATIONAL CHANGE TO DATE	EXAMPLES OF NEW AND CHANGING OCCUPATIONAL PROFILES
Renewable energy 	One of the most significant sectors for development of new occupational profiles, spreading into closely related existing trades (solar energy systems installation)	**MSL:** solar photovoltaic/wind turbine/ biomass systems: installers, technicians, plant managers, quality engineers **HSL:** engineers and system designers (overlap with manufacturing)
Environmental goods and services, including water and waste management 	Significant occupational change in waste and recycling, including R&D functions to create new or improved waste management and recycling New occupations of environmental consulting and environmental auditing	**MSL:** environmental engineering technicians; soil, waste and water engineers (conservationists); environmental science and engineering technicians; health and other protection technicians **HSL:** atmospheric and space scientists; soil and water conservationists; landscape architects; environmental engineers (restoration planners, certification specialists, economists); climate change analysts; industrial ecologists; energy managers (auditors)
Construction and building services 	Mainly skills being added on to and/ or adapted by existing occupations; all main trades and professions likely to be affected in some way, and increasingly, across all countries	**MSL:** carpenters, plumbers, electricians, heating engineers, roofers, painters and decorators, plasterers, building services technicians **HSL:** facilities managers, architects, engineers, energy auditors and energy consultants (overlap with environmental goods and services)
Manufacturing 	New skills are needed related to reduction of environmental impacts and this may involve new occupations, e.g. pollution control officers Most strongly affected are manufacturers involved in design and manufacture of products for the "greenest" sectors, e.g. renewable energy and green construction	**MSL:** occupations related to reducing environmental impacts, e.g. pollution control officers, energy auditors (overlap with environmental goods and services) **HSL:** occupations related to design and production of new products and systems, e.g. product designers, production engineers
Agriculture and forestry 	Mainly skills being added on to and/ or adapted by existing occupations. Greatest occupational effects likely to be felt at higher skill levels where new occupations are in demand	**MSL:** adoption of organic farming techniques; agricultural technicians involved in crop diversification, application of improved technologies. **HSL:** soil and water conservationists; environmental restoration planners (certification specialists, economists); water resource specialists and water/ wastewater engineers' agricultural meteorologists

SECTOR	NATURE AND EXTENT OF OCCUPATIONAL CHANGE TO DATE	EXAMPLES OF NEW AND CHANGING OCCUPATIONAL PROFILES
Transportation services 	Mostly changing existing occupations through addition of knowledge and skills, e.g. use of electric vehicles; conversion of existing vehicles to new technologies and compressed natural gas	**MSL:** occupations related to use, conversion (greening) and maintenance of existing vehicles **HSL:** R&D occupations related to design of greener transport systems, e.g. engineers, systems analysts
Tourism 	Mostly changing existing occupations through addition of knowledge and skills, e.g. eco-tourism	**MSL:** occupations related to eco-tourism
Extractive industries 	Mostly changing existing occupations through addition of knowledge and skills. Evidence of widespread effects to date lacking	**HSL:** R&D occupations related to design of greener extractive processes systems, e.g. engineers

There are a number of private training programs (some examples are described in the box below), available to New Yorkers that are designed to equip participants with the necessary skills to work in a green job. However, they may be costly for participants, have limited places available, or job seekers and incumbent workers are unaware of their existence. Industries supported by union workers have partnered with some private and not-for-profit providers in order to increase awareness of their programs and, in many instances, to cover the cost of the training. Through these initiatives, green job development opportunities have reached a wide audience; however, there is still a large proportion of the City's existing and potential workforce that could benefit from these and other newly developed programs.

Examples of green workforce development programs in New York City:

- NYC CoolRoofs: Launched in 2009, this program is coordinated through the Mayor's Office of Sustainability and the Sustainable South Bronx. Participants are offered 300 hours of paid work experience and can access training to gain certifications in programs such as Occupational Safety and Health Administration (OSHA), in exchange for painting a white, reflective coating on the City's buildings, in an effort to cool buildings and reduce energy use.[795]
- Green Jobs Corps: This initiative was launched by Mayor de Blasio in 2017 and aims to train 3,000 workers, over three years, in retrofitting and energy efficiency.[796]
- Green Professional Building Skills Training: Urban Green Council developed a national green training and certificate program that teaches those in the building trades how to create and maintain energy efficient and sustainable buildings.[797]
- Clean Energy Corps: Run by Green City Force, this is a six or 10 month full-time program that teaches young adults about greening the economy.[798] Four days a week the members are in the field engaging in hands-on work on projects that include conducting energy audits, community outreach, painting CoolRoofs, and engaging in urban farming.[799] One day a week the members undergo training that leads to certifications for entry-level work in energy efficiency and urban agriculture.[800] Members also "receive a monthly stipend, transportation, support services, job placement, and follow-up services."[801]
- Solar One: This New York City-based organization has a host of training and educational programs focused on urban sustainability.[802] In addition to offering workforce trainings related to green building maintenance, green construction, and solar panel installation,[803] Solar One works with teachers to offer its Green Design lab, which is a K-12 program that engages students in science, technology, engineering, and math (STEM) learning to teach about environmental sustainability.[804] Solar One has also partnered with the Fortune Society to offer workforce training to incarcerated and formerly incarcerated individuals, providing them with hands-on skills to enter into the solar installation workforce.[805]
- Green Commercial and Green Residential: 32BJ, an affiliate of the Service Employees International Union (SEIU), offers training to its members that can lead to careers in both green commercial and green residential building maintenance and operation.[806]

In 2009, the State legislature enacted the Green Jobs–Green New York (GJGNY) Act.[807] In addition to reducing energy consumption and GHG emissions, the GJGNY Act aims to create opportunities for the development of green jobs.[808] Funded through revenue from the sale of carbon emissions credits, GJGNY is able to provide financial incentives to residents wishing to switch their homes to renewable energy and fund training programs to support workforce development in green jobs.[809]

The New York State Energy Research and Development Authority (NYSERDA) is the link between public and private stakeholders working on transitioning the State to clean and

efficient energy use. In addition to providing research and analysis, NYSERDA is a key funding source that supports organizations, businesses, and institutions that have developed programs geared toward greening the economy. Currently, NYSERDA has nearly $70 million to boost workforce development in the clean energy sector. This funding is directed at on-the-job training initiatives, internships, and supporting training organizations and educators to teach their courses.[810] For example, up to $10 million of NYSERDA funding has been allocated to support clean energy businesses that offer on-the-job training or are committed to hiring more employees.[811] NYSERDA will pay up to $100,000 to such a business to mitigate employee wages.

Goal: Build a Sustainable Workforce

KEY STRATEGY: FOCUS WORKFORCE DEVELOPMENT ON GREEN JOBS

To help create and diversify green jobs, and to connect training providers, job seekers, and employers, the Mayor's Office of Workforce Development (WKDEV) should focus on green job development. Mayor de Blasio created WKDEV in 2014 and tasked it with partnering with City agencies, businesses, and educational institutions to increase opportunities for job seekers and businesses.[812] Despite launching various workforce development strategies, little attention has been paid to the enormous employment potential that the growing sustainable and circular economy brings. Environmental policies, new technologies, and changing consumer attitudes are transforming the marketplace and creating new workforce pressures. **As such, green jobs will be the jobs of the future.**

In order to assess green job growth and need, as well as to coordinate training and workforce development programs to ready New Yorkers for a clean energy and circular economy, the City should focus its efforts on building a sustainable workforce. In particular, WKDEV should be strengthened to:

- **Quantify and track the need for green jobs.** In order to capture a clearer picture of the City's growing need for a green-skilled work force, WKDEV should assess employer demands and potential for growth. If workforce development initiatives are to be successfully prioritized, WKDEV should evaluate what industries have the greatest need for green jobs, identify what those occupations are, and determine the level of education, training, and certifications required. Furthermore, WKDEV should highlight the areas facing the biggest shortfalls and make recommendations on how best to address this gap, including through the development of additional training programs.
- **Engage more sectors to evaluate the potential of green jobs.** Employers are best equipped to advise on the current and future workforce shortages in their industries. The Career Pathways[813] program has utilized this approach in a number of sectors. However, there is room for green job development within the currently engaged sectors like technology and construction, as well as in additional sectors that have yet to be examined, such as fashion. Through this process, WKDEV should

engage stakeholders to assist in identifying where green job potential exists and ensure appropriate workforce development programs. Additionally, WKDEV should look at government needs for a green workforce, including agencies such as NYC Department of Parks and Recreation (DPR) and NYC Department of Environmental Protection (DEP).

- **Assist New Yorkers in finding green job training and matching them with employment.** In order to match workers with training programs, WKDEV should maintain a database of available green job training initiatives offered throughout the city. This would help individuals access programs and training institutions promote their offerings to a larger number of New Yorkers. WKDEV should also work with businesses that need a skilled pipeline of workers and help connect these businesses with trained workers, as well as match workers with government and not-for-profit opportunities.
- **Promote and monitor diversity.** To ensure that green job opportunities are made available to the widest possible population, WKDEV should conduct, in partnership with relevant stakeholders, community outreach to promote the benefits of, and provide information on how to obtain, a green job. As part of this effort, WKDEV should perform outreach in traditionally marginalized and environmental justice (EJ) communities to inform residents about green job and training opportunities. If individuals lack particular prerequisites, WKDEV should refer individuals to community partners who provide these services. WKDEV should also monitor its outreach programs and the demographic trends in green jobs more broadly, and make recommendations on how to ensure that there is diversity within this career pathway.
- **Evaluate workforce development strategies.** WKDEV should also monitor the success of the City's workforce development programs. This can be done by tracking the job placements that stem from workforce development strategies, and by examining whether agencies are able to fill their green job-related positions. This could also include conducting surveys with job seekers, employees, and employers, to garner their opinions on the successful aspects of the initiatives.

Strategy: Facilitate a Conference on NYC Green Job Development

The City Council will work to facilitate a conference on the green job landscape in New York City. The conference will bring together government, academics, unions, business leaders, trade associations, training providers, environmental justice communities, and other stakeholders to discuss the barriers to, opportunities for, and the future of green jobs in New York City.

Strategy: Call for Offshore Wind Development Projects to Prioritize Green Jobs for Environmental Justice Communities

New York's statewide mandate is to produce 9,000 MW of offshore wind by 2035.[814] This provides a major opportunity for the creation of green jobs in the city. For example, two offshore wind projects currently in development, Sunrise Wind and Empire Wind, are expected to produce over 1,600 green jobs.[815]

The City should facilitate the development of its industrial waterfronts as hubs to manufacture and supply regional renewable energy needs and provide green jobs for EJ communities. New York State has stated that with private investments, it will mobilize $200 million in New York port facilities for offshore wind industry development.[816] In his 2020 State of the City address, Mayor de Blasio proposed that the City invest $57 million by 2024 for a hub for offshore wind apparatus manufacturing, installation, and maintenance at South Brooklyn Marine Terminal.[817] These investments must include appropriate training and sustainable jobs for residents of EJ communities. The City should also explore more opportunities for jobs focusing on offshore wind development, including at the Arthur Kills Terminal in Staten Island.[818]

Strategy: Green Training and Certification for Home Improvement Contractors

According to research conducted by the Pratt Center for Community Development, if half of New York City's homes were retrofitted with basic energy-saving measures (such as air-sealing, weather stripping, insulating basement pipes, etc.), it would save homeowners $255 million each year and would create more than 2,500 jobs.[819] In terms of the impact on reducing carbon emissions, retrofitting 1% of homes and 1.5% of commercial buildings each year could result in a reduction of 850 Mt of emissions.[820]

The City Council will consider legislation updating the licensing requirements for home improvement contractors to include green training and certification. Currently, a home improvement contractor license is required of a business or person engaging in: "construction, repair, remodeling, or other home improvement work" on residential properties.[821] As part of the application process, each licensee has to pass a home improvement exam, which consists of 30 questions relating to the basics of the City's home improvement business law, contracts and cancellations, advertising and selling practices, and general industry and business knowledge.[822] Updating these requirements will promote green-knowledge within this trade, and ensure that home contractors can implement the most energy-efficient and sustainable home improvements for their clients.

Student Pathways to Green Jobs

In recent years, there has been growing interest in career and technical education (CTE) at the national, state and local levels. CTE is seen as a promising approach to improve students' college and career readiness and prepare them for high-demand 21st century jobs. CTE offers career-specific education to students in high school and post-secondary school. In addition to preparing students for college and providing students with the opportunity to pursue topics of interest to them, CTE creates useful pathways into their careers of choice. According to the United States Department of Education, there is a profound skills gap in jobs that require mid-level skill development,[823] and CTE is considered an important avenue to bridge this gap. In addition to addressing the skills shortage, CTE offers beneficial outcomes for students, as research has shown that students who focused on CTE in high school had higher median salaries than their counterparts.[824]

At the end of 2018, New York City public schools offered 301 CTE programs across 135 schools, serving approximately 64,000 high school students.[825] This total was achieved after the addition of 47 new CTE programs as part of a multi-year $113 million investment in CTE.[826] According to data reported by DOE pursuant to Local Law 174 of 2016, more than 38% of students enrolled in CTE programs are Hispanic, 24% are Black, 19% are Asian, and 15% are White.[827] Further, girls comprise more than 44% of CTE students; 74% of CTE students are low-income; and nearly 16% are students with disabilities.[828] CTE students also graduate at higher rates than other City students. While the four-year graduation rate for all City students was 76% in 2018,[829] the four-year graduation rate for CTE students was 83%.[830] Similarly, the six-year graduation rate for CTE students was 87% in 2018,[831] compared to just 80% for students overall that year.[832]

Internships are an additional, work-focused education tool that provide students with insight into potential career paths. Learning through paid professional work experience in a safe and structured environment with help from experts can be invaluable.[833] Internships can help students master professional soft skills, practice and improve their industry skills, and learn what roles and responsibilities of a particular career are from people working in that field. Additionally, internships allow students, while also earning an income, to build a professional network and help them decide if a career in a specific industry is right for them.[834] In building a green jobs pipeline, it is vital to increase and expand the number of paid internships within green jobs.

Internships and work-based learning experiences

Internships and other work-based learning experiences are an essential part of career and technical education (CTE) programs. However, a survey of New York City CTE high school programs conducted by the Partnership for New York City in 2014, found a shortage of available internships.[835] Since then, the NYC Department of Education created a CTE Industry Scholars Program in 2017 that connected 600 CTE high school students from all five boroughs with paid internships at 189 employers, with the goal of providing 3,000 school-year and summer internships in 2019.[836] While this is a good start, it will not fulfill the thousands more internships needed. In July 2019, Mayor de Blasio announced the launch of a new initiative, CareerReady NYC, a partnership between City government, employers, educational institutions, and not-for-profit organizations to better align "education, career exploration, work experience, and youth development from middle school through college."[837] One explicit goal of the initiative is to build pipelines of workers for "the city's most dynamic sectors."[838] The City should tap into this new development and ensure that green jobs are a specific focus.

Goal: Increase Work-Based Learning Programs that Focus on Green Jobs

Strategy: Create Additional CTE Programs Dedicated to Green Jobs

Given the important role that CTE education plays in the current schooling system, DOE should create more CTE programs that provide pathways to green jobs, and find ways to link these students to potential workplaces. In reviewing applications for new CTE programs, the NYC Department of Education (DOE) should ensure that each program has at least one course dedicated to sustainability issues. Currently, New York City offers more than 300 CTE programs in 135 schools comprising 16 areas of study, many of which already integrate a focus on sustainability and green jobs, including: Agriculture, Food and Natural Resources; Architecture and Construction; Manufacturing Production; and Scientific Research and Engineering, among others. DOE should expand the number of these programs and highlight sustainability and green job potential in other areas of study. It's important that any new green jobs-focused CTE programs are created in a wide range of schools, so that students from all areas of the City have access to these programs in their local communities. Additionally, there should be more opportunities for CTE students to access worksites within their fields of study so that they can further develop their learning through hands-on experience.

Strategy: Increase Green Job Focused Internships and Work-Based Learning Experiences for High School Students

The City should also boost internships and other work-based learning experiences that focus on green jobs for New York City high school students. This should include partnering with local businesses who have an interest in sustainability or want to grow their green workforce in the future in order to meet the demands of a clean energy economy. Opportunities for students should include internships (paid or for credit), apprenticeships, afterschool or summer jobs, and service or experiential learning programs.

GREEN STEM

Over the past decade, governments[839] and business leaders[840] alike have acknowledged that education in the science, technology, engineering, and math (STEM) disciplines is important to the development of the modern workforce. As the transition toward sustainability increases, foundational skills in STEM subjects will be even more crucial. In fact, the New York City metro area already has the most clean energy jobs in the country,[841] and this demand is only expected to increase as new emissions targets and regulations are implemented.

While STEM subjects are required to be taught in every school, Mayor de Blasio's administration has sought to increase equity and access to high quality STEM instruction for students in the City's public schools with the introduction of initiatives such as Computer Science for All and Algebra for All.[842] Another initiative, called AP for All, was launched to provide all high school students with access to more rigorous instruction in math, the sciences, and other subjects by offering at least five Advanced Placement courses to students in every high school.[843] This drive toward greater equity in access to STEM instruction is critically

important given the lack of diversity in many STEM fields. For example, the gender gap in STEM jobs is well-known. While women comprise nearly half of the total U.S. workforce, less than 28% of the skilled technical workforce is female.[844] Racial disparities are even more striking. According to the most recent national data, in 2017, the skilled technical workforce was approximately 66% White, 18% Hispanic, and 10% Black.[845]

Green STEM utilizes student enthusiasm for learning about the environment to facilitate education in STEM subjects. Under this approach, tangible environmental projects or problems, such as recycling or water shortages, are tackled using STEM education.[846] Research by the National Wildlife Foundation found that integrating "environment based subject matter…has a positive impact on science learning, literacy, ability to apply learning to new situations, and the ability to work collaboratively."[847] Furthermore, evidence suggests "that environment based education has positive impacts on underserved populations as well as on educator enthusiasm and effectiveness."[848] Green STEM education provides not only a solid foundation in STEM disciplines, but also an introduction to environmental sustainability, both of which are elemental to a future green job.

Connecting students to real-life issues enhances their ability to comprehend a multitude of subjects. However, green STEM programs are not available in all schools; rather, availability is dependent upon the initiative of individual teachers or specific programs and partnerships. One such partnership is between the New York City Department of Education's Office of Sustainability and Solar One's K-12 Education Program—Green Design Lab.[849] Through this program, Solar One educators work with teachers and students to deliver its curriculum, provide professional development, and support school-wide sustainability projects, including school-wide energy reduction challenges.

STEM teaching that is implemented within after-school programming has also shown a number of benefits. According to the Afterschool Alliance, evaluations of after-school STEM programs suggest that students who engage in this programing have a more positive attitude toward STEM subjects and careers, greater knowledge of STEM concepts and skills, and are more likely to graduate and pursue a STEM career.[850] Furthermore, a recent (2019) study that surveyed students who were learning STEM in after-school programs found that 65% to 85% of those students increased their knowledge, career interest, and engagement in STEM and that their relationships, critical thinking, and perseverance skills also improved.[851]

Goal: Improve Access to Green STEM and Climate Change Education

Strategy: Expand Green STEM to All DOE Schools

DOE should partner with organizations and learning institutions who have developed green STEM curricula in order to expand green STEM programing to all DOE schools. New York State Learning Standards require that all students receive instruction in life and earth sciences, including information about the environment and ecosystems, weather, and climate. However, that does not ensure that all students are engaged in the type of hands-on, project-based

learning that tackles environmental problems emblematic of green STEM programs. This type of project-based learning connected to real-life issues is more engaging for students, enhances their ability to collaborate with others, and prepares them for success in the future.[852]

Strategy: Expand Green STEM in After-School Programs

DOE should expand green STEM in after-school programs. Currently, the majority of after-school programs are funded by the City, including the Comprehensive After School System of NYC (COMPASS NYC), which serves students in grades K-12, and School's Out New York City (SONYC) for students in sixth through eighth grades. The COMPASS Elementary model primarily includes literacy instruction, homework help, basic arts instruction, and physical activity. SONYC is structured like clubs and offers middle school students choices and opportunities in sports and arts, leadership, and service activities and trips.[853] While neither the COMPASS nor SONYC models include a green STEM focus, some individual programs may incorporate green STEM activities. The City Council also directly funds a number of other programs through an Afterschool Enrichment Initiative, at almost $6.8 million in Fiscal Year 2020, including Wildlife Conservation Society programs. One notable example of a green STEM after-school program, funded in part by the City Council, is the Green Girls After School program operated by the City Parks Foundation at two schools in Brooklyn and one each in Queens and the Bronx.[854] As previously noted, such programs have been shown to increase STEM knowledge and skills, as well as interest in STEM careers.

Strategy: Implement Climate Change Education in All New York Public Schools

Our response to climate change will be felt for generations. As keepers of this future, students should be provided with a complete and accurate picture of how human activity affects the Earth and how the world can mobilize to address the impacts of climate change. In a landscape where attitudes toward science have become more hostile, with fear and doubt being used to sew confusion, it is vital for students to be provided with evidence-based education on climate change.

Goal: Build Student Interest in Green Jobs

For students to fully take advantage of the career opportunities within a greening economy, they will require vocational information and guidance. The changing nature of green jobs, be that in traditional professions that are being "greened," or in new and emerging occupations, means that students will need to be cognizant of the prerequisites of their preferred career and useful pathways to achieve such positions.

Strategy: Increase Resources for Students Interested in Green Jobs

The City should develop resources to assist students to learn about and prepare for green jobs, including:

- **Creating an environmental sustainability/ green STEM resource handbook.** The City should create a handbook that provides contact information and descriptions about not-for-profits, organizations, and agencies that offer programs within the city that are related to environmental sustainability. This resource could assist students interested in pursuing a career in the field of green jobs.

- **Making green STEM resource coordinators available to DOE schools.** The City should ensure that students have the opportunity to learn about green jobs while in school by having green STEM resource coordinators visit schools across the city and provide information and assistance to students interested in pursuing a green job.
- **Updating and expanding DOE's Career Maps.** DOE should examine its current Career Maps in order to identify potential green job opportunities in all sectors. For example, DOE currently has a Career Map focused on green jobs within the construction industry,[855] but there are many industries that offer sustainability-focused jobs, and these opportunities and pathways should be highlighted in all Career Maps

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APPENDICES

APPENDIX 1 - RECENT CLIMATE STUDIES

Fifth Assessment Report of the Intergovernmental Panel on Climate Change

The Intergovernmental Panel on Climate Change (IPCC) is a United Nations (U.N.) body responsible for assessing climate science.[856] The IPCC's primary function involves producing comprehensive assessment reports on "the scientific basis of climate change, its impacts, its future risks, and options for adaptation and mitigation."[857] The IPCC released its fifth and most recent assessment report in 2014.[858] The report incorporates data from three working groups: the first tasked with assessing the scientific bases of climate change, the second tasked with assessing the vulnerability of socio-economic and natural systems, and the third tasked with assessing options for mitigation.[859] The report also incorporates data from a task force on National Greenhouse Gas Inventories, which develops standards, methodologies, and software for the calculation and reporting of national GHG emissions and removals.[860]

In the report, the IPCC confirms the core assertions about anthropogenic climate change noted above. Specifically, the report confirms that "human influence on the climate system is clear," that "recent anthropogenic emissions of greenhouse gases are the highest in history," and that "warming of the climate system is unequivocal."[861] The report also finds that global surface temperatures are likely to continue rising over the 21st century under a wide range of possible emissions scenarios. In addition, the report predicts that:

- heat waves will continue to increase in duration and frequency;
- extreme precipitation events will continue to occur with greater intensity and frequency across many regions;
- oceans will continue to become warmer and more acidic; and
- the global mean sea level will continue to rise.[862]

The report also anticipates that these impacts will be unevenly distributed, with the greatest harm falling on disadvantaged communities in countries at all levels of development.[863]

Furthermore, the report notes that many aspects of climate change are already "baked in," such that even if global GHG emissions cease, the impacts of climate change are likely to continue for centuries.[864] However, the report notes that the risk of truly catastrophic impacts only increases with further emissions.[865] The report also acknowledges the potential for adaptation to reduce or manage the risks of climate change, but notes that absent efforts to curtail GHG emissions, warming by the end of the 21st century is likely to lead to "severe, widespread, and irreversible" impacts on a global scale.[866] Furthermore, the report notes that there are opportunities for mitigation across every major

sector of the economy, and that meaningful mitigation will require effective policies and initiatives from all levels of government, from the international down to the local.[867]

Fourth National Climate Assessment of the United States Global Change Research Program

The United States Global Change Research Program (USGCRP) is a federal program that is mandated by Congress to coordinate federal research on climate change and its impacts on society.[868] As part of its fourth quadrennial assessment on climate change, the USGCRP recently released a two-volume report. The first volume, released in 2017, analyzes the effects of global warming on the physical earth system across the United States.[869] The second volume, released in 2018, addresses issues related to the human, societal, and environmental impacts of climate change.[870]

The report finds that more frequent and intense extreme weather events, combined with gradual changes in average climate conditions, will likely damage infrastructure, ecosystems, and social systems on which communities throughout the country rely.[871] The report also predicts that impacts will not be distributed equitably within and across regions.[872] Communities in the United States that are already vulnerable, including lower-income and other marginalized communities, are expected to have fewer resources to prepare for climate impacts and therefore are expected to experience greater harms.[873]

The report also concludes that regional economies and industries that rely heavily on natural resources—including agriculture, tourism, and fishing—are likely to be harmed by climate change.[874] In addition, climate change is expected to affect various aspects of global trade, "including import and export prices, as well as U.S. businesses with overseas operations and supply chains."[875] If GHG emissions continue to increase at historic rates, the report predicts that the annual cost to the United States economy could be in the "hundreds of billions of dollars" by 2100.[876]

According to the report, climate change is expected to reduce the quality and quantity of vital natural resources, and allow pathogens, agricultural pests, and diseases to find footholds in new regions.[877] As the ecosystem continues to degrade, many of the vital services that it provides, such as flood control, water purification, and crop pollination, will degrade as well, further increasing the burden on communities and the economy.[878] Additionally, the increase in extreme weather events presents a significant threat to the state of an already stressed national infrastructure system.[879]

IPCC Special Report on Global Warming of 1.5°C

In October 2018, the IPCC released a special report on the impacts of global warming beyond 1.5°C above pre-industrial levels.[880] The IPCC report found that human activities have already caused warming within a likely range of 0.8°C to 1.2°C, and that if warming continues at its current rate it is likely to reach 1.5°C between 2030 and 2052.[881] According to the IPCC, if global warming reaches 2°C above pre-industrial levels, some impacts will be long-lasting and irreversible.[882]

Studies of Warming Beyond 2°C

One recent study found that under a "business-as-usual" scenario where humans continue to emit GHGs at a rapid rate, there is a 50% chance that global average temperatures will rise to about 4°C above pre-industrial levels by 2100, and a 5% chance they will rise even higher, representing what researchers refer to as "existential/unknown" levels.[883] According to an analysis by the World Bank, 4°C of warming above pre-industrial levels could be "devastating," leading to the inundation of coastal cities, food security risk, unprecedented heat waves, substantially exacerbated water scarcity, more intense tropical cyclones, and irreversible loss of biodiversity.[884] Another study found that just less than 4°C of warming would produce $551 trillion in global damages.[885] By comparison, total worldwide wealth today is about $360 trillion.[886]

APPENDIX 2 - THE U.N.'S SUSTAINABLE DEVELOPMENT GOALS

Since June 1992, Member States of the U.N. and other countries have worked to ensure sustainable development globally with the main goal of improving human lives and the environment. Built on decades of work, sustainable development goals (SDGs) were created as global strategies to "improve health and education, reduce inequality, and spur economic growth—all while combating climate change and working to preserve the Earth's oceans and forests."[887] The U.N.'s 2030 Agenda for Sustainable Development, which was adopted by all U.N. Member States, "provides a shared blueprint for peace and prosperity for people and the planet, now and in the future."[888] The 17 SGDs are an important aspect of this blueprint:

- Goal 1. No poverty: End poverty in all its forms everywhere.
- Goal 2. Zero Hunger: End hunger, achieve food security and improved nutrition and promote sustainable agriculture.
- Goal 3. Good Health and Well-Being: Ensure healthy lives and promote well-being for all at all ages.
- Goal 4. Quality Education: Ensure inclusive and equitable quality education and promote lifelong learning opportunities for all.
- Goal 5. Gender Equality: Achieve gender equality and empower all women and girls.
- Goal 6. Clean Water and Sanitation: Ensure availability and sustainable management of water and sanitation for all.
- Goal 7. Affordable and Clean Energy: Ensure access to affordable, reliable, sustainable and modern energy for all.
- Goal 8. Decent Work and Economic Growth: Promote sustained, inclusive and sustainable economic growth, full and productive employment and decent work for all.
- Goal 9. Industry, Innovation, and Infrastructure: Build resilient infrastructure, promote inclusive and sustainable industrialization and foster innovation.
- Goal 10. Reduced Inequalities: Reduce inequality within and among countries.

- Goal 11. Sustainable Cities and Communities: Make cities and human settlements inclusive, safe, resilient, and sustainable.
- Goal 12. Responsible Consumption and Production: Ensure sustainable consumption and production patterns.
- Goal 13. Climate Action: Take urgent action to combat climate change and its impacts.
- Goal 14. Life Below Water: Conserve and sustainably use the oceans, seas, and marine resources for sustainable development.
- Goal 15. Life on Land: Protect, restore, and promote sustainable use of terrestrial ecosystems, sustainably manage forests, combat desertification, halt and reverse land degradation, and halt biodiversity loss.
- Goal 16. Peace, Justice and Strong Institutions: Promote peaceful and inclusive societies for sustainable development, provide access to justice for all, and build effective, accountable, and inclusive institutions at all levels.
- Goal 17. Partnerships for the Goals: Strengthen the means of implementation and revitalize the global partnership for sustainable development.[889]

GLOSSARY

80x50: New York City's requirement pursuant to Local Law 66 of 2014 to reduce citywide greenhouse gas emissions to 80% below 2005 levels by 2050.

Allowance: an authorization to emit, during a specified year, up to one ton of carbon dioxide equivalent.[890]

Anthropogenic climate change: human caused climate change.

ASCE-24: the American Society of Civil Engineers' (ASCE) published standard for Flood Resistant Design and Construction. ASCE-24 specifies, among other things, the minimum amount of freeboard that should be designed for different building classes. The Federal Emergency Management Agency (FEMA) deems ASCE-24 to meet or exceed the minimum National Flood Insurance Program (NFIP) requirements for buildings and structures. It is a referenced standard in Appendix G of the New York City Building Code.

Base flood elevation (BFE): the elevation, above a standard datum, of the water surface during a 1% annual chance, or base, flood. The BFE is provided on Flood Insurance Rate Maps rounded up to the nearest whole foot, and includes a factor for any expected wave action.

Baseload power: the minimum amount of power that a utility or distribution company must generate for its customers, or the amount of power required to meet minimum demands based on reasonable expectations of customer requirements.[891] In the past, sources of baseload power came mostly from coal and nuclear facilities. Sources of renewable baseload power include geothermal, biomass, and hydro power.[892]

Battery electric vehicle (BEV): an all-electric vehicle with rechargeable batteries and no gasoline engine.[893]

Berm: a raised bank, shelf, or barrier above the water level at high tide.

Breakwater: a barrier built out into a body of water to protect a coast or harbor from the force of waves.

Cap and trade: a policy where the government sets an emissions cap and issues a quantity of emission allowances consistent with that cap. Emitters must hold allowances for every ton of greenhouse gas they emit. Companies may buy and sell allowances, and the market establishes an emissions price. Companies that can reduce their emissions at a lower cost may sell any excess allowances for companies facing higher costs to buy.[894]

Carbon capture: a process that involves trapping the carbon dioxide at its emission source, transporting it to a storage location, and isolating it.[895]

Carbon dioxide equivalent: the amount of carbon dioxide by mass that would produce the same global warming impact as a given mass of another greenhouse gas over an integrated 20-year timeframe after emission.[896]

Circular economy: an economic system aimed at minimizing waste and making the most of resources.

Clean energy: energy derived from renewable, zero-emissions sources, as well as energy saved through energy efficiency measures.[897]

Closed-loop recycling: a production process in which post-consumer waste is collected, recycled, and used to make new products. This process can be as simple as using recycled aluminum to make new cans, or as complicated as weaving reclaimed plastic bottles into polyester for clothing and other products. For the closed-loop system to function properly, consumers, recyclers and manufacturers must work together to reclaim valuable materials from the waste stream and use them to make new products.

Coastal flooding: flooding that inundates land from the ocean, as opposed to riverine flooding.

Combined sewer overflow (CSO): a sewer system overflow during which sewage combines with rainwater and is discharged into the City's waterways. Generally, this is the result of heavy rain.

Community choice aggregation: also known as municipal aggregation, are programs that allow local governments to procure power on behalf of their residents, businesses, and municipal accounts from an alternative supplier while still receiving transmission and distribution service from their existing utility provider.[898]

Co-pollutants: hazardous air pollutants produced by greenhouse gas emissions sources.[899]

Curtailment: when a system operator decreases the output from a power source from what it will normally produce.[900]

Demand reduction: reducing the need for the service or for materials to provide the service.[901]

Design flood elevation (DFE): the elevation, above a standard datum, of the flood being used as the basis of design for a building or flood protection structure. DFE is also often used to refer to the final design elevation, including the BFE plus required freeboard, and any adjustments to account for projected sea level rise.

Distributed energy: distributed energy is on-site generation, storage, and delivery of power for business of every size.[902]

Downcycling: recycling a material by partially replacing the use of the primary material.[903]

Electric distribution: the transport of electricity from large substations to smaller ones and ultimately to homes, businesses, and other customers.[904]

Electric power grid: the layout of an electrical distribution system that connects providers with consumers. In the United States, the electric grid consists of three systems: Eastern Interconnect, the Western Interconnect, and the Texas Interconnect.[905]

Electric transmission: the transport of electricity at high voltages from the place of generation to large substations.[906]

Electric vehicle supply equipment (EVSE): a charger that is connected to the electric grid.[907]

Energy aggregation: also known as electricity aggregation, is when a group of people, usually a city, combines their buying power and chooses one energy supplier for the entire group.[908]

Energy efficiency: using less energy to perform the same task; eliminating energy waste.[909]

Energy generation: also known as electrical generation, is the generation of electricity from fossil fuels, nuclear power plants, hydro power plants, geothermal systems, solar panels, biofuels, wind, etc.[910]

Energy grid: also known as the electrical grid, is the electrical power system network comprised of the generating plant, transmission lines, the substation, transformers, distribution lines, and the consumer.[911]

Energy use intensity: the amount of energy used by a building per square foot per year.

Extended producer responsibility (EPR): "an environmental policy approach in which a producer's responsibility for a product is extended to the post-consumer stage of a product's life cycle. An EPR policy is characterized by: (1) The shifting of responsibility (physically and/or economically; fully or partially) upstream toward the producer and away from municipalities; and (2) The provision of incentives to producers to take into account environmental considerations when designing their products. While other policy instruments tend to target a single point in the chain, EPR seeks to integrate signals related to the environmental characteristics of products and production processes throughout the product chain."[912]

Fast fashion: cheaply-made and sold, often poor quality and mass-produced clothes that are manufactured and sent to the market at a rapid speed. Over the past few decades, fast fashion has become the standard profitability model for fashion retailers. Rather than following the traditional fashion model of releasing new designs at each season, fast fashion launches new products multiple times a month, encouraging consumers to continually update their wardrobes. Additionally, because of the relatively cheap price tag, the constant changing trend creates a "wear-once" mentality where clothes are discarded and replaced as quickly as they were purchased.

Flood Insurance Rate Map (FIRM): a map produced by FEMA after an engineering study, to delineate Special Flood Hazard Areas in National Flood Insurance Program (NFIP) communities. These maps establish areas where flood insurance is required and provide the base flood elevation in these areas. These maps also delineate areas with a 0.2% annual chance of flooding, also known as the 500-year flood plain, and areas with a 1% annual chance of flooding, also known as the 100-year flood plain.

Floodplain: a generally flat area of land subject to flooding. Sometimes used to refer generally to areas where there is known flood risk.

Freeboard: the additional elevation above the BFE used as a safety factor in designing structures in the floodplain; often one foot. The term originates from sailing where it refers to the portion of a ship's hull above the water line.

Gigawatt (GW): a unit of energy equal to 1,000 megawatts or one billion watts. In 2012, the total capacity of U.S. electricity generating plants was approximately 1,100 GW.[913]

Green infrastructure: water management practices such as vegetated rooftops, roadside plantings, absorbent gardens, and other measures that capture, filter, and reduce stormwater.[914]

Greened acre: a metric to measure the progress of green infrastructure projects. One greened acre = one acre of impervious area that has at least the first inch of runoff managed by stormwater infrastructure.

Greenhouse gas emission limit: the maximum allowable level of statewide greenhouse gas emissions, in a specified year, expressed in tons of carbon dioxide equivalent.[915]

Greenhouse gas: gases that trap heat in the atmosphere,[916] including carbon dioxide, methane, nitrous oxide, hydrofluorocarbons, perfluorocarbons, and sulfur hexafluoride.[917]

Greenhouse gas emission offset: a deduction representing one metric ton of carbon dioxide equivalent emissions, reduced, avoided, or sequestered by a greenhouse gas emission offset project from a measured baseline of emissions pursuant to the statewide greenhouse gas emissions report.[918]

Greenhouse gas emission offset project: a capital project, including, but not limited to, afforestation, reforestation, or wetlands restoration; greening infrastructure; restoration and sustainable management of natural and urban forests or working lands, grasslands, coastal wetlands and sub-tidal habitats; efforts to reduce hydrofluorocarbon refrigerant, sulfur hexafluoride, and other ozone depleting substance releases; anaerobic digesters; carbon capture and sequestration; and ecosystems restoration.[919]

Groin: a long, narrow structure built out into the water from a beach to prevent beach erosion or trap and accumulate sand that would otherwise drift along the beach face and nearshore zone.

Heavy-duty vehicle: a vehicle that has a maximum weight limit over 26,001 pounds.[920]

Impervious area: land surface impenetrable by water (e.g. concrete).

Intermittent power: electrical energy that is not continuously available due to external factors that cannot be controlled.[921]Sources of intermittent power include solar power, wind power, tidal power, and wave power.[922] Although solar power and tidal power can be predicted by calculating the length of days, weather patterns, and tidal period, they are still considered intermittent because of the limited time period electricity can be produced.[923]

Kilowatts and kilowatt-hours: "what show up on your electricity bill, describing how much electricity you have used. One kilowatt (kW) equals 1,000 watts, and one kilowatt-hour (kWh) is one hour of using electricity at a rate of 1,000 watts."[924]

Low energy intensity building: a building with an energy use intensity that satisfies the requirements of Local Law 31 of 2016.

Level 1 EVSE: electric vehicle supply equipment that provides charging through a 120V alternating current plug and does not require installation of additional charging equipment (i.e., it can be plugged into a standard outlet). It can deliver two to five miles of range per hour of charging. Most often used in homes, but sometimes it is used at workplaces.[925]

Level 2 EVSE: electric vehicle supply equipment that provides charging through a 240 volt (for residential) or 208 volt (for commercial) plug and requires installation of additional charging equipment. It can deliver 10 to 20 miles of

range per hour of charging. It is used in homes, workplaces, and for public charging.[926]

Level 3/DC Fast Charge (DCFC) EVSE: electric vehicle supply equipment that provides charging through a 480 volt alternating current input and requires highly specialized, high-powered equipment as well as special equipment in the vehicle itself (plug-in hybrid electric vehicles typically do not have fast charging capabilities). It can deliver 60 to 80 miles of range in 20 minutes of charging. Used most often in commercial and industrial applications, and in public charging stations, especially along heavy traffic corridors.[927]

Life cycle: the entire process a consumer product goes through, "from materials extraction to product distribution, customer use, and disposal."[928]

Life extension (and refurbishment): extending the life of a product through design or repair.[929]

Light-duty vehicle: a passenger vehicle that has a maximum weight limit of 10,000 pounds.[930]

Lightweighting: reducing the amount of material needed for a given service.[931]

Living shoreline: shoreline techniques that incorporate natural living features alone or in combination with structural components such as rock, fiber rolls, bagged shell, and concrete shellfish aggregate; used to control or reduce erosion while incorporating habitat enhancement and natural features.

Medium-duty vehicles: vehicles that have weight limits between 10,001 and 26,000 pounds.[932]

Megawatt (MW): a unit of energy equal to 1,000 kilowatts or one million watts. For example, a typical coal plant is about 600 MW in size."[933]

Microgrid: a local energy grid, which can disconnect from the traditional grid and operate autonomously.

National Flood Insurance Program (NFIP): a program created by Congress in 1968 through the National Flood Insurance Act of 1968 (P.L. 90-448). The twofold purposes of the NFIP are to share the risk of flood losses through flood insurance and to reduce flood damages by restricting floodplain development. The program enables property owners in participating communities to purchase insurance protection, administered by the government, against losses from flooding, and requires flood insurance for all federally-guaranteed loans or lines of credit that are secured by existing buildings, manufactured homes, or buildings under construction, that are located in the Special Flood Hazard Area (SFHA) in a community that participates in the NFIP. New York City is a participating community.

New York City Panel on Climate Change (NPCC): an independent panel of scientists modeled on the United Nations Intergovernmental Panel on Climate Change, which prepares New York City-specific climate change projections. These reports must be prepared not less than every three years under Local Law 42 of 2012.

Operational carbon: the emissions of carbon dioxide during the operational or in-use phase of a building.[934]

Organics: yard waste, food scraps, and food soiled paper that can be collected to create

compost, used to improve soil, or used to create renewable power.

Overgeneration condition: a condition that occurs when the supply of power could exceed demand and without intervention, generators and certain motors connected to the grid would increase rotational speed and cause damage.[935] The overgeneration risk occurs when the system operator cannot reduce the supply.[936]

Plug-in hybrid electric vehicle (PHEV): a hybrid vehicle whose battery can be recharged by plugging it into an external source of electric power, as well as by its on-board engine and generator.[937]

Post-consumer: the part of the life cycle of a product which takes place after the consumer has used the product.

Product and component reuse: the remanufacturing and refurbishing of materials or components.[938]

Product stewardship: "[t]he act of minimizing the health, safety, environmental, and social impacts of a product and its packaging throughout all lifecycle stages, while also maximizing economic benefits. The manufacturer, or producer, of the product has the greatest ability to minimize adverse impacts, but other stakeholders, such as suppliers, retailers, and consumers, also play a role. Stewardship can be either voluntary or required by law."[939]

Reclaimed asphalt pavement (RAP): reprocessed pavement materials containing asphalt and recyclables. Pavement with a higher RAP ratio is generally regarded as more sustainable for its effective use of recycled materials.

Renewable energy: energy from sources that are naturally replenishing but flow-limited. Renewable resources are virtually inexhaustible in duration but limited in the amount of energy that is available per unit of time.[940]

Revetment: a shoreline protection technique constructed of large rocks or concrete armor units that slope toward the shore, providing a high degree of protection against erosion, inundation, or storm-induced flooding.

SAE J1772: the standard connector and receptacle for electric vehicles (EVs). Most vehicles have this, and any vehicle with this plug receptacle can use any Level 1 or Level 2 EVSE. All major vehicle and charging system manufacturers support this standard.[941] There is currently no fast charging, consistent standard connector. There are three types: SAE International, which has a standard that adds high-voltage direct current power contact pins to the Level 1 and Level 2 connector; CHAdeMO, which is a fast-charge connector on some EVs, such as the Nissan Leaf and Mitsubishi i-MiEV; and the Tesla Supercharger system, which can only be used by Tesla vehicles (Tesla vehicles can use the CHAdeMO connectors through an adapter).

Sea level rise: the observed rise in mean sea level due to climate change and other factors.

Seawall: onshore structures with the principal function of preventing or alleviating overtopping and flooding of the land and structures behind the wall due to storm surges and waves.

Smart grid: an energy grid that allows two-way communication between the energy utility and the consumer. The smart grid allows for sensing along the transmission lines, and consists of controls, computers, automation, and new technologies and equipment working together, which make it a smart grid. These abilities will work with the electrical grid to respond digitally to quickly changing electric demands.[942]

Special flood hazard area (SFHA): an area subject to inundation by a potential flood that has a 1% or greater chance of being equaled or exceeded during any given year. This type of flood is often referred to as the 100-year flood or base flood. SFHAs are delineated on flood insurance rate maps.

Storm surge: an abnormal rise of water caused by the wind and pressure of a cyclonic storm, such as a hurricane.

Storm tide: the water level rise due to the combination of storm surge and the astronomical tide.

Stormwater: runoff or floodwater resulting from rainfall during a storm.

Surge barrier or flood barrier: a floodgate designed to prevent a storm surge or spring tide from flooding the protected area behind the barrier.

Terawatt (TW): a unit of energy equal to 1,000 gigawatts or one trillion watts.

Tidal flooding: flooding resulting only from astronomical tide cycles, sometimes called "nuisance flooding" or "sunny day flooding."

Tidal range: the height difference between high tide and low tide over a tidal cycle. Changes in tidal range occur as the sun's position changes north or south of the equator.

Tides: very long-period waves that move through the oceans in response to the forces exerted by the moon and sun. Tides originate in the oceans and move toward the coastlines where they appear as the regular rise and fall of the sea surface.

Transit oriented development (TOD): the creation of compact, walkable, pedestrian-oriented, mixed-use communities centered around high-quality transit.

Urban heat island effect: the increase in urban air temperature as compared to surrounding suburban and rural temperature. An urban heat island is created when naturally vegetated surfaces–e.g., grass and trees–are replaced with non-reflective, water-resistant impervious surfaces that absorb a high percentage of incoming solar radiation.

Zero Emission Vehicle (ZEV): a vehicle that does not directly emit greenhouse gases or other gaseous pollutants. This primarily refers to electric vehicles.

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