

*“Composting the Big Apple: Climate Mitigation Efforts in New
York City”*

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Abstract

55% of the world's population lives in cities(United Nations 2018). Cities are responsible for high pollution levels, with urban areas making up for 67% of greenhouse gases (World Bank 2018). The question is what are cities doing to mitigate climate change since urban areas are massive contributors to pollution? International organizations are in place for cities to partner together on the topic of climate change. The New Urban Agenda gives cities a framework to mitigate climate change while the C40 transnational climate network gives city leaders the opportunity to share ideas on addressing climate change. To understand the progress cities have made, Helsinki and Copenhagen are closer to a zero-carbon reality. When looking at New York City's effort compared to other cities, New York City has made progress in reducing its carbon dioxide level, but the city still has room for improvement. New York City has seen a decrease in carbon dioxide in the building sector and the waste sector. There has been only a .1 percent decrease in emissions from transportation between 2014 and 2015. Looking at specific policy, New York City must be pushing for sustainable alternatives that lower greenhouse gas emissions.

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On October 29, 2012, New York City became submerged in water, the subways became submarines, and homes collapsed. The name of the apocalypse is called climate change. On October 29, New York City suffered major destruction from Hurricane Sandy. Hurricane Sandy killed 43 people. It ushered in a new reality of coastal storms where flooding and infrastructure damage will be more frequent (Rosenzweig 2013). According to the UN Framework Convention on Climate Change, the warming of the earth is caused directly by human activity and changes to the composition of the global atmosphere. Cities are major contributors to climate change, but they also have the power to reduce global warming. On a global scale, cities are committing to sustainable initiatives that decrease greenhouse gas emissions. For instance, New York City's very survival is threatened by climate change and the city has been leading the way on climate mitigation initiatives. With a list of climate initiatives introduced since Bloomberg's administration, these initiatives have decreased greenhouse gasses. By looking at climate mitigation policy in groundbreaking cities around the world, it's clear cities lead the effort to reduce greenhouse gasses. When looking at a major economic powerhouse like New York City, the city has reduced its emissions of building and waste through a series of innovative laws, but there has not been a major decrease in the transportation sector.

Causes of Climate Change

Climate change is the result of the expansion of greenhouse gasses caused by the greenhouse effect. Greenhouses include : water vapor, carbon dioxide, methane, and nitrous oxide. Humans are responsible for climate change. The addition of these gasses to the

atmosphere results in the trapping of heat, causing the climate to warm. According to the IPCC report, "Human activities are estimated to have caused approximately 1.0°C of global warming above pre-industrial levels, with a likely range of 0.8°C to 1.2°C" (IPCC, 2018, p.6)." CO₂ concentration in the atmosphere is "40% higher than it was when industrialization began" (European Commission 2019).

The largest contributor to climate change is the burning of coal, oil, and gas. The burning of these gasses contributes to the greenhouse effect. The greenhouse effect is when "Several gases, such as carbon dioxide (CO₂) and methane (CH₄), exist naturally in the atmosphere and contribute to the warming of the Earth's surface by trapping heat from the sun" (EESI 2019). Burning fossil fuels for energy creates CO₂ emissions. In 2017 alone, burning fossil fuels for energy was equal to about 76% of total U.S. anthropogenic greenhouse gas emissions (EIA 2019). Oil is the world's leading use of fuel for transportation. Oil is usually extracted out of underground reservoirs. In the United States alone, "Oil is also a major source of greenhouse gas emissions: petroleum is responsible for 45 percent of greenhouse gas emissions in the United States as of 2017" (EESI 2019). The burning of natural gas is "responsible for 29 percent of greenhouse gas emissions in the United States" (EESI 2019). Natural gas is primarily composed of methane, which is a greenhouse gas. It is generated from the decomposition of garbage in landfills and manure from livestock (EESI).

One of the most harmful fossil fuels is coal. Coal poses an environmental threat and a climate threat. Coal damages the environment because it pollutes the air and water sources. When coal is burned it releases pollutants; mercury, lead, sulfur dioxide, nitrogen oxides, particulates, and various other heavy metals (Union of Concerned Scientists 2019). When coal is

burned it reacts with oxygen and produces Carbon Dioxide. (Union of Concerned Scientists 2019). In the United States, 30 percent of the electric power supply comes from burning coal (EESI 2019). The United States is dependent on using fossil fuels to supply energy to its citizens.

To understand the current effects of these fossil fuels on the climate, we can look directly at the 2018 IPCC Report: Global Warming of 1.5 Degrees Celsius. At the beginning of the report, it states that "Human activities are estimated to have caused approximately 1.0°C of global warming above pre-industrial levels, with a likely range of 0.8°C to 1.2°C. Global warming is likely to reach 1.5°C between 2030 and 2052 if it continues to increase at the current rate"(IPCC 2015). The IPCC Report suggests to limit global warming, CO2 emissions would need to decline by about 25% by 2030 (IPCC 2018). The report makes it clear that mitigation needs to address global warming. There would need to be "rapid and far-reaching transitions in energy, land, urban and infrastructure" (IPCC, 2018, p.2).

How Cities Contribute to Climate Change

Cities are major contributors to climate change. As of now, cities consume about 80 percent of energy production which accounts for the world's greenhouse gas emissions (World Bank 2019). To be more precise, urban areas make up 67% percent of greenhouse gasses (World Bank 2019). Specifically, in large income areas, cities are large emitters of carbon dioxide. This includes emissions from "Industrial, transportation, and domestic consumption of fossil fuels that cause global warming" (Harlan, 2011, p. 127). Garbage, waste, and transportation are the three largest greenhouse gas polluters. Each city relies on these sectors heavily.

Garbage and waste contribute to the greenhouse effect because garbage emits methane which traps heat. For instance, when waste decomposes it generates methane and carbon dioxide. The process of disposing waste also known as Municipal Solid Waste Management (MSW) is a major contributor to climate change. It consists of food waste, paper, wood, leather, and plastic, etc. (Jha 2008). The method of anaerobic decomposition, where organic matter is broken down in big tubs generates "60% methane (CH₄) and 40% carbon dioxide (CO₂) together" (Jha, 2008, p.357).

Along with waste management, buildings are also a large contributor to GHG emissions in cities. Buildings contribute one-third of all greenhouse gas emissions and makeup 40% of all energy use (UNEP 2007). Cooling, heating, and the use of electricity contributes to the increase in greenhouse gas emission. Energy is consumed with the manufacturing of a building, the transportation of building materials, the construction of the buildings, the operation of buildings, and the demolition of buildings. The most use of energy is during the operational use of the building (UNEP 2007). Also, people use fossil fuels to generate electricity for power plants and generators. For instance, "power generation using fossil fuels accounts for 40% of all carbon emissions in the United States and about one-quarter of global emissions" (UNEP, 2007, p.7). Hospitals and offices are major energy consumers and the development of these buildings is growing (UNEP 2007). Cities are home to many buildings that use non-renewable energy sources. Moving forward, cities' governments will have to make major adjustments for building to lessen their carbon footprint.

In addition to the emission of fossil fuels with the operations of a building, the urban heat island effect is caused by buildings and it also increases under the conditions of climate change.

Urban heat islands refer to an increase in air temperatures compared with air temperatures in rural areas (Corburn 2009). Compared to rural areas, urban areas are 3.5 to 4.5 degrees Celsius hotter. Climate change will intensify this and an increase in temperature can bring health issues, economic impacts, and environmental impacts (Corburn 2009). Exposure to heat kills people each year. The increase of the urban heat island effect can worsen air quality each year and increase energy demand. The urban heat island effect is already a reality for many cities, but it will get worse as the earth warms closer to 1.5 degrees Celsius. It is predicted that the warming of urban areas increases by 1 degree Celsius every decade (Corburn 2009).

Furthermore, transportation is a huge contributor to a city's carbon footprint. GHG emissions from cars are responsible for producing greenhouse gases. Surprisingly, the most densely populated cities have the lowest carbon footprint (Dulal 2011). For instance, "The transportation sector accounts for approximately 11% of the total city's emissions in Shanghai and Beijing compared to 22%, 23%, and 18%, respectively for London, New York and Washington DC (Dulal, 2011, p.2). The distance a commuter drives, the type of vehicle owned, and less density of a city contributes to the emissions of a city.

The International Approach to Climate Change

Released in 2018, the IPCC Special Report to Policy Makers advocated for the world to take instant action before it's too late. The report finds that "Limiting global warming to 1.5°C would require 'rapid and far-reaching' transitions in land, energy, industry, buildings, transport, and cities" (IPCC, 2018, p.2). To limit global warming emissions will need to be reduced drastically and a just transition is needed. To limit "warming below 2 degrees Celsius, emissions

would have to decline by 25% by 2030" (IPCC, 2018, p.2). In terms of cities, the report emphasizes the sustainable development goals to reduce emissions. The sustainable goals are goals adopted in 2015 by all United Nations member states that call for partnership on improving healthcare, education, the economy, and the climate. They are intended to be achieved by 2030. The report finds that Sustainable Development Goal 11 (Communities and Cities) has a potential tradeoff for mitigation (IPCC 2018).

Both the IPCC Report and New Urban Agenda address the impact cities can have on mitigating climate change. In 2016, Habitat III created an environment where UN stakeholders, governments, NGOs, and the private sector could share ideas about Urban Development. What resulted was the New Urban Agenda. The Agenda advocates for cities to abide by a sustainable policy with the hope of decreasing the effects of climate change. From the Urban Agenda came a discussion of equity and mitigation. On the topic of disadvantaged communities, in "Urban Crises and the New Urban Agenda," Lucy Earle argues that how most refugees and displaced persons are in urban areas. Cities are increasingly vulnerable and those who cannot prove their rights to land or housing can be severely disadvantaged (Earle 2016). When constructing policies, one must consider those who are left behind to construct adequate mitigation and adaptation policy. Earle argues climate should take an area-based approach where one should "take into account how individuals use systems and services at the neighborhood level, how this neighborhood is connected to other areas" (Earle, 2016, p.82). This perspective would also be useful for mitigation because it can be done at a micro-scale which would benefit the health and financial stability of a community (Kousky 2002).

The idea of leaving no one behind is also fundamental to achieving the Sustainable Development Goals. The Sustainable Development Goals directly intersect with the goals of cities. Goal 11: Sustainable Cities and Communities recognizes that by "2050 6.5 billion people will be urban" (UNDP 2019). The Sustainable Development Goals recognize that cities are a key factor in reaching the targets of the goals. Goals relevant to "disaster risk reduction, climate change adaptation, and climate change mitigation in urban areas" are essential targets and goals for 2030 (Satterthwaite 2016). The Sustainable Development Goals provide targets for cities to follow. Like a roadmap, the Sustainable Development Goals provide ten targets covering areas such as housing, transport, air quality, and waste management which are all outlets to mitigate greenhouse gas emissions (Satterthwaite 2016).

With mitigation, The New Urban Agenda extends the targets of the Sustainable Development Goals set a new standard for cities to reduce greenhouse gasses. The Sustainable Development Goals and the Paris Agreement are intertwined in the Agenda. Mitigation is an essential idea for the Agenda because the scale of climate change threatens the progress in all urban areas (Satterthwaite 2016). Principle 101 of the New Urban Agenda calls for mitigation in "age- and gender-responsive urban and territorial development and planning processes" (The New Urban Agenda, 2016, p.25). It points out ways in which mitigation can be implemented on a smaller scale with buildings and construction, greenhouse gas emissions, and infrastructure (The New Urban Agenda 2016). An issue with the New Urban Agenda is that it does not "mention of mayors, democracy, or grassroots organizations" (Satterthwaite, 2016, p.8). These actors are essential to analyzing a cities climate mitigation policy and must be accounted for going forward.

Following the New Urban Agenda, The C40 is a transnational climate network where cities can share in a network of cities that commit to addressing climate change. The C40 is a model network for climate mitigation because it aims to reduce greenhouse gas emissions through programs and policy (Heikkinen 2019). Cities have an emission reduction goal between 32.7% and net-zero (Heikkinen 2019). The C40 advocates for changes in physical infrastructure. This includes decreasing energy consumption, renewable energy sources, and green spaces that should be considered during the planning process (Heikkinen 2019). The benefit of joining this network is that through international socialization, cities can learn from one another (Lee 2013). From the 2014 Report "Climate Action in Megacities," it is recorded that cities with a higher GDP do more climate mitigation. Also, waste and water showed an increase in reported activity (C40 2014).

What Have Cities Done to Mitigate Climate Change?

For cities to implement a just transition, strong governance needs to be in place. To have successful mitigation results, cities implement mitigation policies from either a unit of climate policy in each government agency or an overarching climate group (World Bank 2017). London a C40 city, has an overarching climate group called the London Climate Change Agency. They give support to other government agencies on how to mitigate climate change (World Bank 2017). This management style represents the need for partnerships on a municipal level. The LCCA still works with private and public organizations. Mexico City has a completely different climate governing body. Mexico City has a joint responsibility where the secretariat

coordinates measures for different sectors of the government. The city also has an external group that is assigned to write reports on adaptation and mitigation methods (World Bank 2017).

Megacities have set targets under the impending threat of climate change. In the 21st century, cities have organized and implemented climate plans with target policies. Some of these plans are starting to take effect today and scientists have measured the impact of the policies. But, mitigation efforts can be costly. Stockholm, a wealthy city, has successfully created an achievable climate mitigation plan. The first two plans, 1995–2000 (City of Stockholm, 1998), 2000–05 (City of Stockholm, 2003) set to reduce the emissions of Stockholm on a large scale. Greenhouse gasses decreased by 24 percent between 1990 and 2009 (Rutherford 2014). In Stockholm, the country's plan was a success due to several factors. Sweden has a carbon tax which first began in 1991 (Pierrehumbert 2016). By 2000, carbon reduction was the norm. Stockholm has done such an efficient job at introducing renewable energies to power building, the city's only source of GHG emissions are from liquid fuel that power cars (Pierrehumbert 2016).

Like I mentioned before, Stockholm has made great strides towards carbon neutrality. Taking a close look at Stockholm will provide insight into how a country's policy can contribute to the goal of a carbon-neutral city. Residential and commercial heating in all of Sweden is almost carbon neutral. This is possible from the use of district heating. District heating is when heating can be generated from multiple sources. Most of these sources are carbon-free. Heating is generated from biofuels, non-recyclable garbage combustion, "Waste heat from server farms, and even from the excess body heat of passengers in the central railway station" (Pierrehumbert, 2019, p.108). Biofuels still do release greenhouse gasses, but Stockholm is working to limit this

carbon footprint by incorporating heating pumps which would be powered by renewable energy (Pierrehumbert 2019).

Cities are reaching their net-zero goals from a bottom-up approach. Net-zero refers to when a building is powered from an offsite or on-site renewable energy source like solar, wind, or nuclear power. Many cities are looking to be net zero and carbon neutral in the future. For this to happen, buildings must run on renewable energy. Copenhagen has begun to focus on its building's energy consumption and the city plans to be carbon neutral by 2025 (Landhaur 2017). The Copenhagen Action plan states that buildings need to be designed in an energy-efficient way to support mitigation (Lanhaur 2017). Buildings in Copenhagen create 50,000 tons of Carbon Dioxide each year. Making buildings carbon neutral would reduce the increasing amount of carbon in the world (Copenhagen Climate Plan 2017).

On an international scale, buildings make up a large percentage of a city's emissions, and incorporating new technologies has made net zero a possibility. In Helsinki, only 11% of the buildings are owned by the city (Helsinki 2019). The government has vouched for wooden construction and using timber framing. The government also has pushed companies to use renewable energies through Building Control Services (Helsinki 2019). Also, for buildings to be a success there needs to be a public-private partnership between the government and contractors. Also, the government must provide resources to private entities so that there is education about new carbon-neutral technologies.

A carbon-neutral building uses renewable energy sources and cities are beginning to rely on renewables instead of fossil fuels, resulting in a low carbon footprint. With Helsinki's

extensive plan to be Carbon Neutral in 2035, the city's energy is generated by electricity and is 80% carbon-free (Helsinki Plan 2019). The city relies on fossil fuels for heating, but with their new action plan, emissions are estimated to go down 74%. The government's massive support for this energy transition has revolutionized heating and power usage. With this transition, the use of coal as an energy source should end by 2029 (Helsinki Plan 2019). The city of Helsinki can become carbon neutral because of the country's overall effort to mitigate climate change.

Cities have also turned to methods of soaking up carbon to limit their carbon footprint. Cities have greened their buildings to limit air pollution and ultimately limit carbon dioxide. In the Philippines, Malaysia, and Italy, there are "green skyscrapers" where high rise buildings come attached with a garden and trees (Lindfeild 2014). In Singapore, these new buildings are created to soak in the cities pollutants and collect wastewater (Lindfeild 2014). China has plans in the future to create cities made up of vertical forests. A plan is underway, and these apartments would become high-density urban housing. According to the verticle forest's architect the building "absorbs 30 tons of carbon dioxide and produces 19 tons of oxygen a year" (Holland 2018). So far, the mitigation effort of green skyscrapers has come from the private sector. A city can have mitigation projects with help from the private sector. In the future, these vertical skyscrapers can provide healthy air to residents and reduce emissions.

Cities can have made massive greenhouse gas reductions by targeting transportation and pedestrian planning. Governments have focused on making cities more compact. Lindfield describes this approach as the "avoid-shift-improve" where cities are compact and offer services at a walkable distance that does not require a car (Lindfeild 2014). This would reduce the need to make commuter trips and burn fossil fuels by using a car. According to Lindfield, Amsterdam,

Copenhagen, Freiburg, Madrid, Stockholm, Portland, Curitiba, and Bogota have prioritized compact development (Linfield 2014). Compact development leads to walkable cities that reduce each person's carbon footprint(Lindfeild 2014).

Cities have successfully limited the use of cars through increased transportation and a carbon tax. This creates an incentive to use public transportation that burns less or no fossil fuel. In London, congestion pricing has limited car usage in the downtown area (Lindfeild 2014). Singapore has also gone this route by using an electronic road pricing and a quota system to limit cars into the city's downtown. Policies like this have a benefit for city dwellers and climate change. It slows down the release of carbon in the atmosphere and creates fewer car accidents due to the lack of cars.

Limiting the use of cars reduces the amount of carbon dioxide in a city. To pass congestion pricing or planning that limits cars, constituents need to have an active voice in transportation policy. In Stockholm, congestion pricing evolved. The policy first went through a trial run in July 2006 and then in September, most constituents in the city voted for it to take effect permanently (Rutherford 2014). The outcome was that traffic to the city center decreased by 20% by year and greenhouse gasses have decreased by one percent (Rutherford 2014). One percent is low, but in Helsinki, congestion pricing has had a bigger impact. In the Carbon Neutral Helsinki Plan, the volume of greenhouse gas emissions from traffic in Helsinki amounted to approximately 600 kilotons of carbon dioxide in 2015 (Helsinki Plan 2019). Due to congestion pricing and renewable energy use in public transportation, the emissions were 15 percent lower in 2015 than in 2005 (Helsinki 2019). Helsinki is aiming for 69% of traffic reductions by 2035. Their progress is credited from targeting the use of private vehicles.

Helsinki has done this by limiting the use of cars by connecting public transportation and using congestion pricing to steer people towards electric cars.

Cities have used public transportation as a method to reach their goal of becoming a carbon-free city. Take Stockholm as an example, The Arlanda Express is a train that transports people from Stockholm to the Arlanda airport. This bullet train is mostly powered by renewable energy and provides an alternative to a car because it can transport a passenger in 20 minutes (Rutherford 2015). The city has also made the city buses hybrids and the commuter rail is powered by electricity from renewable sources (Rutherford 2015). As another example, Brazil has made radical changes to its public transportation. Rio de Janeiro has created a rapid bus system that cuts inner-city trips in half and can accommodate 2 million people per day. Ultimately, the bus will save 107,000 tons of carbon dioxide (Rocky Mountain Institute 2017). Electric transportation methods powered by renewable sources are a great alternative to cars. Carbon-free cities also reduce traffic because public transportation runs on a schedule.

Now focusing on waste, cities around the world have altered their waste consumption and collection to reduce methane. Cities have diverted organic waste from landfills because when organic waste is thrown in a landfill, it decomposes and generates methane. Cities are alternatively collecting and composting their organic waste. Infrastructure has been set up in Beijing where residents compost 1,000 tons per day and the compost goes into a composting plant where the odor is sealed (Linfeild 2014). In Alappuzha India, the city launched the Clean Home, Clean City program where residents put their organics into a pipe that is attached to their homes (Rocky Mountain Institute 2017). This initiative has allowed city residents to decrease

fuel usage. Compost initiatives can save fuel emissions from sanitation trucks depending on the collection, reduce methane from decomposing organic waste, and reduce pollution in a city.

New York City: A case study

New York City was hit hard by Hurricane Sandy. Staten Island and Coney Island experienced a high tide with a peak storm surge of 2.9 m (9.4 ft) (Rosenzweig 2014). The city was not prepared for this storm. The impacts were felt everywhere around the city. The subways were submerged in water and an estimated 2 million people were without power (Rosenzweig 2014). According to Rosenzweig, "every tropical cyclone that will hit New York City will bring damaging floods. 7.5-foot floods are projected to happen every 25 years. By 2030, these floods will occur every five years" (Rosenzweig, 2014, p.6).

What is New York City's contribution to climate change? The enormous scale of Hurricane Sandy is related to climate change. Climate change is increasing the intensity and extremity of events like hurricanes (Rosenzweig 2014). A combination of mitigation and adaptation strategies are needed to make New York City a safe place to live. New York City is a major polluter and is part of the problem. Out of all cities, New York City has the world's highest total greenhouse gas emissions. In 2005, New York City was responsible for 58.3 tons of greenhouse gas emissions. Putting this into perspective, when analyzing things per capita, New York City has the lowest percentage of GHG emissions (7.1%) compared to District of Columbia (19.7%), and Toronto (8.2%) (Dodman 2009).

The Office of the Mayor has set the reduction of greenhouse gasses a priority. In 2014, New York City launched 80x50; a plan that aims to reduce greenhouse gasses by 40 percent in

2030 and 80 percent by 2050. In this case study, I analyze the city's progress in reducing greenhouse gasses since 2005 and the policy that is responsible for decreasing emissions. It is important to note that buildings, transportation, and energy are the leading causes of greenhouse gasses for New York City.

Sources of Greenhouse Gas Emissions

The leading cause of emissions in New York City is buildings. Buildings make up 68 percent of citywide greenhouse gas emissions (80x50 2014). This includes the energy used to heat and cool buildings. Generating electricity for these functions are powered by fossil fuels. Transportation had the second-highest emissions and accounted for 29 percent of citywide GHG emissions in 2015 (80x50 2014). The leading cause for this was gasoline which made up 80% of GHG emissions for transportation (80x50 2014). Thirdly, waste accounts for 14 percent of citywide emissions (80x50 2014). Looking at Figure 1 we can gain a better understanding of each sector and its source of emissions. Figure 2 also gives us an insight into how each sector emissions change each year.

Figure 1

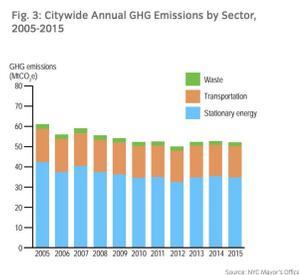
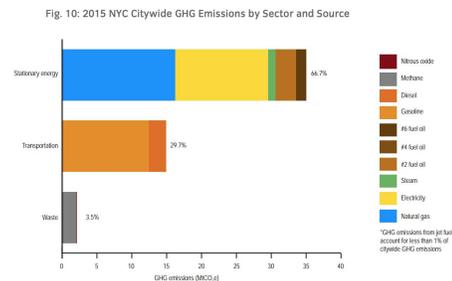


Figure 2



A Decrease In Emissions

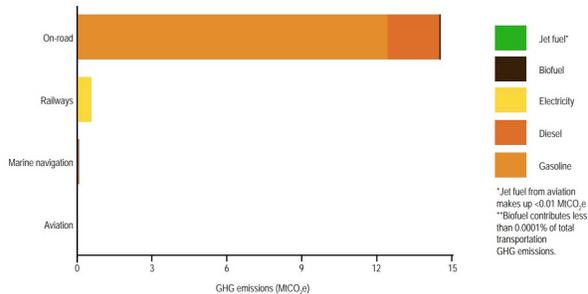
From 2005 to 2015, energy used in buildings and facilities decreased by 18.1 percent (Paison 2017). When looking at government buildings, energy use decreased by 9 percent (Paison 2017). This reduction of GHG emissions can be attributed to the increase of electricity per square foot from sustainable sources in buildings (Paison 2017). To reach an 80 percent reduction of greenhouse gas emissions, the government has created a swath of programs that have already resulted in positive results. Following up with PlaNYC, the city launched the Greener, Greater Buildings Plan. The plan consists of four laws that apply to buildings over 50,000 square feet in area, or complexes that are 100,000 square feet. Although these buildings only consist of 2 percent of total NYC buildings, they account for 45 percent of the city's total energy (One City Built to Last 2016).

Based on the New York City's Energy and Water Report in 2015, buildings have cut their emissions by 8% from 2010 to 2013 (Urban Green Council 2016). The Greener, Greater Building Plan is helping New York City reach their emissions targets. The plan targets at least a million buildings in New York City and the audits are one of the most effective parts of the plan. The audit allows a replacement of a ten-year-old heating or cooling device in large buildings. These renovations and replacements comply with the International Energy Conservation Code. This ensures that a building is energy efficient (IECC 2019).

From shiny building windows to shiny train cars, the Metropolitan Transit Authority has an extensive public transportation system that functions through buses, commuter rail, and subway. Railways make up 3.7 percent of emissions (MacWhinney 2017). It is important to note that the MTA is run by the State of New York and not New York City. Counting transit, from 2015 to 2014 there was only a .1 percent decrease in emissions from transportation (Paison

2017). Vehicles on the road accounted for 2015 on the majority of emissions. Gasoline is the largest contributor to these emissions. Overall, there was a five percent reduction of emissions from 2005 to 2015 (Paison 2017).

Citywide Emissions by Transportation Mode. Source: 80x50



Given that 80% of emissions are from vehicles that use gasoline, New York City has produced numerous policies to get more electric vehicles on the road and fossil fuel-powered cars off the road. Under the NYC Clean Fleet program, New York City will add 2,000 vehicles starting in 2015 to the Municipal vehicle fleet. New York City operated a fleet of 27,152 fuel-burning vehicles. This accounted for four percent of New York City's total on-road transportation-related GHG emissions (City of New York 2015). A replacement of gas-burning vehicles can reduce emissions. This is another step towards a net-zero city. The largest target must be cars considering private vehicles account for most of the city's emissions. Recently, the Department of Transportation has banned cars on 14th street to make room for the 14th street busway. This decision has increased bus speeds and bus ridership. This was a small step towards reducing the number of cars in New York City.

Although there was a small decrease in emissions for the transportation sector, the Metropolitan Transit Authority has made wide changes to make its fleet more sustainable. The Metropolitan Transit Authority is working towards a zero-emissions vehicle fleet. NYC buses are zero-emission and electric (MTA 2019). Under the UN Environment Program, the organization pushes for electric busses around the world. According to the UNEP, buses account for approximately 25% of the black carbon emitted by the transportation sector (UNEP 2019). New York State is going in the right direction with working towards a zero-emissions fleet.

New York City is making great strides in reducing their waste consumption. There has been a 19 percent net reduction of waste reduction from 2005 to 2015 (Paison 2017). This is due to several initiatives carried out by the Department of Sanitation. In 2005, the Department of Sanitation closed six landfills which reduced 4.6 percent emissions. Both recycling and compost have offset the GHG emissions caused by waste. Two laws and increased outreach are responsible for lowering emissions from waste. These two laws are Local Law 19 and Local Law 77. Local Law 19 created New York City's mandatory recycling program for all city sectors both public and private. It came into law in 1989. While passed in 2013, Local Law 77 requires the implementation of an organic waste curbside collection program and an organic waste collection for schools. (Grow NYC 2019). Landfills produce methane and composting provides an alternative to throwing organics in the trash. Food waste comprises to about 2.1% of New York City's waste stream (Grow NYC 2019). Composting allows waste to be used as a healthy source of nutrients for trees and plants.

Looking to the Future

New York City has big plans. The city is aiming for a 100 percent carbon neutrality in buildings by 2050. New York City is first targeting energy sources. While most energy comes from natural gas as of now, New York City is trying to have a just transition from gas to clean energy. Focusing on buildings, the innovative policy has been initiated to lower the city's largest emission source. In 2020, building managers will have to report their energy use and post a grade next to the door based on their energy use (Margolies 2019). Local law 33 was signed in 2017 and says buildings will get a letter grade score (Johnson 2018). This will replace benchmarking which was a tool for NYC to track the building's energy. The letter grade can inform consumers and incentivize landlords to monitor their energy use.

In 2019, New York City also passed the Climate Mobilization Act. This act outlines goals for Local Law 97 which states that buildings larger than 25,000 square feet need to meet a series of restrictions to reduce its emissions (Bergland 2019). This law is applied to 50,000 buildings and would set emission limits. This plan is an urgent solution for reducing emissions of all New York City buildings. Based on Local Law 97, newly built buildings must follow the city's newest energy standards and will have to be built on net-zero energy. Following this, New York City will finance energy upgrades under the Commercial Property Assessed Clean Energy Plan (NYC Office of Sustainability 2017). This will give buildings the chance to switch to cleaner energy like energy from wind turbines. With the city mandating cleaner energy, a transition is already taking place.

From green roofs to green transportation, New York City has had few sustainable transportation initiatives. Since the MTA is a state entity, the city can only fully influence its fleet of vehicles. The city has increased the installation of the charging station and its electric

vehicles for different agency cars. By 2040, all government vehicles will be carbon neutral (NYC Office of Sustainability 2017). Also, the Department of Transportation is working towards having every four out of every five trips a New Yorker takes be by foot, bicycle, or public transit (Office of Sustainability 2017). This has been met with the addition of bike lanes and the expansion of the bike-share program. New York City must make more of an effort to decrease vehicle emissions considering that carbon dioxide only decreased .1 % from 2015 to 2014.

The MTA also plans on expanding its sustainability efforts. On November 7th, 2019 the MTA announced that it was joining the United Nations-sponsored Science Based Targets initiative (SBTi). Under this initiative, the MTA will create emission targets with the hope of reducing its ecological footprint. The MTA has two years to establish targets and fifteen years to meet them (MTA 2019). Their emission reduction will account for citywide emissions and hopefully reduce transportation emissions in the next ten years. This plan will be in line with the Paris Agreement's goal of keeping global warming below 2 degrees Celsius (MTA 2019).

While the city's population is growing and producing more trash, the city will continue to expand its organics program. Now, 34% of all New York City trash is suitable for composting. New York City has the goal of zero waste to landfills. The New York City Compost Program is experiencing some challenges like its high cost and smell. The city has also moved organics collecting to businesses. Beginning in July 2019, businesses are required to separate their organics in a separate bin (Office of Sustainability 2019). This will cut down landfill use and add to compost amounts.

An emerging trend that New York City hopes to expand is the circular economy. The circular economy is when resources are maximized so that materials are used for as long as possible. It reduces waste and allows products to be repurposed so that they don't have to be thrown out. An aspect of this economy is the DSNY re-fashion bins where residents throw their used clothing and the clothing goes to Goodwill or Housing Works.

Conclusion: Policy Recommendations

Putting a Price on Climate Change: Decreasing City-Wide Transportation Emissions

Congestion pricing is an effective strategy to limit congestion in Manhattan and decrease emissions produced by city-wide transportation. Congestion pricing is set to start in December 2020 and will target cars entering Manhattan from 60th Street south to the Battery (Cook 2019). It is estimated that cars entering Manhattan will have to pay an \$11-14 fee, while trucks will have to pay \$25 (Hu 2019). Considering the high cost for the MTA Fast Forward Plan; a plan aimed at modernizing the New York City transportation system, while taking into account the antipathy towards fare increases for public transportation, the congestion fee must be higher. Overall, congestion pricing reduces emissions from city-wide transportation sources, but the current plan must be altered to benefit straphangers and those living in transit deserts.

Congestion pricing shows that New York City is heading in the right direction to mitigate climate change. Internationally, cities that have enforced congestion pricing have seen positive effects from this policy. In London, congestion pricing resulted in a 30 percent decrease in car usage in 2003 (Jaffe 2011). Such policies benefit city dwellers in a variety of ways, lessening the amount of carbon released into the atmosphere while also limiting the rate of car accidents due to

a decline in auto use and ownership. Climate change is also an important aspect of this policy because the policy will lower GHG emissions. This means electric cars must be exempt from congestion pricing to provide an incentive to stop using vehicles powered by fossil fuels.

New York City's planned congestion pricing policy would be greatly improved by charging a fee to automobiles throughout the entire island of Manhattan. Those living above 60th Street, specifically in Central and East Harlem, are disproportionately affected by air pollution. Congestion pricing provides a means of improving air quality and mitigating climate change. In Northern Manhattan, "residents have worse air quality than those in lower Manhattan and in Central Harlem in particular, at least one in four children have asthma" (Foster 2019). In order to reduce air pollution in Harlem, the city must implement congestion pricing above 60th Street, which includes charging cars on the Harlem River Drive and those entering Manhattan through the George Washington Bridge.

As of now, the MTA plans to use funds raised from congestion pricing for its Fast Forward Plan. Congestion pricing is expected to raise \$1 billion a year (Barone 2019). The \$40-\$50 billion Fast Forward Plan includes making 50 stations accessible, 650 new subway cars, and 2,800 buses (MTA 2019). By relying on fees raised through congestion pricing, the MTA can avoid fares hikes. An earlier transit plan based on a similar line of thought, known as the Kheel Plan, stated that transit could be free with congestion pricing. The plan calculated that if cars were charged \$16 and trucks were charged \$32 at all hours, the MTA would not need to charge a fare for public transportation (Haikalis 2008). Considering the revenue that congestion pricing will bring in 2021, free public transportation may not be economically feasible, but a fare cap at \$2.75 can become far more realistic. In 2017, \$4,480,374,414 collected in fare revenue

made up 49.6% of operating funds (MTA 2017). Congestion pricing is expected to generate \$1 billion annually, which can be bonded for \$15 billion dollars. Ultimately, the \$15 billion dollars can fund the Fast Forward Plan and maintain the \$2.75 fare charge.

In order to effectively implement congestion pricing, the MTA must address the issue of transit deserts to decrease car dependability. The MTA must provide additional transit options for those living in transit deserts and residents in the outer boroughs who might still prefer driving into Manhattan regardless of the fee. The plan must also factor in low-income New Yorkers that would endure additional financial hardship in traveling to Manhattan. Those who make less than \$60,000 a year are expected to receive a tax break (Hu 2019). LIRR and Metro-North Cards should also be discounted for those who qualify for Fair Fares NYC. This would sway those living outside the city transportation system to still use public transportation.

New York City must prioritize decreasing transportation emissions to meet the goal of 80 x 50. Although emissions from buildings and waste have steadily decreased, the decline in transportation emissions is hardly noticeable. In order to see a steeper decline in city-wide transportation emissions, congestion pricing must be implemented. Though, it is crucial that the plan not neglect straphangers and residents of transit deserts. Congestion pricing needs to prioritize equity and provide financial relief for low-income households. This can be enacted by putting a ceiling on public transportation fares through using funds raised from congestion pricing towards better servicing riders.

Waste: Expanding Organics Collections and Making Compost Mandatory

Waste accounts for 14% of all citywide emissions (80x50, 2014). New York City has been making progress in reducing waste emissions. There has been a 19 percent net reduction of waste from 2005 to 2015 (Paison 2017). These improvements are due to local laws that target recycling and compost. At the same time, it is clear that composting and recycling can decrease emissions even more in the future if these programs are used at higher rates.

Local Law 19 and Local Law 77 can be attributed to the decrease in greenhouse gasses caused by waste. Local Law 19 created New York City's mandatory recycling program for all city sectors both public and private. It came into law in 1989. While passed in 2013, Local Law 77 requires the implementation of an organic waste curbside collection program and an organic waste collection for schools. (Grow NYC 2019). New York City has a Bureau of Recycling and Sustainability which focuses on initiatives to reduce waste while keeping recyclables from reaching landfills (City of New York 2016). The division's focus is to send zero waste to landfills by expanding recycling and compost programs. Although the policies exist for these programs, they have not successfully been implemented.

Expanding compost and recycling in New York City would decrease carbon dioxide and make zero waste a reality, but when looking at the compost program, there is low participation. In 2018, the program only collected 43,000 tons of food scraps, which is only about 5% of food scraps produced by the city (Collins 2018). The program also had to scale back due to low participation. In some neighborhoods, brown-bin pickup service was reduced from twice to once weekly (Collins 2018). These low participation rates can be explained by several challenges.

When Mayor de Blasio took office in 2013, he vowed to create a mandatory city-wide municipal composting system within five years (Goldenberg, Muoio 2020). The composting program has not been mandatory and the participation is not fully there. The Mayor has a goal of zero waste in landfills by 2030 but this will not be met. This is especially true given that on April 20, 2020, the New York City Department of Sanitation announced that it would suspend the curbside collection program until June 2021 due to budget cuts (Eyewitness News 2020). The program can only work if it is a requirement, there is more education outreach, and if the mayor is more committed to the cause.

The organics program should expand more widely in the 5 boroughs. Currently, 470,000 buildings and single-family homes have signed up for the pickup service (Goldenberg, Muoio 2020). It is voluntary and currently, highrise buildings must sign up for compost collection. At the moment, 2,000 high rises have compost collection (Collins 2018). That is a small amount and it would be more effective if all residents in highrises were required to compost. There also needs to be more education on the benefits of composting and how to properly compost. If the city made composting required, education on the subject must also be expanded.

Before coronavirus peaked, city council speaker Corey Johnson was scheduled to bring a proposal to the city council to make composting mandatory. It would also pressure the Mayor to expand the organics recycling program which was on hold since 2018 (Barnard 2020). Johnson believes that implementing citywide compost is the only way to change behavior and reduce waste in landfills (Barnard 2020). If the program would be expanded, then the Department of Sanitation needs to re-examine why city residents are reluctant to use the bins they already have. The cost has also been an issue for expanding the program. With mandatory compost, the

Department of Sanitation would provide all city residents a brown bin. At the moment organics collected from bins are processed at a Department of Sanitation facility at Newtown Creek Wastewater Treatment Plant. If the program was expanded, the city must pay for additional labor to manage compost (Barnard 2020). Ultimately, this will save New York City money in the long run. An increase in organic waste will reduce the need for vehicles to transport garbage that is usually dumped in facilities across the country. When compost curbside collection went into effect in Portland, Oregon, the city reduced garbage going into the landfill by 37 percent (City of Portland 2013). This enabled a decrease in the monthly garbage bill for residents (City of Portland 2013). Expanding the organics program will save gas and save taxpayer money.

The mayor also needs to continue pushing for zero waste if the city is set to meet an 80% reduction of greenhouse gases by 2050. Composting starts at the local level, and it is our politician's responsibility with a partnership with the Department of Sanitation to educate residents about composting. Since residential composting is not meeting its goals, composting in the business sector is needed. With an analysis by the Department of Sanitation, "5 regional facilities, including McEnroe Organic Farm in Millerton, N.Y. and Quantum Biopower in Connecticut, could handle up to 185,000 tons of organic waste each year from business establishments." (Goldenburg, Muoio 2020). As of July 31, 2020, the Department of Sanitation is requiring that food service establishment (7,000 to 14,999 feet) and retail food stores separate their organics food waste (City of New York 2016). This also applies to temporary public events and food preparation locations. When it comes down to effectiveness, education and signage are much needed because food separation is an individual action. Each person at each restaurant and event must know what they can compost and what they cannot.

Besides organic separation, recycling is another piece to reduce greenhouse gases. New York City is doing a better job recycling than organic separation, but that isn't much of a comparison. Right now, “New York City recycles about one-fifth of its garbage with 18 percent of trash from homes and about 25 percent from businesses” (Barnard 2020). The Department of Sanitation must work with neighborhoods to provide more recycling bins. In 2015, only 15 percent of New York City Housing Authorities had recycling bins (Barnard 2020). Politicians can play a key role by holding recycling outreach along with the outreach division of the Department of Sanitation.

Lowering Building Emissions: A Public and Private Effort

Buildings are the leading cause of emissions in New York City. New York City has also done an impressive job lowering their emissions from the buildings sector. This decrease can be attributed to the use of renewable energy for electricity (Con Edison). Going forward, New York City should not only focus on renewables for electricity, but the government should also pressure contracting companies to build sustainable buildings and provide information to building managers on managing emissions.

According to the Mayor’s Office of Sustainability, buildings are the highest polluter of the three sectors with 68% of emissions coming from buildings. There are more than 1 million buildings in NYC (Plitt 2018) and only half of the emissions come from 2% of all buildings (NYC Office of Sustainability 2020). Before the outbreak of COVID-19, New York City was undergoing a building boom. Since 2016, there has been massive spending on commercial,

residential, and government buildings (NYBC 2020). With this increase, policymakers must implement sustainable measures for buildings to decrease greenhouse gases.

Starting in January 2020, mid-size and large buildings need to post their energy efficiency grades. This policy would be similar to a food letter grade, where a building would submit their energy use data and the city would calculate a building's score using the E.P.A (Margolies 2019). The energy grade would be seen in the public (Garodnick 2018). The A-D rating would help consumers pick the most sustainable place to live. To go a step further, there should be incentives that come with an "A" rating. This will be the case in 2024 where buildings will be required to pay fines if they do not meet emission lines (Margolies 2019). Hopefully, this will curb building emissions.

New York City should also push for the creation of "vertical rainforests" which are seen in Milan and Nanjing. On each balcony are plants and trees. Trees absorb carbon dioxide and produce oxygen. These buildings should be constructed in New York City. The building would operate to counter the urban heat island effect and also generate cleaner air. New York City government should also promote the use of wood to construct buildings which do not pollute as much as concrete or steel (Hughes 2019).

Local law 97 is a groundbreaking law passed by the city council in 2019. The law "establishes long-term, low-interest property-assessed clean energy financing to fund upgrades to building energy and water efficiency" (NYC Office of Sustainability 2020). 50,000 of the city's largest building will have to meet the regulations of reducing their emissions by 40% by 2030 and 80% by 2050 (Gerdes 2020). If buildings don't comply with these standards, the buildings

face fines of \$268 per ton of emissions above each emission maximum. Education is needed to meet these new standards. Building landlords must understand how to lower their emissions and how to monitor emissions. A system is present for these ambitious laws. The Climate Advisory Board was enacted by local law 97 and is made up of 15 individuals that will report to the Mayor (NYC News 2020). The board will be monitoring the progress of buildings and their emission benchmarks.

By far, the building sector has seen the most progress in lowering emissions. In the future, the emissions from buildings are expected to lower even more based on upcoming laws. Building contractors and the NYC Office of Sustainability are partnering to monitor emissions and are introducing sustainability building strategies to lower New York City's carbon emissions. With the upcoming implementation of local law 97, building owners will feel pressured to comply with standards to lower carbon emissions. Local Law 97 is part of the plan to reach an 80% reduction of carbon dioxide by 2050. To reach this benchmark, "there needs to be a 40 percent citywide emissions reductions by 2030 from a 2005 baseline" (Urban Green 2020). Since building represents 70% of all city emissions, Local Law 97 is a path towards a successful decrease in carbon emissions (Urban Green 2020).

Works Cited

1. "All About NYC's Historic Building Emissions Law." *Urban Green Council*, Urban Green, 13 Apr. 2020,
www.urbangreencouncil.org/content/projects/all-about-nycs-historic-building-emissions-law.
2. Barnard, Anne. "Mandatory Composting in New York? It Could Happen." *The New York Times*, The New York Times, 12 Mar. 2020,
www.nytimes.com/2020/03/12/nyregion/nyc-compost-recycling.html.
3. Barnard, Anne. "7 Reasons Recycling Isn't Working in New York City." *The New York Times*, The New York Times, 29 Jan. 2020,
www.nytimes.com/2020/01/29/nyregion/nyc-recycling.html.
4. Barone, Vincent. "Congestion Pricing Passes, but without Key Details." *amNewYork*. amNewYork, April 1, 2019.
<https://www.amny.com/transit/mta-congestion-pricing-cuomo-1-29209432/>.
5. Bergland, Christian. "The Climate Mobilization Act Overview." *The Climate Mobilization Act Overview*. Building Energy Exchange, 2019.
6. Bonczak, Bartosz, and Constantine Kontokosta. "GHG Inventory - NYC Mayor's Office of Sustainability." *GHG Inventory - NYC Mayor's Office of Sustainability*. NYC Mayor's Office of Sustainability, 2019.
7. "Buildings Making New York City's One Million Buildings Clean and Efficient." *NYC Office of Sustainability*, NYC Office of the Mayor, 2020,
www1.nyc.gov/site/sustainability/our-programs/buildings.page.

8. Buildings and Climate Change Summary for Decision-Makers. United Nations Environment Programme, 2009.
9. "Bureau of Recycling and Sustainability." DSNY - The City of New York Department of Sanitation, City of New York, 2016, www1.nyc.gov/assets/dsny/site/about/bureaus/brs.
10. Byford, Andy. "Fast Forward: The Plan to Modernize New York City Transit." New York City Transit, 2019.
https://www.mta.info/sites/default/files/mtaimgs/fast_forward_the_plan_to_modernize_nyct.pdf.
11. Carolyn Kousky & Stephen H. Schneider (2003) Global climate policy: will cities lead the way?, *Climate Policy*, 3:4, 359-372.
12. The Carbon-Free City Handbook. Rocky Mountain Institute, Nov. 2017.
13. "Carbon Neutral Helsinki 2035 Action Plan Summary," January 30, 2019.
14. "Causes of Climate Change." Climate Action - European Commission, June 28, 2017.
15. Cavallaro, Richard. "Construction Outlook 2017-2019." New York Building Congress, New York Building Congress, 2019,
www.buildingcongress.com/advocacy-and-reports/reports-and-analysis/Construction-Outlook-2017-2019.html.
16. "Climate Action in Megacities Version 2.0." C40, 5 Feb. 2014.
https://www.c40.org/blog_posts/CAM2
17. "Climate Change: Another Year of Record Gas Emissions, Warns UN Meteorological Agency | UN News." United Nations. United Nations, November 25, 2019.
18. "Coal Power Impacts." Union of Concerned Scientists. Accessed November 11, 2019.

19. Collins, Lisa M. "The Pros and Cons of New York's Fledgling Compost Program." *The New York Times*, *The New York Times*, 9 Nov. 2018, www.nytimes.com/2018/11/09/nyregion/nyc-compost-zero-waste-program.html.
20. "Composting Works: 37 Percent Less Garbage and Rates Going Down." News RSS, City of Portland, Oregon, 19 June 2013, www.portlandoregon.gov/bps/article/453801.
21. Cook, Lauren, and Lauren Cook. "Congestion Pricing in NYC: What to Know about the Manhattan Toll Plan." *amNewYork*. *am New York*, April 2, 2019. <https://www.amny.com/transit/congestion-pricing-nyc-1-29251703/>.
22. "Copenhagen Climate Plan The Short Version." Copenhagen Carbon Neutral by 2025.
23. "Coronavirus News: NYC Suspends Curbside Composting Program until June 2021." ABC7 New York, Eyewitness News ABC 7, 20 Apr. 2020, abc7ny.com/nyc-sanitation-department-composting-of-coronavirus/6117120/.
24. Corburn, Jason. (2009). Cities, Climate Change and Urban Heat Island Mitigation: Localizing Global Environmental Science. *Urban Studies*. 46. 413-427.
25. DeBlasio, Bill. "NYC Clean Fleet." NYC Office of Sustainability, 2015.
26. Dodman, David. "Blaming Cities for Climate Change? An Analysis of Urban Greenhouse Gas Emissions Inventories." *Environment and Urbanization* 21, no. 1 (April 2009): 185–201. <https://journals.sagepub.com/doi/pdf/10.1177/0956247809103016>
27. Dulal, Hari & Brodnig, Gernot & Onoriose, Charity. (2011). Climate change mitigation in the transport sector through urban planning: A review. *Habitat International*. 35. 494-500.

28. Earle, Lucy. "Urban Crises and the New Urban Agenda." *Environment and Urbanization* 28, no.1 (April 2016): 77–86.
29. Espinal, and Corey Johnson. LOCAL LAWS OF THE CITY OF NEW YORK FOR THE YEAR 2019, LOCAL LAWS OF THE CITY OF NEW YORK FOR THE YEAR 2019.
30. Foster, S., Leichenko, R., Nguyen, K.H., Blake, R., Kunreuther, H., Madajewicz, M., Petkova, E.P., Zimmerman, R., Corbin-Mark, C., Yeampierre, E., Tovar, A., Herrera, C. and Ravenborg, D. (2019), *New York City Panel on Climate Change 2019 Report Chapter 6: Community-Based Assessments of Adaptation and Equity*. *Ann. N.Y. Acad. Sci.*, 1439: 126-173.
31. Garodnick, Daniel. "Energy Efficiency Scores and Grades for Certain Buildings." *The New York City Council - File #: Int 1632-2017*, New York City Council, 18 Jan. 2018, legistar.council.nyc.gov/LegislationDetail.aspx?ID=3066694&GUID=A4E3E696-2927-4A44-BD39-4C2DCC8CAADD&Options=ID%7CText%7C&Search=energy%2Bgrade.
32. Gerdes, Justin. "After Pandemic, New York's Buildings Face Daunting Decarbonization Mandate." *After Pandemic, New York's Buildings Face Daunting Decarbonization Mandate* | *Greentech Media*, Greentech Media, 23 Apr. 2020, www.greentechmedia.com/articles/read/new-york-citys-ambitious-building-emissions-law-turns-one.
33. Goldenberg, Sally, and Danielle Muoio. "Wasted Potential: New York City's Food Recycling Failures Exacerbate Climate Crisis." *Politico*, Politico, 7 Jan. 2020,

www.politico.com/states/new-york/city-hall/story/2020/01/07/wasted-potential-new-york-city-food-recycling-failures-exacerbate-climate-crisis-1237743.

34. "Goal 11: Sustainable Cities and Communities." UNDP, United Nations Development Programme, 2019.
35. Goldenberg, Sally, and Danielle Muoio. "Wasted Potential: New York City's Food Recycling Failures Exacerbate Climate Crisis." Politico , Politico, 7 Jan. 2020, www.politico.com/states/new-york/city-hall/story/2020/01/07/wasted-potential-new-york-city-food-recycling-failures-exacerbate-climate-crisis-1237743.
36. Haikalis, George. "Kheel Report." Balancing Free Transit and Congestion Pricing in New York City. Nurture New York's Nature, January 2008.
37. Heikkinen, Tuomas Ylä-Anttila & Sirkku Juhola (2019) Incremental, reformistic or transformational: what kind of change do C40 cities advocate to deal with climate change? Journal of Environmental Policy & Planning, 21:1, 90-103,
38. Holland. "The Architect Transforming Cities into 'Vertical Forests'." CNN, Cable News Network, 19 Nov. 2018.
39. Hoorweg, Daniel A. "Cities and Climate Change Responding to an Urgent Agenda " Washington, D.C: World Bank, 2011.
40. "How We Source Our Electricity." How We Source Our Electricity | Con Edison, Con Edison Company, 2019, www.coned.com/en/our-energy-future/how-we-source-our-energy/electricity.
41. Hu, Winnie. "Confused About Congestion Pricing? Here's What We Know." The New York Times. The New York Times, April 24, 2019.

42. Hughes, Sara. "The Politics of Urban Climate Change Policy: Toward a Research Agenda." *Urban Affairs Review* 53, no. 2 (March 2017): 362–80.
43. Hughes, C. J. "Log Cabins? No, These Wooden Buildings Are High-Rises." *The New York Times*, The New York Times, 1 Jan. 2019, www.nytimes.com/2019/01/01/business/timber-wood-construction-real-estate.html.
44. "INVENTORY OF NEW YORK CITY GREENHOUSE GAS EMISSIONS IN 2015." Mayor's Office of Sustainability, 2017.
45. IPCC, 2018: Global warming of 1.5°C. Delmotte, P. Zhai, H. O. Pörtner, D. Roberts, J. Skea, P.R. Shukla, A. Pirani. In Press.
46. Jaffe, Eric, Eric Jaffe, and CityLab. "The Limits of Congestion Pricing." CityLab. CITYLAB, November 29, 2011.
47. "Greenhouse Gas Emissions from Municipal Solid Waste Management in Indian Mega-Cities: A Case Study of Chennai Landfill Sites." *Chemosphere* 71, no. 4 (2008): 750–758.
48. Lamb, William F, Callaghan, Max W, Creutzig, Felix, Khosla, Radhika, and Minx, Jan C. "The Literature Landscape on 1.5°C Climate Change and Cities." *Current Opinion in Environmental Sustainability* 30 (February 2018): 26–34.
49. Landauer Mia, Sirkku Juhola & Johannes Klein (2019) The role of scale in integrating climate change adaptation and mitigation in cities, *Journal of Environmental Planning and Management*, 62:5, 741-765,

50. Lindfield, Michael, and Steinberg, Florian, eds. *Green Cities*. Manila: Asian Development Bank Institute, 2012. Accessed November 30, 2019. ProQuest Ebook Central.
51. Lee, T 2013, 'Global Cities and Transnational Climate Change Networks', *Global Environmental Politics*, vol. 13, no. 1, pp. 108-127.
52. MacWhinney, Ross, and Omri Klagsbald. *Inventory of New York City Greenhouse Gas Emissions in 2016*. The City of New York Mayor Bill de Blasio, 2016.
53. Margolies, Jane. "Like Restaurants, Buildings Will Get Grades (D's for Energy Guzzlers)." *The New York Times*. November 21, 2019.
54. Margolies, Jane. "Like Restaurants, Buildings Will Get Grades (D's for Energy Guzzlers)." *The New York Times*, *The New York Times*, 21 Nov. 2019, www.nytimes.com/2019/11/21/nyregion/nyc-building-grades-letters.html.
55. "Mayor De Blasio and DEP Announce That All 5,300 Buildings Have Discontinued Use of Most Polluting He." The official website of the City of New York. City of New York, February 9, 2016.
56. "Mayor De Blasio Announces Appointees to Climate Advisory Board Ahead of First Meeting." *The Official Website of the City of New York*, City of New York, 19 Dec. 2019, www1.nyc.gov/office-of-the-mayor/news/630-19/mayor-de-blasio-city-council-speaker-johnson-appointees-climate-advisory-board.
57. MTA. *MTA New York City Transit 2017 Annual Agency Report*. www.transit.dot.gov/sites/fta.dot.gov/files/transit_agency_profile_doc/2017/20008.pdf.

58. "MTA Sustainability Efforts." MTA. MTA, 2019.
59. "MTA Joins Ambitious U.N. Climate Agreement to Reduce Greenhouse Gas Emissions Aligned with Paris Climate Goals." MTA Joins Ambitious U.N. Climate Agreement to Reduce Greenhouse Gas Emissions Aligned with Paris Climate Goals. MTA, November 8, 2019.
60. NEW YORK CITY'S ENERGY AND WATER USE 2013 REPORT. Urban Green Council, 2016.
61. "Overview of the International Energy Conservation Code® (IECC®)." ICC. ICC Family of Solutions, July 24, 2018.
62. "PART III Cities' Contribution to Climate Change - World Bank." The World Bank, 2017.
63. Patrick Moriarty, Stephen Jia Wang, Low-carbon Cities: Lifestyle Changes are Necessary, *Energy Procedia*, Volume 61,2014, Pages 2289-2292, ISSN 1876-6102,
64. Pasion, Cathy, et al. "City of New York Inventory of New York City's Greenhouse Gas Emissions." Mayor's Office of Sustainability, Apr. 2017.
65. Piccirilli Dorsey, Inc. "Fossil Fuels." EESI. Accessed November 11, 2019.
66. Plitt, Amy. "See Every Single Building in Manhattan Mapped with This New Tool." *Curbed NY*, Vox Media, 23 Apr. 2018,
ny.curbed.com/2018/4/23/17271092/manhattan-buildings-data-visualization-taylor-baldwin.

67. Pasion, Cathy, et al. "City of New York Inventory of New York City's Greenhouse Gas Emissions." Mayor's Office of Sustainability, Apr. 2017.
68. Piccirilli Dorsey, Inc. "Climate Change." EESI. Accessed November 11, 2019.
69. Pierrehumbert Raymond. (2019) There is no Plan B for dealing with the climate crisis. *Bulletin of the Atomic Scientists* 75:5 pages 215-221.
70. Reckien, Diana, Felix Creutzig, Blanca Fernandez, Shuaib Lwasa, Marcela Tovar Restrepo, Darryn Mcevoy, and David Satterthwaite. "Climate Change, Equity, and the Sustainable Development Goals: An Urban Perspective." *Environment and Urbanization* 29, no. 1(April 2017): 159–82.
71. Rutherford, Jonathan. "The Vicissitudes of Energy and Climate Policy in Stockholm: Politics, Materiality, and Transition." *Urban Studies* 51, no. 7 (May 2014): 1449–70.
72. Rosenzweig, Cynthia, Solecki, William. Hurricane Sandy and adaptation pathways in New York: Lessons from a first-responder city, *Global Environmental Change*, Volume 28, 2014, Pages 395-408,
73. Satterthwaite, David. "Successful, Safe and Sustainable Cities: Towards a New Urban Agenda." *Commonwealth Journal of Local Governance*, no. 19 (January 1, 2016): 3– 18.
74. Schofer, Evan, and Ann Hironaka. "The Effects of World Society on Environmental Protection Outcomes." *Social Forces* 84, no. 1 (2005): 25-47.
75. Simon, David. *Rethinking Sustainable Cities: Accessible, Green and Fair*. 107-44. Bristol, UK; Chicago, IL, USA: Bristol University Press, 2016.

76. Solecki, William. "Urban Environmental Challenges and Climate Change Action in New York City." *Environment and Urbanization* 24, no. 2 (October 2012): 557–73.
77. Solecki, W, Seto, KC, Balk, D, Bigio, A, Boone, C, Creutzig, F, Fragkias, M, Lwasa, S, Marcotullio, P, Romero-Lankao, P & Zwickel, T 2015, 'A conceptual framework for an urban areas typology to integrate climate change mitigation and adaptation', *Urban Climate*, vol. 14, pp. 116-137.
78. "Summary for Policymakers of IPCC Special Report on Global Warming of 1.5°C Approved by Governments." IPCC Summary for Policymakers of IPCC Special Report on Global Warming of 15C approved by governments Comments. Accessed November 11, 2019.
79. "The New Urban Agenda." Habitat III, United Nations, habitat3.org/the-new-urban-agenda.
80. "Tackling Urban Air Quality Improvement with Zero-Emission Buses." UN Environment Programme. United Nations Environment Programme, 2019.
81. "U.S. Energy Information Administration - EIA - Independent Statistics and Analysis." Where greenhouse gases come from - U.S. Energy Information Administration (EIA).
82. "Why Zero Waste Matters." Why Zero Waste Matters. GrowNYC, 2019.
83. Wilson, David C, Ljiljana Rodic, Anne Scheinberg, Costas A Velis, and Graham Alabaster. "Comparative Analysis of Solid Waste Management in 20 Cities." *Waste Management & Research* 30, no. 3 (March 2012): 237–54.

84. Yosef Jabareen (2013) Planning for Countering Climate Change: Lessons from the Recent Plan of New York City — PlaNYC 2030, *International Planning Studies*, 18:2, 221-24
85. New York City's Roadmap to 80 x 50, Mayor's Office of Sustainability, 2014.
86. "Zero Waste Challenge." Zero Waste Challenge - Mayor's Office of Sustainability, 2019.