HOBOKEN

HOBOKEN CLIMATE ACTION PLAN

& GREENHOUSE GAS EMISSION INVENTORIES

City of Hoboken

April 2019

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EXECUTIVE SUMMARY

The City of Hoboken, New Jersey (the City) is addressing the causes and local impacts of climate change through actions at both the community and government operations levels. Through its commitment to adaptation projects such as Rebuild by Design-Hudson River, Hoboken is addressing climate change impacts such as rising sea-levels and more frequent and intense rainfall events. More than $90 million has been invested in resilient stormwater management by the City and local partners, $230 million will be invested in coastal flood risk reduction by state and federal partners, and $300 million has been invested in energy security by PSE&G.

Hoboken is also committed to mitigating climate impacts by reducing greenhouse gas (GHG) emissions from its governments operations and community at large. This Climate Action Plan (CAP) establishes a baseline carbon footprint for GHG emissions, establishes achievable goals and targets for GHG emissions reductions, and identifies actions required to achieve those goals. These goals and actions will be re-evaluated every five years, in order to ensure that the City is taking an ambitious yet achievable path toward carbon neutrality.

Carbon Footprints

The foundation of Hoboken's CAP is a baseline GHG emissions inventory (2017 carbon footprint). The purpose of the baseline is to track future emissions reductions as well as facilitate climate reporting and communications. Two GHG inventories were prepared: (1) the community inventory encompasses the entire City of Hoboken, and (2) the municipal inventory includes all local government operations. The municipal footprint is a subset of the overall community footprint.

The community of Hoboken has a total carbon footprint of 445,313 tonnes of CO_2 equivalents (tCO_2e) for its base year of 2017. The unit CO_2e represents the impact of all greenhouse gases (GHGs) reported as if they were all CO_2, the most common GHG. **Figure 1** presents a breakdown of Hoboken's largest sectors for GHG emissions.

The three largest sectors of GHG emissions include Commercial Energy (commercial facilities' heating and electricity), Transportation (mass transit, vehicles and infrastructure), and Residential Energy (home heating and electricity)[1]. Within these sectors, major sources of emissions include combustion of fossil fuels and the consumption of electricity.

The second carbon footprint for Hoboken is the emissions generated by its local government or municipal operations. The total GHG emissions for calendar year 2017 amounted to 4,280 tCO_2e. **Figure 2** presents the largest sectors of GHG emissions for municipal operations. For Hoboken's local government, its facilities, lighting (street and traffic), and vehicle fleet are the three largest sectors of

[1] For large apartment buildings, energy consumption in individual units is included in the "Residential" category, but energy consumption for common spaces, such as the lobby or elevators, is included in the "Commercial" category.

FIGURE 1: Breakdown of Hoboken's GHG Emissions by Sector

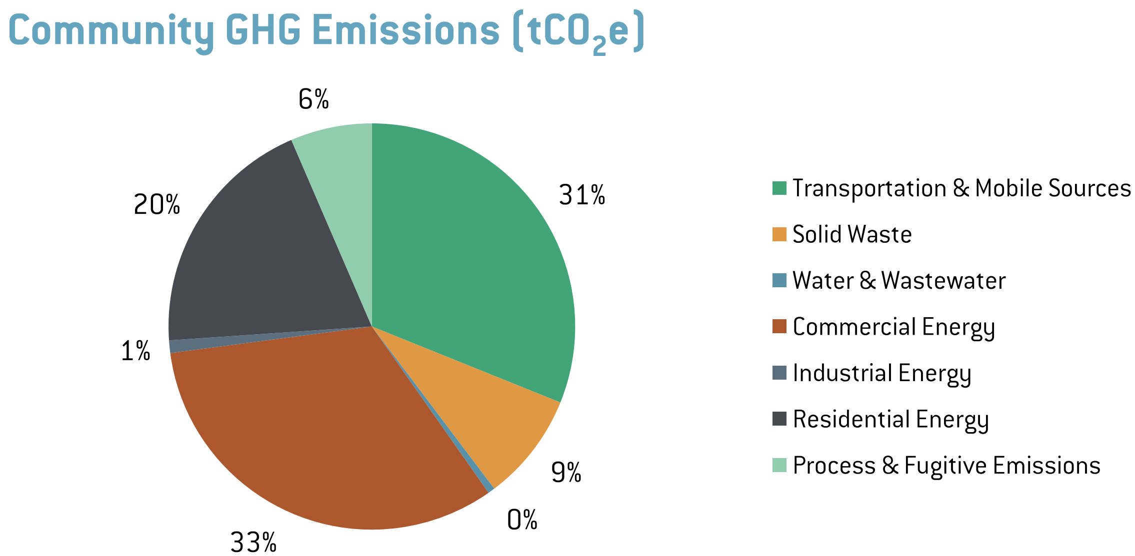
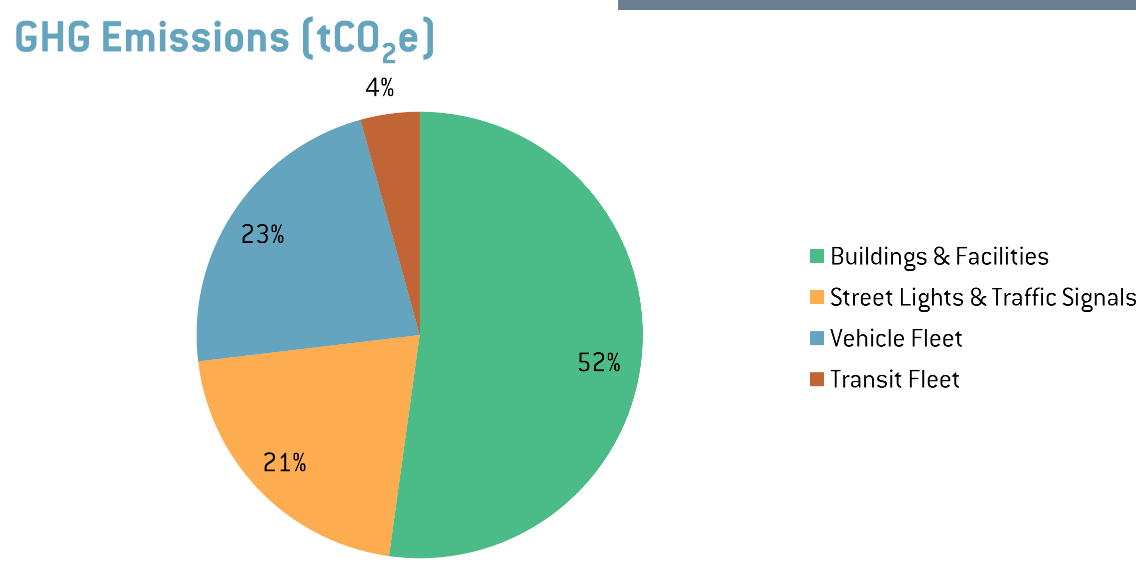


FIGURE 2: Breakdown of Hoboken's City Operations GHG Emissions by Sector



GHG emissions. Here again, fossil fuel and electricity consumption are the largest sources of GHG emissions.

The objective of this CAP is to target these major emission sources for emissions reduction through climate actions. The challenge is to select actions that are likely to be cost-effective and feasible.

Climate Actions

The following climate actions have been identified as priorities to address Hoboken's climate action goals.

City Operations

- Purchase renewable power for municipal buildings
- Install solar energy systems
- Install LED lighting (e.g., street lights and traffic lights)
- Conduct energy audits and energy efficiency upgrades
- Phase in hybrid and electric vehicles to the municipal fleet
- Phase in Compressed Natural Gas (CNG) buses into HOP local bus service fleet
- Increase HOP transit frequency
- consider incentives for employees who commute via non-vehicular transportation or electric vehicles

EXPLANATION OF TERMS

From Hoboken's Sustainability Element

- **Net Zero: Producing or purchasing as much energy as is consumed from secure, affordable and clean energy sources, dramatically reducing GHG emissions**
- **Carbon Neutral: Reducing or offsetting all GHG emissions**

Community-at-Large

- Make Hoboken Electric Vehicle (EV) friendly
  - Establish favorable zoning, ordinances, on-line training, community education, and access to EV charging infrastructure
- Make Hoboken solar friendly
  - Establish favorable zoning, ordinances, outreach program, and purchasing program
- Conduct residential and community energy efficiency outreach
- Employ various community education, incentives, and audits

Climate Goals & Targets

Before completing the GHG inventories, the City had established the following mitigation goals in the 2017 Green Building & Environmental Sustainability Element of the Hoboken Master Plan (Sustainability Element):

- Achieve Sustainable Jersey Gold Star Award in Energy
- Become a Net Zero City by 2022[2]
- Exceed reduction target established in the Paris Climate Agreement by achieving carbon neutrality by 2027[3]

Meeting the Gold Star Award and Paris Accord target will require the City to meet the following GHG emission reduction targets:

[2] The Sustainability Element of Hoboken's Master Plan defines Net Zero Cities as cities that "produce as much energy as they consume from secure, affordable, and clean energy sources, and in doing so they dramatically reducing their carbon emissions."
[3] Hoboken's Sustainability Element, Section 6- Energy and Communications, December 2017, p. 57. The Paris Accord seeks to hold the increase in global average temperature to well below 2 degrees Celsius above pre-industrial levels and to limit the temperature increase to 1.5 degrees Celsius above pre-industrial levels (https://unfccc.int/sites/default/files/english_paris_agreement.pdf)

- Community-wide GHG reductions of one percent annually on average over the next three years.
- Local government GHG reductions of 3.6% annual reduction over next three years.

Becoming a Net Zero City by 2022 will require the City to produce as much energy as is consumed from secure, affordable and clean energy sources, and becoming carbon neutral will require reducing or offsetting all inventoried sources of carbon emissions.

After reviewing the GHG inventories that established the City's baseline for emissions reductions, it was determined that not all of these original goals would be readily achievable in the ambitious timeframe. Specifically, meeting carbon reduction goals established by the Paris Climate Agreement by becoming Carbon Neutral by 2027 and having the entire community of Hoboken become a Net Zero City by 2022 would not be feasible. However, both of these goals are achievable over longer periods of time.

TABLE 1: Summary of Existing and Suggested Climate Goals

Goal or Target	Community	Municipal Operations
Sustainable Jersey Gold Star in Energy	1% average annual emissions reductions over three years (by **2022**)	3.6% average annual emissions reductions over three years (by **2022**)
Exceed the Paris Agreement[4] by achieving greater than 16% reduction from the 2017 baseline*	Achieve goal by **2027**	Achieve goal by **2027**
Net Zero (produce or purchase as much or more renewable electricity as consumed)*	Achieve goal by **2030**	Achieve goal by **2025**
Carbon Neutral (reduce or offset 100% of carbon footprint)*	Achieve goal by **2050**	Achieve goal by **2035**

Table 1 summarizes the revised municipal and community goals suggested based on review of the inventories and proposed climate actions. Suggested revised goals are marked with an asterisk (*).

The City is committed to achieving its original climate goals and will strive to exceed these revised goals. According to the Fourth National Climate Assessment, "Impacts on coastal energy and transportation infrastructure driven by sea level rise and storm surge have the potential for cascading costs and disruptions across the country." In regard to communities, this report concludes that "while mitigation and adaptation efforts have expanded substantially in the last four years, they do not yet approach the scale considered necessary to avoid substantial damages to the economy, environment, and human health over the coming decades." [5]

Because of changing conditions and emerging technologies, all climate goals, targets and suggested commitments as well as this Climate Action Plan will be reviewed at least every five years.

[4] The U.S. original Paris commitment was to use best efforts to achieve a 28% emissions reduction from a base year of 2005 by year 2027. The U.S. has already reduced its GHG inventory by approximately 14.8% from 2005 to 2017 (U.S. EPA). Thus Hoboken's goal is reduce its base year (2017) by 16% to exceed the 28% reduction of the 2005 baseline.

[5] Fourth National Climate Assessment, Volume II: Impacts, Risks and Adaptation in the United States, November 2018.

Costs and Benefits

Costs for implementing the priority climate actions will vary based on the size and extent of each initiative. Section 5 – Emission Reduction Actions presents the estimated costs, potential savings and perhaps the biggest benefit – the estimated GHG emission reductions.

Other identified benefits include, but are not limited to:

- Enhanced economic growth through green job creation
- Increased eco-visibility and resiliency for existing and future corporate facilities
- Reduced energy costs by increasing energy efficiencies
- Reduced base-load energy demands resulting in less electrical generation
- Reduced property damage and business interruption resulting in reduced insurance costs
- Reduced maintenance costs for LED lighting systems and electric vehicles
- Increased property values and related tax revenues due to improvements
- Improved air quality resulting in better health outcomes for community members
- Heightened community awareness and support from positive engagement

Report Structure

The structure of this CAP, as outlined in **Table 2**, is designed to address the most common questions about climate change and how the City can address climate change by reducing its carbon footprints.

TABLE 2: Report Structure

Section	Description	Essential Question
Section 1	Introduction to Climate Change	How is climate change impacting Hoboken?
Section 2	Hoboken's Goals	What are Hoboken's goals to address climate change?
Section 3	Current Climate Protection Initiatives	How is Hoboken currently addressing climate change?
Section 4	Summary of 2017 Greenhouse Gas Inventories	What is Hoboken's baseline contribution to climate change?
Section 5	Emissions Reductions Actions	Which climate actions can be taken to cost-effectively meet Hoboken's goals?
Section 6	Implementation and Impact Forecasts	Who will be responsible for taking the lead?
Section 7	Communication: Community Access and Monitoring Impact	When will these actions start having an impact (short, medium, long-term)?
Section 8	Conclusions	How will these impacts be measured, tracked and reported?

1. INTRODUCTION

Climate change is one of the defining issues of the 21st century. Global warming, the gradual increase in the average worldwide temperature, is of particular significance because it is likely to disrupt natural systems upon which society depends. The International Panel on Climate Change (IPCC) estimates a greater than 95% probability this warming is a result of human activity since the mid-20th century and is proceeding at a rate that is unprecedented over millennia. According to the recent IPCC special update (October 7, 2018), the impacts and costs of global warming will be far greater at 2°C of global warming than at 1.5°C. If temperatures exceed an increase of 1.5°C, there will be increases in mean temperature of most regions, increased heavy precipitation in several regions and greater probability of drought and precipitation deficits in other regions, and other devastating effects.[6]

11th and Washington St.

National, regional, and local governments and communities from around the world are needed to address this challenge by making commitments and taking actions to reduce their own emissions (carbon footprints). Local action is even more important in the United States since the federal government announced its intent to leave the Paris Agreement. Without climate leadership on a national level, regional and local jurisdictions will have to step up to ensure that the United States still does its part to reduce global emissions.

From a climate change perspective, the City is in both a fortunate and unfortunate position. Hoboken enjoys being centrally located between several important urban centers, including New York City. It is a hub for commerce, education, transportation and cultural activities. This allows the city to leverage its access to new technologies, infrastructure such as mass transit, and a motivated population to develop and implement cost-effective climate solutions. However, the City is built on historic wetlands

[6] IPCC, 2018: Summary for Policymakers. In: Global warming of 1.5°C. An IPCC Special Report on the impacts of global warming of 1.5°C above pre-industrial levels and related global greenhouse gas emission pathways, in the context of strengthening the global response to the threat of climate change, sustainable development, and efforts to eradicate poverty [V. Masson-Delmotte, P. Zhai, H. O. Pörtner, D. Roberts, J. Skea, P. R. Shukla, A. Pirani, W. Moufouma-Okia, C. Péan, R. Pidcock, S. Connors, J. B. R. Matthews, Y. Chen, X. Zhou, M. I. Gomis, E. Lonnoy, T. Maycock, M. Tignor, T. Waterfield (eds.)]. World Meteorological Organization, Geneva, Switzerland, 32 pp.

next to the Hudson River with some parts at or below sea level. This makes the community and government operations vulnerable to storm surge and frequent flooding.

By the year 2030, storms that result in flooding on the scale of Hurricane Sandy could occur as often as every five years. The Rutgers Climate Institute estimates that sea level affecting the Hoboken coastline could rise between 13 and 28 inches by 2050, further increasing the likelihood of coastal flooding[7]. The New Jersey Climate Alliance predicts that by 2050, 70% of New Jersey summers will be warmer than the current record for warmest summer in the State. Detrimental health impacts, such as risk of heat-related death, asthma rates and cardiovascular disease are all projected to increase as climate change progresses[8].

Experts generally refer to a two-pronged approach to addressing climate change: adaptation and mitigation. The City defines adaptation as creating a more resilient city, which can adapt to and absorb future shocks and stresses to its built and natural systems. The City defines mitigation as creating a more sustainable city, which is able to provide an environmentally, socially and economically healthy community today, without compromising the ability of future generations to experience the same. In terms of climate actions, adaptation actions are those that reduce the negative impacts of climate change on a given community or region and mitigation actions are those that reduce the causes of climate change (e.g. greenhouse gas emissions). Both are increasingly important as the atmospheric concentration of CO_2 and other greenhouse gases increases and impacts of climate change become more pronounced.

The City, its residents, and businesses have observed the devastating effects of a changing climate during extreme events such as Hurricane Sandy, and is at the forefront of taking action to protect itself. Because of Hoboken's vulnerability to many climate change impacts, the City has the responsibility and opportunity to be a leader for other cities facing the challenges of climate change.

1.1 Hoboken's Commitment

Hoboken's commitment to addressing climate change includes both adaptation and mitigation

[7] State of the Climate Report, December 2013. Rutgers Climate Institute
[8] Understanding New Jersey's Vulnerability to Climate Change, Georgetown Climate Center and Rutgers Climate Institute

efforts. The Hoboken Master Plan and Sustainability Element consider the impacts of climate change, both observed and predicted, and identify actions that address both adaptation and mitigation. In December 2017, the City adopted the Sustainability Element, a new section of the Master Plan. This element details an extensive list of over 250 actions that Hoboken believes will improve the sustainability and resiliency of the City.

The largest and most well-known adaptation measure undertaken by the City is the Rebuild by Design-Hudson River (RBD-HR) project. The RBD-HR project is a comprehensive water management strategy to mitigate coastal and rainfall flooding. It will resist flooding from coastal storm surge and sea level rise; delay rainfall from entering the combined sewer system, add capacity to store it in the system, and actively discharge it from the system.

Greater than $90 million has been invested in resilient stormwater management by the City and local partners, and $230 million will be invested in coastal flood risk reduction measures, by a federal grant to the State of New Jersey. Additionally, PSE&G is investing $300 million to invest in energy security projects to strengthen and increase the resiliency of Hoboken's electric grid. Section 3: Current Climate Protection Initiatives provides additional details regarding these projects.

In addition to adaptation actions, the Sustainability Element also includes mitigation efforts aimed at reducing greenhouse gas emissions at the municipal and community level. This CAP is the first major step in identifying priority mitigation actions from this list of potential actions.

1.2 Focus on Mitigation (GHG Reductions)

As previously mentioned, both adaptation and mitigation are crucial to responding to the impacts of climate change because they each focus on a different aspect of the multifaceted problem. Adaptation actions will reduce the short-term impacts of climate change for Hoboken's residents, businesses, and property. However, adaptation measures will not directly address the problem of climate change itself, which is caused by the increase in atmospheric carbon dioxide and other greenhouse gases. Mitigation is necessary to reduce greenhouse gases in the atmosphere from anthropogenic (human activity) sources. By addressing the root cause of climate change through emissions reductions, the long-term impacts of climate change will be lessened.

1.3 Benefits of Taking Climate Actions

For this CAP to be viable and sustainable, it must provide greater benefit than emissions reductions alone. Luckily, most actions that reduce emissions also have economic and social benefits, which increase their value to the community in which they are implemented.

Climate actions can result in the following benefits for Hoboken:

- Enhanced economic growth through green job creation
- Increased eco-visibility and resiliency for existing and future corporate facilities
- Reduced energy costs by increasing energy efficiencies
- Reduced base-load energy demands resulting in less electrical generation
- Reduced property damage and business interruption resulting in reduced insurance costs
- Reduced maintenance costs for LED lighting systems and electric vehicles
- Increased property values and related tax revenues due to improvements

- Improved air quality resulting in better health outcomes for community members
- Heightened community awareness and support from positive engagement

Perhaps the greatest benefit of mitigating climate change is the avoided future costs to the economy. According to the recently released Fourth National Climate Assessment published by the U.S. government, annual economic losses are projected to reach hundreds of billions of dollars by the end of the century[9]. The report concludes with a "key message" for cities in the Northeast, such as Hoboken, that climate change will result in major negative impacts on critical infrastructure, urban economies, and significant historic sites. Changing climate will also threaten the health and well-being of people in the Northeast through more extreme weather, warmer temperature, degradation of air and water quality, and sea level rise[10].

Reducing energy usage will reduce emissions resulting from power generation, and save money for residents and businesses on energy bills. Less energy usage also reduces base-load energy demands and spending on legacy infrastructure. This increases the viability of renewable energy baseload power sources to replace aging fossil fuel electricity generation. In addition, the community enjoys health benefits from replacing old dirtier technology with cleaner renewable power.

Many mitigation actions also result in lower maintenance costs. For example, LED lightbulbs have a much longer lifespan than traditional bulbs and use a fraction of the energy to produce equivalent quality and amount of illumination. When widely implemented, LED bulbs can drastically reduce time spent procuring and changing lightbulbs. The difference in maintenance may seem small in a single family residence, but when LEDs are used in streetlights, athletic complexes, or large municipal buildings, the difference can be enormous. Electric vehicles also have much lower maintenance costs than their traditional, combustion engine counterparts. This results in less time and money spent on maintaining a vehicle, or vehicle fleet.

Green infrastructure has been shown to improve property values for both residential and commercial buildings. An analysis of residential property in Philadelphia found a ten percent increase in the value of residences that were located near green infrastructure practices[11]. Various studies have shown the value of adding green infrastructure to and around commercial facilities resulting in improved rentals, increased shopping, and higher property values. A study by the National Resources Defense Council found that the cumulative value of the benefits can total in the millions of dollars for an individual property over 40 years.[12]

When a community like Hoboken develops a Climate Action Plan, it provides highly visible, tangible evidence of the City's commitment to long-term sustainability. By selecting and implementing actions that meet or exceed the goals of the Paris Climate Accord, Hoboken will do its part to aid in curbing the truly global impacts of climate change. Existing or potential business can build on this commitment to attract and keep the best and brightest talent.

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[9] Fourth National Climate Assessment, Volume II, U.S. Global Change Research Program, summary of findings, November, 2018

[10] Fourth National Climate Assessment, Volume II, U.S. Global Change Research Program, chapter 18 Northeast region, November, 2018

[11] Sustainable Business Network, The Economic Impact of Green Cities, Clean Waters, January, 28, 2016

[12] Natural Resource Defense Council. "The Green Edge: How Commercial Property in Green Infrastructure Creates Value." 2013


Hoboken: The Mile Square City

2. GOALS AND OBJECTIVES

Hoboken cannot afford to be complacent in the face of a changing climate, and the City is pursuing ambitious goals to promote sustainability. Hoboken has committed to several local, regional, and international agreements aimed at reducing the impacts of climate change. From the Climate Mayors, to Sustainable Jersey, to the Paris Accord, Hoboken has established ambitious goals and objectives to remain a leader in climate policy.

2.1 Gold Star Certification in Energy

Hoboken joined Sustainable Jersey in 2010; just one year after the program was established. The City received Bronze certification from Sustainable Jersey in 2011 and was recertified in 2014. The City then received a Silver certification in 2017. During each three-year certification period, the City reaffirms the commitment to sustainability and seeks a higher certification level.

Hoboken has decided to pursue the Sustainable Jersey Gold Star in Energy certification, which further affirms their commitment to sustainability and, specifically, mitigation efforts. To achieve this, the City must demonstrate at least 3.6% average annual reductions in municipal GHG emissions and one percent average annual reduction in community GHG emissions over a three year period. Developing a greenhouse gas inventory was the first step in attaining the Gold Star. Now, the climate actions presented in this report will provide a roadmap to reaching the emissions reductions goals.

2.2 Exceed Paris Accord Reduction Targets

In 2017, Hoboken signed on to Climate Mayors, a bipartisan, peer-to-peer network of

U.S. mayors committed to demonstrating climate change leadership and building political will for federal and global policy action. Through this network, Hoboken and other U.S. municipalities have committed to adopt, honor, and uphold the Paris Climate Agreement. Also known as the Paris Accord, this international agreement sets emissions reductions goals that are intended to keep the global average temperature below 2°C above pre-industrial levels. The City of Hoboken has also adopted a resolution to achieve city-wide carbon neutrality by 2027, which would exceed the goals set by the Paris Climate Agreement in 2015.

However, analysis of the municipal and community GHG inventories shows that the goal of carbon neutrality by 2027 would require purchasing extensive carbon offsets every year – especially for the community at large.

If the municipal operations achieve the projected 62.4% emissions reduction by 2027, there is still a remaining carbon footprint of 1,601 tCO_2e that would have to be offset. The current average cost of a carbon offset is approximately $3.30 per tonne of CO_2 equivalent, although the price has varied greatly over the last 10 years.[13] The cost of some high quality (gold standard) carbon offset can be has high as 12 dollars.[14] Assuming a carbon offset cost of $3.30 per tonne in 2027, the City would have to pay an additional $5,240 annually to purchase offsets necessary for the municipal inventory to be carbon neutral. Although a relatively small expense, Hoboken's municipal operations represents less than one percent of the total City's carbon footprint.

[13] Energysage.com, "Costs and benefits of carbon offsets,"

EXPLANATION OF TERMS

From Hoboken's Sustainability Element

- **Net Zero: Producing or purchasing as much energy as is consumed from secure, affordable and clean energy sources and dramatically reducing GHG emissions**
- **Carbon Neutral: Reducing or offsetting all GHG emissions**

If the community achieves the projected 11% emissions reduction by 2027, there is still a remaining carbon footprint of 396,399 tCO_2e that would have to be offset. Assuming carbon offsets cost $3.30 per tCO_2e in 2027, the City of Hoboken would pay an additional $1,308,000 annually to purchase the needed carbon offsets for the community inventory. For the municipal operations and community inventories together, the City would be spending more than $1.3 million annually in carbon offsets. Alternatively, these monies could be used to fund Hoboken-based emission reduction projects to produce the City's own carbon offsets within the community.

[14] Ecosystem Marketplace, State of the Voluntary Carbon Markets 2017, Figure 4: Average Price of Offsets Transacted, p.8, May 2017.

The original commitment to the Paris Agreement was that the U.S. would use best efforts to achieve 28% emissions reduction from the 2005 baseline by 2027. The national GHG inventory has been reduced by about 14.8% from 2005 to 2017. Thus, if Hoboken achieves at least 16% reduction from the 2017 baseline by 2027, the City will exceed the US commitment. It is suggested that the City pursue 16% emissions reductions from the 2017 baseline by 2027 for both the municipal operations and the community inventory. This revised climate goal is environmentally significant and still challenging, especially for the community.

2.3 Net Zero City

In the Sustainability Element, the City established a goal to become a Net Zero City by 2022 by consuming electricity solely from alternative and renewable sources. The Sustainability Element defines Net Zero Cities as cities that "produce as much energy as they consume from secure, affordable, and clean energy sources and in doing so they dramatically reduce their carbon emissions." Achieving Net Zero by 2022 is an extremely ambitious goal. After analysis of the Municipal GHG Inventory, it is suggested that the City revise the goal to achieve municipal Net Zero by 2025. This allows for a longer timeframe in which to purchase renewable energy from a growing market potentially offering lower costs. It also provides more time to potentially pursue more creative ways to source alternative clean electricity. For the Hoboken community, it is suggested to set a goal of achieving Net Zero by 2030. This allows sufficient time to identify new cost-effective sources of renewable electricity to power the entire community.

2.4 Carbon Neutral City

Hoboken originally aimed to achieve carbon neutrality (reducing or offsetting 100% of the carbon footprint) by 2027 as part of exceeding the U.S. commitment to the Paris Agreement.

Example of EV charging stations

To do so would likely require purchasing annual carbon offsets worth potentially multi-millions of dollars. Instead the City could take advantage of developing technologies by aiming to achieve municipal carbon neutrality by 2035 and community carbon neutrality by 2050. Because the City has control over all municipal operations, it is easier to facilitate the necessary changes to reduce the municipal carbon footprint. Achieving community carbon neutrality by 2050 is still an ambitious goal, and it aligns with the carbon reduction and neutrality goals set by New York City, Boston, and Washington, DC, Seattle and San Francisco who are fellow leaders in climate change policy.[15]

The above goals and objectives were important considerations in selecting priority climate actions.

[15] Carbon Neutral Cities Alliance Members (CNCA), https://carbonneutralcities.org/cities/

NJ Transit Terminal

3. CURRENT CLIMATE ACTIONS

Current climate actions in Hoboken are led by a multitude of stakeholders, from municipal, state and federal government to utilities providers. This section highlights some existing and ongoing sustainability and resiliency initiatives in Hoboken.

3.1 Sustainability Element

The Sustainability Element outlines goals and actions across eight sectors of sustainability, such as coastal flooding and waste management, and provides guidance for future projects and developments. An extensive community planning process was utilized through this and other planning projects to ensure that Hoboken's residents had the opportunity to include the actions that were most important to them.

The scope of the Sustainability Element is broad, covering issues from stormwater runoff to curbside composting, and touches on nearly every aspect of urban sustainability. All of these topics are essential for ensuring that Hoboken is a thriving city for generations to come and that residents are safe, healthy, and have the resources available for a high quality of life. However, not all actions directly address climate change. Only those actions that impact GHG emissions are included in this Climate Action Plan.

The Sustainability Element established Hoboken's three major climate-related goals described in Section 2 - receiving the Sustainable Jersey Gold Star in Energy; becoming a Net Zero City by 2022; and achieving carbon neutrality by 2027. The Element then lists actions that the City can take to achieve these goals. These actions were the starting point for developing this CAP.

3.2 Rebuild by Design

After Hurricane Sandy, the U.S. Department of Housing and Urban Development launched the Rebuild by Design competition and awarded the State of New Jersey a grant based on a proposal for the Hudson River Project: Resist, Delay, Store, Discharge. The project provides a regional flood risk reduction strategy for Hoboken and parts of Jersey City and Weehawken. A feasibility study and environmental impact statement were prepared in 2017 with engineering an extensive community engagement process. The final Record of Decision was issued in September 2017. The project is now proceeding through engineering design and construction is anticipated to begin in 2020.

The Rebuild by Design project is a comprehensive water management strategy to reduce the impact of coastal and rainfall flooding. As seen during Hurricane Sandy, major storm events inundate the City with storm surge from the Hudson River. The City is also vulnerable to stormwater flooding from intense rain events. The four facets of the project (Resist, Delay, Store, Discharge) describe the methods being utilized to protect the City in the face of more frequent storm events, more intense rainfall, and rising sea level.

Rebuild by Design

The project also incorporates community spaces and urban design to provide benefits such as additional park space and services, while protecting waterfront access and views.

3.3 Resiliency Parks

As part of the formal Delay, Store, Discharge (DSD) project, which aims to implement solutions to urban coastal flooding and improve stormwater management, Hoboken has created or upgraded three public parks. These parks serve the dual purpose of providing recreational and green space for residents while also increasing green infrastructure in the City. Examples of green infrastructure include rain gardens, shade tree pits, porous pavers and concrete, and rainwater collection systems. These design features help reduce stormwater flooding, mitigate the urban heat island effect, and improve air quality. Additionally, 61 right-of-way bioswales are being installed in critical locations throughout the City.

Southwest Hoboken Park features passive recreational space, green infrastructure, and an underground water detention system to hold approximately 200,000 gallons of stormwater and reduce localized flooding. The City plans to acquire a portion of the adjacent block to expand the Southwest Park and associated stormwater detention capacity.

The Northwest Park, located on the former BASF property, will feature green infrastructure and innovative stormwater management features to detain up to one million gallons of stormwater.

The 7th & Jackson Park, while not formally part of DSD, is being redeveloped to include a new two acre park, public gymnasium and flood resiliency measures. The park will include an underground storage system capable of detaining nearly 470,000 gallons of stormwater.

3.4 Sustainable Jersey

Hoboken has completed many Sustainable Jersey actions. They have passed policies and resolutions, such as the 2010 Complete Streets Resolution, the 2013 legislation to limit flood risk within the City, and the 2017 Green Purchasing Policy Ordinance. Hoboken has also hosted regular educational events, like Green Fairs, to promote sustainability in the community and encourage resident participation. A full list of completed actions can be found on Hoboken's participant profile on Sustainable Jersey's website.

Northwest Resiliency Park

3.5 PSE&G Electrical Infrastructure Improvements

After the power outages and infrastructure damage resulting from Hurricane Sandy, PSE&G embarked on a $300 million infrastructure improvement project in Hoboken. They have consolidated and protected the three electrical substations located in the special flood hazard area. For example, the Marshall and Madison Street substations are being combined to form the new expanded Madison Street substation, which will also be raised to meet the elevation requirement of the Hoboken Flood Damage Prevention Ordinance. Improvements such as this will improve the reliability of the existing grid and reduce the frequency of electrical outages caused by flooding.

To further improve the resiliency of the grid in Hoboken, PSE&G has partnered with the New Jersey Board of Public Utilities (BPU), the U.S. Department of Energy (DOE), and the City of Hoboken to conduct a microgrid feasibility study.

Proposed Site Plan for Madison Street Substation – Nastasi Architects

A microgrid is a local, independent energy grid that runs in parallel to the existing grid. It connects dispersed energy generation sources, such as backup generators or alternative energy sources. A microgrid provides redundancy to the existing grid so that in the case of a power outage on the main grid, the microgrid-connected facilities still have access to power. The system currently under study would connect vital services such as police and fire stations, City Hall, two senior centers, pharmacies, grocery stores, and multi-family housing buildings. A total of 22 facilities are eligible for redundant power through a microgrid.

The City has made significant progress on implementing the projects above to adapt to climate impacts, and now plans to make significant progress to mitigate climate change. To meet this objective, the City must establish a baseline carbon footprint that identifies the major sources of GHG emissions, set reduction targets for these emissions sources, and outline climate actions to meet these targets.

4. UNDERSTANDING HOBOKEN'S CARBON EMISSIONS

The first step in understanding the City's carbon emissions (carbon footprint) is to create a baseline greenhouse gas inventory. A GHG inventory represents an accounting of a defined set of emissions sources that results in a value that represents the entity's contribution to atmospheric greenhouse gases. Greenhouse gas emissions are reported using the unit "metric tons carbon dioxide equivalent," or tCO_2e. GHG inventories take into account seven greenhouse gases, and each GHG has a different Global Warming Potential (GWP). Using CO_2e equalizes all GHGs to one standard reference of metric tons of carbon dioxide equivalent. Unless otherwise noted in this report, GHG emissions were converted to CO2e using Global Warming Potentials (GWPs), a standard conversion factor, from the Intergovernmental Panel on Climate Change's (IPCC) Fifth Assessment Report (AR5).

Generally, GHG inventories are prepared by following a standard. This ensures that different cities' inventories and future GHG inventories after the baseline will be comparable to each other and to the original baseline. Hoboken's community GHG inventory was prepared in accordance with the Global Protocol for Community-Scale Greenhouse Gas Emission Inventories (GPC), developed by the Local Governments for Sustainability (ICLEI) in partnership with the World Resources Institute. The municipal operations GHG inventory was prepared in accordance with ICLEI's Local Government Operations Protocol (LGOP).

GHG inventories are divided into three main categories: Scope1, Scope 2, and Scope 3. Scope 1 emissions are direct emissions, or those under the entity's control, which includes stationary and mobile combustion. Scope 2 emissions are indirect emissions resulting from the consumption of purchased electricity. Scope 3 emissions are all other indirect emissions, such as those from wastewater processing. The ICLEI protocols used provide two levels of reporting: BASIC and BASIC+. Hoboken opted to report to the BASIC level so no Scope 3 emissions were included in the municipal inventory and only select Scope 3 emissions were included in the community inventory.

For more details on the GHG inventory process and results, see **Appendices A and B** for the full Community and City Operations Greenhouse Gas Inventory reports.

4.1 Community Greenhouse Gas Inventory

The Community GHG Inventory represents the greenhouse gas emissions of the entire City, including residents, businesses, and commercial and industrial activity.

4.1.1 Quantification of Emissions

To determine the total community GHG emissions, a variety of sources were compiled and analyzed.

Direct emissions (Scope 1) from stationary and mobile combustion were calculated using natural gas bills provided by the utility and aggregated transportation data provided by the North Hudson Traffic Planning Authority (NJTPA). Data from the United States Energy Information Administration (US EIA) was used for other heating fuels, such as heating oil. Fugitive emissions were estimated based on average GHG emission data from EPA[16] at national level, appropriately scaled according to the City population data.

[16] https://www.epa.gov/ghgemissions/inventory-us-greenhouse-gas-emissions-and-sinks-1990-2016

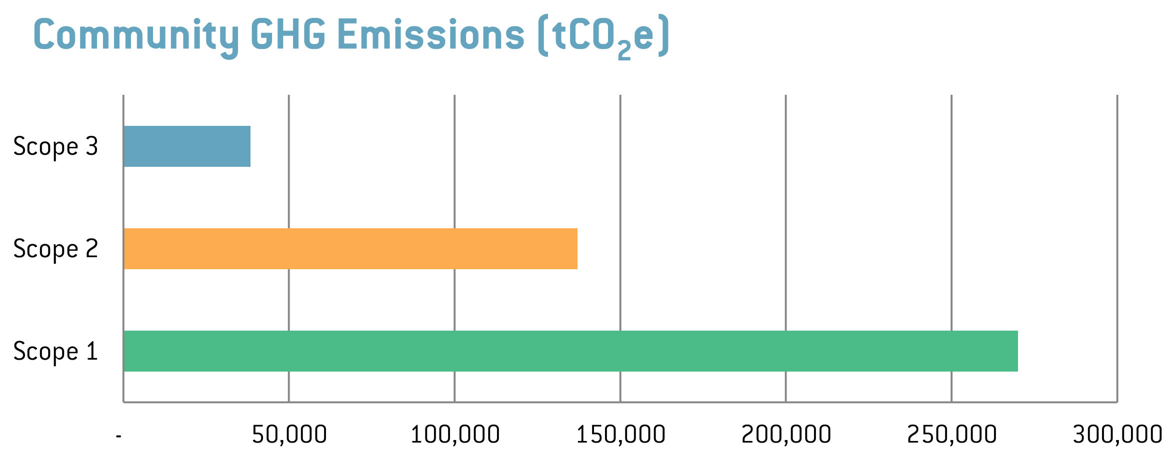
Indirect emissions (Scope 2) from purchased electricity were calculated using aggregated data provided by PSE&G, which is the only utility that supplies electricity to the City of Hoboken. Data was aggregated by residential, commercial, and industrial users. PSE&G also provided electricity usage data for the streetlights and traffic lights in Hoboken.

The only Scope 3 emissions included in the Community inventory are those resulting from solid waste disposal (the only Scope 3 source required by the BASIC protocol used). City staff provided data and information about the quantity of residential and commercial waste collected for disposal in 2017.

4.1.2 Major Sources

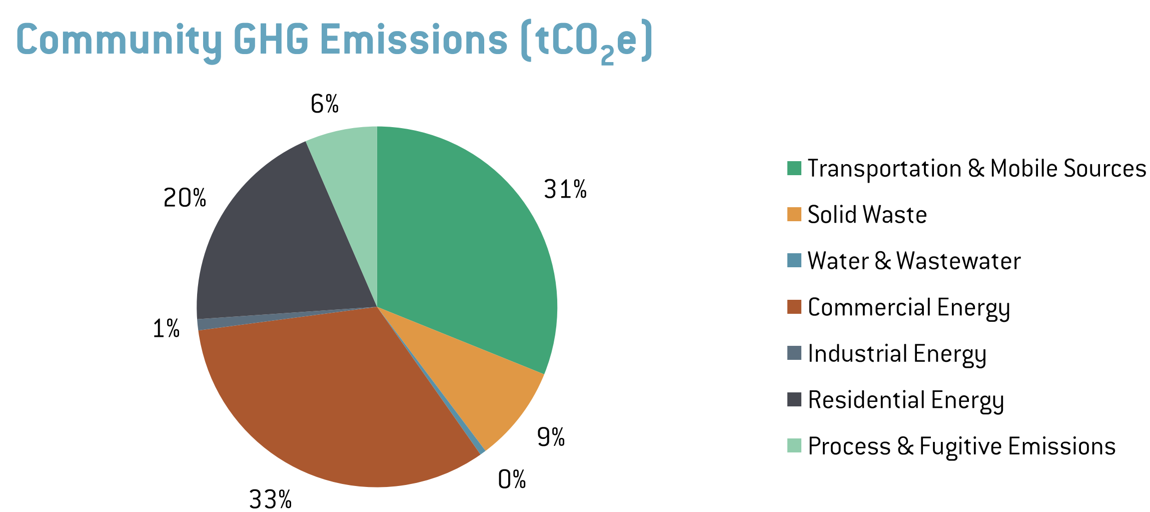
The total GHG emissions for the community amounted to 445,313 tCO_2e. Of this, 270,041 tCO_2e was Scope 1 (direct emissions), 136,958 tCO_2e was Scope 2 (indirect emissions), and 38,314 tCO_2e was Scope 3 (indirect emissions) (see **Figure 3**). Commercial Energy was 33% of total emissions, Transportation and Mobile Sources was 31%, Residential Energy was 20%, Solid Waste was 9%, Process and Fugitive Emissions was 6%, Industrial Energy was 1%, and Water and Wastewater was <1% (see **Figure 4**). The proportion of emissions resulting

FIGURE 3: Total Community GHG Emissions by Scope in tCO_2e



	Scope 1	Scope 2	Scope 3
tCO2e	270,041	136,958	38,314

FIGURE 4: Total Community GHG Emissions by Sector in Percentage



from each source was a major factor in selecting and defining priority climate actions.

4.2 City Operations Greenhouse Gas Inventory

The City Operations GHG Inventory represents the total emissions resulting from the municipal government and operations. The municipal inventory is a subset of the overall community inventory.

4.2.1 Quantification of Emissions

Direct emissions from stationary and mobile combustion were calculated using the heating fuel bills for municipal buildings; fuel purchases by City employees for City fleet vehicles; and fuel usage for the HOP shuttle bus.

Indirect emissions from electricity purchasing were calculated using the utility invoices for all municipal buildings, street lighting, and traffic signals. As previously described, Scope 3 emissions were not included in the municipal inventory.

4.2.2 Quantification of Emissions

The total municipal GHG emissions in 2017 amounted to 4,260 tCO_2e. Of this, 1,853 tCO_2e was Scope 1 (direct emissions) and 2,407 tCO_2e

FIGURE 5: Total Municipal GHG Emissions by Scope in tCO_2e

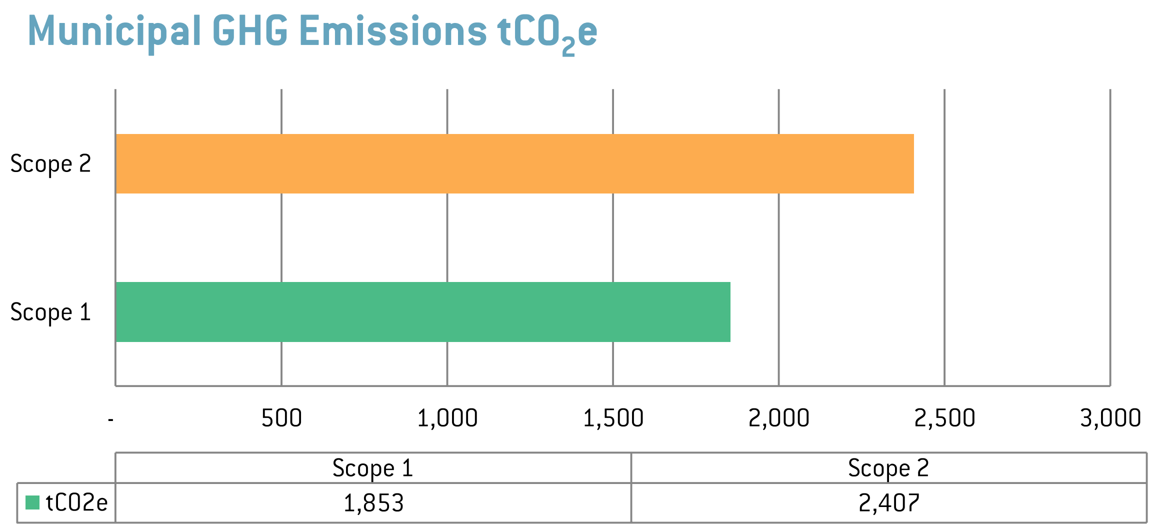
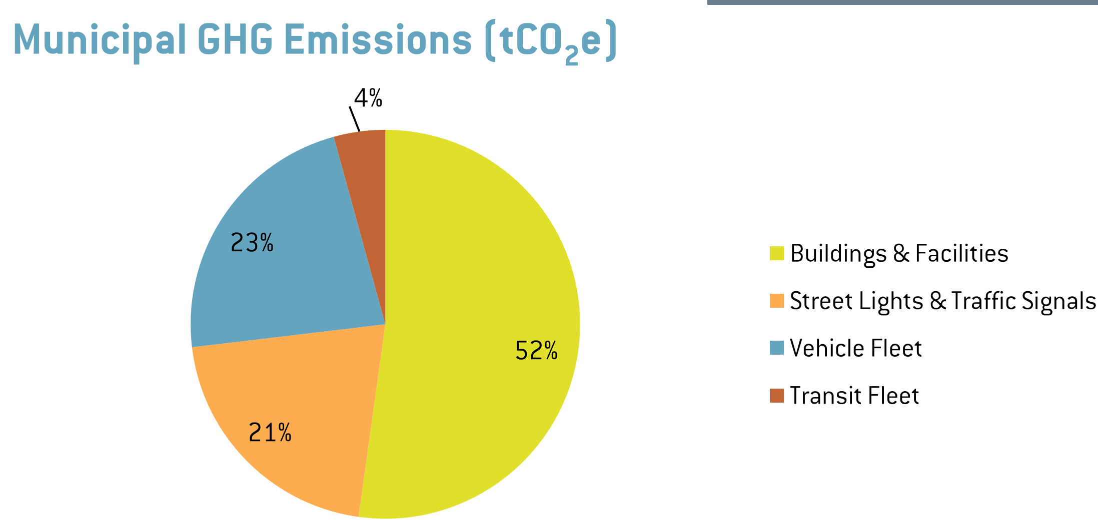


FIGURE 6: Total Municipal GHG Emissions by Scope in Percentage



was Scope 2 (indirect emissions) (see **Figure 5**). Buildings and Facilities accounted for 52% of the total emissions; vehicle fleet was 23% of the total; streetlights and traffic lights were 21% of the total; and the transit fleet was 4% of the total municipal emissions (see **Figure 6**). The proportion of emissions resulting from each source was a major factor in selecting and defining priority climate actions.

4.3 Comparison to Other Cities

To better understand Hoboken's current climate performance, it can be useful to compare Hoboken's GHG inventory to that of other cities. In **Table 3**, Hoboken's municipal and community inventories are listed along with those of other similar cities. It is important to note than many factors influence the total GHG emissions of each city. For example, Woodbridge, NJ is more industrialized and less dense than Hoboken. Additionally, some cities have not updated their inventories recently, and differences in available technology at the time will also impact the inventory. These confounding factors must be taken into account when comparing inventories.

TABLE 3: Carbon Footprints of Comparable Cities

City and Inventory Year	Municipal Footprint ($tCzO_2e$)	Community Footprint (tCO_2e)		Population in Inventory Year[17]
	Total	Total	Per Capita	
Hoboken (2017)	4,280	445,313	**8.08**	55,131
Cambridge, MA (2016)	19,910 [18]	-	**-**	112,183
Cambridge, MA (2012)	22,762 [19]	1,462,236 [20]	**13.76**	106,298
Rochester, NY (2014)	-	1,800,000 [21]	**8.56**	210,228
Rochester, NY (2011)	32,532 [22]	-	**-**	210,859
Providence, RI (2015)	-	2,700,000 [23]	**15.05**	179,408
City of Trenton (2008)	44,879	850,842	**10.27**	82,883
Woodbridge Township (2009)	36,871	3,700,000	**37.77**	97,963
New York City (2015)	3,000,000	52,000,000	**6.11**	8,517,000

[17] U.S. Census Bureau

[18] https://www.cambridgema.gov/CDD/climateandenergy/municipalsustainability/municipalghginventory

[19] https://www.cambridgema.gov/~/media/Files/CDD/Climate/municipalghg/Municipal-GHG-Emissions-and-Energy-Use-3282016.pdf?la=en

[20] https://www.cambridgema.gov/CDD/climateandenergy/greenhousegasemissions/communityemissions

[21] https://www.cityofrochester.gov/WorkArea/linkit.aspx?LinkIdentifier=id&ItemID=8589972197&libID=8589972179

[22] https://www.cityofrochester.gov/uploadedFiles/Departments/Des/Articles/COR_FINAL_CAP_9-30-13.pdf

[23] https://performance.providenceri.gov/stat/goals/r6yh-954f/qfcp-d4ec/fsh7-6f7t/view

5. EMISSION REDUCTION ACTIONS

The major sources of GHG emissions informed the identification and assessment of potential climate actions and selection of priority actions.

5.1 City Operations Greenhouse Gas Inventory

The following selection factors were used to help identify priority climate actions:

- Recommended by Hoboken Master Plan and/or Sustainability Element
- Fosters significant emission reductions identified in the GHG inventories
- Helps achieve targets and goals
- Accounts for Hoboken's uniqueness as described via community engagement
- Maximizes benefits while minimizing costs
- Feasible and cost-effective implementation

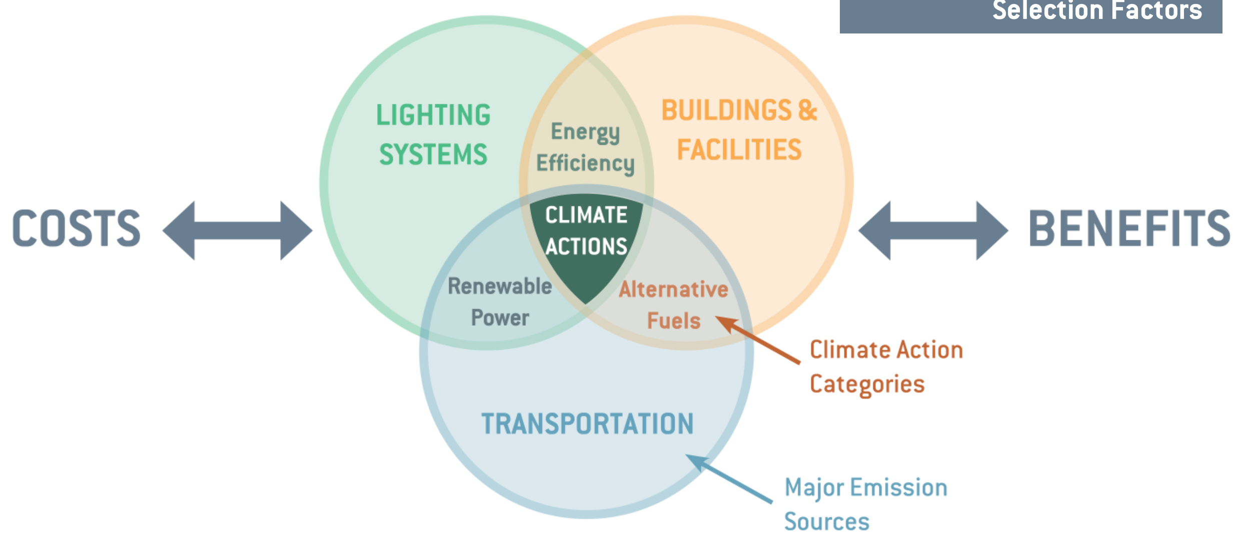
This plan seeks to select climate actions that address a cross-section of these factors. **Figure 7** presents a simple Venn diagram of how these selection factors interact.

The large circles represent the three largest sources of emissions. For example, mobile combustion (or transportation) is a major source for both the community and the municipal operations (see Section 4 for an analysis of these emissions sources). Where two major sources overlap, it creates a climate action category. For example, "Alternative Fuels" is a climate action category that applies to both transportation (mobile combustion) and buildings and facilities (stationary combustion). Each category contains specific climate actions. Within the category of Alternative Fuels, actions could include using compressed natural gas for buses or using natural gas instead of heating oil in buildings.

The costs and benefits of all climate actions must be considered as well. No matter how relevant, if the climate action's benefits did not outweigh the costs, the action was not prioritized. The ideal climate action provides the greatest number of benefits at the lowest cost.

The Sustainability Element identified a significant number of potential adaptation and mitigation climate actions. This long list had to be narrowed to a much shorter list of priority climate actions with the greatest potential for climate mitigation for inclusion in this Climate

FIGURE 7: Interaction of Selection Factors



Action Plan. Figure 8 presents the process flow for selecting priority mitigation climate actions.

The process starts with a comprehensive ("long") list of over 250 climate actions identified in the Sustainability Element of Hoboken's Master Plan. Given that this plan is focused on GHG emission reductions, only actions addressing mitigation were considered for prioritization. This "long list" was then assessed based on expected contributions to meeting reductions goal and the selection factors describe above. For example, the mandatory Gold Star requirements were automatically included in the final Priority List. These requirements are detailed in the following Section 5.2.

FIGURE 8: Selection Process for Priority Climate Actions

Community feedback was also considered during the final selection process. Members of the community and other stakeholders provided their perspective on proposed climate actions and insight into potential benefits and marketing strategies. Section 5.3 provides additional details on this community engagement and feedback.

5.2 Sustainable Jersey Gold Star Requirements

Sustainable Jersey's Gold Star in Energy identifies the specific actions and levels of performance that municipalities can and must achieve to work toward a sustainable New Jersey. The Gold Star award indicates that a municipality is making a fair and timely contribution to the collective achievement of the following sustainability goals in the Energy Dimension:

1. Decrease greenhouse gas emissions in time to avoid catastrophic climate impacts (minimize environmental harm)
2. Increase the renewable energy fraction (decrease vulnerability of energy system)
3. Increase affordability of energy
4. Increase resilience (decrease outages and vulnerability to disruptions)
5. Decrease risk to human health from the energy system

As discussed in Section 2, the Gold Star in Energy will be awarded when Hoboken meets two standards:

1. Municipal Operations Standard: Demonstrate reductions in GHG emissions from municipal operations and facilities at an average annual rate of 3.6% per year for three years (i.e., a rate amounting to 10.8% over three years or less)
2. Community-wide Emissions Standard: Requires Hoboken to take effective steps to bring down energy consumption, and thus emissions in the broader community, by demonstrating an average annual rate of one percent reductions in GHG emissions and by implementing the following Sustainable Jersey actions at the specified

Gold level of performance (or approved alternatives):

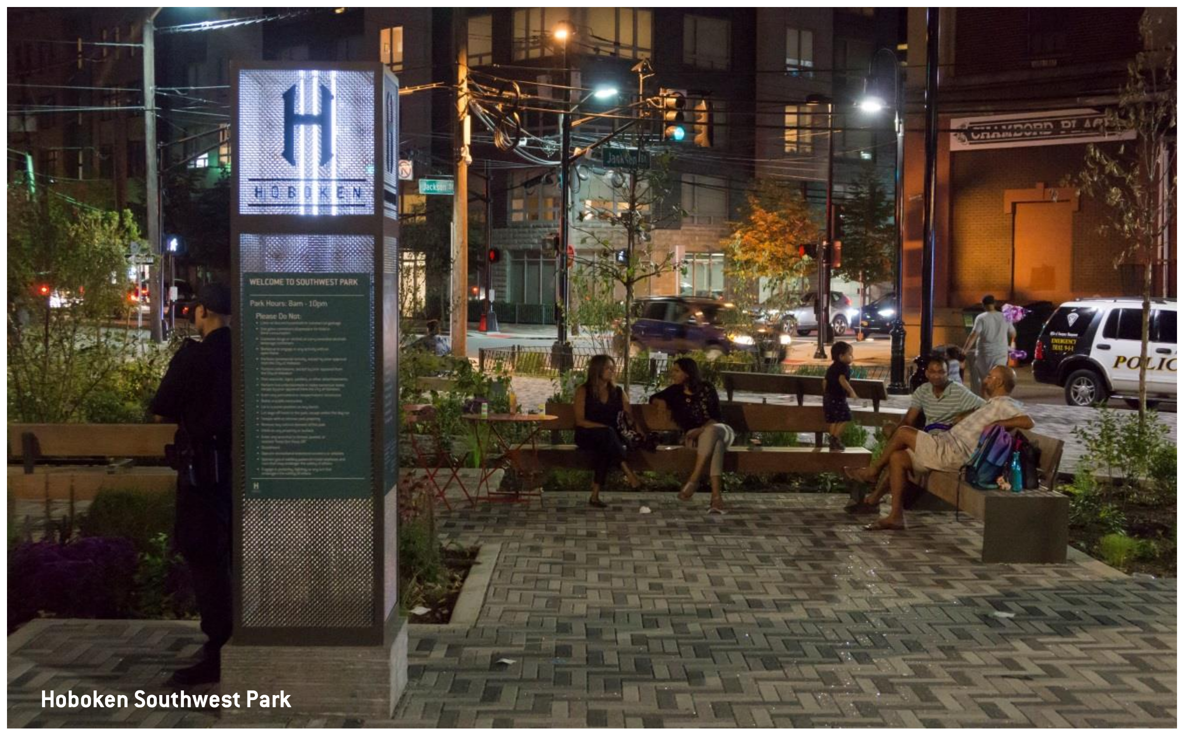
a. Make Your Town Electric Vehicle Friendly
b. Public Electric Vehicle Charging Infrastructure
c. Make Your Town Solar Friendly
d. Community-led Solar Initiatives
e. Residential Energy Efficiency Outreach
f. Commercial Energy Efficiency Outreach

5.3 Community Engagement and Feedback

An important part of developing this climate action plan was engaging community stakeholders and gathering their perspectives and input on the proposed climate actions. This engagement involved three presentation and listening sessions with a core group of environmentally focused stakeholders. This group consisted of members of the Hoboken Green Team, the Climate Mobilization, and Citizen's Climate Lobby; North Jersey Transportation Planning Authority; local real estate developers; and other active participants in Hoboken's climate change and sustainability initiatives. In addition; two public meetings were conducted to present climate actions and gather community feedback. These were well attended by community members who offered their insights as to the proposed climate actions.

Key points of feedback include the following observations:

- Rooftop solar is expensive and logistically difficult because of the types of buildings found in Hoboken.
- Residents would like to participate in installing solar capacity but most cannot do so in their own residences, so there is interest in a community solar project.
- Location of EV charging stations would depend on their intended use. The ideal location would be different for resident use than for visitors or commuters.
- There should be a focus on reducing car usage because of Hoboken's dense urban characteristics, which make solutions like



Hoboken Southwest Park

shared vehicles and other alternative transit options more viable and attractive to residents.

Community members were also invited to participate in a survey to rank their preference of the six community climate actions. The survey was distributed at the first Community Engagement Meeting and was also available online for two weeks. Community members identified energy efficiency and community solar as more favorable climate actions. Many respondents also provided additional suggestions, such as improvements to biking infrastructure.

5.3.1 Hoboken is Unique

In each engagement discussion, the unique aspects of the City of Hoboken were mentioned as both an opportunity and a potential difficulty. Hoboken is a small, dense urban environment which results in some specific characteristics that may impact potential climate actions. For example, the building types found in Hoboken are not conducive to widespread rooftop solar, and the high proportion of renters makes individually-owned rooftop solar even more difficult. Hoboken also has a lot of visitors. Because many visitors arrive by car, the municipality may have little or no control over offering alternative modes of low-carbon transportation. The City can, however, incentivize the use of EVs. Having convenient access to low or no-cost charging stations would make Hoboken "EV friendly". This could attract a wider variety of residents and visitors looking for environmentally friendly urban areas.

Historic context can also facilitate climate action planning. Hoboken was particularly hard hit during Hurricane Sandy. Many residents have since become more interested in and committed to addressing climate change. This personal connection has helped increase community interest in mitigating climate change. Additionally, Hoboken has a unique culture that prides itself as a "City of Firsts" and a leader in municipal sustainability. Hoboken has committed to addressing climate change head on with the support of the City government and its constituents.

5.4 Priority Reduction Actions

Based on the above described qualifications and considerations, the following priority climate actions were chosen to enable the City to address their reductions goals for the municipal operations and the community. **Table 4** lists the priority climate actions for the municipal operations, while **Table 5** lists the priority climate actions for the community. These actions were chosen to be challenging but achievable. Actions highlighted in green are eligible for Sustainable Jersey points towards the Gold Star in Energy.

Section 6 – Implementation and Impact Forecasts is designed to provide a roadmap for the City operations and the community to reach their emission reductions targets and goals.

TABLE 4: Priority Climate Actions for Municipal Operations

ID	Municipal Operations - Climate Actions	Costs	Cost Savings	Expected Percentage Annual GHG Reduction			
				Year 1	Short-Term Year 3	Med.-Term Year 5	Long-Term Year 10
M1a	Renewable Energy Supply - 6.5% OR	$4,500/year	N/A	3.6%	3.6%	3.6%	3.6%
M1b	Renewable Energy Supply - 19.5%[24] OR	$13,500/year	N/A	10.8%	10.8%	10.8%	10.8%
M1c	Renewable Energy Supply - 100%	$70,000/year	N/A	56.5%	56.5%	56.5%	56.5%
M2	Install photovoltaic solar energy systems on municipal buildings (50% of rooftop area of major parking facilities)	$2,500,000	$45,500/ year	5.3%	5.3%	5.3%	5.3%
M3	Implement Energy Efficiency Upgrades at City Hall demonstrating 10% cost savings	$15,800	$13,800/ year	0.7%	0.7%	0.7%	0.7%
M4a	Install LED street lamps	$578,100	$86,900/ year	9.1%	9.1%	9.1%	9.1%
M4b	Install LED traffic lights	$28,400	$8,100/ year	0.8%	0.8%	0.8%	0.8%
M5a	Phase in hybrid electric (plug-in hybrid) vehicles into the City's vehicle fleet.	$35,000/ vehicle, 26 vehicles	$13,500/ year	0.9%	0.9%	0.9%	0.9%
M5b	Phase in electric vehicles into the City's vehicle fleet.	$35,000/ vehicle 29 vehicles	$32,000/ year	2.2%	2.2%	2.2%	2.2%
M7	Phase in low-emission (CNG) buses into the City's HOP fleet.	$80,000/ vehicle, 5 vehicles	$20,000/ year	1.6%	1.6%	1.6%	1.6%
M8	Conduct energy audits and implement Energy Efficiency Upgrades at other City facilities.	$78,900	$95,400/ year	5.7%	5.7%	5.7%	5.7%
M9	Consider incentives for City employees commuting via non-vehicular transp. or electric vehicles.	TBD	N/A	TBD			

[24] Note that 19.5% renewable energy is the minimum needed to achieve 10.8% emissions savings required for Sustainable Jersey Gold Star in Energy. If increased to 20%, this action is also eligible for Sustainable Jersey points towards certification.

TABLE 5: Priority Climate Actions for Hoboken Community

ID	Municipal Lead - Climate Actions	Costs	Cost Savings	Expected Percentage Annual GHG Reduction			
				Year 1	Short-Term Year 3	Medium-Term Year 5	Long-Term Year 10
A. Making Hoboken Electric Vehicle Friendly & Implementing EV Charging Stations							
A0	Electric Vehicle Initiative implementation plan to address tasks A1 to A5 including charging station locations, distribution infrastructure and budget,	½ Full Time Equivalent – City Employee	N/A				
A1	Amend the zoning code to include EV supply equipment and EV charging stations as a permitted accessory use			0.31%	0.94%	1.56%	3.13%
A2	Adopt a PEV ordinance to include regulations and design standards for EV supply equipment, EV charging and parking						
A3	Required First responders' on-line training on EV supply equipment						
A4	Awareness event - Host an EV awareness event for the community						
A5	Provide public access to at least one EV Charging Stations[25]	$5,000 to $10,000 per station	N/A				
B. Making Hoboken Solar Friendly & Implement Solar Initiatives							
B1	Adopt a supportive solar zoning and permitting fee ordinance as recommended by Sustainable Jersey guidance	One Full Time Equivalent – City Employee	N/A	TBD			
B2	Show evidence of streamlining solar permitting processes and inspections			TBD			
B3	Implement Community-Led Residential and Commercial Solar Purchasing Program (e.g., special solar pricing via approved solar installers)		$231,000 /year	0.24%	0.70%	1.16%	1.16%

[25] Note: Ten chargers per year are suggested to increase percentage of EVs owned by 1.5% each year among vehicles registered in Hoboken. There are funding and partnership opportunities available so that the City does not have to purchase all charging stations outright, but instead provides space and access for a third-party to purchase and install the charging stations.

TABLE 5: Priority Climate Actions for Hoboken Community

ID	Municipal Lead - Climate Actions	Costs	Cost Savings	Expected Percentage Annual GHG Reduction			
				Year 1	Short-Term Year 3	Medium-Term Year 5	Long-Term Year 10
B4	Implement at least one outreach activity and one incentive for solar		TBD	TBD			
C. Residential & Community Energy Efficiency Outreach							
C1	Implement a general residential outreach program focused on Home Performance Energy Star and Comfort Partners	½ Full Time Equivalent – City Employee	$277,000 /year	0.55%	1.64%	2.73%	5.45%
C2	Implement PACE Program in Hoboken						
C3	Advocate for statewide adoption of Property Assessed Clean Energy (PACE) Program		N/A	TBD			
C4	Support adoption of the International Green Construction Code at the State level						
C5	Identify municipally-approved contractor(s) to perform Home Performance Energy Star audits. Competitive RFP/RFQ required. Must be within top 10% "lifetime penetration" rate in NJ.						
C6	Implement a commercial outreach program focused on Direct Install Program for local businesses within 2.5 years of application submission. Must reach a 5% (of all commercial and industrial parcels) participation rate among NJ communities.	½ Full Time Equivalent – City Employee + $465,000/ year	$76,000/ year	0.13%	0.38%	0.64%	1.28%
D. Other Potential Measures							
D1a	Expand Bike Share network	TBD	N/A	0.04%	0.04%	0.04%	0.04%
D1b	Complete citywide on-street bicycle network						
D2	Increase HOP Transit Frequency-Switch to CNG	$80,000/ vehicle	$20,240/ year	1.02%	1.02%	1.02%	1.02%

N/A: Not applicable

TBD: To be determined; for all reductions marked "TBD," there is not sufficient data to make a projection of expected emissions reductions for that action

2nd Street at Clinton Street during Hurricane Sandy, 2012

6. IMPLEMENTATION AND IMPACT FORECASTS

The timing for implementation of the priority climate actions can have a large effect on the ultimate impact, and actions should be phased to minimize cost and maximize return. The best climate actions, those with a high impact, a relatively easy implementation process, or a low upfront cost, should be implemented first. This can kick-start the climate action process with a simple and effective project. Actions that require interagency cooperation or have a lengthy implementation period should also begin earlier to allow their impacts to be visible in medium- or long-term analysis, which is crucial for hitting milestones and achieving reduction goals.

The full range of implementation and impact factors are described in the next section, followed by emissions forecasts based on the suggested implementation of the priority climate actions.

6.1 Implementation & Impact Factors (Strategies, Costs, Benefits, Timing)

Each priority climate action carries with it a set of benefits and costs. For each action, the costs and benefits of implementation, or how to complete the action and impact, or the amount of GHG reductions, must be considered. This then informs how and when the actions will be implemented. **Table 5** provides a summary of the municipal (local government) climate actions and their implementation and impact factors. **Table 6** provides the same information for community climate actions.

Certain actions may provide opportunity for cross-cutting efforts with other agencies, which can enhance the viability of that action by providing additional credibility or even financial support. For example, some energy efficiency actions could be supported by local utility or New Jersey Clean Energy programs, which could provide rebates or discounts to participating residences. Sustainable Jersey actions are already vetted to have measurable climate impact and implementing these actions

brings additional visibility to the City and contributes to achieving Gold Star status in Energy.

GHG emission reduction is a crucial component of each climate action as it is the primary motive for implementing the actions. It is also the primary indicator of success: Hoboken's goals are almost entirely based on achieving stated GHG reduction for municipal operations and the community as a whole. Each action's potential for GHG reduction is presented in relative terms (low, medium, or high) to present a simple comparison of the actions.

Time and cost necessary to implement each action are also presented in relative terms. Again, this allows for simple comparison of actions. The cost to implement considers the cost of the action as well as the potential cost savings that could occur after the action is complete. For example, LED streetlights present a medium upfront cost but have the potential for a medium or high cost savings after implementation. A significant payback can make an initially expensive action more affordable.

Finally, the task leader and partners are given to hold those entities accountable for implementing the necessary actions to achieve Hoboken's emissions reduction goals. In many cases, the City of Hoboken will work with a partner agency to successfully implement a given action.

Table 6 provides a summary of the municipal climate actions, impacts, costs, and factors affecting their implementation. As described in more details in the GHG inventory reports in Appendices, the implementation scenarios were modeled over a 10-year span, assuming that the City would begin phasing-in the measures in 2019.

Similarly, **Table 7** provides the actions' implementation and outcome factors information for community climate actions.

6.2 Impact (GHG Reduction) Forecasts

Emissions forecasts can help to see the trajectory of an entity's emissions. Forecasts can also help predict whether the selected climate actions will be sufficient to achieve emissions reduction goals. Different scenarios can be modeled to test when climate actions should be implemented and if they should be phased in over time. This can help the City plan how to implement the climate actions in order to achieve their goals.

If all climate actions are phased in over ten years, the City will achieve its municipal reduction goal of 3.6% reductions annually, and will surpass the goal of 16% reductions by 2027 to exceed the US commitment to the Paris Accord. Additionally, the City is on track to achieve Net Zero status in 2025.

TABLE 6: Implementation and Impact Factors for Municipal Climate Actions

Name of Initiative	Description	Cross-Cutting Efforts	Potential GHG Reduction	Time to Implement	Cost to Implement	Task Leader/ Partners
Municipal Actions (2017 Baseline GHG 4,260 tCO_2e) *Potential GHG Reduction: low <4%; medium 4-10%; high >10%* *Cost: low<$10k/year; medium $10k-100k/year; high >$100k/year* *Cost Savings: low <$10k/year; medium $10k-50k/year; high >$50k/year*						
Renewable Energy Supply	Purchase up to 100% of electricity usage using certified renewable energy.	Gold Star Energy Requirements	Low to High	Short-Term	Low to no cost with no cost savings	City of Hoboken /Energy Consultant
Install photovoltaic solar energy systems on public buildings	City installs rooftop PV energy systems on municipally owned buildings, where practical and cost effective, such as on parking structures or City Hall.	Gold Star Energy Requirements	Medium	Medium-Term	High cost with medium cost savings	City of Hoboken /Solar Project Developer
Implement energy efficiency upgrades at City Hall demonstrating 10% cost savings	Install energy efficiency upgrades to City Hall and a submetering system to measure energy savings.	Gold Star Energy Requirements	Low	Medium-Term	Medium cost with medium cost savings	City of Hoboken /Energy Consultant or Utility
Install LED street lights	Replace and upgrade street lamps with LED technology and advanced controls.	Utility programs	Medium	Short to Medium-Term	High cost with high cost savings	City of Hoboken, Utility
Install LED traffic lights	Replace and upgrade traffic lights with LED technology and advanced controls.	Utility programs	Low	Short to Medium-Term	Medium cost with low cost savings	City of Hoboken, Utility
Phase in hybrid electric (plug-in hybrid) vehicles into the City's vehicle fleet	Replace 26 gasoline vehicles (average 18 mpg) with plug-in hybrid vehicles (average 99 mpg).	Gold Star Energy Requirements	Low	Long-Term	Medium to high cost with medium cost savings	City of Hoboken

TABLE 6: Implementation and Impact Factors for Municipal Climate Actions

Name of Initiative	Description	Cross-Cutting Efforts	Potential GHG Reduction	Time to Implement	Cost to Implement	Task Leader/ Partners
Phase in electric vehicles into the City's vehicle fleet	Replace 29 HPU gasoline vehicles (average 18 mpg) with electric vehicles (average 99 mpg).[26]	Gold Star Energy Requirements	Low	Long-Term	Medium to high cost with medium cost savings	City of Hoboken
Conduct energy audits and implement energy efficiency upgrades at other City facilities	Install energy efficiency upgrades to the Hoboken Volunteer Ambulance Corps, Fire Department, Public Library, Parking Utility, Environmental Services Dept. and Transportation & Parking Dept.	Gold Star Energy Requirements	Medium	Medium-Term	Medium cost with high cost savings	City of Hoboken
Consider incentives for City employees who commute via non-vehicular transportation or electric vehicles	Incentivize City employees who currently commute via gasoline vehicles to switch to more climate-friendly methods.	City Hall	Low	Short to medium-term	Low cost with no cost savings	City of Hoboken

[26] Note: All gasoline passenger cars could be replaced with fully electric vehicles to achieve greater emissions savings, but both options are presented here for reference in case the increased flexibility of hybrid vehicles is desired.

TABLE 7: Implementation and Impact Factors for Community Climate Actions

Name of Initiative	Description	Cross-Cutting Efforts	Potential GHG Reduction	Time to Implement	Cost to Implement	Task Leader/ Partners
Community Actions (2017 Baseline GHG 445,313 tCO_2e) *Potential GHG Reduction: low <1%; medium 1-5%; high >5%* *Cost: low<$10k/year; medium $10k-100k/year; high >$100k/year* *Cost Savings: low <$10k/year; medium $10k-50k/year; high >$50k/year*						
Municipal electric vehicle-friendly policy and programs	Pass local code updates, establish training and host awareness events for electric vehicles.	Gold Star Energy Requirements	Medium	Long-Term	Medium cost to City	City of Hoboken
Provide public access to EV charging stations	Working with the City, the Community will site and install at least one EV charging station.	Gold Star Energy Requirements	(included in above)	Medium-Term	Medium to High cost to City	City of Hoboken
Municipal solar-friendly policy and programs	Pass local legislation and establish favorable solar purchasing and incentives.	Gold Star Energy Requirements; Federal tax credits and State Rebate programs	Low	Medium-Term	Medium cost to City with high cost savings distributed among users	City of Hoboken /Federal and State input
Community-Led Residential and Commercial Solar Purchasing Program	Obtain special solar pricing via approved solar installers.	Gold Star Energy Requirements	Low	Medium-Term	Medium cost to City with high cost saving distributed among users	City of Hoboken
Commercial Energy Efficiency	Conduct outreach for Direct Install Program and achieve 5% participation rate among local businesses.	Gold Star Energy Requirements	Low	Long-Term	High total cost with high cost savings (distributed between participants)	City of Hoboken /Utility

TABLE 7: Implementation and Impact Factors for Community Climate Actions

Name of Initiative	Description	Cross-Cutting Efforts	Potential GHG Reduction	Time to Implement	Cost to Implement	Task Leader/ Partners
Residential Energy Efficiency	Conduct outreach for Energy Star Program and identify municipally-approved contractor(s) to perform Home Performance Energy Star audits.	Gold Star Energy Requirements	Medium	Long-Term	Medium total cost with high total cost savings (each distributed between participants)	City of Hoboken /Approved Contractor
Advocate for and implement PACE program	Advocate for statewide adoption of legislation allowing Property Assessed Clean Energy programs and implement in Hoboken.	State of New Jersey	Medium	Medium to Long-Term	Low cost	City of Hoboken
Advocate for statewide adoption of the IGCC	Statewide adoption of the International Green Construction Code (IGCC) would mandate green construction in Hoboken.	State of New Jersey	Medium	Medium to Long-Term	Low cost	City of Hoboken
Expand Bike Share network	The existing Bike Share network will be assessed and expanded to meet current and future need.		Low	Medium-Term	Low cost to City	City of Hoboken
Complete citywide on-street bicycle network	The existing Community bike infrastructure will be reviewed for expansion and upgrades.		Low	Medium-Term	Low cost to City	City of Hoboken
Improve HOP shuttle service	Double the HOP frequency and switch to compressed natural gas (CNG).		Medium	Long-Term	High cost to City with no savings by the community	City of Hoboken

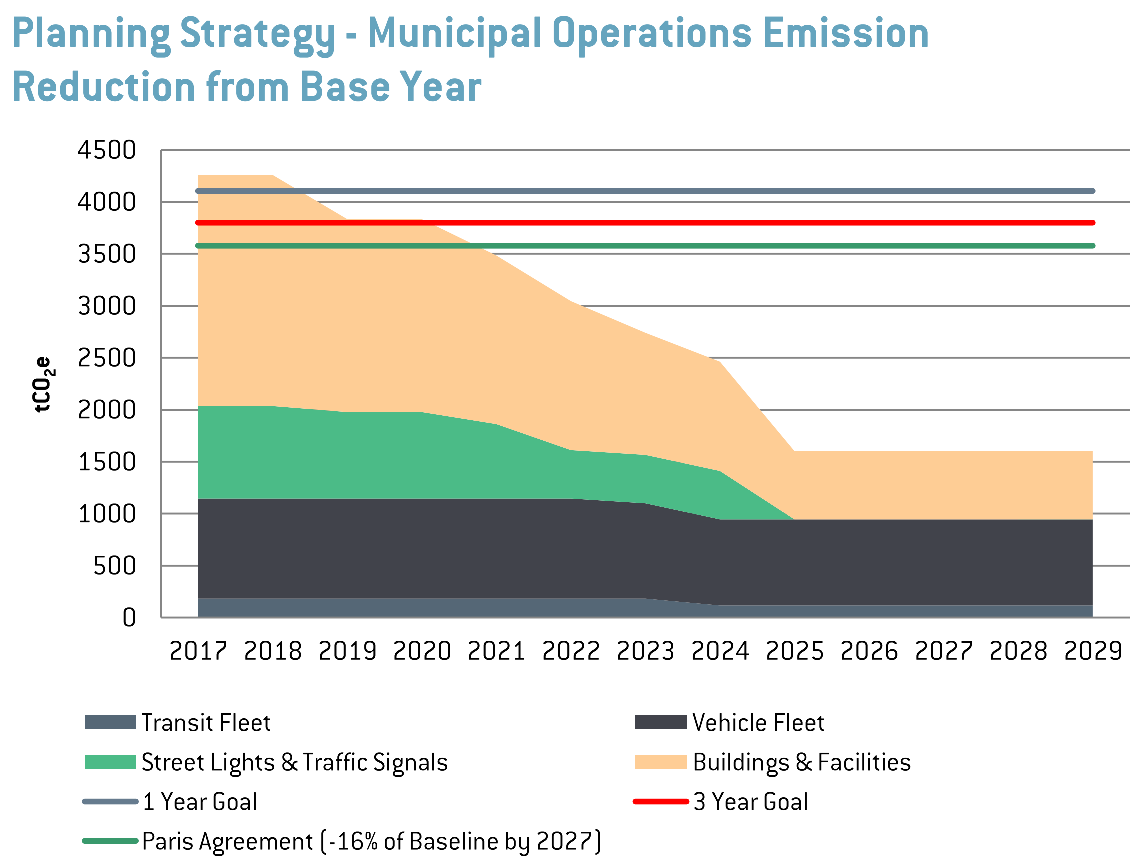
The community inventory shows that the community will achieve the 1% annual reductions needed to receive the Gold Star in Energy. However, the City is not on track to achieve the 16% community reductions needed to exceed the U.S. commitment to the Paris Accord. The City will have to choose additional climate actions with more dramatic impact on emissions to reach this goal. Additionally, this is an opportunity for the Hoboken community to step up and contribute to achieving the City's goals, as the City can only do so much without imposing strict regulation. Community members can contribute to lowering emissions by reducing the number of trips in gasoline vehicles, increasing energy efficiency of their homes and businesses, and using less electricity overall.

Because the Community Net Zero and the Municipal and Community Carbon Neutral goals are more than ten years into the future, and technology is changing so rapidly, those projections are not included in the following Planning Strategy figures. It is suggested that when the Climate Action Plan is revised in the future, these goals are reviewed and included in projections when they are more imminent.

Figure 9 shows the impact forecast for the municipal inventory including the emissions sources and goals from 2017-2029. This scenario assumes a gradual phase-in of the renewable power purchase agreement (PPA) and associated costs to achieve Net Zero status in 2025. After full implementation, the major remaining emissions sources are stationary combustion in buildings & facilities and mobile combustion form the vehicle fleet and transit fleet.

The community impact forecast is shown in **Figure 10**. This scenario assumes that all climate actions are phased in over ten years, starting in 2019, achieving the goal of one percent average

FIGURE 9: Municipal GHG Emission Reduction Plan – Net Zero 2025 Scenario



annual community GHG emissions reductions (see **Appendix A** for a description of all assumptions made). After full implementation, the two major emissions sources are commercial energy usage and transportation and mobile sources.

These implementation forecasts for both the municipal and community inventories should inform future climate action planning by identifying the major remaining sources of emissions.

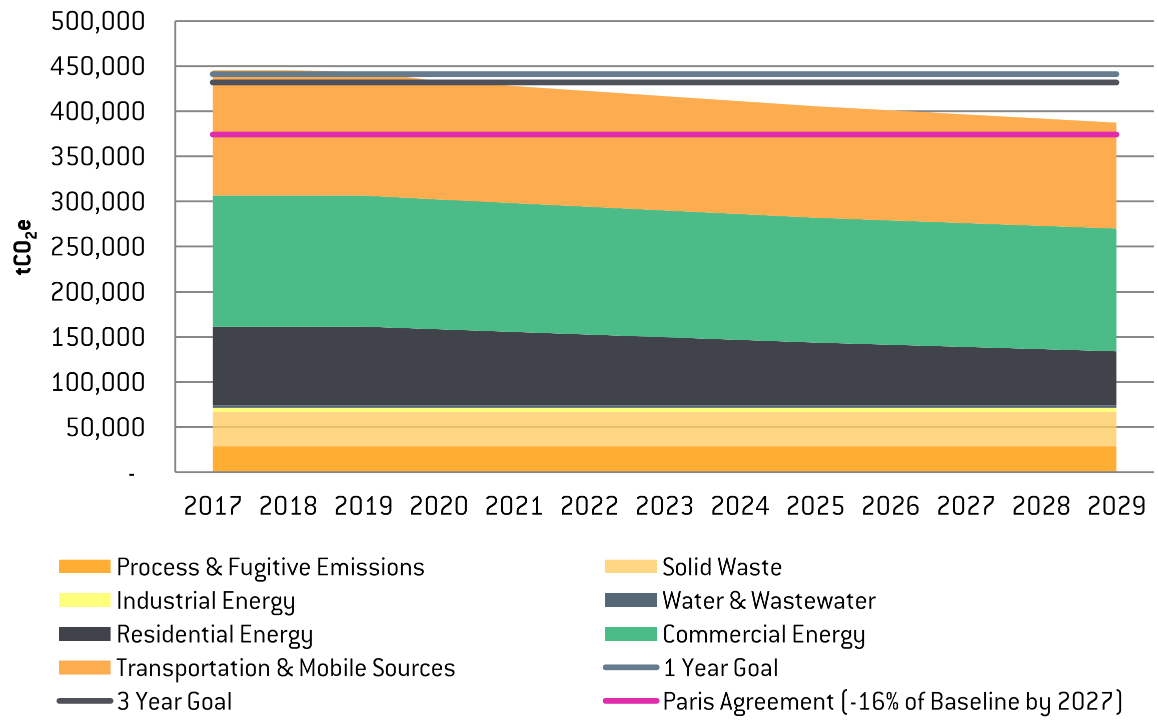
6.3 Potential Sources of Funding and Incentives

The initial capital costs for the proposed climate actions can be large. Funding and incentives are available to assist with the development and implementation of several types of climate actions. The U.S. Department of Energy maintains a database of State incentives for energy efficiency and renewable energy. A listing of 97 programs for the State of New Jersey can be found here. **Table 8** presents some selected sources of funding and incentives from this listing.

In addition to funding sources, the City of Hoboken should consider participating in the American Cities Climate Challenge Renewables

FIGURE 10: Community GHG Emission Reduction Plan

Planning Strategy - Community Emission Reduction from Base Year



Accelerator (ACCCRA or www.cityrenewables.org). This initiative is providing technical resources to help U.S. cities reach their renewable energy goals. The program is backed by the Bloomberg American Cities Climate Challenge, the Rocky Mountain Institute, the World Resources Institute and the Urban Sustainability Directors Network (Link to Fact Sheet).

6.4 Innovative Longer-term Solutions

Because of the urgency to mitigate the causes of Climate Change, the primary focus of the

Climate Action Plan has been on the short-term solutions that can be implemented in three to seven years. As technologies and green infrastructure develop, there will be a number of longer-term mitigation solutions to consider. Therefore, this plan will be re-evaluated every five years. The following are just a few potential innovative solutions that could significantly contribute towards meeting Hoboken's long-term GHG reduction goals:

- Wastewater treatment facilities owned by North Hudson Sewerage Authority could consider using advanced anaerobic digester technology to convert wastewater sludge into bio-gas at the Adams Street facility. Gas produced in anaerobic digesters can be used to generate green electricity and reduce the community's carbon footprint. Local food wastes could also be digested rather than sent to landfills. Potential carbon offsets and/or renewable energy credits could be monetized to pay for these improvements. New Jersey's recent reintroduction into the Regional Greenhouse Gas Initiative (RGGI) would facilitate such actions.
- The City of Hoboken could consider attracting vertical farming operations or expanded community garden opportunities. Vertical farms, using aeroponic growing technology, can reduce regional carbon emissions related to food production, distribution and consumption by 20%.[27] In addition, such operations can attract green jobs and improve tax base revenues.
- For large public housing projects, hospitals, and campus infrastructure, combined power and heat (or co-generation) units could be considered to augment alternative energy options. The average efficiency of the typical fossil-fueled power generation has been 33%. By recovering wasted heat, CHP systems achieve total system efficiencies up to 80% with some systems approaching 90%.[28]

TABLE 8: Potential Funding for Climate and Sustainability Initiatives

Program	Description	Potential Applications
Board of Public Utilities Clean Energy Program	Energy efficiency audits, rebates and incentives for Homeowners; Businesses; and Local Governments	Community and municipal energy efficiency retrofits
New Jersey Transportation Infrastructure Bank	Low interest loans for local transportation infrastructure projects	Municipal upgrades to improve public transit to discourage use of cars
Sustainable Jersey Grants & Resources Portal	Comprehensive resource for Sustainable Jersey-related grants and other funding opportunities that apply to Sustainable Jersey Actions	Sustainable Jersey-eligible actions, especially creative or unorthodox projects
Drive Green NJ	One-stop resource for all federal and state electric and alternative fuel vehicle incentives	Encouraging residents to purchase EVs; incentives for municipal fleet EVs
Federal Tax Credits: Solar and Wind	Information about federal solar and wind investment tax credit	Community and municipal rooftop solar installation
Regional Greenhouse Gas Initiative (RGGI)	Proposal pending to return NJ to full RGGI participation	Funding for alternative energy programs and projects

[27] The Urban Vertical Farm Project, "Vertical Farming Could Cut 20% off Global Emissions," December 3, 2015

[28] US EPA web site, Combined Heat and Power (CHP) Partnership, January 28, 2019, https://www.epa.gov/chp/chp-benefits.

7. COMMUNICATIONS

Community messaging about climate action should be locally-focused, relevant, non-technical, clear, and consistent. Additionally, messaging should focus on communicating risk, benefits and incentives for group action.[29] Other best practices for climate communications include emphasizing outcomes and benefits that support the achievement of community goals.[30] The objective is to translate climate awareness into support and action.

7.1 Community Access

As described in Section 5.2, Community Engagement was an important part of the climate action planning process. One of the community engagement activities involved brainstorming about potential approaches for gaining support for ongoing implementation. The following suggestions were identified:

- Hoboken is a city of "firsts" as chronicled in its Historical Museum. Although Woodbridge Township has recently received the first Sustainable Jersey "gold star" award in energy, Hoboken government operations is positioned to be the first city in New Jersey to be Net Zero by 2022.
- Hoboken is a city of renters. These residents may have limited authority to implement energy efficient upgrades; however, armed with appropriate data they can make the business case to their landlords to implement energy efficiency savings.

[29] Shome, D., and Marx, S. *The Psychology of Climate Change Communication: A Guide for Scientists, Journalists, Educators, Political Aides, and the Interested Public.* (New York: Center for Research on Environmental Decisions, 2009).

[30] Lawson-Millar, S., Carlson, L. and Marshall, N. "More than Climate Change – Best Communications Practices,"? Oregon Sustainable Transportation Initiative, February, 2012.

- Hoboken residents are practical. Focusing on financial paybacks, value propositions and economic benefits can influence many stakeholders' behavior.
- Hoboken is a healthy place to live. It's important the community understands climate change threatens their health and their general way of life.

These suggestions should be kept in mind when implementing an ongoing persuasive communication and marketing program for the local community. The costs of such programs can be minimized by leveraging existing communication vehicles such as the City's web site, newsletters, and social media.

7.2 Monitoring Progress

Regular reporting is an important part of keeping stakeholders informed and engaged with the City of Hoboken climate actions. It also provides the City opportunities to highlight local achievements while helping to identify issues and, if necessary, adapt implementation.

7.2.1 Inventory Update

Having the Community and Government Operations GHG inventories updated each year will be critical to tracking and reporting progress to stakeholders. The level of effort to gather the required data and update these inventories will be significant. An estimated level of effort for updating the annual inventory is 40 to 60 hours. Appendix A and B present the complete GHG inventories including descriptions of the required activity data (e.g., energy consumption, waste generation, etc.). The boundaries, methodologies, and assumptions used are also included. Instructions on how to access and update the ClearPath tool are also provided in a separate memorandum.

To provide additional credibility to future communications, it is recommended that the City of Hoboken have these GHG inventories verified by a third party accredited to international GHG verification standard (i.e., ISO 14064). Having a verified carbon footprint would put the City of Hoboken among a small number of elite climate leading communities. Verification also positions Hoboken to participate in additional climate leadership programs such as the Climate Registry or CDP (formally known as the Carbon Disclosure Project). Because the existing GHG inventories were built with a high degree of technical rigor to best practices, the cost of third-party verification is expected to be minimal compared to undocumented inventories.

7.2.2 Reporting Template

As a minimum, it is recommended that an annual progress report, or even a brief report card, be disseminated via the City's web site and social media. This progress report will update the community on how implementation

TABLE 9: Climate Action Progress Report Card Template

Climate Action	Status	Tracking Metric	Progress to Date
Renewable energy purchasing	In Progress	% electricity purchased from renewable sources; tCO_2e reduced; % contribution to targets	20% City operations from green-e solar/wind; 450 tCO_2e reduced; 50% to GHG Mid-term City operations target
LED Street Lamps and Traffic Lights	In Progress	% power reduction; tCO_2e reduced; % contribution to targets	60% power reduction over base year for lighting; 420 tCO_2e reduced; 50% to GHG Mid-term City Operations target
Municipal solar friendly policy	In Progress	Estimated % completion of legislative effort	100% drafted, awaiting city approval

efforts are helping to reach targets and achieve goals. To keep this update clear and consistent, the City of Hoboken should consider using a simple report table or report card. After a brief introduction to goals and targets as well as the implementation process, the status of each climate action is presented. **Table 9** presents an example of such a template.

It is important not to provide too much technical information in the annual report. Readers can be directed to this Climate Action Plan for additional details on GHG inventory development and climate actions. This reporting should continue until the goals have been met.

Southwest Park

8. CONCLUSION

8.1 Community Access

For both the community and the city operations, most climate actions fall into a few major categories: improving energy efficiency, reducing use of conventional combustion engine vehicles, and increasing the proportion of alternative energy sources in electricity used. These actions address the major emissions sources identified in the 2017 baseline greenhouse gas inventories created for the community and government operations. The actions described in this report, if implemented as suggested, also enable Hoboken to meet their ambitious goal of achieving the Sustainable Jersey Gold Star in Energy by realizing one percent annual community emissions reductions and 3.6% annual government operations emissions reductions.

The climate actions also help Hoboken get close to achieving their goals of exceeding the US commitment to the Paris Accord for both the community and municipal operations by 2027 and municipal Net Zero status. The additional, long-range climate goals will not be achieved solely by the actions suggested in this Climate Action Plan, which focuses on the first ten years of implementation. As technology improves and new strategies emerge, the City will adapt and revise this Climate Action Plan to work towards the goals of community Net Zero status in 2030, municipal carbon neutrality in 2035, and community carbon neutrality in 2050. It is suggested that the Climate Action Plan is reviewed every five years as revised as necessary to achieve the City's goals.

8.2 Summary Projected Costs, Benefits, and Impacts

Generally, climate actions come with an upfront investment that can then generate long-term savings. The best examples of such actions are energy efficiency upgrades and switching to LED lights, which require purchasing new equipment and contractor costs but result in energy cost savings for many years after. Other climate actions have no direct financial payback, like purchasing renewable power, but have other benefits like improved health outcomes from better air quality and a positive public image from the highly-visible commitment to climate change mitigation.

Additionally, each action has a different level of impact. Some actions, such as outreach activities, may not have a large direct impact on emissions, while others, like purchasing green power, directly contribute to large emissions reductions.

In selecting climate actions, and planning their implementation, the City will evaluate each action holistically. Each action has different costs, benefits, and level of impact that must be considered. Over time, the climate action plan will evolve in response to changing conditions in the City. What seems feasible now may be less so in the future, and what seems far-fetched now may become much more attainable as technology develops or regulations change. The City will update the GHG inventories and the climate action plan to make sure that they are responding to the current needs of the city and the community.

8.3 Summary of Benefits

Climate actions to reduce greenhouse gas emissions are not solely altruistic; they have real, tangible benefits for community members and municipal governments. Energy savings, more comfortable buildings, and lower maintenance costs can result from many climate actions. Others can improve air quality and boost roadway safety for pedestrians and cyclists. Lower insurance premiums and increased property values often follow climate change-sensitive building improvements. Overall, a city that is considerate of climate change is also a healthier, safer and more economically-resilient place to live and work. Hoboken prides itself on being a comfortable and inclusive community, and its values directly align with the benefits of mitigation- and adaptation-based climate actions.

APPENDIX A

Community Greenhouse Gas Emissions Inventory Report – Base Year 2017

Greenhouse Gas Emissions Inventory
Community Activities
City of Hoboken, New Jersey
Activities Year 2017

April 2019

Prepared by: First Environment, Inc.
91 Fulton Street
Boonton, New Jersey 07005

FIRST ENVIRONMENT

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LIST OF ACRONYMS

AR5 - Intergovernmental Panel on Climate Change's Fifth Assessment Report
CAGR – Compound Annual Growth Rate
CH_4 - methane
CO_2 – carbon dioxide
CO_2e - Carbon Dioxide Equivalents
CSC – New York State Climate Smart Communities
EF – GHG Emission Factor
eGRID – US EPA Emissions & Generation Resource Integrated Database
EPA – Environmental Protection Agency
GHG – greenhouse gas
GPC – Global Protocol for Community-Scale Greenhouse Gas Emission Inventories
GWP – global warming potential
HFC – hydrofluorocarbon
ICLEI - Local Governments for Sustainability
IMP – Inventory Management Plan
IPCC – Intergovernmental Panel on Climate Change
LGO – Local Government Organization
LGOP – ICLEI's Local Government Organization Protocol
LPG – liquid petroleum gas (propane)
t – metric tonnes
MSW – municipal solid waste
MWh – Mega Watt hour
NHSA - North Hudson Sewerage Authority
NJRTM-E - North Jersey Regional Transportation Model- Enhanced
NJTPA - North Hudson Traffic Planning Authority
N_2O – Nitrous Oxide
PSE&G - Public Service Electric and Gas Company
PFC – perfluorocarbon
RFCE – NERC region: Reliability First Corporation/ East
SF_6 – sulfur hexafluoride
TCR – The Climate Registry
the City – City of Hoboken
US EPA - United States Environmental Protection Agency
UNFCCC – United Nations Framework Convention on Climate Change
US EIA - United States Energy Information Administration
WRI – World Research Institute

1. Executive Summary

First Environment, Inc. (First Environment) was retained by the City of Hoboken ("Hoboken" or the "City") to prepare the greenhouse gas (GHG) emissions inventory for both the community (also referred to as the City within this report) and the municipal operations activities in 2017. The community GHG inventory was conducted in accordance with the Global Protocol for Community-Scale Greenhouse Gas Emission Inventories (GPC) developed by the Local Governments for Sustainability (ICLEI) in partnership with the World Resources Institute. The municipal operations GHG inventory was instead conducted in accordance with ICLEI's Local Government Operations Protocol (LGOP). ICLEI's ClearPath Pro web based tool provided the platform for data collection, processing, and GHG quantification and reporting for both inventories.

The GHG inventory assessed emissions of seven greenhouse gases (GHGs):

- carbon dioxide (CO_2),
- methane (CH_4),
- nitrous oxide (N_2O),
- hydrofluorocarbons (HFCs)
- perfluorocarbons (PFCs),
- sulfur hexafluoride (SF_6), and
- Nitrogen tri-fluoride (NF_3).

Conducting the GHG inventories demonstrates the City's recognition of its relationship to both the local and global environment. It allows the City to better understand and take responsibility for its activities and their climate impacts. Accordingly, the inventories provide a foundation and starting point for the City's efforts to reduce greenhouse gas emissions from its activities and demonstrate environmental stewardship. The inventories serve as a reference point to guide the development of policies, programs, and projects as the City pursues its climate change mitigation and adaption objectives.

This report addresses the community GHG inventory emissions; a separate report was prepared for the municipal operations GHG emissions.

Community Inventory

The scope of the inventory includes all emissions sources reportable under the GPC's city-induced framework. This reporting approach includes the GHG emissions attributable to activities taking place within the geographic boundary of the city, aggregated as Scope 1, Scope 2, and selected Scope 3 emissions.

The city-induced framework provides two reporting level options: BASIC or BASIC+. The BASIC level includes Scope 1 and Scope 2 emissions from stationary energy and transportation, as well as Scope 1 and Scope 3 emissions from waste generated by the community. The BASIC+ level includes additional Scope 3 categories such as upstream and downstream processes and products use. The Community of Hoboken opted to follow the BASIC reporting level.

Emissions in the GHG Inventory are reported in Carbon Dioxide Equivalents (CO_2e). CO_2e is used to quantify total emissions because each GHG has a different Global Warming Potential (GWP) which is converted to CO_2e by using a gas-specific factor. Unless otherwise noted in this report, GHG emissions were converted to CO_2e using Global Warming Potentials (GWPs),

a standard conversion factor, from the Intergovernmental Panel on Climate Change's (IPCC) Fifth Assessment Report (AR5). Using CO_2e equalizes all GHGs to one standard reference, quantified in metric tonnes of carbon dioxide equivalent (tCO_2e), the global standard unit used to measure GHG emissions.

Table 1: Summary of GHG Inventory

Reporting Protocol	World Resources Institute/Local Governments for Sustainability (ICLEI)'s Global Protocol for Community-Scale Greenhouse Gas Emission Inventories, v1, 2014
Reporting Tool	ICLEI ClearPath – Community Track - https://clearpath.icleiusa.org
Geographic Boundary	City of Hoboken Municipal Boundary
Reporting Framework	City-Induced Framework - BASIC Reporting
Operational Boundary	Scope 1, Scope 2, selected Scope 3 from waste generated
Inventory Reporting Period	January 1 to December 31, 2017
Base Year	2017
Greenhouse Gas	Kyoto Seven GHG
GWP Defaults	IPCC 5th Assessment Report (AR5)

Community GHG Emissions by Scope

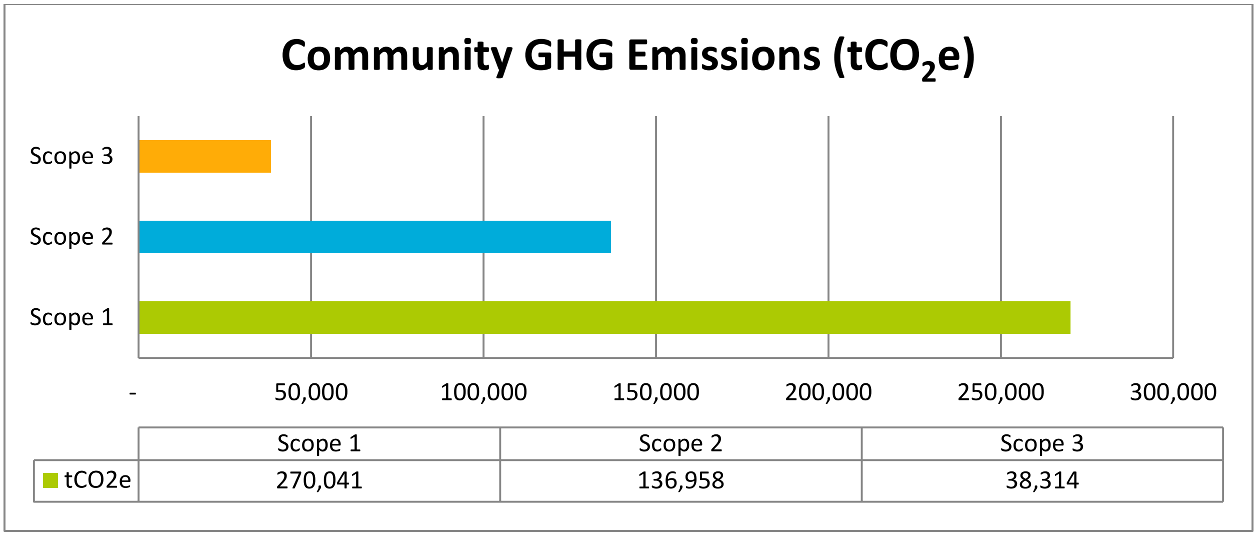
The Community's total Scope 1 GHG emissions for 2017 amounted to 270,041 tCO_2e. These total emissions originate from stationary combustion such as natural gas for heating, and from mobile combustion such as gasoline and diesel consumption by the Community vehicles.

The City's total Scope 2 GHG emissions for 2017 amounted to 136,958 tCO_2e. In addition, the Scope 3 emissions, selected according to the BASIC reporting level, amounted to 38,314 tCO_2e.

Table 2: Total GHG Emissions by Scope (tCO_2e)

GHG Emissions	tCO_2e
Scope 1	270,041
Scope 2	136,958
Scope 3	38,314
Total	445,313

Figure 1: Total GHG Emissions by Scope (tCO_2e)



The distribution of Scope 1, Scope 2, and Scope 3 emissions by sector is shown in percentage and in tCO_2e in the charts below.

Figure 2: Total GHG Emissions by Sector in Percentage

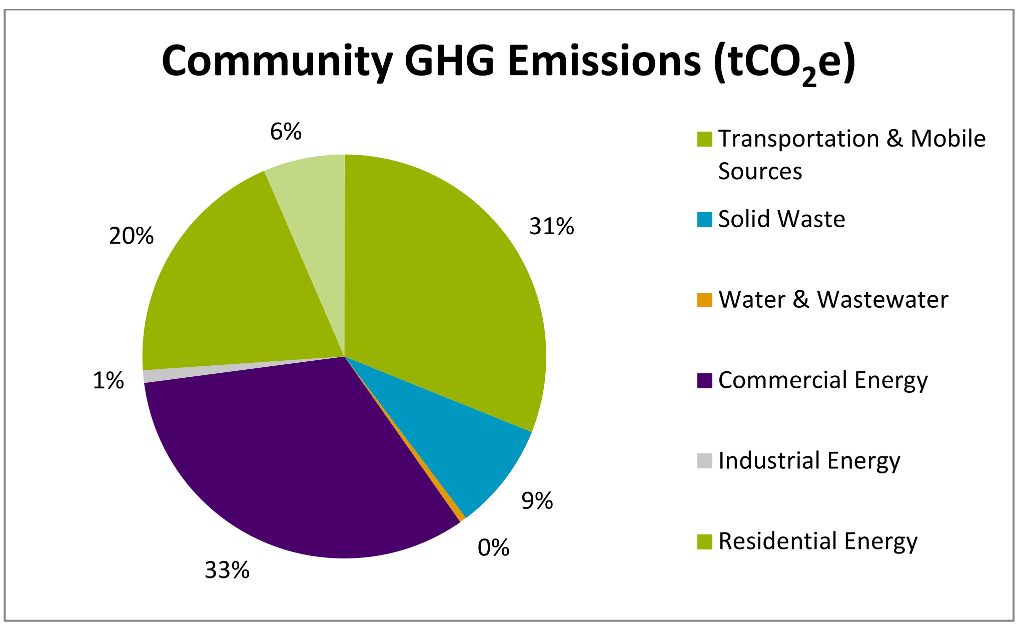
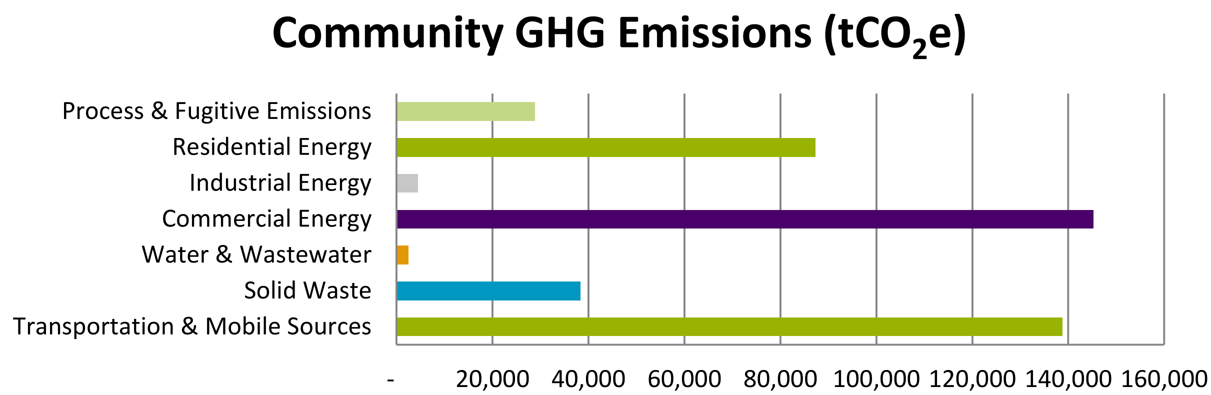


Figure 3: Total GHG Emissions by Sector (tCO_2e)



	Transportation & Mobile Sources	Solid Waste	Water & Wastewater	Commercial Energy	Industrial Energy	Residential Energy	Process & Fugitive Emissions
GHG Emissions (tCO2e)	138,768	38,314	2,457	145,239	4,441	87,260	28,833

The results highlight the predominance of the emission from buildings and facilities (residential and commercial energy) as the major sources of GHG emissions. Scope 1 emissions from mobile fuel combustion rank as the next largest source.

2. Introduction

A GHG emissions inventory identifies an organization's GHG emission sources and quantifies them according to a set of acknowledged conventions using established estimation methodologies.

The City air emission inventory quantifies GHG from the "Kyoto six" GHGs—carbon dioxide (CO_2), methane (CH_4), nitrous oxide (N_2O), hydrofluorocarbons (HFCs), perfluorocarbons (PFCs), and sulfur hexafluoride (SF_6) plus the additional nitrogen tri-fluoride (NF_3), recently added to the reportable GHGs. These are the most recognized and common GHGs from human-made sources, as identified in the United Nations Framework Convention on Climate Change Kyoto Protocol (UNFCCC).

The City of Hoboken Community GHG inventory includes the emissions generated or induced by the City residents and businesses, including those produced by power generation, waste disposal, or wastewater treatment facilities, if present within the City geographic boundaries. In accordance with the GPC city-induced framework the GHG inventory also includes the emissions from transportation by vehicles operating within the City boundaries, according to certain criteria better explained in the following sections, notwithstanding if the vehicles are operated by City residents or travelers to and from the City boundary.

Because the data required for the inventory was collected with a top-down approach (for example, aggregated energy data provided by the local utility), the Community inventory also includes the emissions by the municipal government operations. As previously mentioned, the emissions from the municipal operations sources were also accounted for according to a separate specific protocol in a separate GHG Inventory conducted in parallel with the Community Inventory.

3. Overview of the City of Hoboken

The City of Hoboken is located in Hudson County, New Jersey, across the Hudson River west of New York City.

According to the United States Census Bureau[1], the town has a total area of 2.011 square miles including 1.275 square miles of land. The population according to the 2010 census data was 50,006 and it has increased to 55,131 as estimated by July 1, 2017[2]. The number of households according to the same 2017 census estimates is 24,812 and the population density according to the 2010 census data is 39,220 people per square mile.

The City territory borders the municipalities of Jersey City to the west and south; and Union City and Weehawken on the north side. The Hudson River flows on the eastern side of the City.

The City was formed as a Township in 1849 and incorporated as a City in 1855.

Table 3: City Demographic Data

Demographic	Data
Population (2017)	55,131
Households	24,812
Civilian Labor Force, percent of population 16+	78.9
Median Household income (2013-2017)	$127,523
Gross Domestic Product (2016 - $million)[3]	$4,313
Businesses, all firms (2012)	5,946
Hoboken residents working elsewhere (2015)[4]	30,179
Hoboken residents working in Hoboken (2015)[4]	2,267
Non-Hoboken residents working in Hoboken (2015)[4]	16,109

Source: US Census QuickFacts, unless noted.

The City's recently updated Master Plan includes a description of the existing land uses and associated acreage, summarized in the following table and map.

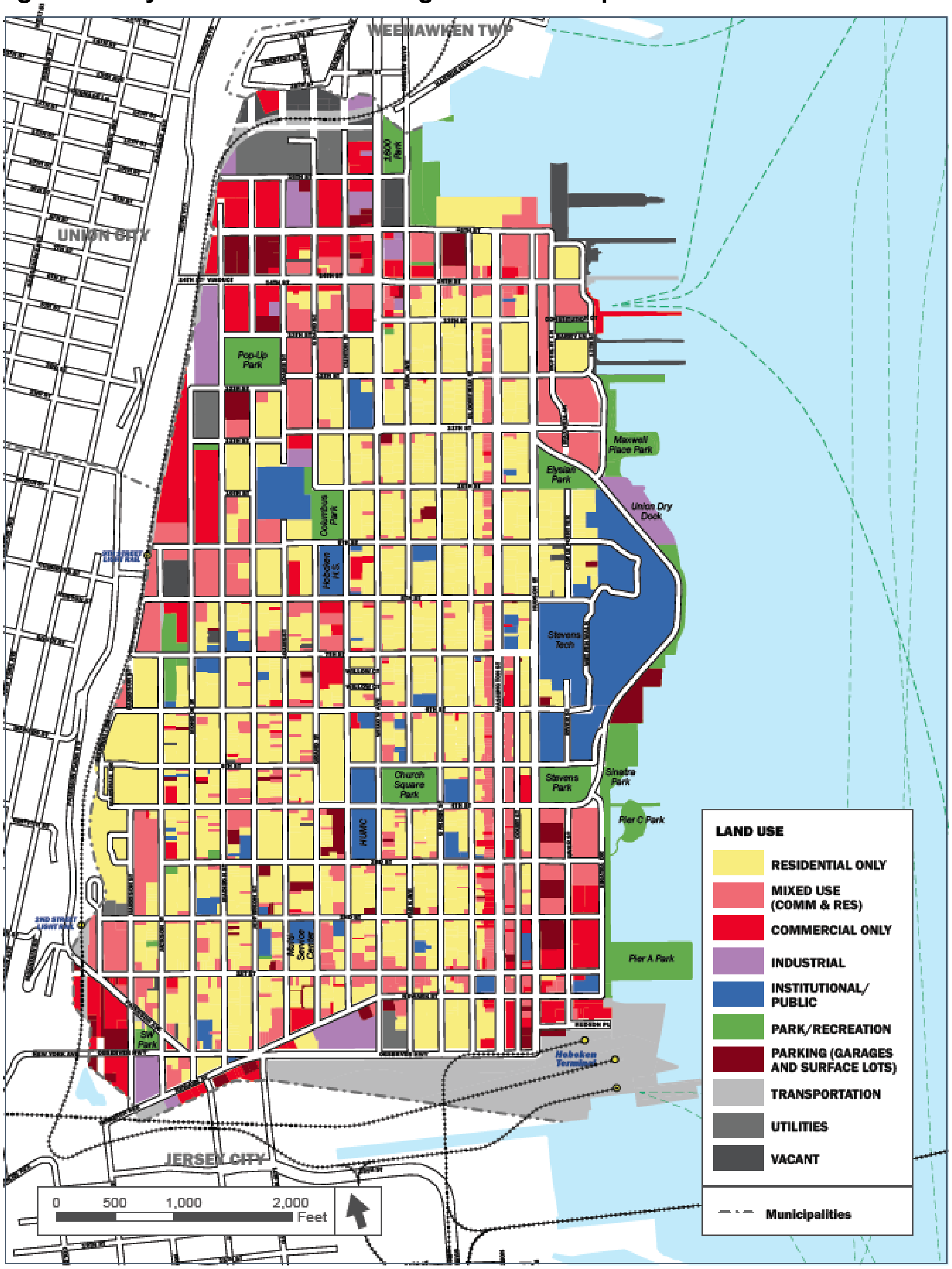
[1] https://factfinder.census.gov/faces/nav/jsf/pages/index.xhtml
[2] https://www.census.gov/quickfacts/hobokencitynewjersey
[3] https://www.bea.gov/news/2017/gross-domestic-product-metropolitan-area-2016
[4] US Census, On the Map – Work Area Profile Analysis – provided by City of Hoboken.

Table 4: Existing Land Use and Acreage[5]

Land Use by Parcel	Acres	Percent
Residential Only	217	39
Mixed Use (Comm. & Res.)	84	15
Commercial Only	54	10
Industrial	17	3
Institutional/Public	57	10
Parks/Recreation	42	8
Parking (Surface & Garage)	20	4
Transportation (Excluding Streets)	45	8
Vacant	12	2
Total	548	100

[5] City of Hoboken Master Plan - Land Use Element 2018 – Table 1

Figure 4: City of Hoboken - Existing Land Use Map[6]



There are no solid waste disposal facilities within the Hoboken geographic boundary, but the North Hudson Sewerage Authority (NHSA) operates a wastewater treatment facility located on Adams Street on the northern end of the Hoboken territory. This facility serves the communities of Hoboken, Union, and Weehawken, collecting sewer and wastewater for treatment and disposal.

6 City of Hoboken Master Plan - Land Use Element 2018 – Figure 2

The City operates a fleet of five paratransit buses providing public transit within the City territory. In addition, the Community is served by several public transit modes provided by New Jersey Transit (bus, light rail, commuter rail) as well as ferry services connecting the City to New York City and other communities on the Hudson River.

3.1 Staff Responsible for the GHG Inventory

This GHG inventory was developed by First Environment through consultation with the City staff led by Jennifer Gonzales, Director of Environmental Services, Chief Sustainability Officer.

3.2 GHG Inventory Reporting Protocol

The City of Hoboken Government Operations GHG inventory was conducted in accordance with Global Protocol for Community-Scale Greenhouse Gas Emission Inventories (GPC), developed by the World Resources Institute (WRI) in partnership with the Local Governments for Sustainability (ICLEI). The GPC is based on WRI's "Greenhouse Gas Protocol: A Corporate Accounting and Reporting Standard," which provides the standards and guidance for companies and other types of organizations preparing a GHG emissions inventory. The goal of the GPC is to offer additional guidance to cities on applying the GHG Protocol within the context of local community. The GPC provides a standardized method and procedures to assist local governments in quantifying and reporting GHG emissions associated with the activities of the community they govern.

3.3 GHG Inventory Reporting Tool

The GHG inventory was prepared using ICLEI's ClearPath Tool, an online platform designed to incorporate all the GPC requirements for inventory data including all parameters, factors, and methodologies necessary to perform the GHG emissions quantification. ClearPath suite of tools also includes modules allowing forecasting of emissions scenarios, as well as planning and monitoring of measures aimed at reducing GHG emission over time.

3.4 GHG Inventory Boundaries

The inventory boundaries identify the geographic area, time span, gases, and emission sources covered by a GHG inventory. The following paragraphs identify the boundaries selected for the City of Hoboken Community GHG Inventory.

3.4.1 Geographic Boundary

The geographic scope of the emissions inventory determines which emissions are accounted for and reported by the Hoboken community. The geographic boundary applied for the Hoboken community inventory is the City of Hoboken jurisdiction boundary, as identified in the City's official maps (see Figure 4 for Land Use Map).

3.4.2 GHG Inventory Reporting Period – Base Year

This GHG inventory report covers GHG emissions from the city-wide activities within the boundaries described during the period of:

- January 1 through December 31, 2017.

This first GHG Inventory provides a full calendar year baseline of data about the energy consumption and resulting GHG emissions from the city-wide activities. The baseline will be used to establish emissions reductions targets and track progress towards achieving them.

3.4.3 Greenhouse Gases and GWP

The Inventory accounts for the emissions of the seven gases currently required for national GHG inventory reporting under the Kyoto Protocol. The following table lists the gas included and their 100-year time horizon GWP according to the IPCC Fifth Assessment Report, 2014 (AR5).

Table 5: Greenhouse Gas and GWP (AR5 100-year time horizon)

Greenhouse Gas	Chemical Formula	Global Warming Potential (AR5 100-year)
Carbon Dioxide	CO_2	1
Methane	CH_4	28
Nitrous Oxide	N_2O	265
Hydrofluorocarbons	HFCs	Various
Perfluorocarbons	PFCs	Various
Sulfur Hexafluoride	SF_6	23,500
Nitrogen Trifluoride	NF_3	16,100

3.4.4 GHG Emissions Sources - Sectors

Community inventories differ from corporate or local government entities inventories because the organizational boundaries definitions (operational control vs. financial control) do not apply. Instead the GPC identifies the sectors that should be applied to classify the GHG emission from cities.

- stationary energy;
- transportation;
- waste;
- industrial processes and product use (IPPU);
- agriculture, forestry, and other land use (AFOLU);
- any other emissions occurring outside the geographic boundary as a result of city activities (collectively referred to as Other Scope 3).

Each one of these sectors includes sub-sectors to better identify the emission sources. The following table summarizes the sectors and sub-sectors according to Table 3 of the GPC.

Table 6: GPC Emission Sources - Sectors and Sub-sectors

Sector	Sub-Sectors
Stationary Energy	Residential buildings
	Commercial and institutional buildings and facilities
	Manufacturing industries and construction
	Energy industries
	Agriculture, forestry, and fishing activities
	Non-specified sources
	Fugitive emissions from mining, processing, storage, and transportation of coal
	Fugitive emissions from oil and natural gas systems
Transportation	On-road
	Railways
	Waterborne navigation
	Aviation
	Off-road
Waste	Solid waste disposal
	Biological treatment of waste
	Incineration and open burning
	Wastewater treatment and discharge
Industrial processes and product use	Industrial processes
	Product use
Agriculture, forestry, and other land use (AFOLU)	Livestock
	Land
	Aggregate sources and non-CO_2 emission sources on land
Other Scope 3	

The selection of the applicable sectors also depends on the reporting approach selected, as discussed in the next paragraphs. For the City of Hoboken, the applicable sectors are stationary energy, transportation, and waste.

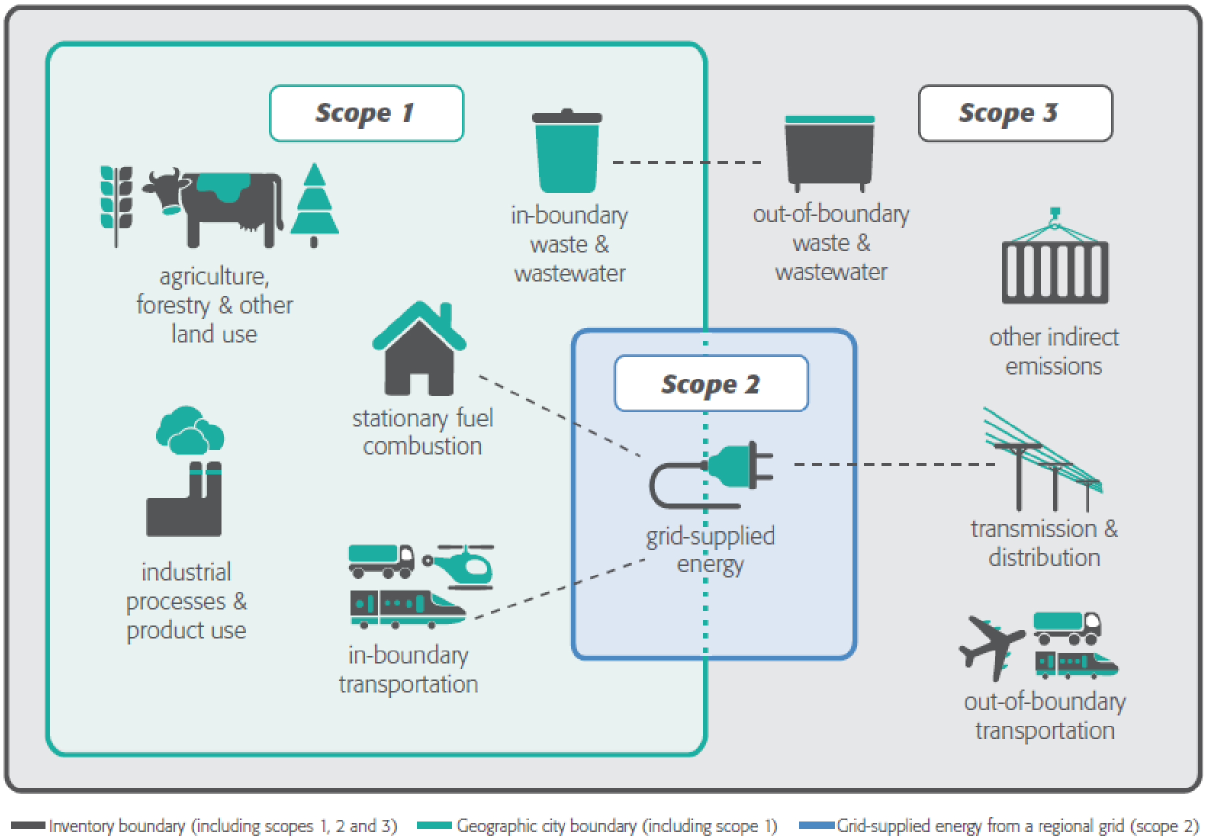
3.4.5 Operational Boundaries – Emissions by Scope

GPC defines the Scope of the emission adapting the scopes framework used in WRI's GHG Protocol - Corporate Standard. GPC aggregates the emissions as Scope 1, Scope 2, or Scope 3, depending on where they are generated.

- Scope 1 (Direct emissions): GHG emissions from sources located within the city boundary.
- Scope 2 (Indirect emission): GHG emissions occurring as a consequence of the use of grid-supplied electricity, heat, steam, and/or cooling within the city boundary.
- Scope 3 (Indirect emission): All other GHG emissions that occur outside the city boundary as a result of activities taking place within the city boundary.

The following diagram from the GPC summarizes the aggregation of emissions by scopes.

Figure 5: GPC Community GHG Inventory Scope of Emissions



Source: Global Protocol for Community-Scale Greenhouse Gas Emission Inventories – Figure 3.1

3.5 GPC Reporting Requirements

GPC requirements for reporting GHG emissions follow two complimentary approaches:

- Scopes Framework: report GHG emissions attributable to the activities taking place within the geographic boundary of the city according to the Scope 1, 2, and 3 defined above.
- City-Induced Framework: similarly to the Scope Framework, measure GHG emissions attributable to the activities taking place within the geographic boundary, according to the Scope 1, 2 and 3 definitions but report them according to two reporting levels:

  - BASIC level:
    - Scope 1 from Stationary Energy, Transportation, Waste;
    - Scope 2 from Energy and Transportation;
    - Scope 3 from exported Waste.

  - BASIC+ level:
    - All BASIC level emissions;
    - Scope 1 emissions from IPPU;
    - Scope 1 emissions from AFOLU;
    - Scope 3 emissions from Stationary Energy sources and from Transportation.

The following diagram from GPC summarizes the sectors and reporting requirements:

Figure 6: GPC Reporting Requirements – BASIC vs. BASIC+

Sectors and sub-sectors	Scope 1	Scope 2	Scope 3
STATIONARY ENERGY			
Residential buildings	✓	✓	✓
Commercial and institutional buildings and facilities	✓	✓	✓
Manufacturing industries and construction	✓	✓	✓
Energy industries	✓	✓	✓
Energy generation supplied to the grid	✓		
Agriculture, forestry, and fishing activities	✓	✓	✓
Non-specified sources	✓	✓	✓
Fugitive emissions from mining, processing, storage, and transportation of coal	✓		
Fugitive emissions from oil and natural gas systems	✓		
TRANSPORTATION			
On-road	✓	✓	✓
Railways	✓	✓	✓
Waterborne navigation	✓	✓	✓
Aviation	✓	✓	✓
Off-road	✓	✓	
WASTE			
Disposal of solid waste generated in the city	✓		✓
Disposal of solid waste generated outside the city	✓		
Biological treatment of waste generated in the city	✓		✓
Biological treatment of waste generated outside the city	✓		
Incineration and open burning of waste generated in the city	✓		✓
Incineration and open burning of waste generated outside the city	✓		
Wastewater generated in the city	✓		✓
Wastewater generated outside the city	✓		
INDUSTRIAL PROCESSES AND PRODUCT USE (IPPU)			
Industrial processes	✓		
Product use	✓		
AGRICULTURE, FORESTRY AND OTHER LAND USE (AFOLU)			
Livestock	✓		
Land	✓		
Aggregate sources and non-CO_2 emission sources on land	✓		
OTHER SCOPE 3			
Other Scope 3			

✓ Sources covered by the GPC

Sources required for BASIC reporting

\+ Sources required for BASIC+ reporting

Sources required for territorial total but not for BASIC/BASIC+ reporting (*italics*)

Sources included in Other Scope 3

Non-applicable emissions

Source: Global Protocol for Community-Scale Greenhouse Gas Emission Inventories – Figure 4.1

The City of Hoboken selected to adopt the BASIC reporting level; therefore, all emissions from IPPU, AFOLU, and other Scope 3 are not included in the 2017 calendar year.

The following table summarizes the key information about the 2017 City of Hoboken Community Inventory:

Table 7: 2017 City of Hoboken Community Inventory – Key Information

Reporting Protocol	World Resources Institute/Local Governments for Sustainability (ICLEI)'s Global Protocol for Community-Scale Greenhouse Gas Emission Inventories, v1, 2014
Reporting Tool	ICLEI ClearPath – Community Track - https://clearpath.icleiusa.org
Geographic Boundary	City of Hoboken Municipal Boundary
Reporting Framework	City-Induced Framework - BASIC Reporting
Operational Boundary	Scope 1, Scope 2, selected Scope 3 from Waste generated
Inventory Reporting Period	January 1 to December 31, 2017
Base Year	2017
Greenhouse Gas	Kyoto Seven GHG
GWP Defaults	IPCC 5th Assessment Report (AR5)

The complete list of Sectors and Sub-sectors and Scopes reportable for the City according to the BASIC level the sources present in the City.

Table 8: City of Hoboken – BASIC Level Reportable Sectors and Sub-sectors

Sector	Sub-Sectors	Scope Reported
Stationary Energy	Residential buildings	Scope 1, Scope 2
	Commercial and institutional buildings and facilities	Scope 1, Scope 2
	Manufacturing, industries and construction	Scope 1, Scope 2
Transportation	On-road	Scope 1
	Railways	Scope 2
Waste	Disposal of solid waste generated in the city	Scope 3
	Wastewater generated in the city	Scope 1

3.6 GHG Inventory Exclusions and Exceptions

The City administration provided information regarding large sources of emission located within the boundary and confirmed the following:

- no grid connected power generation facility is located within the City boundary;
- no sources of fugitive emissions from mining, processing, storage, and transportation of coal are located within the City boundary;
- no significant sources of fugitive emissions from oil and natural gas systems are located within the City boundary;
- no solid waste disposal facility is located within the City boundary;
- no biologic treatment, incineration, or open burning of waste takes place within the City boundary;

- the NHSA operates a water treatment facility located within the City boundary;
- no livestock farm or significant agricultural, forestry land use or fishing activity takes place within the City boundary;
- no significant waterborne transportation (freights, ferries) takes place, with trips originating and ending within the City boundary;
- no aviation facility is located within the City boundary

Fugitive emissions from refrigerants and halogenated gases (HFCs, PFCs, NF3 or SF6) were quantified city-wide according to average emission data at state and national level. According to the GPC, fugitive emission from refrigerants fall under the IPPU sectors as Scope 3 product use emissions. As such they are not reported under the BASIC level, but they should be reported under BASIC+. ClearPath instead quantifies fugitive emission from refrigerants as Scope 1, an approach similar to the Local Government Operations Protocol and the GHG Reporting Protocol Corporate Standard. We selected to follow ClearPath and accounted fugitive emission from refrigerants as Scope 1.

3.7 Inventory Data Collection Methodologies

There are several approaches that can be applied in order to collect data for a GHG inventory that can be summarized in two categories. Top-down data collection is when aggregated data for a certain source or energy usage are used to quantify the emissions from multiple generators/users of that same source. Bottom-up is instead when the data is collected from multiple users/sources of that energy or emission and then aggregated to obtain the total or city-wide emissions information. For example, city-wide data on electricity consumption could be collected top-down from the utility serving the area or bottom up by aggregating the consumption information obtained from all the users located in that area (e.g., distributing a survey). There are pros and cons for both methods, and choosing which method to use depends largely on the actual data availability for that source or type of energy. For the City of Hoboken we have used primarily a top-down approach, as discussed in the following paragraphs.

The primary methodologies utilized to collect data were the following:

- Data and information were provided by the City staff. Where data was not available for a particular source, individuals with knowledge of the activities provided an estimate based on experience.
- Aggregated energy consumption data were provided by the utility supplying the City (PSE&G).
- Aggregated transportation data were provided by the North Hudson Traffic Planning Authority (NJTPA).
- In cases when data were not available for a particular source, proxy data was researched from statistical agencies, databases, or studies at state or national level. If applicable, such data was scaled down appropriately to be used at city-wide level.

The collection methodology for each source is summarized below.

3.7.1 Stationary Energy – Scope 1

The City of Hoboken receives its supply of fuel for stationary combustion primarily from the local utility, PSE&G, providing natural gas service to residential, commercial, industrial users located within the City. Other fuels commonly used for stationary combustions (heating oil, propane, etc.) are supplied by smaller distributors and it was not feasible to collect

consumption information from those fragmented sources so proxy data from the United States Energy Information Administration (US EIA) was used to estimate usage of other heating fuels.

3.7.1.1 Natural Gas

The local utility PSE&G provided aggregated data for the volume of natural gas supplied in calendar year 2017 to users located within the City boundary. The data was aggregated on a monthly basis, separately for residential, commercial and industrial users, and the number of accounts in each category was also provided. The number of accounts in each category was compared to demographic data for each category and they were found consistent. PSE&G was not able to confirm or provide data regarding any volume of renewable natural gas or associated environmental attributes delivered to its customers within the City boundaries; therefore, it was assumed that no biogenic gas fuel was distributed in 2017.

3.7.1.2 Other Fuels for Stationary Combustion

The City administration was not able to provide an inventory of residential/commercial/industrial combustion equipment installed city-wide or any estimate of the usage of fuels other than natural gas by City users. Similarly, PSE&G was not able to provide any information on the usage of other fuels; therefore, data from the New Jersey Energy Profile by US EIA for was used as proxy. The data provide the percentage of use of the most common residential heating fuels in New Jersey[7]. The volumes of use for propane and heating oil were reverse-calculated from such percentage and the natural gas data from PSE&G. A similar approach was applied to estimate other fuels for the Commercial sector.

3.7.2 Stationary Energy – Scope 2

Similarly to the natural gas supply, PSE&G is the only utility distributing the electricity to the City of Hoboken, providing service to all residential, commercial, and industrial users located within the City. PSE&G provided aggregated data for the electricity supplied in calendar year 2017 to users located within the City boundary. The data was totaled on a monthly basis, separately for residential, commercial and industrial users, and the number of accounts in each category was also provided. The number of accounts in each category was compared to demographic data for each category and they were found consistent. PSE&G also provided separately the electricity consumption by street and traffic lights located within the City boundary. Emissions for this source were calculated as a separate source. It was also confirmed that the aggregated consumption data did not include electricity used by public transportation, but it included the NHSA wastewater plant as part of the industrial users.

PSE&G was not able to confirm or provide data regarding any renewable or associated environmental attributes delivered to its customers within the City boundaries; therefore, it was assumed that no renewable electricity was distributed during calendar year 2017.

3.7.3 Transportation

3.7.3.1 On-Road Transportation – Scope 1

No bottom-up data was available to quantify the mobile combustion emissions from on road transportation according to fuel sales data. There are only a handful of gas stations within the City boundary, but the large number of commuters and commercial traffic in and out of the City would have made this approach inaccurate.

[7] https://www.eia.gov/state/print.php?sid=NJ

The alternative was to use data from a traffic model specific for the area, if such data is available. In the case of Hoboken, it was possible to use the results provided by the North Jersey Regional Transportation Model- Enhanced (NJRTM-E)[8] developed by the NJTPA[9]. The NJTPA is the federally authorized Metropolitan Planning Organization for the 13-county northern New Jersey region. The NJRTM_E model was developed in 2008 and further revised in 2011, 2015, and recently revalidated in 2018. The model includes 2,712 traffic analysis zones (TAZ), of which over 1,600 of these are in the North Jersey region and specifically 12 constitute the City of Hoboken. The model includes all of New York City and Long Island, portions of southern New Jersey, portions of southern New York State, and portions of eastern Pennsylvania.

The NJRTM-E data provided by NJTPA was the result of the 2018 update of the model and while the Authority allowed the use of the data, it also cautioned that the results are still under review prior to official publication.

The option of using data from a traffic model is one of the methods recommended in the GPC. In fact, these traffic models usually apply the induced-activity approach to quantify vehicle traffic in a certain area, which is consistent with the GPC. The parameters measuring the transportation activity are the vehicle miles traveled (VMT) calculated for assigned categories of vehicles (passenger cars, light trucks, bus, etc.) and corresponding fuel usage. The model includes default fuel consumption and GHG emissions factors used to calculate the fuel usage, fuel per mile, GHG emissions, etc. by each vehicle category in each TAZ.

Traffic data are estimated from surveys, sample traffic monitoring, etc. then modeled and projected to cover larger areas and longer period of times.

According to the GPC induced-activity approach, all trips that begin, end, or are fully contained within the city (excluding pass-through trips) are included. Within-boundary trips are accounted 100 percent. Pass-through trips, i.e., trips that start and end outside of the boundary are not accounted for: they are not considered induced by the City because the source and destination are outside of it. Transboundary trips, whether incoming or outgoing, are accounted for at 50 percent of the distance traveled. Of that 50 percent distance, the portion outside of the boundary should be accounted for as Scope 3, as trans-boundary transportation, but this is not required under BASIC reporting. Because the NJTPA data provided does not show information on the individual trip distance of travel modeled and given the small area of the City of Hoboken, it is possible that this approach overestimates the Scope 1 emissions for transboundary trips by including a significant share of travel that should be reported as Scope 3.

The NJRTM-E model includes a large number of vehicle categories, each one modeled separately for each TAZ. The categories were aggregated according to the following table in order to streamline the data input in ClearPath.

[8] https://www.njtpa.org/data-maps/modeling/travel-demand-modeling
[9] https://www.njtpa.org/home

Table 9: NJRTM-E Vehicles Categories

NJRTM_E Vehicle Category	First Environment - ClearPath Input Category
Combination Long-haul Truck	Heavy Trucks
Combination Short-haul Truck	
Single Unit Long-haul Truck	Medium Trucks
Single Unit Short-haul Truck	
Refuse Truck	
Motor Home	
Light Commercial Truck	Light Commercial Truck
Intercity Bus	Intercity Bus
Transit Bus	Transit Bus
School Bus	School Bus
Passenger Truck	Passenger Truck
Passenger Car	Passenger Car
Motorcycle	Motorcycle

3.7.3.2 Railway Transportation – Scope 2

In accordance with the GPC, only emissions from direct combustion of fossil fuels incurred during the length of railway transit within the city boundary for railway lines that have stops in the city boundary should be reported as Scope 1. Because of the geographic location of the railway systems in Hoboken, a very short distance (~0.5 miles) of the NJ Transit commuter rail pertinent to the Hoboken Terminal is included in the City boundary. Similarly, the NJ Transit Light Rail connecting North Bergen with Jersey City runs along the western border of the City for a distance estimated at 2.5 miles. By reviewing NJ Transit modes information from their website and energy and ridership data from the Federal Transit Administration[10] (NTD), it was determined that these modes of transportation actually use electric propulsion. As such, Scope 1 emissions for railway transportation were not quantified; but the information, data sources, and approach described above were used to quantify Scope 2 emissions from electricity consumed for railway transportation.

3.7.4 Waste – Wastewater Treatment – Scope 1

North Hudson Sewerage Authority (NHSA) operates a wastewater treatment facility located on Adams Street on the northern end of the Hoboken territory. This facility serves the communities of Hoboken, Union, and Weehawken, collecting sewer and wastewater for treatment and disposal.

The NHSA provided information regarding the volume of water treated annually, the volume discharged, the treatment process as well as the population served by the Adams Street facility.

[10] https://www.transit.dot.gov/ntd/ntd-data

3.7.5 Waste – Solid Waste Disposal – Scope 3

The City staff provided data and information about the quantity of both residential and commercial waste collected for disposal throughout the City during calendar year 2017 and the modalities of disposal. No information was available regarding the collection and disposal of construction and demolition waste.

3.7.6 Fugitive Emissions – Scope 1

First Environment was unable to obtain sufficient information regarding the possible sources of fugitive emissions such as air conditioning equipment, certain type of fire extinguishing systems, and electrical equipment. Fugitive emissions from refrigerants and halogenated gases (HFCs, PFCs, NF3 or SF6) were quantified city-wide according to average GHG emission data from EPA[11] at national level, appropriately scaled according to the City population data. The same approach was applied by the state of New Jersey for the 2016 state-wide GHG inventory.

[11] https://www.epa.gov/ghgemissions/inventory-us-greenhouse-gas-emissions-and-sinks-1990-2016

4. Emissions Quantification Methodologies

GHG emissions are calculated applying the appropriate methodologies from:

- WRI/ICLEI Global Protocol for Community-Scale Greenhouse Gas Emission Inventories (GPC), Version 1, 2014.

In addition, GHG emissions are calculated using emission factors (EF) sourced from:

- US EPA Center for Corporate Climate Leadership - Emission Factors for Greenhouse Gas Inventories – March 9, 2018;
- US EPA Emissions & Generation Resource Integrated Database - eGRID2016;
- Fifth Assessment Report of the Intergovernmental Panel on Climate Change - IPCC AR5.

The GHG emissions quantification was performed by ICLEI's ClearPath Pro Tool, which includes the algorithms calculating the emission according to GPC methods.

The quantification methodology for each source is summarized in the following paragraphs.

4.1 Scope 1 Emissions

4.1.1 Stationary Energy – Natural Gas

Emissions were calculated by multiplying the total volume of natural gas used by stationary sources by the appropriate CO_2, CH_4, and N_2O emission factors sourced from US EPA emission factors for GHG inventories. The results of these calculations in metric tonnes of CO_2, CH_4, and N_2O emissions were converted to tCO_2e by applying the appropriate GWP factor for each GHG from IPCC AR5.

4.1.2 Stationary Energy – Heating Oil, Propane

Emissions were calculated by multiplying the total volume of each fuel used by stationary sources by the appropriate CO_2, CH_4, and N_2O emission factors sourced from US EPA emission factors for GHG inventories. The results of these calculations in metric tonnes of CO_2, CH_4, and N_2O emissions were converted to metric tonnes of CO_2e by applying the appropriate GWP factor for each GHG from IPCC AR5.

4.1.3 Transportation – On-road

GHG emissions were calculated in ClearPath according to the "On-Road factor" method. For each vehicle category identified, the model requires the VMT/year and a set of GHG emission factors (CO_2, CH_4, and N2O) measured in g/mile. The VMT and emission factors were provided by the NJRTM-E model results; the fuel is assigned by vehicle category.

The results of these calculations in metric tonnes of CO_2, CH_4, and N_2O emissions were converted to tCO_2e by applying the appropriate GWP factor for each GHG from IPCC AR5.

4.1.4 Wastewater Generated in the City

GHG emissions were calculated in ClearPath by quantifying the N_2O emissions from discharging the effluent to a waterway. Because the daily load of nitrogen data was not available for the total volume of effluent discharged, the alternative method of estimating it

according to the population served was applied. The NHSA facility does not have a nitrification/denitrification treatment; therefore, it was excluded in the calculator.

The emission result in tN_2O was converted to tCO_2e by applying the appropriate GWP factor for N_2O from IPCC AR5.

Scope 2 emissions from electricity consumption by the wastewater facility are included in the aggregated Industrial Use quantified under Stationary Energy.

4.2 Scope 2 Emissions

4.2.1 Stationary Energy

Location-based electricity GHG emissions were calculated according to multiplying the total electricity consumption in MWh by residential/commercial/industrial users, street lighting, and traffic signals for the appropriate CO_2, CH_4, and N_2O electricity emission factors for the New Jersey region (RFC East) sourced from the US EPA eGRID 2016 database[12].

eGRID subregion acronym	eGRID subregion name	Total output emission rates (lb/MWh)		
		CO_2	CH_4	N_2O
RFCE	RFC East	758.2	0.050	0.009

The results of these calculations in metric tonnes of CO_2, CH_4, and N_2O emissions were converted to tCO_2e by multiplying for the appropriate IPCC AR5 GWP factor for each GHG.

An equivalent calculation was performed to quantify “market-based electricity emissions.” PSE&G was not able to provide information about any direct supply of electricity from dedicated sources, or about any contractual instruments that would convey specific emissions rates for the purchased electricity, so the market-based electricity GHG emissions were considered equivalent to the location-based electricity GHG emissions.

4.2.2 Transportation – Railways

Location-based electricity GHG emissions were calculated from the estimated total electricity consumption in MWh by the railway system located and with railway stops within the city boundary. Appropriate CO_2, CH_4, and N_2O electricity emission factors for the New Jersey region (RFC East) sourced from the US EPA eGRID 2016 database were used in the calculator. The electricity use, VMT, and passenger boardings were estimated from NJ Transit publicly available data and from the NTD databases[13] for energy use and ridership for public transit agencies.

4.3 Scope 3 Emissions

In accordance with the BASIC reporting level, city-wide Scope 3 emissions were quantified only for waste generated in the City but disposed of outside of the City boundary.

[12] https://www.epa.gov/energy/emissions-generation-resource-integrated-database-egrid
[13] https://www.transit.dot.gov/ntd/ntd-data

4.3.1 Disposal of Solid Waste Generated in the City

There is no solid waste disposal facility located within the City boundary; therefore, the emissions associated with the disposal are quantified as Scope 3. The City provided data for the total weight of solid waste collected in 2017 within the City boundary; single stream recycled waste was excluded from the total tonnage. The GHG emissions were calculated in ClearPath applying a default municipal solid waste characterization and equation SW.4.1 of the GPC. Accurate information about the disposal location was not available; therefore, no assumptions were made about the presence of GHG reduction measures at the landfill (e.g., methane collection and flaring). The emissions from collection and transportation of the waste were not estimated.

5. GHG Inventory Quantification Results

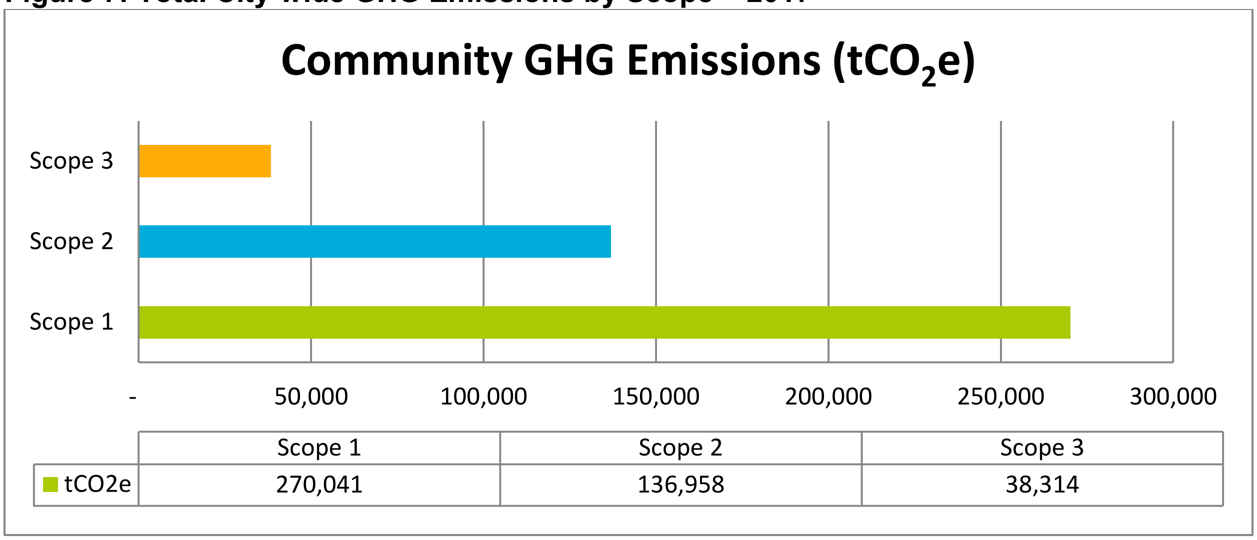
5.1 Total GHG Emissions

Total city-wide emissions for calendar year 2017 were 445,313 tCO_2e, including the following contributions by Scope:

Table 10: Total City-wide GHG Emissions by Scope – 2017

GHG Emissions	tCO_2e
Scope 1	270,041
Scope 2	136,958
Scope 3	38,314
Total	**445,313**

Figure 7: Total City-wide GHG Emissions by Scope – 2017

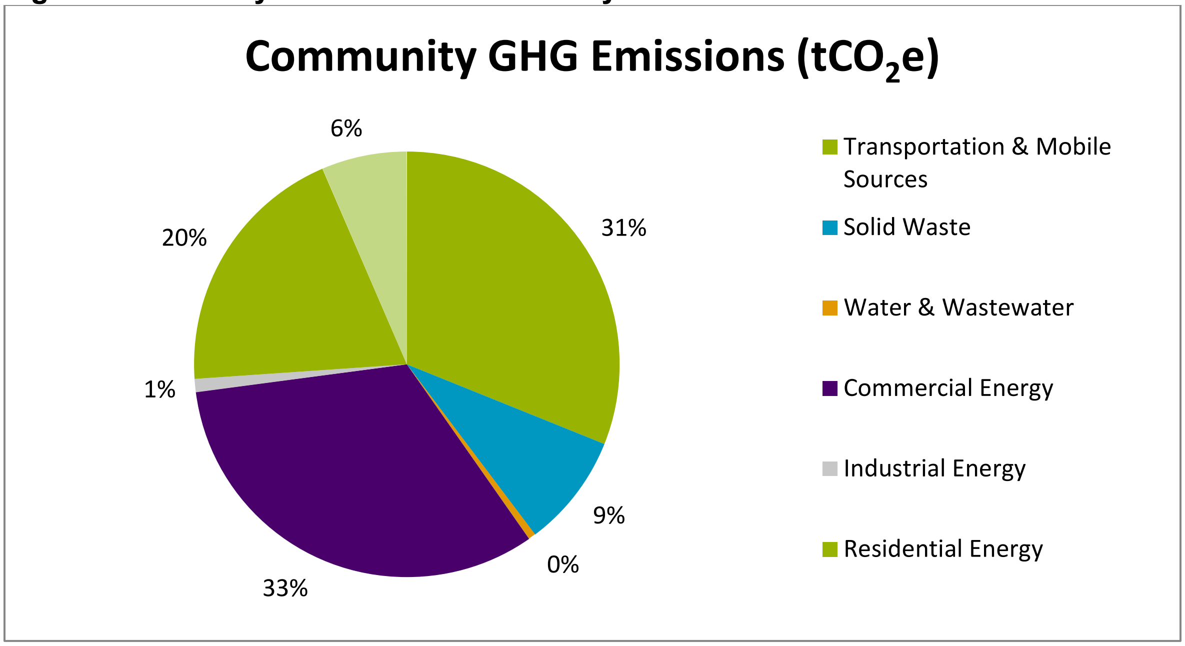


The break down by Sector in the following table and diagram:

Table 11: Total City-wide GHG Emissions by Sector – 2017

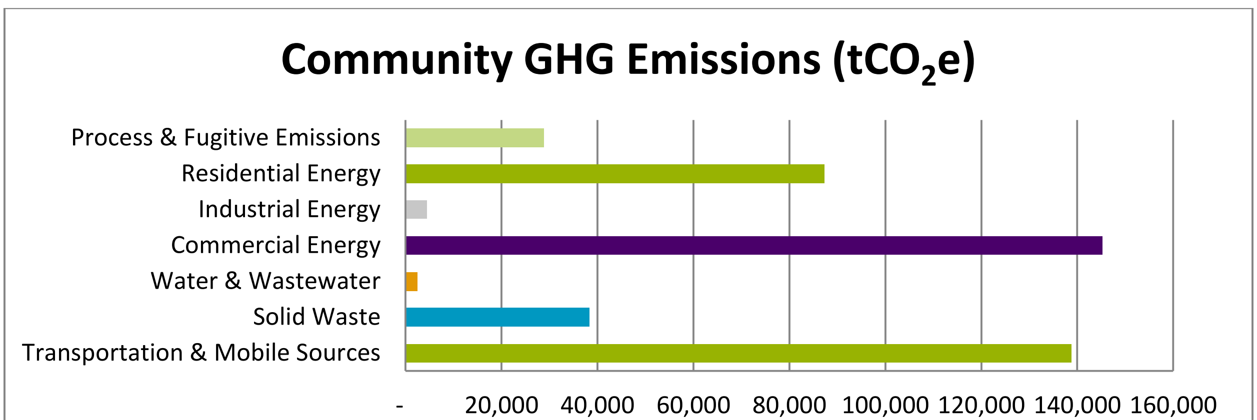
Sector	GHG Emissions (tCO_2e)
Transportation & Mobile Sources	138,768
Solid Waste	38,314
Water & Wastewater	2,457
Commercial Energy	145,239
Industrial Energy	4,441
Residential Energy (including Street Lights)	87,260
Process & Fugitive Emissions	28,833
Total	**445,313**

Figure 8: Total City-wide GHG Emissions by Sector – 2017



And in bar-diagram:

Table 12: Total City-wide GHG Emissions by Sector – 2017



	Transportation & Mobile Sources	Solid Waste	Water & Wastewater	Commercial Energy	Industrial Energy	Residential Energy	Process & Fugitive Emissions
GHG Emissions (tCO2e)	138,768	38,314	2,457	145,239	4,441	87,260	28,833

5.2 Scope 1 GHG Emissions

The City Total Scope 1 Emissions were quantified as 270,041 tCO_2e, including the following specific GHG contributions:

Table 13: Scope 1 GHG Emissions

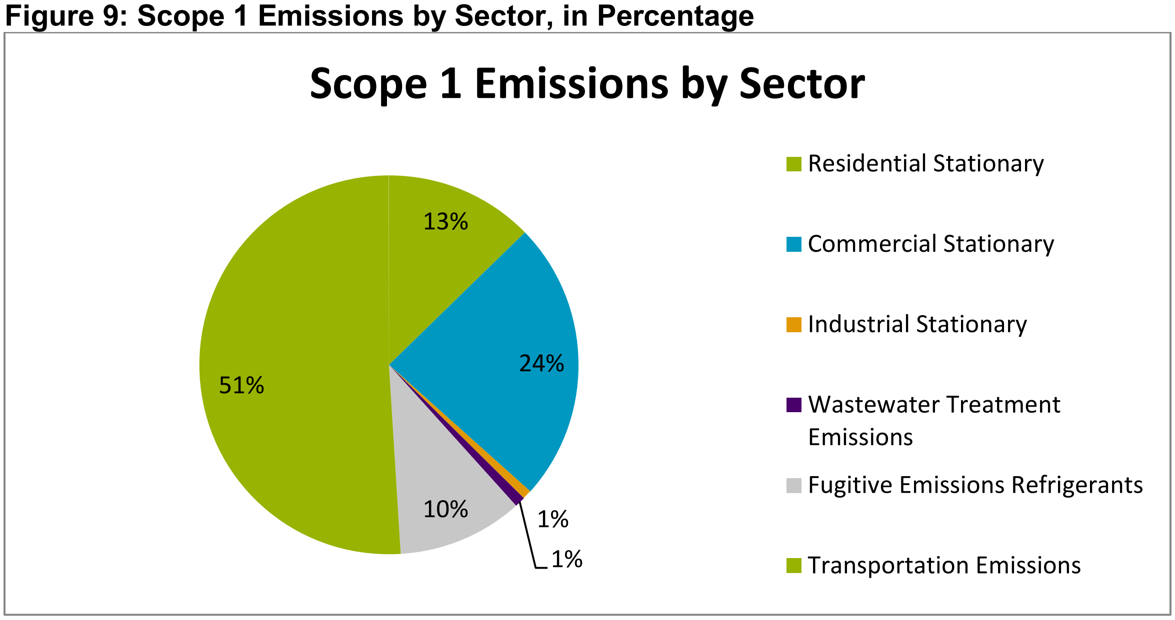
Greenhouse Gas	t GHG	t CO_2e
Carbon Dioxide (CO_2)	266,363.16	266,363
Methane (CH_4)	14.06	394
Nitrous Oxide (N_2O)	12.39	3284
	Total	**270,041**

The distribution of Scope 1 emissions by sector is shown in tCO_2e and in percentage in the charts below.

Table 14: Scope 1 Emissions by Sector - (tCO2e)

Sector	GHG Emissions (tCO_2e)
Residential Stationary	34,281
Commercial Stationary	64,613
Industrial Stationary	2,145
Wastewater Treatment Emissions	2,457
Fugitive Emissions Refrigerants	28,833
Transportation Emissions	137,712
Total	**270,041**

Figure 9: Scope 1 Emissions by Sector, in Percentage



The results highlight the predominance of Transportations the major source of GHG emissions. Scope 1 emissions from buildings and facilities (residential, commercial, industrial) rank as the second largest source followed by fugitive emission from refrigerants and halogenated gases.

5.3 Scope 2 GHG Emissions

The City Total Scope 1 Emissions were quantified as 136,958 tCO_2e, including the following specific GHG contributions:

Table 15: Scope 2 GHG Emissions

Greenhouse Gas	t GHG	t CO_2e
Carbon Dioxide (CO_2)	136,957.38	136,957
Methane (CH_4)	0.009	0.25
Nitrous Oxide (N_2O)	0.002	0.43
	Total	**136,958**

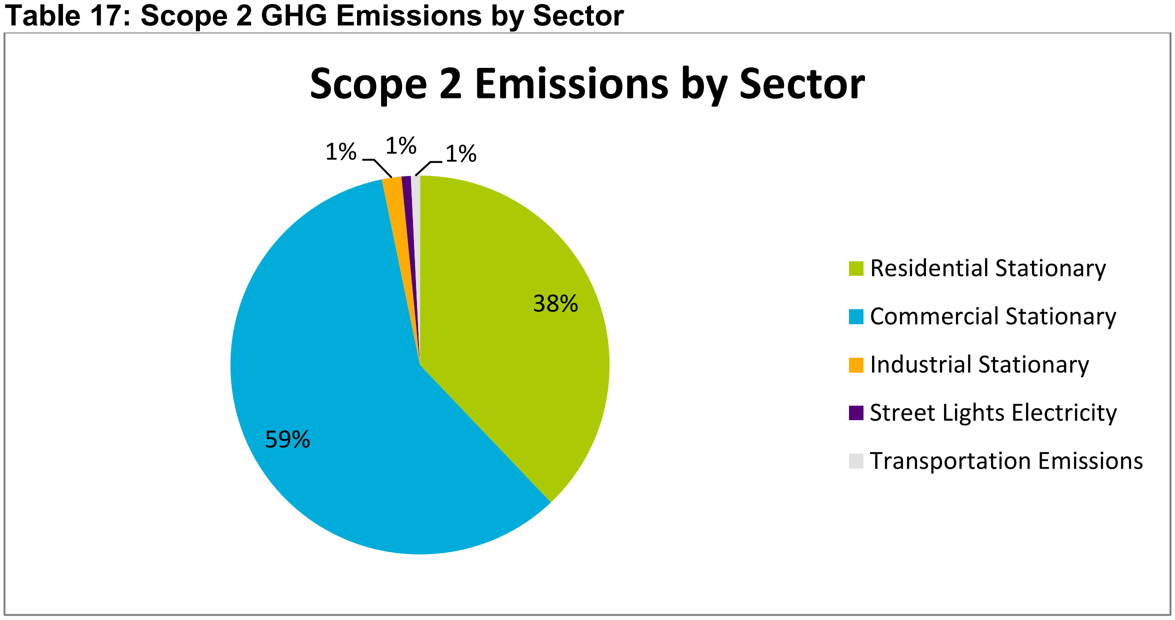
The distribution of Scope 2 emissions by sector is shown in tCO_2e and in percentage in the charts below.

Table 16: Scope 2 GHG Emissions by Sector

Sector	GHG Emissions (tCO_2e)
Residential Stationary	51,898
Commercial Stationary	80,627
Industrial Stationary	2,296
Street Lights Electricity	1,081
Transportation Emissions	1,056
Total	**136,958**

The results show that residential and commercial electricity consumption are responsible for the majority of the Scope 2 emissions and actions to reduce GHG emissions should prioritize the reduction of energy consumption by these sectors.

Table 17: Scope 2 GHG Emissions by Sector



5.4 Scope 3 GHG Emissions

The Scope 3 emissions were reported only for the disposal of waste generated by the City, in accordance with the BASIC requirements. ClearPath estimated the amount of methane (CH_4) emissions generated by the organic decomposition of solid waste in a landfill, then converted to tCO_2e.

Table 18: Scope 3 GHG Emissions

Greenhouse Gas	t GHG	t CO_2e
Carbon Dioxide (CO_2)	0	0
Methane (CH_4)	1,368.36	38,314
Nitrous Oxide (N_2O)	0	0
	Total	**38,314**

GHG emissions from solid waste disposal represent a significant share of the City-wide emissions. These could be mitigated by reducing at the source the total amount of solid waste sent to landfill (the City already has a single stream recycling program) or by increasing the separate collection of organic waste. Additional actions could focus on the disposal site(s) ensuring that GHG emission are captured and destroyed (methane flaring) or better yet converted in useful renewable energy (electricity or pipeline grade natural gas).

The following paragraphs detail the sources of GHG emissions in each sector, identifying the contribution.

5.5 Stationary Energy Emissions

The City-wide emission from stationary energy, including both Scope 1 (stationary combustion) and Scope 2 (electricity consumption) were quantified as 236,941tCO_2e.

The contribution by each sub-sector in the following table shows the predominance of emission by commercial energy, followed by residential.

Stationary Energy (Scope 1, Scope 1)	GHG Emissions (tCO_2e)
Residential Stationary	51,898
Commercial Stationary	80,627
Industrial Stationary	2,296
Street Lights Electricity	1,081
Total	**135,902**

The overall contribution from each Scope is shown in the table below which demonstrates that emissions from electricity are higher than those from fuel combustion:

Table 19: Stationary Energy by Scope

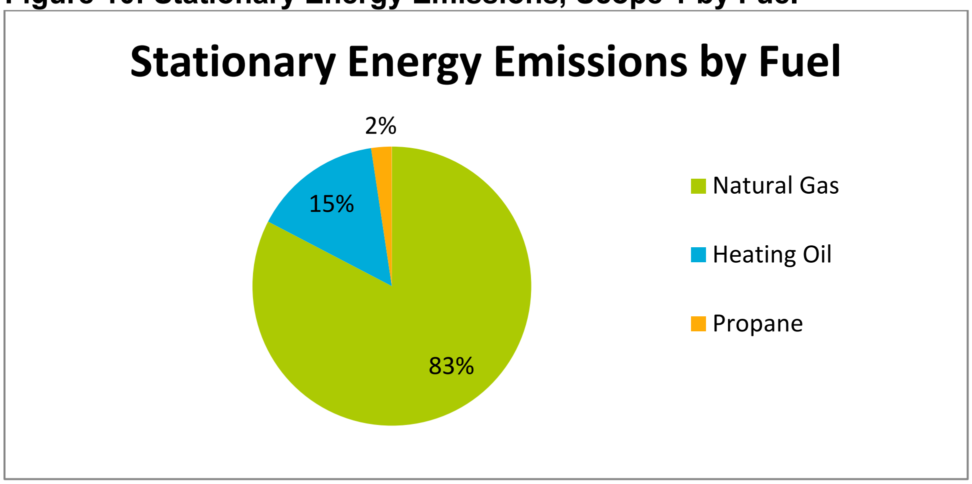
Stationary Energy	GHG Emissions (tCO_2e)
Stationary Energy Combustion (Scope 1)	101,039
Stationary Energy Electricity (Scope 2)	135,902
Total	**236,941**

For the stationary combustion component (Scope 1), the contribution by the three fuels modeled is shown in the following table and diagram, showing the predominance of natural gas.

Table 20: Stationary Energy Emissions – Scope 1, by Fuel

Stationary Energy By Fuel	GHG Emissions (tCO_2e)
Natural Gas	83,506
Heating Oil	15,115
Propane	2,418
Total	**101,039**

Figure 10: Stationary Energy Emissions, Scope 1 by Fuel



5.6 Transportation Emissions – On-Road

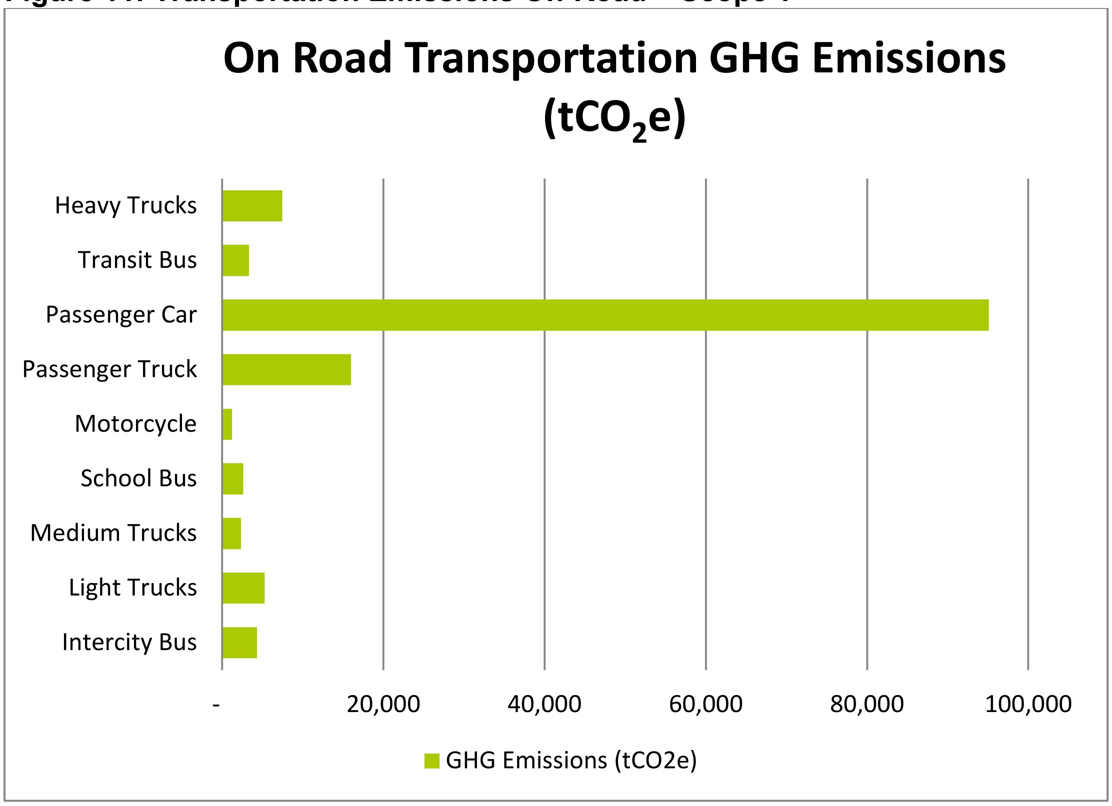
The mobile combustion emissions by city-wide on-road transportation were quantified as 137,712 tCO_2e. The total emissions can be broken down according to the following table:

Table 21: Transportation Emissions On-Road – Scope 1

On Road Transportation	Fleet On-Road VMT (miles)	GHG Emissions (tCO_2e)
Intercity Bus	2,995,003	4,312
Light Trucks	9,645,718	5,292
Medium Trucks	2,033,878	2,354

On Road Transportation	Fleet On-Road VMT (miles)	GHG Emissions (tCO_2e)
School Bus	1,816,969	2,616
Motorcycle	3,914,670	1,229
Passenger Truck	29,185,664	16,013
Passenger Car	232,781,836	95,112
Transit Bus	2,319,696	3,340
Heavy Trucks	3,493,578	7,445
Total	**288,187,012**	**137,712**

Figure 11: Transportation Emissions On-Road – Scope 1



The detailed breakdown by sources indicates passenger car activity is by far the largest source of transportation emissions. Even considering a potential overstatement of the VMT due to the induced-activity approach and the contribution from the portion of transboundary travel that should be accounted for as Scope 3 emissions, passenger vehicle traffic should definitely be the focus of any climate mitigation strategy considered by the City.

5.7 Transportation Emissions – Railway

The GHG emissions associated with railway transportation within the City were quantified assuming 100 percent electric propulsion and totaled 1,056 tCO2e. The contributions from the two modes quantified are shown in the table below.

Table 22: Transportation Emissions Railway – Scope 2

Railway Transportation	Mode VMT (passenger-miles)	GHG Emissions (tCO_2e)
Public Transit Electricity - Light Rail	7,858,370	755
Public Transit Electricity - Commuter Rail	4,713,405	301
Total	**12,571,775**	**1,056**

5.8 Emissions from Waste Generated in the City – Wastewater

GHG emissions from disposal of solid waste generated in the City have already been discussed in the Scope 3 Section above.

GHG emissions from sewer and wastewater treatment taking place within the City boundary are reported as Scope 1, due to the location of the NHSA facility. The emissions are the result of the nitrogen released with the effluent flow into the Hudson River. ClearPath applied nitrogen load defaults for urban sewer/wastewater to estimate the N_2O emissions.

Table 23: GHG Emissions from Wastewater Treatment in City Boundary (Scope 1)

Greenhouse Gas	tGHG	tCO_2e
Carbon Dioxide (CO_2)	0	0
Methane (CH_4)	0	0
Nitrous Oxide (N_2O)	9.27	2,457
	Total	**2,457**

This source of emissions could be mitigated by installing a nitrification/de-nitrification treatment in the facility, which would reduce the impact of nitrogen discharged with the effluent.

Also, currently the sludge generated by the water treatment is disposed of at a nearby facility. Depending on the volume generated, it could be processed on site in anaerobic digesters to recover the biogas and then be processed to generate electricity or renewable natural gas.

6. GHG Inventory Base Year

The GHG inventory base year provides a standardized point of reference against which future inventories can be compared to identify changes, such as reductions, or track progress toward an emission goal or action plan. The City has selected year 2017 as the GHG inventory base year.

Once the Base Year has been selected, the next step is to select one or several future years by which the City wishes to achieve certain emissions reduction goals.

7. GHG Emission Reduction Goals

As described in more detail in the Climate Action Plan, the City of Hoboken joined the Sustainable Jersey program in 2010; just one year after the program was established. The City received Bronze certification from Sustainable Jersey in 2011, was recertified in 2014, and received the Silver certification in 2017. Hoboken has decided to pursue the Sustainable Jersey Gold Star in Energy certification, which further affirms their commitment to sustainability and, specifically, mitigation efforts. As such, the City has selected to establish GHG reduction goals in line with the Sustainable Jersey Gold Star targets, which require the City to demonstrate at least 3.6 percent annual reductions in municipal GHG emissions and 1 percent annual reductions for Community GHG emissions over the base year.

In accordance with these requirements, the City set the reduction goal of 1 percent per year. The City also set goals of achieving net-zero status for the Community GHG emissions by year 2022 and exceeding the Paris Agreement US reduction target[14] by 2027.

Because the GHG inventory is completed in 2018 based on 2017 year activity data, we assume that the first feasible year for climate actions implementation would end in 2019, with 2022 being the fourth year and the end of 2027 being nine years after the beginning of the climate action implementation.

The table below shows the reductions goals of 1 percent by the end of 2019, 4 percent by 2022, and the equivalent amount in tCO_2e required to achieve the goals.

In summary, the proposed emission reduction goals for the community are the following:

Table 24: Emission Reduction Goals and Targets

Target	Target Year	Reduction Goal from 2017 Base Year GHG Inventory (%)	Reduction Goal from 2017 Base Year GHG Inventory (tCO_2e)
Year 1	2019	1%	- 4,453 tCO_2e
Year 4	2022	4%	-17,813 tCO_2e
Year 9	2027	16%	-71,248 tCO_2e

[14] U.S. commitment: 26%-28% below 2005 level by 2025

8. GHG Emission Reduction Measures

In order to achieve the reduction goals described in the previous section, the City must identify a series of GHG emission reduction measures necessary to achieve such goals within the established timeline. The analysis of the City-wide energy consumption and GHG emission sources performed to conduct the inventory provides a basis to conduct an informed selection of potential emission reduction strategies. These measures will have to be compatible with the Community activities, targeting as much as possible the largest sources of emissions where the most significant reductions could be achieved. This should be accomplished while considering financial constraints and achieving the best balance between cost and benefits.

In addition, as discussed in more detail in the City's Climate Action Plan, the selected measures should be in line with the requirements of the Sustainable Jersey program, maximizing where possible the points earned to achieve certification.

The review of the GHG emissions inventory results included in the previous paragraphs highlighted that the largest contributions were identifiable in the emissions from passenger vehicles in the transportation sector and the residential/commercial stationary energy.

Based on this analysis and on the experience garnered from reviewing case studies for similar municipalities, these are the possible emission reduction measures identified for discussion:

Emission Reduction Measure	Target Scope and Sector	Sustainable Jersey Action
Making Hoboken Electric Vehicle Friendly & Implementing EV Charging Station	Scope 1 – On-Road Transportation	Yes
Making Hoboken Solar Friendly & Implement Solar Initiatives	Scope 2 – Stationary Energy in Buildings	Yes
Implement a Community-Led Residential Solar Purchasing Program (e.g., special solar pricing via approved solar installers)	Scope 2 – Stationary Energy in Buildings	Yes
Implement a Community-Led Commercial Solar Purchasing Program (e.g., special solar pricing via approved solar installers)	Scope 2 – Stationary Energy in Buildings	Yes
Implement a general residential outreach focused on Home Performance Energy Star and Comfort Partners	Scope 1, Scope 2 – Stationary Energy in Buildings	Yes
Implement a commercial outreach focused on Direct Install Program for local businesses within 2.5 year of application submission.	Scope 1, Scope 2 – Stationary Energy in Buildings	Yes
Improve Bicycle Transit Infrastructure	Scope 1 – On-Road Transportation	No
Increase HOP Transit Frequency-Switch to CNG	Scope 1 – On-Road Transportation	No

Each one of these measures was modeled in ClearPath to quantify potential emissions reductions as well as to estimate implementation cost, based on either ClearPath default

information or appropriate reference data sourced from literature. ClearPath also tracks the potential emission reductions achievable by each measure during the 2019-2029 period, allowing the City to develop the best implementation strategy to maximize the benefits while distributing the costs of deploying each measure over the target period.

8.1 Making Hoboken Electric Vehicle Friendly and Implementing EV Charging Station

The action consists of several of measures aimed at increasing the penetration of electric vehicles (EV) in the mix of vehicles driven by Hoboken residents as well as drivers from other jurisdictions traveling within the City boundaries.

Table 25: Electric Vehicle Friendly Action Measures

	Action
A1	Amend the zoning ordinances to include EV Supply Equipment and EV charging stations as a permitted accessory use
A2	Adopt a PEV ordinance to include regulations and design standards for EVSE, EV charging and parking
A3	Required First responders' On-line training on EV Supply Equipment
A4	Awareness event - Host an EV awareness event for the community
A5	Provide public access to EV Change Stations

First Environment reviewed the City vehicle registration records for 2017 and estimated that the number of hybrid/electric vehicles registered within the City boundary is only 45 out of 21,180, or 0.22 percent. The projected average for 2018 in the US is 1.75 percent, but there are areas such as California where the concentration is much higher: 7.50 percent statewide and 38 percent for communities such as Palo Alto.

The ClearPath planning module includes a model simulating the effects of implementing policies and measures favoring the adoption of EV. The climate action was assumed to gradually increase the share of EV in the passenger vehicles circulating in Hoboken, reaching 15 percent over the next 10 years, by the end of 2028. The model estimated the decrease in carbon emissions for the passenger car fleet as much as 1,390 tCO_2e per year (approximately 0.31 percent of the baseline), which assumes that the increase in EV share keeps growing at the 1.5 percent/year rate assumed.

EV Circulation Share Target	Target Year	Emission Reduction (tCO_2e/year)	Percentage Reduction to Baseline
15%	2028	-1,392	- 0.31%

8.2 Implementation of Solar Initiatives – Community Led Solar Program

The action recommends the adoption of policy facilitating the access by the community to renewable electricity generated by solar energy. This could include both streamlining the procedures, permitting, and financing for solar PV systems, the pre-qualification of approved

installers and contractors, but also exploring new mechanisms such as the Community Solar Programs. These are innovative approaches designed to allow residents of, for example, dense urban areas, where installation of solar PV system is problematic or ineffective, to gain access to renewable electricity by participating in a solar PV project developed by third parties installed in a more appropriate location. The participation could be either through purchase of shares of the PV projects (such as kW of installed capacity) or by buying a certain allocation of electricity production on a periodic basis. In both cases, any excess electricity besides the monthly usage by the user is sold on the market, potentially generating revenue. In case of deficit, the user is billed for the difference by the utility. A similar approach is when the City itself becomes the developer of the solar PV project and then offers to its residents to opt-in and receive the renewable electricity through various participation mechanisms similar to the ones previously described. In these cases, there are still a few regulatory hurdles before they can be implemented in New Jersey, beginning with the requirements for to allow virtual net-metering.

Nonetheless, the feedback received during the Community meetings held during the development of the GHG Inventory and Climate Action Plan clearly highlighted the difficulties in accessing affordable and effective solar energy as a major hurdle that the Community would like to overcome. It was also communicated how previous efforts by the City administration to favor residential installation of solar PV systems had not met much success due to the nature of the dense urban environment characterized by small roof areas that are inefficient for solar PV installation.

Based on this feedback, it was decided to model a program that would aggressively target an innovative approach to solar PV energy. It was assumed that the City would implement two programs, one for residential and the other for commercial users, building participation in each program at the rate of one megawatt (MW) each year, for five years, until two 5 MW Community Solar projects are completed. Under these assumptions, the ClearPath planning module estimated potential reduction of 515 tCO_2e/ MW installed for each program, reaching the maximum benefit of 2,575 tCO_2e annual reduction for each program after five years.

The table below shows the estimate of electricity production and GHG reduction based on the baseline year electricity consumption.

Renewable Energy Installed Capacity	Renewable Energy Production (kWh/Year)	Emission Reduction (tCO_2e/year)	Percentage Reduction to Baseline
1 MW	1,500,000	-515	-0.12%
5 MW	7,500,000	-2,575	-0.60%
10 MW	15,000,000	-5,150	-1.2%

8.3 Buildings Retrofit – Residential and Commercial

The GHG inventory results highlighted that besides transportation, the largest contribution to the community emissions are generated from stationary energy used in residential and commercial buildings. This includes both emissions from stationary combustion and electricity consumption. This is not surprising given the dense urban environment of the City and the absence of major industrial or process sources of emissions.

As discussed in the municipal GHG inventory report, the City government is in the process of implementing a series of building energy efficiency retrofits in conjunction with the Direct Install initiative under the New Jersey's Clean Energy Program (NJCEP) by the New Jersey Board of Public Utilities (NJBOP). The Direct Install program provides funding to implement energy efficiency upgrades for local governments. The upgrades include improvements to buildings' heating, air conditioning, and electrical equipment. Heating, ventilation, and air conditioning (HVAC) equipment represents 30 to 40 percent of commercial building energy use. Additional energy savings can be achieved by improving the building insulation and envelope. Building inspections and energy audits can help identify areas of improvement and better plan the upgrades and costs.

The climate action proposed would entail a City outreach program combined with policies aimed at informing, facilitating, and incentivizing energy efficiency analysis and retrofits in residential and commercial properties. The goal would be to gradually improve the thermal and electrical performance of the City buildings inventory over a number of years. The ClearPath planning tool provided a calculator modeling two separate measures: one for residential outreach and education, the other for commercial properties retrofits. In both cases, the model assumes default performance improvements in kWh/sqft and therms/sqft when the measures are implemented. The calculator also assumes an annual quantity of residential and commercial space being affected by the program. For the residential program, it was assumed that 3,000 households participate in the program each year (Hoboken currently counts 24,812 households). For the commercial property, it was assumed that 500,000 sqft would be retrofit each year, out of the current 6,700,000 sqft of commercial space present in the City. The program is modeled to begin in 2020 and continue until 2029; by then, the majority of the households and commercial properties will have been included in the program.

The expected results are detailed in the table below. The annual reduction is calculated for the share of households or commercial space joining the program that year; therefore, year after year the savings add up, reaching approximately 5.5 percent GHG emissions reduction compared the baseline inventory for residential and 1.3 percent for commercial space.

Energy Efficiency Program	Property affected /year	Thermal Energy Savings (therms/year)	Electricity Savings (MMBtu/Year)	Emission Reduction (tCO_2e/year)	Annual Reduction to Baseline
Residential Property	3000 households	112 th/home/year	619 kWh/home/year	-2,425	-0.54%
Commercial Property	500,000 sqft	0.013 therms/sqft	1.3 kWh/sqft	- 569	-0.13%

8.4 Improvement of Bicycle Infrastructure

The City of Hoboken has already built a significant bicycle lane and paths infrastructure extending for eight miles; the system also includes a bike share program. This was started in 2015 and counts 20,000 members with 29 stations and 250 bicycles available for sharing. There were no data available regarding the current rate of use of the bicycle infrastructure so it was decided to model a system improvement measure, using the average defaults provided by ClearPath for a dense urban area. The model assumes an existing bicycle infrastructure and quantifies the potential emissions reductions according to a moderate improvement of the mode share. The increased use of the bicycle infrastructure leads to a reduction of use of other modes (passenger cars, transit) modeled in the transportation emission module, resulting in a reduction of overall emissions. The results are showed in the following table.

Energy Efficiency Program	Project Timeline	Annual Emissions Reduction (tCO_2/year)	Annual Percentage reduction to Baseline	Annual Percentage reduction at end of 10 years
Bike Infrastructure	10 years	-164	-0.04%	-0.4%

8.5 Increase City Public Transit Frequency - Low Emissions Fuel Switch

The City operates a small fleet of five paratransit buses, named HOP buses, providing a network of public transit transportation within Hoboken. Additional bus routes are operated by New Jersey Transit, but these are outside of the City's control and operation. The vehicles are gasoline engine small buses and the 2017 records provided by the City show a fuel consumption of 20,672 gallons of fuel and estimated 206,719 miles for VMT. The reduction measure modeled consists of increasing (doubling) the transit frequency based on the recorded VMT as well as replacing or retrofitting the current gasoline vehicles with equivalent ones running on Compressed Natural Gas (CNG) fuel.

The CNG fuel emits lower volume of CO_2e per mile and could also be fueled with renewable fuel, further reducing the GHG emissions, if the City were to purchase bio-CNG produced, for example, by recovering biogas emitted from a landfill or a wastewater plant sludge bio-digester. The fuel conversion measure would also require the installation of a CNG fueling station fed from a utility gas supply line, adding to the overall cost. On the other hand, once the CNG fueling infrastructure is installed, it could also be used to expand the CNG fueling to other City vehicles such as sanitation trucks, a common conversion for municipalities operating landfills and generating their own bio-CNG. On average, it was estimated that each bus replacement could cost $80,000. The fuel cost savings amount to approximately $20,000/year for the current HOP fleet, according to the average market price difference of $1 per gallon of gasoline equivalent fuel and the current VMT/year. In addition, ClearPath estimated the emissions reduction that could be achieved by the change in transit mode share due to increasing the frequency or extending the routes of the HOP systems. The assumption is to double the annual VMT traveled by the buses and the default ClearPath factors were used, assuming the baseline service is located in dense urban center with fairly infrequent service (waiting time more than 50 minutes).

The overall emission reduction due to the two-fold measure is estimated as 4,555 tCO_2e/year, or approximately one percent of the 2017 baseline. This significant improvement is probably affected by the large contribution to emission due to passenger car travel, where the model considers that the increased frequency would attract significant mode sharing from passenger cars to public transit.

HOP Fleet Vehicles	Emission Reduction (tCO_2e/year)	Emissions Reduction to Baseline	Estimated Cost	Fuel Savings ($/Year)[15]
5	4,554	-1.02%	$80,000/ vehicle	$20,240

[15] Fuel savings are calculated on the basis of the current VMT of ~ 200,000 miles. Doubling the frequency would incur in additional fuel cost, but the switch to less expensive fuel would reduce such increase.

8.6 Street Lights and Traffic Lights Conversion to LED

This measure is discussed in more detail in the Municipal GHG inventory and Climate Action Plan and consists of upgrading the street lights and traffic lights installed within the City boundary to advanced street light technology such as light-emitting diodes (LEDs). The measure was modeled in ClearPath for the lights operated by the City administration (a small number of lights are operated by other entities, such as Hudson County). If the measure were to be implemented by the City administration, the benefits would also benefit the Community GHG inventory and for that reason we are including it in the report. The conversion to LED can reduce street lighting energy use by as much as 70 percent. Besides saving energy and reducing electricity costs, LED lights also have a longer useful life requiring less maintenance.

The following results were modeled in ClearPath and match the reduction results estimated for the City municipal inventory. The results show that at Community level the emissions reductions are less significant than compared to the much smaller municipal inventory.

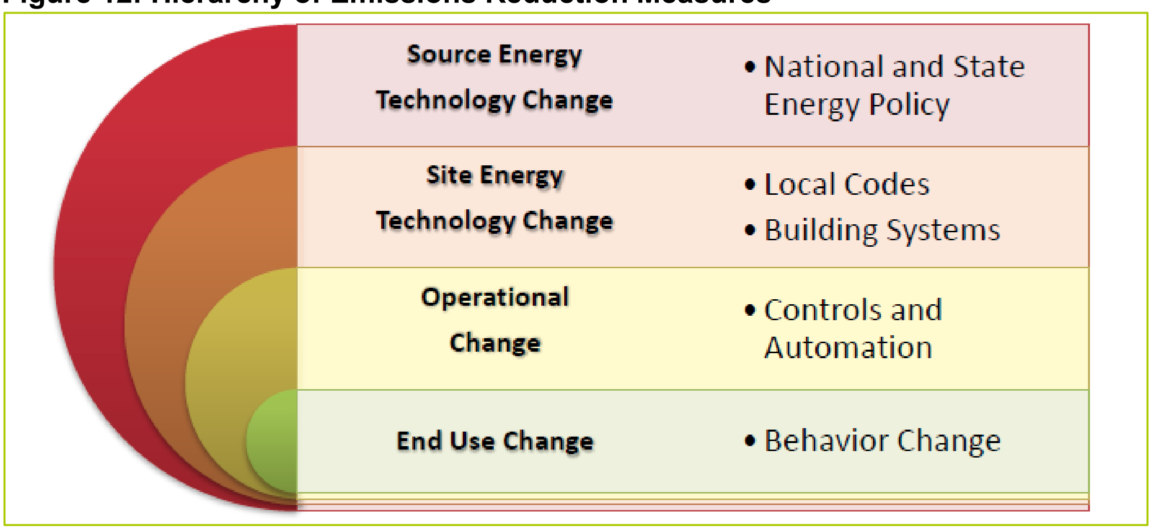
Reduction Measure	Change Electricity Use (kWh/Year)	Emission Reduction (tCO_2e/year)	Percentage reduction to Community GHG Baseline
Street Lights	-1,128,300	-388	-0.10%
Traffic Lights	-104,700	-36	

9. Emission Reduction Planning

The ClearPath GHG inventory tool includes a planning module that allows evaluating the outcomes in terms of energy and emissions reductions of the GHG emission measures identified in the previous chapter. The planning module provides a tool for assessing the effectiveness of the proposed climate actions in achieving the planned reduction goals against the baseline year emissions. The module includes the option of selecting the implementation timeline for each measure, allowing testing different strategies to design the optimal sequence of implementation. This is very important for those measures that require considerable financial investment or lengthy planning and preparation before they can be launched. This would be the case for example, for the Community Solar and Energy Efficiency Outreach programs previously described.

The objective is to plan the climate actions in order to meet the GHG reduction goals timeline, balancing the priority of achieving the emission as early as possible with realistic timeline and financial constraints. Where possible, measures should be planned prioritizing those measures that have an impact to the source of emissions, followed by those that are focused on end use and behavioral changes, which may be harder to fully implement or follow. On the other hand, measures targeting the sources may be more complex and expensive (e.g., upgrading a power plant), requiring more time to prepare and implement than a relatively simple building management policy setting rules on thermostat settings to reduce waste of heating energy. The following diagram from ICLEI's ClearPath Planning Module User Manual provides a useful guidance on the hierarchy of reduction measures.

Figure 12: Hierarchy of Emissions Reduction Measures



Source: ICLEI ClearPath Planning Module User Guide, February 2014.

The following table lists the proposed reduction measures in order of priority, based on reduction potential, cost and complexity of implementation.

Table 26: Summary of GHG Emissions Reduction Measures

Reduction Measure	Expected GHG Emission Reduction (tCO_2e/year)	Priority	Comment
Making Hoboken Electric Vehicle Friendly & Implementing EV Charging Station	-1,392	1	Medium complexity implementation; Medium Cost; Significant GHG emissions reduction
Making Hoboken Solar Friendly & Implement Solar Initiatives	-2,575	1	Medium complexity implementation; Low Cost; Low GHG emissions reduction
Implement a Community-Led Residential Solar Purchasing Program (e.g., special solar pricing via approved solar installers)		2	Complex implementation; Cost dependent on program; Significant GHG emissions reduction
Implement a Community-Led Commercial Solar Purchasing Program (e.g., special solar pricing via approved solar installers)	-2,575	2	Complex implementation; Cost dependent on program; Significant GHG emissions reduction
Implement a general residential outreach focused on Home Performance Energy Star and Comfort Partners	-2,425	2	Medium complexity implementation; Medium Cost (FTE); Significant GHG emissions reduction
Implement a commercial outreach focused on Direct Install Program for local businesses	-569	2	Medium complexity implementation; Medium Cost; Low GHG emissions reduction
Improve Bicycle Transit Infrastructure	-164	2	Medium complexity implementation; High Cost; Low GHG emissions reduction
Increase HOP Transit Frequency-Switch to CNG	-4,554	3	Medium complexity implementation; High Cost; GHG emissions reduction highly dependent on behavioral change

The priority order should also take into account the reduction goals at year 1, 4, and 9, planning the implementation of the measures in order to meet the reduction timeline while avoiding concentrating implementations in a short time span. To achieve some of the City’s goals for the community, a more ambitious approach will have to be considered because of the short time frame (e.g., net zero by 2022). To demonstrate what this may mean for implementation, the data for each measure were input in ClearPath planning module and several tests were performed. The table below shows an aggressive implementation plan, reducing the time for the City to plan for the financing and implementation of the different measures but trying to maximize the reduction to achieve the Net-Zero goal planned for 2022.

Table 27: GHG Emission Reduction Measures Implementation Timeline - Net-Zero 2022 Scenario

Reduction Measure	Implementation Start Year	Implementation End Year	Forecast End Year
Making Hoboken Electric Vehicle Friendly & Implementing EV Charging Station	2019	2029	2029
Making Hoboken Solar Friendly & Implement Solar Initiatives	2019	2029	2029
Implement a Community-Led Residential Solar Purchasing Program	2020	2025	2029
Implement a Community-Led Commercial Solar Purchasing Program	2020	2025	2029
Implement a general residential outreach focused on Home Performance Energy Star and Comfort Partners	2020	2029	2029
Implement a commercial outreach focused on Direct Install Program for local businesses	2020	2029	2029
Improve Bicycle Transit Infrastructure	2020	2029	2029
Increase HOP Transit Frequency-Switch to CNG	2020	2029	2029

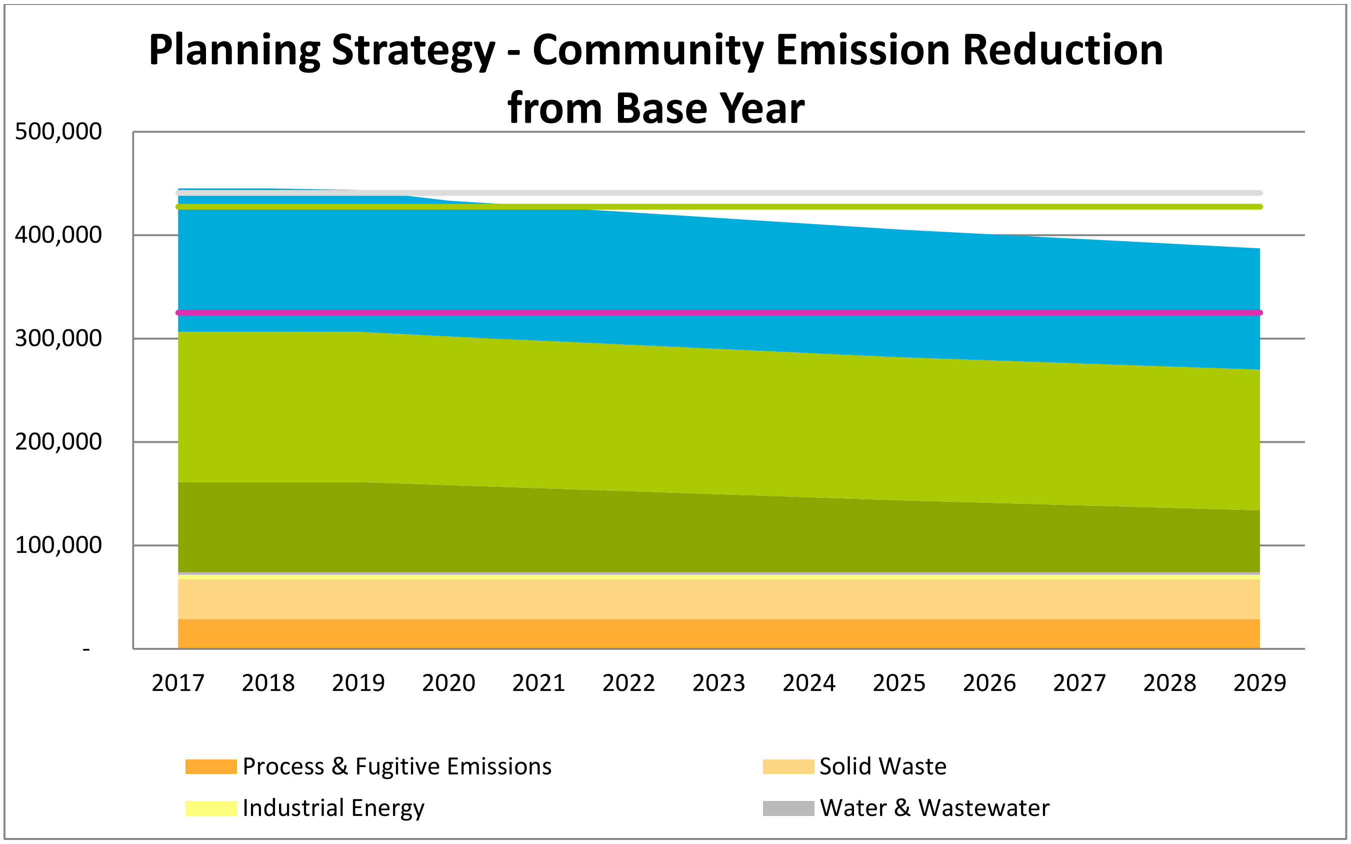
The results of the reduction measures planning and the estimate of the emission reduction are shown in the following tables and diagrams.

Table 28: GHG Emission Reduction Plan – Net Zero 2022 Scenario

	2017	2018	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029
Process & Fugitive Emissions	28,833	28,833	28,833	28,833	28,833	28,833	28,833	28,833	28,833	28,833	28,833	28,833	28,833
Solid Waste	38,314	38,314	38,314	38,314	38,314	38,314	38,314	38,314	38,314	38,314	38,314	38,314	38,314
Industrial Energy	4,441	4,441	4,441	4,441	4,441	4,441	4,441	4,441	4,441	4,441	4,441	4,441	4,441
Water & Wastewater	2,457	2,457	2,457	2,457	2,457	2,457	2,457	2,457	2,457	2,457	2,457	2,457	2,457
Residential Energy	87,260	87,260	87,260	84,319	81,377	78,436	75,495	72,554	69,613	67,187	64,761	62,336	59,910
Commercial Energy	145,239	145,239	145,203	143,731	142,646	141,561	140,476	139,391	138,306	137,737	137,168	136,599	136,029
Transportation & Mobile Sources	138,768	138,768	137,212	131,323	129,766	128,210	126,653	125,096	123,539	121,982	120,425	118,868	117,311
Total Emissions	**445,312**	**445,312**	**443,720**	**433,418**	**427,834**	**422,252**	**416,669**	**411,086**	**405,503**	**400,951**	**396,399**	**391,848**	**387,295**
Reduction to 2017 Baseline	0	0.0%	-0.4%	-2.7%	-3.9%	-5.2%	-6.4%	-7.7%	-8.9%	-10.0%	-11.0%	-12.0%	-13.0%
1 Year Goal	440,859	440,859	440,859	440,859	440,859	440,859	440,859	440,859	440,859	440,859	440,859	440,859	440,859
4 Year Goal	427,500	427,500	427,500	427,500	427,500	427,500	427,500	427,500	427,500	427,500	427,500	427,500	427,500
2027 - Paris Agreement -16% Baseline	374,062	374,062	374,062	374,062	374,062	374,062	374,062	374,062	374,062	374,062	374,062	374,062	374,062

The emissions reductions are calculated according to the 2017 baseline. The results in the table show that even if the reduction measures are implemented according to a more aggressive schedule, only the annual goals of -1 percent reduction could be achieved but it would be very difficult to achieve the Net Zero status by 2022 as well as exceeding the Paris agreement goal of -16 percent by the end of 2027. Even with the -5.2 percent reduction achieved by 2022, a large share of emissions due to stationary energy would have to be still reduced or potentially offset to obtain a Net-Zero status.

Figure 13: GHG Emission Reduction Plan – Net-Zero 2022 Scenario



10. Uncertainty Assessment and Quality Assurance

With regard to a GHG Inventory, quality refers to the general accuracy and consistency between an organization's actual emissions and quantified emissions. The difference between actual and quantified emissions results from uncertainty and error introduced by activities such as data collection, data management, calculations, and reporting. Inventory quality is impacted as data progresses from individual sources to the final report.

The inventory contains reporting uncertainty resulting from the potential for errors to be introduced in certain activities. Overall uncertainties are as follows:

- Not all data was received from primary sources (i.e., invoices) and backup data was not provided for the information recorded. Thus, errors present in the initial data will be transferred to errors in the emission calculations.
- Default emission factors, though used as a best practice, may present a level of uncertainty from the actual emissions.

11. Verification of this Report

This report, the information it contains, and the data it is based upon have not been verified by an external third party.

APPENDIX B

City Operations Greenhouse Gas Emissions Inventory Report – Base Year 2017

Greenhouse Gas Emissions Inventory
Government Operations
City of Hoboken, New Jersey
Activities Year 2017

April 2019

Prepared by: **First Environment, Inc.**
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FIRST ENVIRONMENT

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LIST OF ACRONYMS

AR5 - Intergovernmental Panel on Climate Change's Fifth Assessment Report
CAGR – Compound Annual Growth Rate
CH_4 - methane
CO_2 – carbon dioxide
CO_2e - Carbon Dioxide Equivalents
CSC – New York State Climate Smart Communities
EF – GHG Emission Factor
eGRID – US EPA Emissions & Generation Resource Integrated Database
EPA – Environmental Protection Agency
GHG – greenhouse gas
GPC – Global Protocol for Community-Scale Greenhouse Gas Emission Inventories
GWP – global warming potential
HFC – hydrofluorocarbon
ICLEI - Local Governments for Sustainability
IMP – Inventory Management Plan
IPCC – Intergovernmental Panel on Climate Change
LGO – Local Government Organization
LGOP – ICLEI's Local Government Organization Protocol
LPG – liquid petroleum gas (propane)
t – metric tonnes
MSW – municipal solid waste
MWh – Mega Watt hour
NHSA - North Hudson Sewerage Authority
N_2O – Nitrous Oxide
PFC – perfluorocarbon
RFCE – NERC region: Reliability First Corporation/ East
SF_6 – sulfur hexafluoride
TCR – The Climate Registry
the City – City of Hoboken
US EPA - United States Environmental Protection Agency
UNFCCC – United Nations Framework Convention on Climate Change
WRI – World Research Institute

Executive Summary

First Environment, Inc. (First Environment) was retained by the City of Hoboken (Hoboken or the City) to prepare the greenhouse gas (GHG) emissions inventory for both the community and the municipal operations activities of year 2017. The community GHG inventory was prepared in accordance with the Global Protocol for Community-Scale Greenhouse Gas Emission Inventories (GPC), developed by the Local Governments for Sustainability (ICLEI) in partnership with the World Resources Institute. The municipal operations GHG inventory was prepared in accordance with ICLEI's Local Government Operations Protocol (LGOP). ICLEI's ClearPath Pro web based tool provided the platform for data collection, processing, and GHG quantification and reporting for both inventories.

The GHG inventory assessed emissions of seven greenhouse gases (GHGs):

- carbon dioxide (CO_2),
- methane (CH_4),
- nitrous oxide (N_2O),
- hydrofluorocarbons (HFCs)
- perfluorocarbons (PFCs),
- sulfur hexafluoride (SF_6), and
- Nitrogen tri-fluoride (NF_3).

Conducting the GHG inventories demonstrates the City's recognition of its relationship to both the local and global environment. It allows the City to better understand and take responsibility for its activities and their climate impacts. Accordingly, the inventories provide a foundation and starting point for the City's efforts to reduce GHG emissions from its activities and demonstrate environmental stewardship. The inventories serve as a reference point to guide the development of policies, programs, and projects as the City pursues its climate change mitigation and adaption objectives.

This report addresses the municipal operations GHG inventory emissions; a separate report was prepared for the community GHG emissions.

Municipal Operations Inventory

The scope of the inventory included all emissions sources under the City's operational control. This consisted of the City's Scope 1 "direct" emissions from stationary combustion and mobile combustion, as well as Scope 2 "indirect" emissions from the consumption of purchased electricity. In accordance with the LGOP, the inventory does include any City Scope 3 emissions.

Emissions in the GHG Inventory are reported in Carbon Dioxide Equivalents (CO_2e). CO_2e is used to quantify total emissions because each GHG has a different Global Warming Potential (GWP) which is converted to CO_2e by using a gas specific factor. Unless otherwise noted in this report, GHG emissions were converted to CO_2e using Global Warming Potentials (GWPs), a standard conversion factor, from the Intergovernmental Panel on Climate Change's (IPCC) Fifth Assessment Report (AR5). Using CO_2e equalizes all GHGs to one standard reference, quantified in metric tonnes of carbon dioxide equivalent (tCO2e), the global standard unit used to measure GHG emissions.

Table 1: Summary of GHG Inventory

Reporting Protocol	Local Governments for Sustainability (ICLEI)'s Local Government Operations Protocol, v1.1, May 2010
Reporting Tool	ICLEI ClearPath – Government Track - https://clearpath.icleiusa.org
Geographic Boundary	City of Hoboken Municipal Boundary
Organizational Boundary	Operational Control
Operational Boundary	Scope 1, Scope 2
Inventory Reporting Period	January 1 to December 31, 2017
Base Year	2017
GWP Defaults	IPCC 5th Assessment Report (AR5)

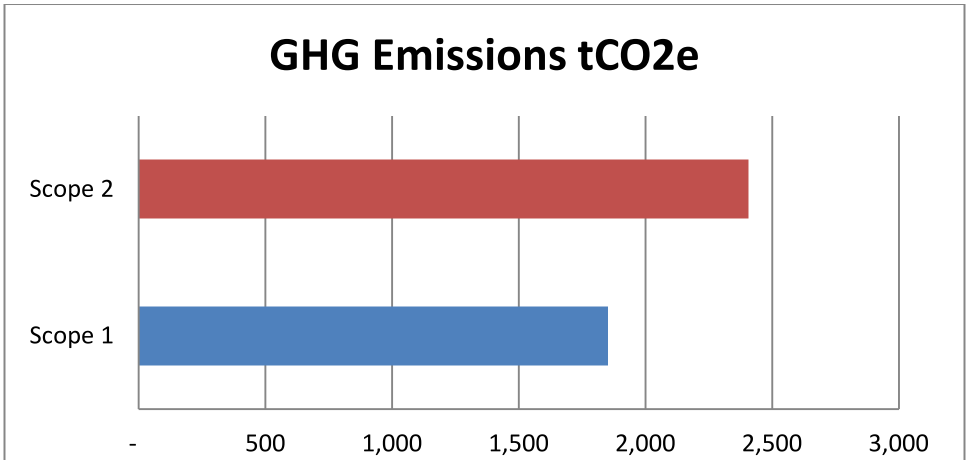
The City's total Scope 1 GHG emissions for 2017 amounted to 1,852 tCO_2e. These total emissions originate from stationary combustion, such as natural gas for heating, and mobile combustion, such as gasoline and diesel consumption by the City fleet vehicles.

The City's total Scope 2 GHG emissions for 2017 amounted to 2,407 tCO_2e.

Table 2: Total GHG Emissions by Scope (tCO_2e)

GHG Emissions	tCO_2e
Scope 1	1,853
Scope 2	2,407
Total	**4,260**

Figure 1: Total GHG Emissions by Scope (tCO_2e)



	Scope 1	Scope 2
tCO2e	1,853	2,407

The distribution of Scope 1 and Scope 2 emissions by sector is shown in percentage and in tCO_2e in the charts below.

Figure 2: Total GHG Emissions by Sector in Percentage

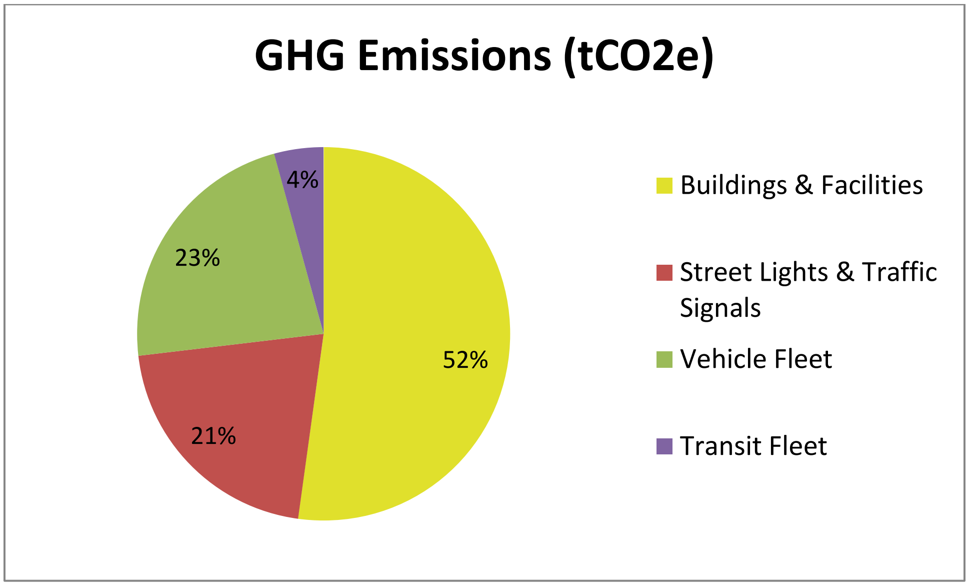
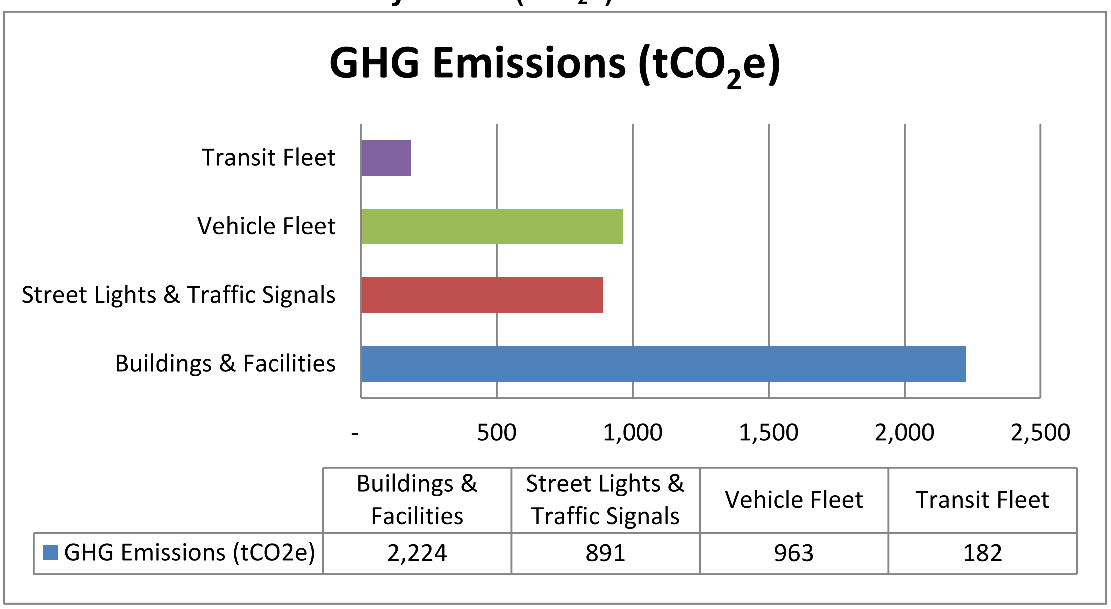


Figure 3: Total GHG Emissions by Sector (tCO_2e)



The results highlight the predominance of the building and facilities as the major source of GHG emissions. Scope 1 emissions (mobile fuel combustion) from the vehicle fleet and electricity consumption by streetlights are almost equal, ranking as the next largest sources. Mobile emissions by the City-operated transit fleet ranks fourth.

1. Introduction

A GHG emissions inventory identifies an organization's GHG emission sources and quantifies them according to a set of acknowledged conventions using established estimation methodologies.

The City air emission inventory quantifies GHG from the "Kyoto six" GHGs—carbon dioxide (CO_2), methane (CH_4), nitrous oxide (N_2O), hydrofluorocarbons (HFCs), perfluorocarbons (PFCs), and sulfur hexafluoride (SF_6) plus the additional nitrogen tri-fluoride (NF_3), recently included to the reportable GHGs. These are the most recognized and common GHGs from human-made sources, as identified in the United Nations Framework Convention on Climate Change Kyoto Protocol (UNFCCC).

The GHG inventory of local government operations (LGO) identifies the amounts of electricity and fuels used in municipal buildings, streetlights, fleets, and other operations controlled by the local government. If operated by the City, GHG emissions from waste and water treatment facilities would also be included, but this is not the case for the City of Hoboken.

The LGO inventory does not include GHG emissions generated by the City residents and businesses, including those produced by power generation facilities, if present. The emissions from these sources are accounted for separately and constitute the Community GHG emissions inventory, which are reported under a different Protocol (U.S. Community Protocol for Accounting and Reporting of Greenhouse Gas Emissions). First environment quantified the City of Hoboken Community GHG Inventory for calendar year 2017 in a separate report.

2. Overview of the City of Hoboken

The City of Hoboken is located in Hudson County, New Jersey, across the Hudson River west of New York City.

According to the United States Census Bureau[1], the town has a total area of 2.011 square miles including 1.275 square miles of land. The population according to the 2010 census data was 50,006 and it has increased to 55,131 as estimated by July 1, 2017. The City territory borders the municipalities of Jersey City to the west and south, Union City and Weehawken on the north side. The Hudson River flows on the eastern side of the City.

The City was formed as a Township in 1849 and incorporated as a City in 1855.

The City government staff is composed of 528 full time employees and 251 part-time/seasonal employees as of November 2018.

Table 3: City Government Staff by Department

Department	Full Time Employees
Finance	13
Human Services	24
Administration	59
Public Safety	276
Community Development	9
Environmental Services	53
Hoboken Parking Unit	90
Mayor's Office	4

The City operates several facilities and buildings, summarized by Department in the table below. A detailed schedule of properties is attached in Appendix 1.

Table 4: Buildings and Facilities with the City Operations

City Departments	Square feet Area of Facilities
Hoboken Volunteer Ambulance Corps	3,800
Environmental Services Department	595,216
City Hall	20,400
Fire Department	20,505
Hoboken Parking Utility	424,067
Transportation & Parking Department	12,356
Human Services Department	40,000
Police Department	23,242
Hoboken Public Library	50,000
Boys & Girls Club	2,500

[1] https://factfinder.census.gov/faces/nav/jsf/pages/index.xhtml

All the buildings and facilities listed are either owned and operated by the City or the City is ultimately responsible for paying the utilities for them. These include electricity and natural gas for heating.

In addition to the buildings and facilities listed above, the City operations also include the street lighting and traffic lights, metered independently from the building and facilities. The electricity for street lighting and for the building and facilities is provided by the local utility (PSE&G). According to a recent inventory provided by PSE&G, there were 2,836 metered streetlights and 23 traffic lights in operation within the City of Hoboken.

The City does not operate waste disposal facilities or wastewater treatment facilities, though the North Hudson Sewerage Authority (NHSA) operates a wastewater treatment facility located on Adams Street on the northern end of the Hoboken territory.

The City operates several fleets of vehicles for the various departments, including police and fire department, environmental services, the Hoboken Parking Unit (HPU), and a fleet of five paratransit buses providing public transit within the City territory. The fleet consists of different type of vehicles including passenger cars, pickups, heavy trucks for road maintenance equipment, sanitation, etc. The fleet uses both diesel and gasoline fuel.

2.1 Staff Responsible for the GHG Inventory

This GHG inventory was developed by First Environment through consultation with the City staff led by Jennifer Gonzales, Director of Environmental Services, Chief Sustainability Officer.

2.2 GHG Inventory Reporting Protocol

The City of Hoboken Government Operations GHG inventory was conducted in accordance with the ICLEI's Local Government Operations Protocol (LGOP), Version 1.1, May 2010. The LGOP was developed through a partnership among the California Air Resources Board (ARB), California Climate Action Registry (CCAR), The Climate Registry, and ICLEI. The LGOP is based on the "Greenhouse Gas Protocol: A Corporate Accounting and Reporting Standard" developed by the World Business Council for Sustainable Development and the World Resources Institute (WRI/WBCSD), which provides the standards and guidance for companies and other types of organizations preparing a GHG emissions inventory. The goal of the LGOP is to offer additional guidance to local governments on applying the GHG Protocol within the context of local government operations. The LGOP provides a standardized method and procedures to assist local governments in quantifying and reporting GHG emissions associated with their operations.

2.3 GHG Inventory Reporting Tool

The GHG inventory was prepared using ICLEI's ClearPath Tool, an online platform designed to incorporate all the LGOP requirements for inventory data including all parameters, factors, and methodologies necessary to perform the GHG emissions quantification. The ClearPath suite of tools also includes modules allowing forecasting of emissions scenarios, as well as planning and monitoring of measures aimed at reducing GHG emission over time.

2.4 GHG Inventory Reporting Period – Base Year

This GHG inventory report covers GHG emissions form the City operations within the boundaries described below during the period of:

- January 1 through December 31, 2017.

This first GHG Inventory provides a full calendar year baseline of data about the energy consumption and resulting GHG emissions from the City municipal operations. The baseline will be used to establish emissions reductions targets and track progress towards achieving them.

2.5 GHG Inventory Boundaries

2.5.1 Geographic Boundary

The geographic scope of the emissions report determines which emissions are accounted for and reported by the City. The City operations are conducted within the City municipal boundary; the City does not control or operates any facility outside such geographic boundary.

2.5.2 Organizational Boundaries

Organizational boundaries define the limits of a GHG inventory by identifying the activities that are owned and/or controlled by the entity and determining which emission sources should be included in its GHG inventory. As recommended by the LGOP, the GHG emissions contained in this report were consolidated according to the Operational Control approach. The operational control is established for facilities, activities, and sources over which the City possesses the authority to implement operating policies such as financial, environmental, health, or safety directives. A description of the facilities and sources included in the City's Operational Control boundary is provided in the following paragraph, further detailed according to the Operational Boundary described in the next paragraph.

2.5.3 Operational Boundaries

Operational boundaries in GHG inventory identifies the specific types of emission sources that the City, as defined by the inventory's organizational boundaries, includes in its GHG Inventory. A key distinction in setting operational boundaries is whether GHG emissions sources are categorized as direct emissions or indirect emissions.

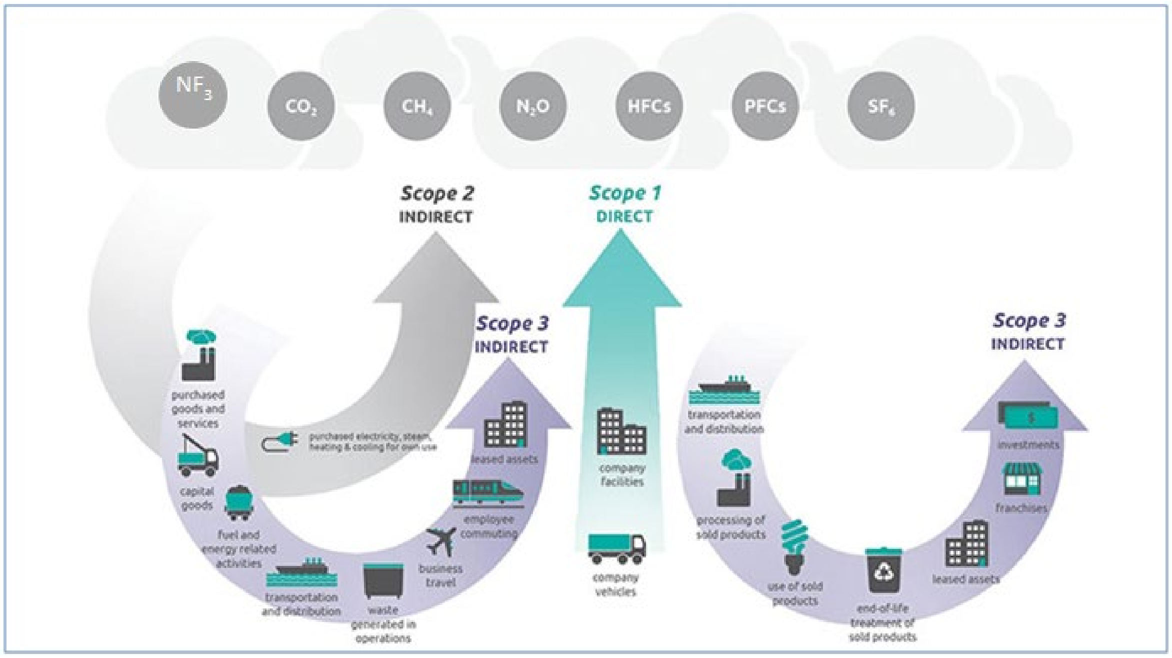
- Direct emissions (Scope 1): result from emission sources that are owned or operated by the organization.
- Indirect emissions (Scope 2, Scope 3): emissions that are due to an organization's activities but occur from sources owned or controlled by another organization.

The concept of emission "scopes" expands upon the distinction between direct and indirect emissions, splitting indirect emissions into two separate categories: Scope 2, associated with indirect energy emissions such as those due to electricity purchased from a utility; Scope 3, capturing all other types of indirect emissions such as employee commuting, disposal of waste generated, etc. Due to the complexity of determining them, Scope 3 emissions are not included in this GHG inventory.

In addition, categories of common sources, such as stationary combustion, mobile combustions, fugitive emissions, etc., create a framework for the organization of the inventory. This framework facilitates the identification of appropriate quantification methodologies for emission sources, collection of data, as well as reporting of inventory results.

The following diagram provides a summary of the scopes and categories of emissions across the value chain of a reporting entity, as defined in the WRI GHG Protocol.

Figure 4: Overview of GHG Protocol Scopes and Emissions Across the Value Chain



Source: GHG Protocol - Scope 3 Corporate Value Chain Accounting Reporting Standard_041613 (WRI, WBCSD)

The general operational boundaries of the City GHG inventory are as follows:

Scope 1: Direct GHG emissions from activities that are owned or controlled by the reporting entity.

The City Scope 1 GHG emission categories include the following:

- stationary combustion,
- mobile combustion,
- fugitive emissions.

Scope 2: Indirect GHG emissions from the generation of purchased or acquired energy, such as electricity, which is consumed by the reporting entity.

The City Scope 2 GHG emission categories include the following:

- purchased electricity.

Scope 3: All other indirect emissions not covered in Scope 2. Not included in this report

The complete list of emission sources in the City GHG inventory are listed in the following tables, organized by Scope and Sector.

2.6 Scope 1 - Direct Emissions

The following sectors were identified as Scope 1 sources of GHG emissions:

Table 5: Scope 1 Emission Sources

Sector	Emission Category
Fleet Vehicle Emissions	Mobile Fuel Combustion
Public Transit Emissions	Mobile Fuel Combustion
Buildings and Facilities	Stationary Fuel Combustion

A detailed breakdown of the Scope 1 specific sources is provided in the following paragraphs.

2.7 Scope 2 - Energy Indirect Emissions

The following sectors were identified as Scope 2 sources of GHG emissions.

Table 6: Scope 2 Emissions Sources

Sector	Emission Category
Buildings and Facilities	Emissions from Grid Electricity
Street Lights and Traffic Signals	Emissions from Grid Electricity

A detailed breakdown of the Scope 2 specific sources is provided in the following paragraphs.

2.8 GHG Inventory Exceptions

Fugitive emissions from refrigerants and (HFCs, PFCs, $NF_{3,}$ or SF_6) were not quantified for the City GHG inventory due to the absence of records and information on air conditioning and refrigeration equipment inventory or service and maintenance. This is an area that should be improved for future GHG inventories efforts by the City.

2.9 Inventory Data Collection Methodologies

The primary methodologies utilized to collect data were the following:

- Data and information were provided by the City staff.
- Energy consumption data were provided by the utility supplying the City, upon authorization by the City.
- In some cases when data were not available for a particular source, individuals with knowledge of the activities provided an estimate based on experience.

The collection methodology for each source is summarized below.

2.10 Scope 1 Emissions

2.10.1 Stationary Combustion

The City provided an inventory of the buildings and facilities owned and or operated by the City. Each building and facility in the inventory was confirmed as being under the City operational control and the associated fuel and electricity consumption were included in the inventory.

2.10.1.1 Natural Gas

The City staff provided the list of natural gas utility accounts for each building and service address and the bills for the consumption for year 2017, quantified in therms. The fuel usage data was checked against the accounting records provided by PSE&G and the total natural gas usage for each City-controlled building was calculated. Where appropriate, buildings and facilities were aggregated according to the City department that utilizes them. The applicable emissions quantification methodology from the LGOP was applied to these fuel values as described in the next paragraphs.

Sources of Emissions from Stationary Fuel Combustion	Fuel
Hoboken Parking Utility	Natural Gas
Environmental Services Department	
City Hall	
Public Library	
Police Headquarter	
Boys and Girls Club	
Fire Department	
Human Services Department	
Volunteer Ambulance Corps	
Transportation & Parking Department	

2.10.2 Mobile Combustion – Gasoline and Diesel

The City provided an up-to-date inventory of all the vehicles owned and operated by the various City departments. The fleet includes various types of vehicles, such as passenger cars, light and heavy trucks, and off-road vehicles for road maintenance. The fleet inventory did not include sufficient data on vehicle age and odometer readings; therefore, the annual mileage driven by each vehicle was estimated based on fuel usage data.

All the fleet vehicles were aggregated by department and by fuel as listed in the table below:

Mobile Combustion Sources-Fuel
Administration - Gasoline
Ambulance Corps Fleet - Diesel
Ambulance Corps Fleet - Gasoline
Buildings - Gasoline
Community Development - Gasoline
Environmental Services - Diesel
Environmental Services - Gasoline
Fire Dept. Fleet - Diesel

Mobile Combustion Sources-Fuel
Fire Dept. Fleet - Gasoline
Hoboken Parking Unit Fleet - Diesel
Hoboken Parking Unit Fleet - Gasoline
Human Services - Diesel
Human Services - Gasoline
Police Fleet - Diesel
Police Fleet - Gasoline
Transportation & Parking - Gasoline
HOP Public Transit - Gasoline

The entire City's fleet is fueled at public gas stations by using city-issued fuel cards. The City provided fuel card records for the entire calendar year 2017 that identify the type of fuel, the employee fueling the vehicle, and the department he or she belongs to. The total volume of gasoline or diesel used by each department was then used to estimate the total VMT for all the vehicles used by that department. This was necessary due to the absence of detailed odometer readings or mileage records for each vehicle.

2.10.3 Fugitive Emissions

First Environment was unable to obtain sufficient information regarding the possible sources of fugitive emissions such as air conditioning equipment or certain type of fire extinguishing systems. As such it was decided to not include these sources for emission year 2017.

2.11 Scope 2 Emissions

2.11.1 Purchased Electricity

The City staff provided all the utility invoices for year 2017 electricity consumption by City buildings, street lighting and traffic signals. The total electricity consumption was calculated by aggregating the invoices for each electrical service account, prorated as required for the months of January and December. The appropriate GHG emissions quantification methodology was applied to the annual totals for each account.

2.12 Scope 3 Emissions

On accordance with LGOP, these are not mandatory and therefore not included in the 2017 GHG inventory for the municipal operations.

3. Emissions Quantification Methodologies

GHG emissions are calculated applying the appropriate methodologies from:

- ICLEI's Local Government Operations Protocol (LGOP), Version 1.1, May 2010.

In addition, GHG emissions are calculated using emission factors (EF) sourced from:

- US EPA Center for Corporate Climate Leadership - Emission Factors for Greenhouse Gas Inventories – March 9, 2018;
- US EPA Emissions & Generation Resource Integrated Database - eGRID2016;
- Fifth Assessment Report of the Intergovernmental Panel on Climate Change - IPCC AR5.

The GHG emissions quantification was performed by ICLEI's ClearPath Pro Tool, which includes the algorithms calculating the emission according to LGOP methods.

The quantification methodology for each source is summarized in the following paragraphs.

3.1 Scope 1 Emissions

3.1.1 Stationary Combustion – Natural Gas

Emissions were calculated according to Equations 6.2, 6.3 and 6.5 of LGOP by multiplying the total gallons of natural gas usage by stationary sources by the appropriate CO_2, CH_4, and N_2O emission factors sourced from US EPA emission factors for GHG inventories. The results of these calculations in metric tonnes of CO_2, CH_4, and N_2O emissions were converted to metric tonnes of CO_2e by using Equation 6.7 of the LGOP and applying the appropriate GWP factor for each GHG from IPCC AR5.

3.1.2 Mobile Combustion

3.1.2.1 Gasoline

GHG emissions were calculated according to Equation 7.2, of LGOP by multiplying the total gallons of gasoline usage for mobile sources by the appropriate CO_2 emission factor sourced from the US EPA emission factors for GHG inventories. Emissions of CH_4, and N_2O were calculated according to Equations 7.6 and 7.7 of LGOP by multiplying the estimated mileage driven by the vehicles in each fleet category for the appropriate CH_4, and N_2O emission factors sourced from the US EPA emission factors for GHG inventories.

The results of these calculations in metric tonnes of CO_2, CH_4, and N_2O emissions were converted to metric tonnes of CO_2e by applying Equation 7.8 of the LGOP using the appropriate GWP factor for each GHG from IPCC AR5.

3.1.2.2 Diesel

GHG emissions were calculated according to Equation 7.2 of LGOP by multiplying the total gallons of diesel usage for mobile sources by the appropriate CO_2 emission factor sourced from the US EPA emission factors for GHG inventories. Emissions of CH_4, and N_2O were calculated according to Equations 7.6 and 7.7 of LGOP by multiplying the estimated mileage driven by the vehicles in each fleet category for the appropriate CH_4, and N_2O emission factors sourced from the US EPA emission factors for GHG inventories.

The results of these calculations in metric tonnes of CO_2, CH_4, and N_2O emissions were converted to metric tonnes of CO_2e by applying Equation 7.8 of the LGOP using the appropriate GWP factor for each GHG from IPCC AR5.

3.2 Scope 2 Emissions

3.2.1 Purchased Electricity

Location-based electricity GHG emissions were calculated according to Equation 6.10 and 6.11 of the LGOP by multiplying the total electricity consumption in MWh by City-controlled buildings, street lighting, and traffic signals for the appropriate CO_2, CH_4, and N_2O electricity emission factors for the New Jersey region (RFC East) sourced from the US EPA eGRID 2016 database[2].

eGRID subregion acronym	eGRID subregion name	Total output emission rates (lb/MWh)		
		CO_2	CH_4	N_2O
RFCE	RFC East	758.2	0.050	0.009

The results of these calculations in metric tonnes of CO_2, CH_4, and N_2O emissions were converted to metric tonnes of CO_2e by multiplying for the appropriate IPCC AR5 GWP factor for each GHG.

An equivalent calculation was performed to quantify "market-based electricity emissions." Because the City does not make use of any direct supply of electricity from dedicated sources or of any contractual instruments that would convey specific emissions rates for the purchased electricity, the market-based electricity GHG emissions are equivalent to the location-based electricity GHG emissions.

3.3 Scope 3 Emissions

Scope 3 GHG emissions from City operations were not accounted for and are not included in this Inventory.

3.4 Global Warming Potentials

The Global Warming Potentials, identified in the Fifth Assessment Report of the Intergovernmental Panel on Climate Change, were used to convert the GHG emissions associated with Airport activities into carbon dioxide equivalents (CO_2e).

The Global Warming Potentials applied to the City GHG inventory are the following:

Name	Chemical Formula	SAR GWP Value
Carbon Dioxide	CO_2	1
Methane	CH_4	28
Nitrous oxide	N_2O	265

[2] https://www.epa.gov/energy/emissions-generation-resource-integrated-database-egrid

3.5 Quantification of Emissions

3.5.1 Scope 1 GHG Emissions

The City Total Scope 1 Emissions were quantified as 1,853 tCO_2e, including the following specific GHG contributions:

Table 7: Scope 1 GHG Emissions

Greenhouse Gas	t GHG	t CO2e
Carbon Dioxide (CO_2)	1,847.49	1,847.49
Methane (CH_4)	0.0938	2.62
Nitrous Oxide (N_2O)	0.0098	2.60
Total		1,852.72

The distribution of Scope 1 emissions by sector is shown in percentage and in tCO_2e in the charts below.

Figure 5: Scope 1 Emissions by Sector, in Percentage

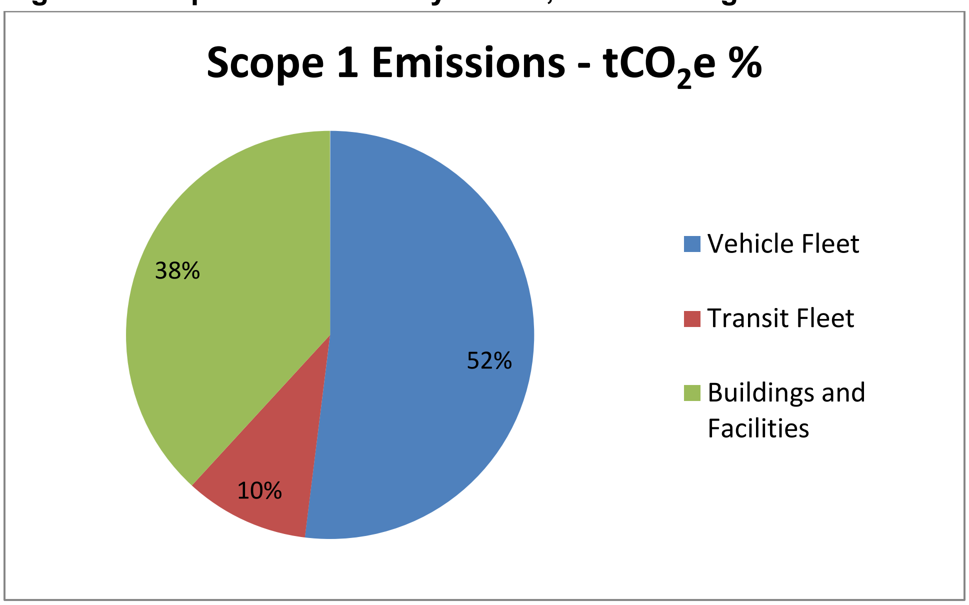
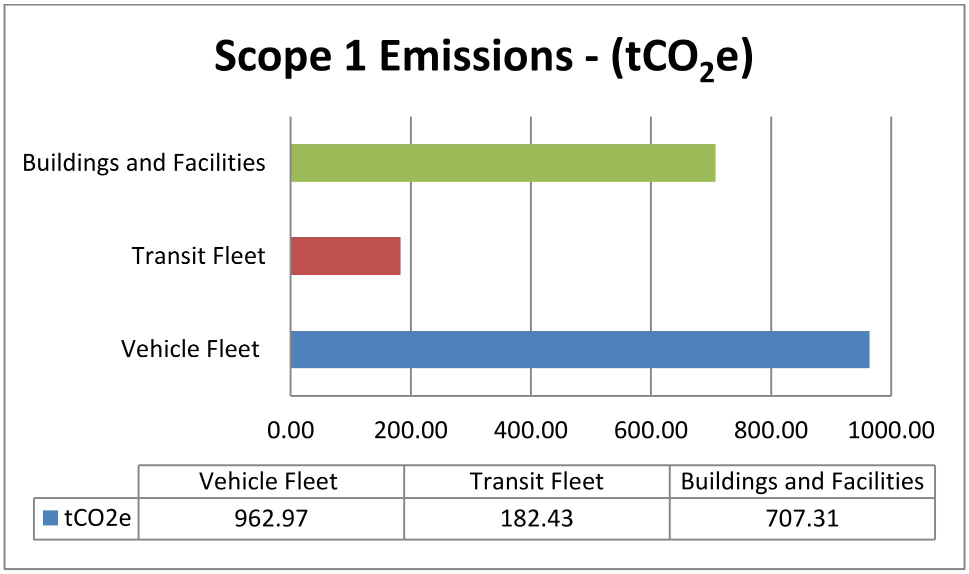


Figure 6: Scope 1 Emissions by Sector (tCO_2e)



The results highlight the predominance of the vehicle fleet as the major source of GHG emissions. Scope 1 emissions (stationary fuel combustion) from buildings and facilities rank as the second largest source followed by a lower amount of emissions from the transit fleet operated by the City.

The following sections detail the sources of GHG emissions in each sector, identifying the contribution by each fuel, or refrigerant GHG for the fugitive emission.

3.5.2 Direct Stationary Combustion Emissions – Building and Facilities

The City's direct stationary combustion emissions were quantified as 707.31 tCO_2e. This stationary combustion quantity includes contributions only from natural gas:

Table 8: Direct Stationary Combustion by Fuel

Stationary Combustion Emissions	tCO_2e
Natural Gas	707.31
Total	**707.31**

3.5.3 Direct Mobile Combustion Emissions – Vehicle Fleet

The direct mobile combustion emissions by the City Vehicle Fleet were quantified as 962.97 tCO_2e. This mobile combustion quantity includes contributions from the following fuels:

Table 9: Direct Mobile Combustion Emissions by Fuel – Vehicle Fleet

Mobile Combustion Emissions – Vehicle Fleet	
Fuel	tCO_2e
Gasoline	716.18
Diesel	246.79
Total	**962.97**

3.5.4 Direct Mobile Combustion Emissions – Transit Fleet

The City Transit Fleet mobile combustion emissions were quantified as 182.43 tCO_2e. The mobile combustion emissions include contributions from gasoline only.

Table 10: Direct Mobile Combustion Emissions by Fuel – City Transit Fleet

Mobile Combustion Emissions – City Transit Fleet	
Fuel	tCO_2e
Gasoline	182.43
Total	**182.43**

3.5.4.1 Scope 1 Emissions by Source

The following tables and chart show the Scope 1 emissions from each specific source, as identified in the inventory. For simplicity, sources are separated according to mobile and stationary combustion. For each source, the energy usage responsible for the emissions is also reported, expressed in volume of fuel combusted.

Table 11: Scope 1 – Mobile Combustion Emissions by Source (tCO_2)

Source	Fuel Use (Gal)	Fleet VMT (miles)	GHG Emissions (tCO_2e)
Ambulance Corps Fleet - Gasoline	5,557	77,793	48.96
Ambulance Corps Fleet - Diesel	1,158	9,262	11.83
Fire Dept. Fleet - Gasoline	5,822	81,507	51.26
Fire Dept. Fleet - Diesel	9,774	78,192	99.90
Hoboken Parking Unit Fleet - Gasoline	19,255	269,575	169.47
Police Fleet - Gasoline	31,438	440,134	276.67
Environmental Services - Diesel	13,084	104,673	133.74
Environmental Services - Gasoline	10,655	149,166	93.80
Buildings - Gasoline	292	4,081	2.57
Transportation & Parking - Gasoline	724	10,141	6.37
Administration - Gasoline	1,248	17,472	10.99
Human Services - Gasoline	6,326	88,568	55.69
Hoboken Parking Unit Fleet - Diesel	85	680	0.87
Police Fleet - Diesel	14	111	0.14
Community Development - Gasoline	45	630	0.40

Source	Fuel Use (Gal)	Fleet VMT (miles)	GHG Emissions (tCO_2e)
Human Services - Diesel	31	247	0.32
Transit Fleet - Gasoline	20,672	206,719	182.43
Total	**126,180**	**1,538,951**	**253.97**

Table 12: Scope 1 – Stationary Combustion Emissions by Source (tCO_2)

Source	Energy Use (Therms)	GHG Emissions (tCO_2e)
Hoboken Parking Unit - Natural Gas	12,718	67.64
Environmental Services Dept. - Natural Gas	9,460	50.31
City Hall - Natural Gas	19,055	101.35
Public Library - Natural Gas	10,027	53.33
Police Headquarter - Natural Gas	10,536	56.04
Boys and Girls Club - Natural Gas	983	5.23
Fire Department - Natural Gas	17,880	95.10
Human Services Dept. - Natural Gas	37,363	198.72
Volunteer Ambulance Corps - Natural Gas	2,247	11.95
Transportation & Parking Dept. - Natural Gas	12,718	67.64
Total	**132,987**	**707**

The same results displayed in bar diagrams:

Figure 7: Scope 1 Mobile Emission by Source (tCO_2e)

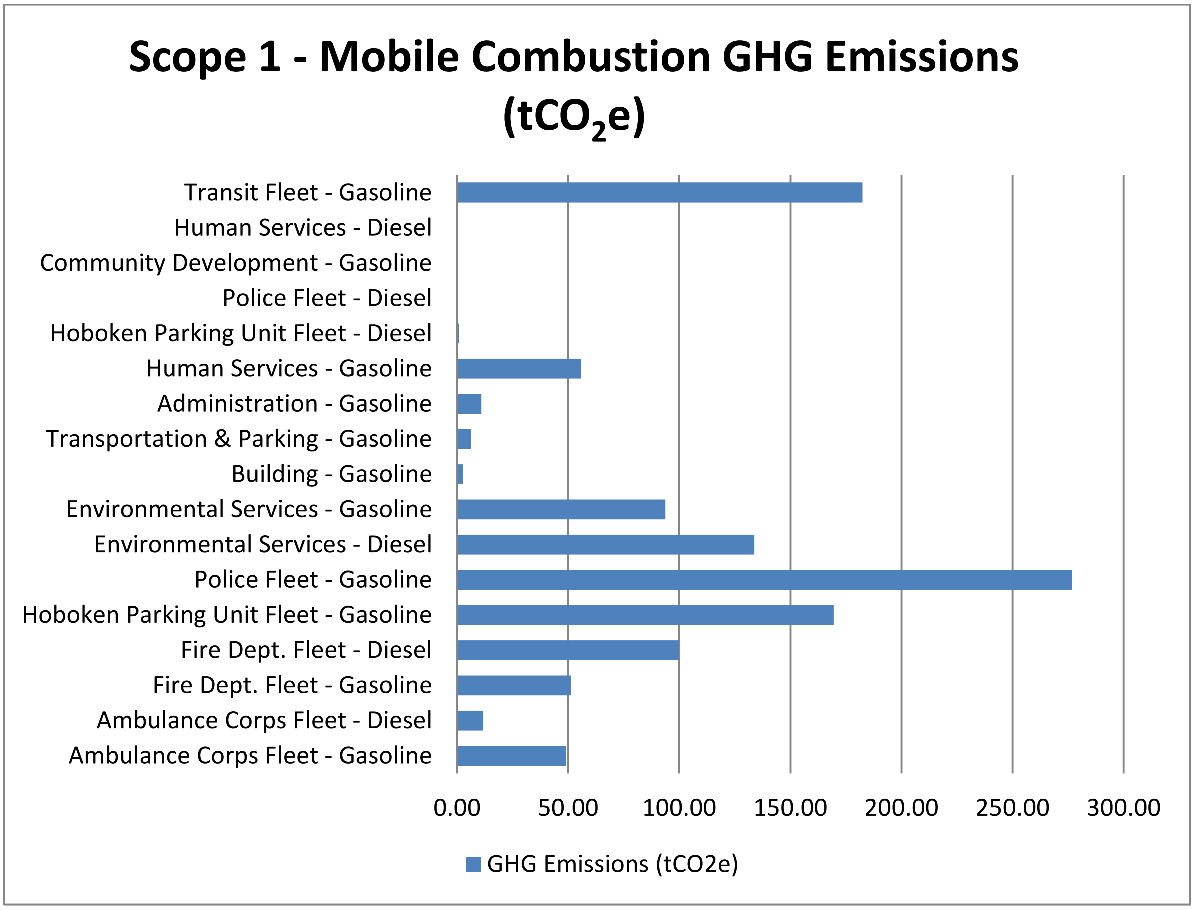
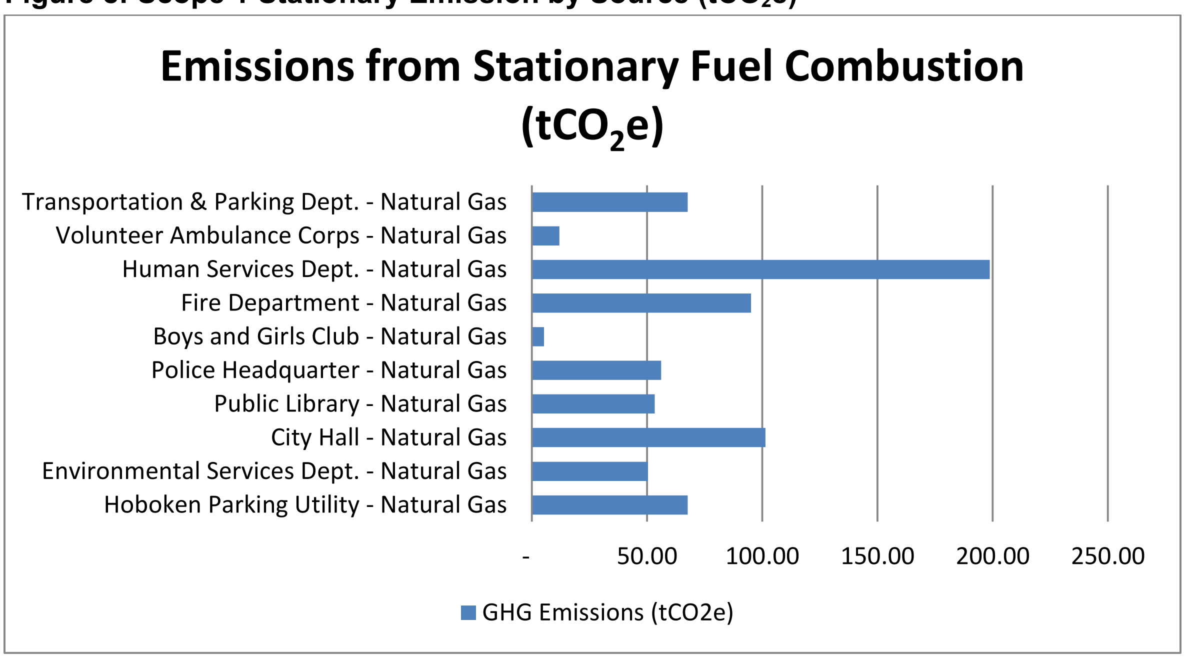


Figure 8: Scope 1 Stationary Emission by Source (tCO_2e)



For fleet emissions, the detailed breakdown by sources indicates the police, public transit, and parking unit fleets as generating the largest shares of emissions. The result is not surprising considering that these are the fleets with the largest VMT by the vehicles.

For stationary emissions, the human services department (mostly located in the multi-service building), and the City Hall are the largest sources of emissions. These are some of the largest buildings (excluding the parking garages) operated by the City and as expected are generating the largest shares of emissions from stationary combustion.

3.6 Scope 2 GHG Emissions – Purchased Electricity

All Scope 2 emissions reported are from purchased electricity. Total Scope 2 Emissions were quantified as 2,406.99 metric tonnes t CO_2e, including contributions of the following GHGs:

Table 13: Scope 2 GHG Emissions

Greenhouse Gas	t GHG	t CO_2e
Carbon Dioxide (CO_2)	2,406.98	2,406.98
Methane (CH_4)	0.00016	0.0044
Nitrous Oxide (N_2O)	0.00003	0.0076
	Total	**2,406.99**

The distribution of Scope 2 emissions by sector is shown in percentage and in tCO_2e in the charts below.

Figure 9: Scope 2 Emissions by Sector, in Percentage

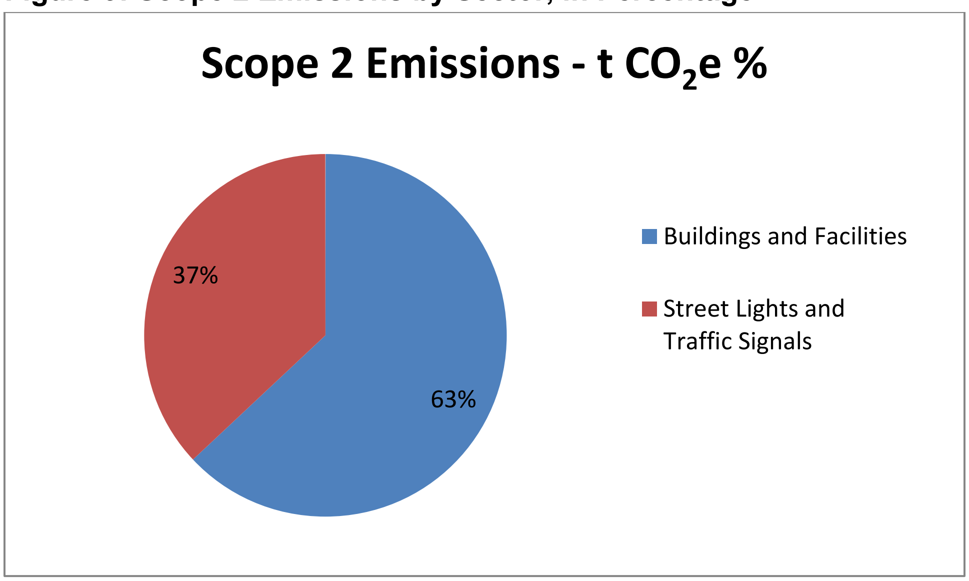
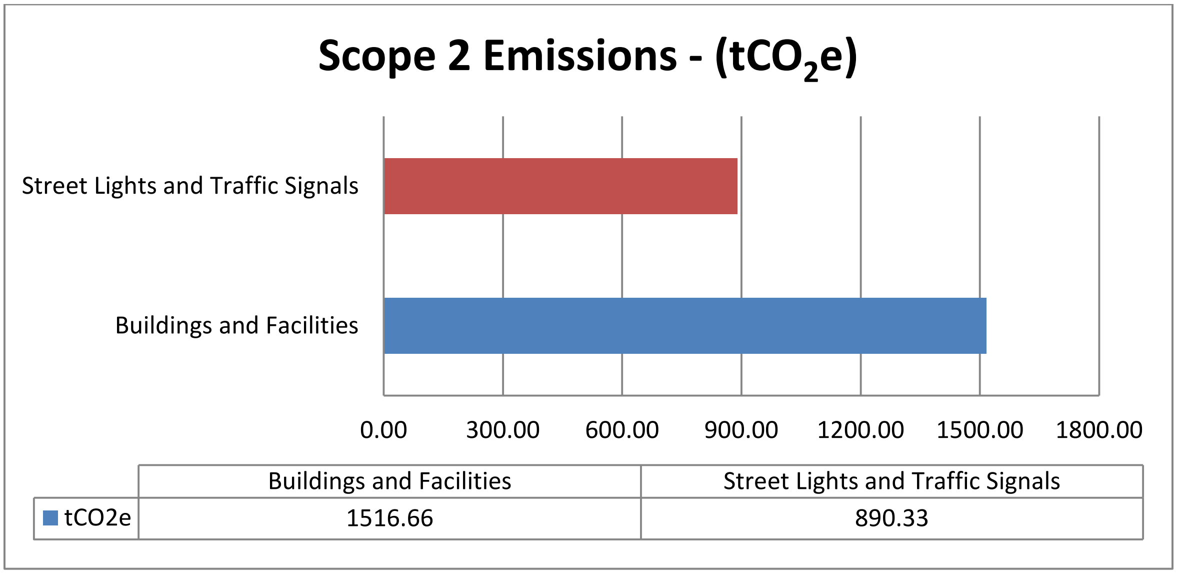


Figure 10: Scope 2 Emissions by Sector (t CO_2e)



The results indicate that electricity consumption by streetlights is higher than that by buildings and facilities (which also include lighting for the park and ball park facilities).

3.6.1.1 Scope 2 Emissions by Source

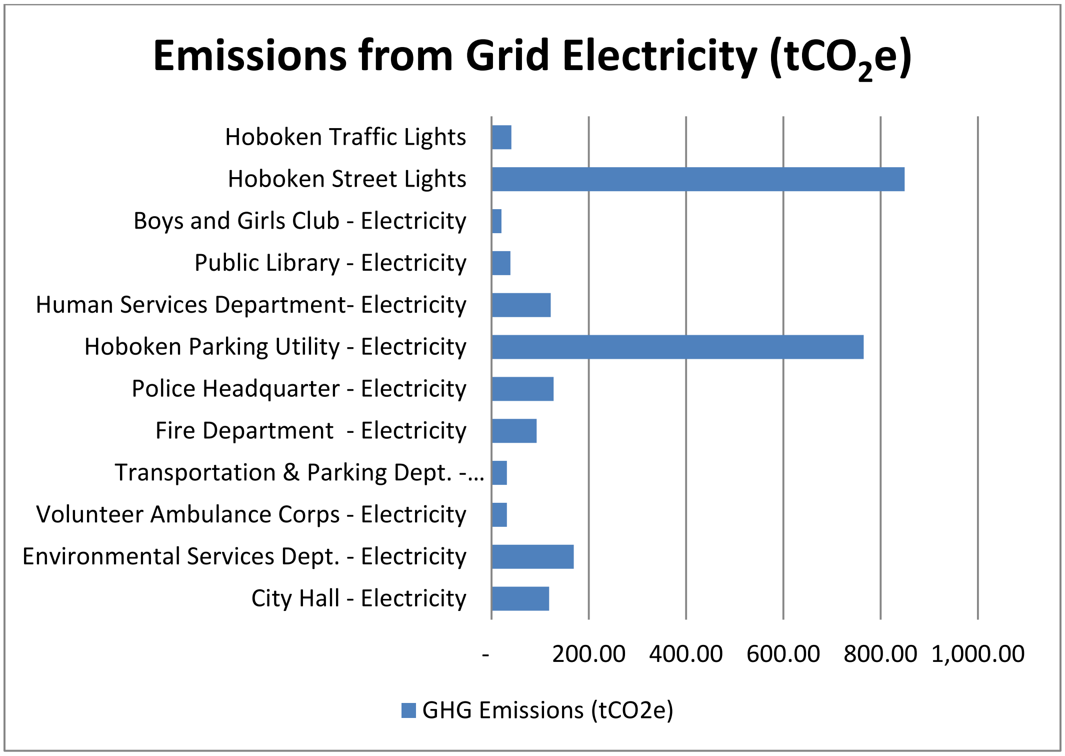
The following table and chart show the Scope 2 emissions from each specific source, as identified in the inventory. For each source, the energy usage responsible for the emissions is also reported, expressed in kWh of electricity used.

Table 14: Scope 2 Emissions by Source (tCO_2)

Source	Energy Use (kWh)	GHG Emissions (tCO_2e)
City Hall - Electricity	344,872	118.60
Environmental Services Dept. - Electricity	491,864	169.15
Volunteer Ambulance Corps - Electricity	91,348	31.42
Transportation & Parking Dept. - Electricity	91,311	31.40
Fire Department - Electricity	268,806	92.44
Police Headquarter - Electricity	371,248	127.67
Hoboken Parking Utility - Electricity	2,224,503	765.02
Human Services Department- Electricity	354,712	121.99
Public Library - Electricity	112,800	38.79
Boys and Girls Club - Electricity	58,640	20.17
Hoboken Street Lights	2,470,506	849.62
Hoboken Traffic Lights	118,364	40.71
Total (kWh - tCO_2e)	**6,998,974**	**2,407**

The same results displayed in a bar diagram:

Figure 11: Scope 2 Emission by Source (tCO_2e)



The results show that street lights and the parking utility buildings are responsible for the majority of the Scope 2 emissions, followed by the City Hall, Environmental Services, and Human Services departments. Besides the street lights, the parking utility consumption is also due almost entirely to lighting equipment and the immediate conclusion is that actions to reduce GHG emissions should prioritize the reduction of energy consumption by lighting equipment.

3.7 Scope 2 Emission: Location-based vs. Market-based approach

The City's reported emissions from purchased electricity were calculated using a location-based method by applying the grid emissions factor from the US EPA eGRID emission factor for the RFCE sub-region. The current version of the LGOP, published in 2010, does not require separately quantifying the Scope 2 emissions according to location-based and the market-based approach. Nonetheless this requirement has become common in GHG inventory protocols issues or updated after 2014; therefore, we are including a brief discussion of the quantification approach applied for this inventory.

The City does not use any direct supply of electricity from dedicated sources, neither any contractual instrument that would convey specific emissions rates for the purchased electricity. Therefore, applying the market-based method emission factors hierarchy from WRI's GHG Protocol Scope 2 Guidance, leads to the conclusion that the market-based method emission factor is equivalent to the location-based factor.

The table below provides a comparison of the market-based and location-based method emission factors and the resulting GHG emissions from these different approaches, which in the case of the City of Hoboken, are identical:

Table 15: Location-based and Market-based and EFs and GHG Emissions

Location-based Method			
RFCE Emission Factors	$lbCO_2$/MWh	$lbCH_4$ /GWh	lbN_2O /GWh
	758.2	0.050	0.009
Emissions	CO_2 (tCO_2e)	CH_4 (tCO_2e)	N_2O (tCO_2e)
	2,406.98	0.00444	0.00757
Market-based Method			
RFCE Emission Factors	$lbCO_2$/MWh	$lbCH_4$ /GWh	lbN_2O /GWh
	758.2	0.050	0.009
Emissions	CO_2 (tCO_2e)	CH_4 (tCO_2e)	N_2O (tCO_2e)
	2,406.98	0.00444	0.00757

4. GHG Inventory Base Year

The GHG inventory base year provides a standardized point of reference against which future inventories can be compared to identify changes, such as reductions, or track progress toward an emission goal or action plan. The City has selected year 2017 as the GHG inventory base year.

Once the Base Year has been selected, the next step is to select one or several future years by which the City wishes to reach certain emissions reduction goals.

5. GHG Emission Reduction Goals

As described in more detail in the Climate Action Plan, the City of Hoboken joined the Sustainable Jersey program in 2010; just one year after the program was established. The City received Bronze certification from Sustainable Jersey in 2011, was recertified in 2014, and received the Silver certification in 2017. Hoboken has decided to pursue the Sustainable Jersey Gold Star in Energy certification, which further affirms their commitment to sustainability, and specifically, mitigation efforts. As such, the City has selected to establish GHG reduction goals in line with the Sustainable Jersey Gold Star targets which require the City to demonstrate at least 3.6 percent annual reductions in municipal GHG emissions and 1 percent annual reductions in community GHG emissions over the base year.

In accordance with these requirements, the City set two reduction goals at one year and three years from the base year (3.6 percent and 10.8 percent, respectively), but it also added the goals of achieving net-zero GHG emissions for municipal operations by 2022 and exceeding the Paris Agreement target[3] by becoming carbon neutral by 2027.

Because the inventory is completed in 2018 based on 2017 year activity data, we assume that the first year of implementation would end in 2019, the third year would be the end of 2021, and the municipality will achieve carbon neutrality by the end of 2027, or year nine of the climate actions implementation.

The table below shows the reductions goals of 3.6 percent by the end of 2019, 10.8 percent by 2021, and the equivalent amount in tCO2e required to achieve the goals.

In summary, the proposed emission reduction goals are the following:

Table 16: Emission Reduction Goals and Targets

Target	Target Year	Reduction Goal from 2017 Base Year GHG Inventory (%)	Reduction Goal from 2017 Base Year GHG Inventory (tCO_2e)
Year 1	2019	3.6%	153
Year 3	2021	10.8%	460
Year 4	2022	Net Zero	Obtain all municipal electricity from renewable sources
Year 9	2027	Carbon Neutral	Maximize the GHG reduction and offset the remaining emissions

[3] U.S. commitment: 26%-28% below 2005 level by 2025

6. GHG Emission Reduction Measures

In order to achieve the reduction goals described in the previous paragraph the City must identify a series of GHG emission reduction measures tailored at achieving such goals within the established timeline. The analysis of the City energy consumption and emission sources performed to conduct the GHG inventory provides a basis to conduct an informed selection of potential emission reduction measures. These will have to be compatible with the City operations, target as much as possible the largest sources of emissions where the largest reductions could be achieved, all this while balancing budget constraints and achieving the best balance between cost and benefits.

In addition, as discussed in the City's Climate Action Plan, the selected measures should be in line with the requirements of the Sustainable Jersey program, maximizing the points earned to achieve registration.

The review of the Scope 1 and Scope 2 emissions inventory results included in the previous paragraphs highlighted that the largest contributions were identifiable in the electricity consumption by the street lights and parking facilities, and the fuel consumption by the vehicle fleets. These are followed by emissions from stationary fuel combustion and electricity consumption in buildings.

Based on this analysis and on the experience garnered from reviewing case studies for similar municipalities, these are the possible emission reduction measures identified for discussion:

Table 17: GHG Emissions Reduction Measures – Municipal Operations

Emission Reduction Measure	Target Scope and Sector	Sustainable Jersey Action
Renewable Power Purchase Agreement	Scope 2 – Electricity in Buildings	No
Install photovoltaic solar energy systems on City buildings	Scope 2 – Electricity in Buildings	Yes
Implement Energy Efficiency Upgrades at City Hall	Scope 2 – Electricity in Buildings Scope 1 – Stationary Combustion in Buildings	Yes
Conduct energy audits and implement Energy Efficiency Upgrades at other City facilities.	Scope 2 – Electricity in Buildings Scope 1 – Stationary Combustion in Buildings	Yes
Install LED street lamps	Scope 2 – Electricity in Street Lights	No
Phase in hybrid electric and electric vehicles into the City's vehicle fleet.	Scope 1 – Mobile Combustion	Yes
Phase in low-emission buses into the City's Public Transit fleet.	Scope 1 – Mobile Combustion	Yes

Each one of these measures was modeled in ClearPath to quantify potential emissions reductions as well as to estimate implementation cost, based on either ClearPath default

information or appropriate reference data sourced from literature. ClearPath also tracks the potential emission reductions achievable by each measure during the 2019-2028 period, allowing developing the best implementation strategy to maximize the benefits while distributing the costs of deploying each measure over the target period.

6.1 Renewable Power Purchase Agreement

The action recommends the adoption of a policy requiring the use of renewable energy to meet the City's government operation demand. This measure is not included in the Sustainable Jersey list of priority climate actions but it would nonetheless allow for a significant reduction of the City's GHG emissions.

The policy should include a commitment to allocate funding for the purchase of renewable energy, renewable energy credits (RECs), and/or the installation of renewable energy systems; the last item is discussed as a separate climate action. For this action we are focusing on the City's purchase of an increasing share of their annual electricity consumption from a renewable energy provider. This can be achieved by establishing a power purchase agreement (PPA) directly with a renewable power plant, such as a solar photovoltaic (PV) plant or a wind energy farm, or otherwise through the utility serving the City or a renewable energy marketer. In general, at current market conditions, the renewable energy PPA requires the payment of a premium per each unit of electricity delivered and as such this action would not provide a potential for energy cost savings, at least in the short term. ClearPath does not provide a default cost per kWh for procuring renewable electricity, but it was estimated that the electricity consumption rate increase could be as much as $0.01 per kWh.

For the emissions estimate in ClearPath, we assumed that the City procures a share of their annual consumption (6.5 percent for 2019 and 2020), sufficient to cover the annual reduction goal (3.6 percent per year). The share increases to 19.5 percent of the annual electricity consumption by 2021 and up to 100 percent from 2025 onwards.

The table below shows the estimate of GHG reduction and costs based on the baseline year electricity consumption. The costs will actually be lower in the future years if other climate action measures are implemented and the overall electricity consumption is gradually reduced.

Renewable Energy Purchase (% Baseline Electricity/Year)	Renewable Energy Purchase (kWh/Year)	Emission Reduction (tCO_2e/year)	Estimated Cost ($/year)
6.5%	455,000	-156	$4,555
19.5%	1,364,800	-470	$13,648
100%	6,998,974	-2,407	$70,000

6.2 Solar Photovoltaic Energy System Installation

This energy reduction measure requires the installation of solar PV energy production systems on the suitable City buildings. ClearPath provides an estimate of the potential savings according to installed capacity and generation efficiency, the latter dependent on the geographic location of the system. The potential square footage available for the installation was conservatively estimated by assuming 50 percent of the rooftop area of the major parking facilities operated by the City could be utilized. This resulted in approximately 50,000 sqft of solar installation. This data was entered in the National Renewable Energy Laboratory (NREL) PVWatts Calculator to estimate the capacity installed and the generation efficiency that could be

achieved. According to the calculator, the electricity production capacity could be 500 kW with an expected output of 650,000 kWh/year. An estimate of the implementation cost is not provided by ClearPath, but it was budgeted based on market data at $5,000/kW installed. The measure would yield potential energy cost savings of $45,000/year and reduce the GHG emission by 5.3 percent year from the baseline, or approximately 224 tCO_2e/year. The overall benefits in terms of GHG Inventory are estimated at 2-3 tCO_2e/year.

Change Electricity Use (kWh/Year)	Emission Reduction (tCO_2e/year)	Estimated Cost	Electricity Savings ($/Year)
-650,000	-224	$2,500,000	$45,500

6.3 City Hall Retrofit - Energy Efficiency

The City is in the process of implementing a series of building energy efficiency retrofits in conjunction with the Direct Install initiative under the New Jersey's Clean Energy Program (NJCEP) by the New Jersey Board of Public Utilities (NJBOP). The Direct Install program provides funding to implement energy efficiency upgrades for local governments.

This measure includes improvements to the City Hall building's heating, air conditioning and electrical equipment. Heating, ventilation, and air conditioning (HVAC) equipment represents 30 to 40 percent of commercial building energy use. This measure is consistent with Sustainable Jersey priority climate actions for Gold Star certification. According to documents provided by the City, the Direct Install measures planned for the City Hall building will deliver annual savings of 64,500 kWh/year for electricity and 1,200 therms/year for natural gas consumption.

By using the ClearPath calculator and applying the actual Direct Install energy saving estimates in lieu of ClearPath's default factors, the annual GHG emission reduction was estimated at approximately 28 tCO_2e/year.

Change Electricity Use (kWh/Year)	Change Heating Fuel Use (MMBtu/Year)	Emission Reduction (tCO_2e/year)	Estimated Cost	Electricity Savings ($/Year)	Heating Fuel Savings ($/Year)
-64,451	-1,200	-28	$15,800	$12,800	$944

The cost estimate is based on the final cost provided by the City after accounting for the Direct Install benefits. This measure was conducted not only for the City Hall building but also extended to other City facilities, potentially increasing the energy and emission reductions, as discussed in the next section.

6.4 City Buildings Retrofit - Energy Efficiency

As mentioned in the previous paragraph, the City is in the process of implementing a series of building energy efficiency retrofits in conjunction with the Direct Install initiative under the NJBOP-NJCEP program, providing funding to implement energy efficiency upgrades for local governments.

This energy efficiency measure includes improvements to the several City building's heating, air conditioning and electrical equipment. In addition, it includes the conversion to LED for the lighting system in the City's parking garage facilities. This combination of measures is consistent with Sustainable Jersey priority climate actions for Gold Star certification. According

to documents provided by the City, the Direct Install measures planned for the City buildings will deliver an overall annual savings of 615,570 kWh/year for electricity and 5,550 therms/year for natural gas consumption.

By using the ClearPath calculator and applying the actual Direct Install energy saving estimates in lieu of ClearPath's default factors, the annual GHG emission reduction was estimated at approximately 242 tCO_2e/year.

Change Electricity Use (kWh/Year)	Change Heating Fuel Use (MMBtu/Year)	Emission Reduction (tCO_2e/year)	Estimated Cost	Electricity Savings ($/Year)	Heating Fuel Savings ($/Year)
-615,570	-5,550	-242	$78,900	$90,900	$4,560

The cost estimate is based on the final cost estimates provided by the City after the Direct Install benefits are accounted for. A summary table with the measures aggregated by City department is included below:

Department/Facility	Direct Install Final Cost after Subsidy	kWh Saving	Therms Saving	Cost Saving Annual Electric	Cost Saving Annual Gas
Hoboken Volunteer Ambulance Corps	$2,000	18,400	570	$2,730	$244
Fire Department	$27,385	125,635	3,471	$20,457	$2,905
Hoboken Public Library	$7,000	62,000	359	$8,700	$350
Hoboken Parking Utility	$37,236	400,880	-	$57,814	-
Environmental Services Department, Transportation & Parking Department	$5,300	8,655	1,152	$1,200	$1,060
Total	**$78,921**	**615,570**	**5,552**	**$90,901**	**$4,559**

6.5 Street Lights Conversion to LED

This measure consists of upgrading the street lights within the City boundary to advanced street light technology such as light-emitting diodes (LEDs). The conversion to LED can reduce street light energy use by as much as 70 percent. Besides saving energy and reducing electricity costs, LED lights also have a longer useful life requiring less maintenance. The installation of efficient street lights is a demonstration of the City's commitment to resource conservation that can be seen by the community it serves. This measure is not included in the Sustainable Jersey priority climate actions for Gold Star certification.

Currently, the City is responsible for the electricity consumption of more than 2,000 street lights installed within the City jurisdiction. Of these, 1,871 could be upgraded to LED technology. The lights are owned by the utility (PSE&G) and the City pays monthly fees for each light, poles, etc. plus the charges for electricity consumption. The fees per light vary depending on the type (metal halide, high pressure sodium, mercury vapor, etc.) and the wattage of each fixture. The average electricity consumption is ~190,000 kWh per month, costing approximately $60,000 per

month on average. Since the City does not own the lights, there are two possible pathways to LED street light conversion: upgrade to utility-owned LEDs according to an agreed upon tariff, or the City purchases their own LED streets lights and replacing the utility-owned ones. The discussion of the two alternatives would require an in-depth analysis of the utility tariffs and fees vs. the cost of purchasing, installing, and maintaining the street lights on its own. Both solutions have pros and cons; in general, the option of purchasing the lights should deliver higher long-term savings at the cost of a higher upfront investment. Sizing of the lights can also be tailored to City's specification rather than going by the standard options offered by the utility. The City should also explore taking advantage of NJBOP programs facilitating the transition to LED lighting, similarly to what they did for the Direct Install program for buildings and facilities.

ClearPath includes a tool to estimate the energy and emissions reduction benefits achievable by the LED retrofit project. An inventory of the current street lights installed in the City jurisdiction shows many different types and sizes of lights including high pressure sodium (HPS); metal halide (MHL); and mercury vapor (MRC).

Light Type	Light Count	% of Total	Average Watts per Type	Average LED Replacement Wattage	Average Cost of Retrofit ($/light)	Total Cost
HPS	1157	61.84%	273.90	120	$309	$357,513
MHL	611	32.66%	145.62	120	$309	$188,799
MRC	103	5.51%	382.52	120	$309	$31,827
					Total	$578,139

ClearPath provides a suggested LED replacement for various light types and average wattage size currently installed and a common replacement size was selected for all the different lights. In reality, depending on the street location, smaller LED could be installed, further reducing energy consumption. ClearPath estimated the cost of the replacement at $309 for each LED light, which is in line with current estimates found in literature. As such, the estimated cost of purchasing and replacing all the lights would be $578,139. The annual energy savings are estimated as ~1,128,000 kWh/year, which is ~46 percent of the current total consumption for street lights (including already converted LED and unmetered lights). The annual savings are estimated ~$86,900/year in electricity cost only, not counting additional savings due to lower demand charges and potentially reduction in annual fees for equipment supply and maintenance. The GHG emission reduction is estimated at approximately 388 tCO_2e per year.

Change Electricity Use (kWh/Year)	Emission Reduction (tCO_2e/year)	Estimated Cost	Electricity Savings ($/Year)
-1,128,300	-388	$578,100	-$86,900

**Assuming municipal ownership of replacement LED street lights.*

6.6 Traffic Lights Conversion to LED

Similar to the previous measure, this measure consists of upgrading the traffic signal lights in operation within the City boundary to advanced technology such as LED. The conversion to LED will significantly reduce traffic lights energy use, saving energy, and maintenance cost due to the longer lifespan of LED bulbs.

Currently there are 23 intersections regulated by City operated traffic lights; additional intersections are controlled by traffic lights operated by Hudson County. We assumed 4 fixtures

per intersection, each with 3 lights, for a total of 276 bulbs. Typical incandescent traffic lights use 150-watt bulbs that are operating 24 hours a day. For the ClearPath model, we assumed LED arrays consuming 20 watts instead, significantly reducing overall energy consumption. The cost of LED conversion was assumed the same as for street lights, at $309 for each fixture of 3 lights. Based on this assumptions, the overall energy saving was estimated as 104,700 kWh/year or 86 percent reduction compared to the baseline. The annual cost saving was estimated as $8,100/year, accounting only for the saving in electricity delivered cost, compared to an estimated implementation cost of $28,400. The overall annual GHG emissions reduction was estimated as 36 tCO_2e/year.

Number of City Operated Intersections	Estimated Traffic Light Fixtures	Change Electricity Use (kWh/Year)	Emission Reduction (tCO_2e/year)	Estimated Cost	Electricity Savings ($/Year)
23	92	-104,700	-36	$28,400	-$8,100

6.7 Electric-Hybrid Vehicle Replacement

The vehicle fleets operated by the various departments are responsible for a large share of the City's GHG emission. According to the vehicle inventory provided by the City, passenger cars and small quad vehicles represent a large share (72 percent) of the City gasoline vehicle fleet (Environmental Services, Community Development, Administration, Human Services, Buildings, Transportation and Parking). A similar share is present in the Hoboken parking Unit fleet, which is 88 percent composed of passenger cars and quad/tricycle vehicles. These vehicles are the ideal candidates for replacement with hybrid or electric vehicles due to their frequent use in traffic with light loads. Light and heavy-duty hybrid trucks may not be commercially available yet, though a few models are appearing on the market. Same for police vehicles, which is a very limited niche market with few vehicles available and very limited options for hybrid engines. Nonetheless, for the scope of simulating a replacement of gasoline engine vehicles with hybrid or electric vehicles, we assumed the replacement of the passenger/quad vehicles in the City fleet with hybrid vehicles, while we assumed that similar vehicles in the HPU fleet would be replaced with electric or plug-in hybrid vehicles. This combination of measures is consistent with Renewable Jersey priority climate actions for Gold Star certification. The electric/plug-in hybrids provide an even better fuel efficiency and we assumed 99 mpg for the electric/plug-in hybrid vehicles, instead of the 35 mpg mileage assumption for hybrid vehicles (both for city driving). The baseline average mileage for the existing fleet of gasoline passenger cars/quad/tricycles was assumed at 18 mpg, with an estimated VMT of 195,042 miles/year for the City's 26 vehicles and 236,900 miles/year for the HPU 29 vehicles. All these values were estimated from the City fleets inventory data and fuel consumption records.

According to ClearPath estimates, replacing one passenger vehicle with a hybrid engine model would more than double the fuel efficiency and save approximately 1.5 tCO_2e per year at current level of miles driven. For a full electric vehicle or a plug-in hybrid where fuel use would be drastically reduced or eliminated, the reduction amounts to 3.2 tCO_2e/year. The overall fuel cost savings for each fleet amount to $13,500 for the City fleet and $32,000/year for the HPU fleet.

Gasoline Fuel Fleet	Vehicles Replaced	Estimated Cost	Change Fuel Use (Gal/Fleet/Year)	Fuel Savings ($/Fleet/Year)*	Emission Reduction (tCO_2e/year)
City Fleet – Passenger Vehicles	26	$35,000/vehicle	-4,555	-$13,700	-40
HPU Fleet – Passenger Vehicles	29	$35,000/vehicle	-10,706	-$32,100	-94

**Assuming $3.00/gal fuel cost for gasoline.*

6.8 Low Emissions Vehicles in the City Public Transit Fleet

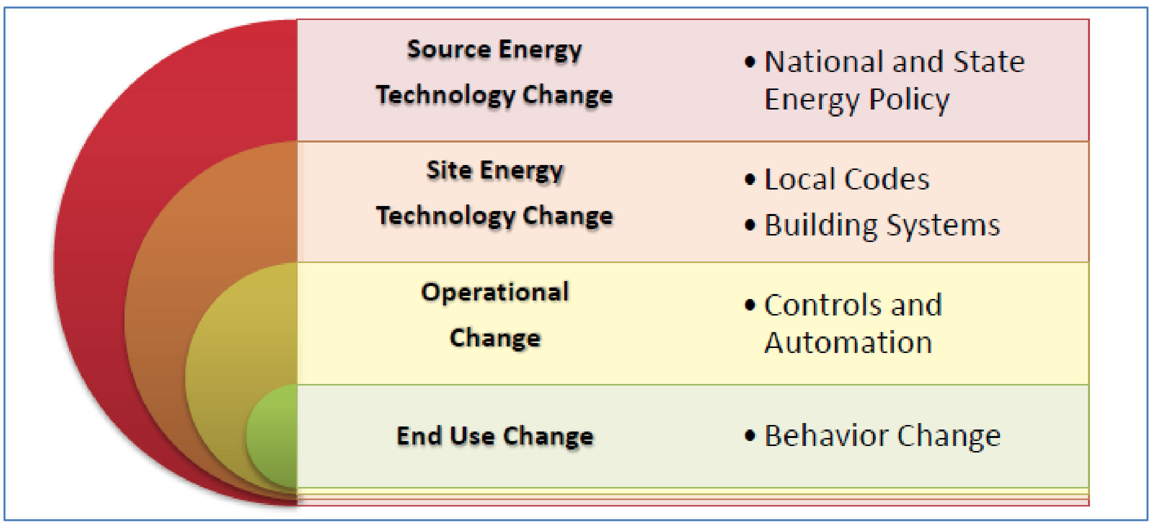
The City operates a small fleet of five paratransit buses, named HOP buses, providing a network of public transit transportation within Hoboken. Additional bus routes are operated by New Jersey Transit, but these are outside of the City's control and operation. The vehicles are gasoline engine small buses and for 2017 the records provided by the City show a fuel consumption of 20,672 gallons of fuel and estimated 206,719 miles for VMT. The measure consists of replacing or retrofitting the current gasoline vehicles with equivalent ones running on Compressed Natural Gas (CNG) fuel. The CNG fuel emits lower volume of CO_2e per mile and could also be fueled with renewable fuel, further reducing the GHG emissions, if the City were to purchase bio-CNG produced for example by recovering biogas emitted from a landfill or a wastewater plant sludge bio-digester. The fuel conversion measure would also require the installation of a CNG fueling station fed from a utility gas supply line, adding to the overall cost. On the other hand, once the CNG fueling infrastructure is installed, it could also be used to expand the CNG fueling to other City vehicles such as sanitation trucks, a common conversion for municipalities operating landfills and generating their own bio-CNG. On average it was estimated that each truck replacement could cost $80,000. The fuel cost savings amount to approximately $20,000/year for the entire HOP fleet, according to the average market price difference of $1 per gallon of gasoline equivalent fuel. The GHG emission reduction achievable would be approximately 67 tCO_2e/year, or one third of the total HOP fleet baseline emissions (~182 tCO_2e/year).

HOP Fleet Vehicles	Emission Reduction (tCO_2e/year)	Estimated Cost	Fuel Savings ($/Year)*
5	-67	$80,000/vehicle	$20,240

7. Emission Reduction Planning

The ClearPath GHG inventory tool includes a planning module that allows evaluating the outcomes in terms of energy and emissions reductions of the GHG emission measures identified in the previous chapter. The planning module provides a tool for assessing the effectiveness of the proposed climate actions in achieving the planned reduction goals against the baseline year emissions. The module includes the option of selecting the implementation timeline for each measure, allowing testing different strategies to design the optimal sequence of implementation. This is very important for those measures that require considerable financial investment or lengthy planning and preparation before they can be launched. This would be the case for example of the street lights LED conversion or the solar PV installation previously described. The objective is to plan the climate actions in order to meet the GHG reduction goals timeline, balancing the priority of achieving the emission as early as possible with financial budget and costs constraints. Where possible, measures should be planned prioritizing those measures that have an impact to the source of emissions, followed by those that are focused on end use and behavioral changes, which may be harder to fully implement or follow. On the other hand, measures targeting the sources may be more complex and expensive (for example upgrading a power plant) requiring more time to prepare and implement, than a relatively simple building management policy setting rules on thermostats settings to reduce waste of heating energy. The following diagram from ICLEI's ClearPath Planning Module User Manual provides a useful guidance on the hierarchy of reduction measures.

Figure 12: Hierarchy of Emissions Reduction Measures



Source: ICLEI ClearPath Planning Module User Guide, February 2014.

The following table lists the proposed reduction measures in order of priority, based on reduction potential, cost and complexity of implementation.

Table 18: Summary of GHG Emissions Reduction Measures - Pros & Cons

Reduction Measure	Expected GHG Emission Reduction (tCO_2e/year)	Priority	Comment
Renewable Power Purchase Agreement	-156 to -2,407	1	Simple implementation; Low-High Cost; Potentially significant GHG emissions reduction
Implement Energy Efficiency Upgrades at City Hall	-28	1	Medium complexity implementation; Medium Cost; Medium GHG emissions reduction
Energy Efficiency Upgrades at other City facilities.	-242	1	Medium complexity implementation; Medium Cost; Medium GHG emissions reduction
Install LED street lights	-388	2	Complex implementation; High Cost; Medium GHG emissions reduction
Install photovoltaic solar energy systems on City buildings	-224	2	Complex implementation; High Cost; Medium GHG emissions reduction
Install LED traffic lights	-36	2	Medium complexity implementation; Medium Cost; Low GHG emissions reduction
Phase in hybrid electric and electric vehicles into the City's vehicle fleet.	-55	3	Low complexity implementation; Medium to High Cost; Low GHG emissions reduction
Phase in low-emission buses into the City's Public Transit fleet.	-67	3	Medium complexity implementation; High Cost; Medium GHG emissions reduction

The priority order should also take into account the reduction goals at year 1, 3 and 9, planning the implementation of the measures in order to meet the reduction timeline while avoiding concentrating investment cost in a short time span. The data for each measure were input in ClearPath planning module and several tests were performed. The table below shows a proposed implementation plan, allowing sufficient time for the City to plan for the financing and implementation of the different measures. According to this plan, the Net-Zero goal is reached by 2025 when the Scope 2 emissions are reduced to zero due to energy savings measures combined with renewable electricity generation and power purchase agreements.

Table 19: GHG Emission Reduction Measures Implementation Timeline - Net-Zero 2025 Scenario

Reduction Measure	Implementation Start Year	Implementation End Year	Forecast End Year
Municipal Power Purchase Agreement - 6.5% Baseline	2019	2020	2029
City Hall Building retrofit - Direct Install	2019	2029	2029
Multi-Building retrofit - Direct Install	2019	2029	2029

Reduction Measure	Implementation Start Year	Implementation End Year	Forecast End Year
Municipal Power Purchase Agreement - 19.5% Consumption	2021	2024	2029
LED Traffic Lights Retrofit	2021	2029	2029
LED Streetlights Retrofit	2022	2029	2029
City Car Fleet - Hybrid Vehicles	2023	2029	2029
Rooftop Solar PV Installation	2023	2029	2029
HPU Car Fleet - Hybrid/Electric Vehicles	2024	2029	2029
HOP Fleet Fuel Switch - CNG	2024	2029	2029
Municipal Power Purchase Agreement - 100% Consumption	2025	2029	2029

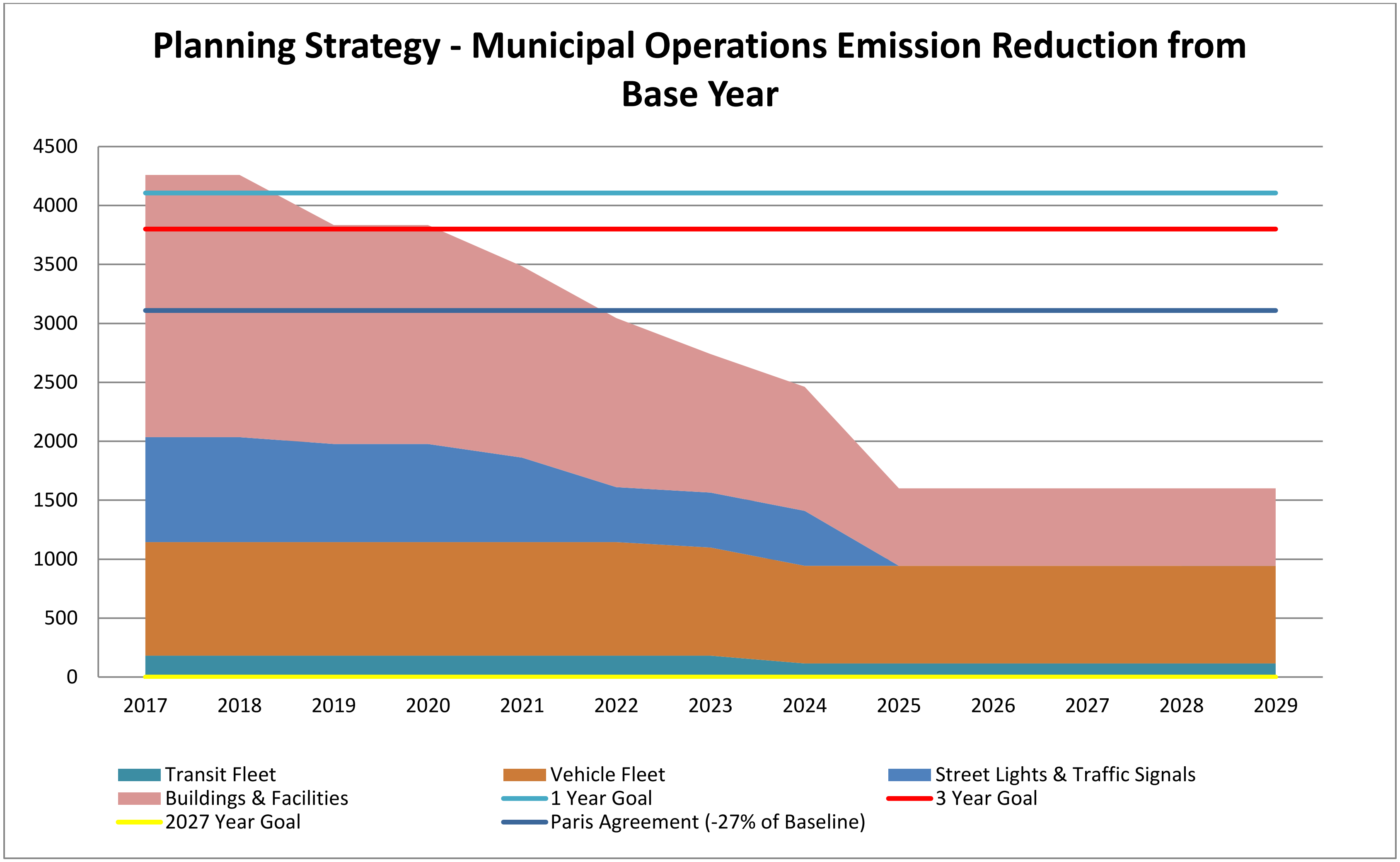
The results of the reduction measures planning and the estimate of the emission reduction are shown in the following tables and diagrams.

Table 20: GHG Emission Reduction Plan – Net-Zero 2025 Scenario (tCO_2e)

	2017	2018	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029
Transit Fleet	182	182	182	182	182	182	182	116	116	116	116	116	116
Vehicle Fleet	963	963	963	963	963	963	917	828	828	828	828	828	828
Street Lights & Traffic Signals	890	890	832.15	832.15	716.45	466	466	466	0	0	0	0	0
Buildings & Facilities	2224	2224	1857	1857	1623	1434	1175	1052	657	657	657	657	657
Total Emissions	**4,259**	**4,259**	**3,834**	**3,834**	**3,484**	**3,045**	**2,740**	**2,462**	**1,601**	**1,601**	**1,601**	**1,601**	**1,601**
Reduction to 2017 Baseline	**0**	**0.0%**	**-10.0%**	**-10.0%**	**-18.2%**	**-28.5%**	**-35.7%**	**-42.2%**	**-62.4%**	**-62.4%**	**-62.4%**	**-62.4%**	**-62.4%**
1 Year Goal	4,106	4,106	4,106	4,106	4,106	4,106	4,106	4,106	4,106	4,106	4,106	4,106	4,106
3 Year Goal	3,799	3,799	3,799	3,799	3,799	3,799	3,799	3,799	3,799	3,799	3,799	3,799	3,799
Paris Agreement (-16% of Baseline)	3,578	3,578	3,578	3,578	3,578	3,578	3,578	3,578	3,578	3,578	3,578	3,578	3,578

The emissions reductions are calculated according to the 2017 baseline. The results in the table show that the reduction measures are expected to achieve the planned reduction goals, possibly exceeding the three-year goal (10.8 percent) and the Paris agreement (-16 percent by 2027). The Scope 2 emissions are minimized by 2025, the year when the 100 percent PPA agreement on the residual electricity consumption becomes active.

Figure 13: GHG Emission Reduction Plan – Net Zero 2025 Scenario



The table below shows an alternative implementation plan, reducing the time for the City to plan for the financing and implementation of the different measures. According to this plan, the Net-Zero goal is reached by 2022 when the Scope 2 emissions are reduced to zero due to energy savings measures combined with a more aggressive renewable electricity power purchase agreements and generation.

Table 21: GHG Emission Reduction Measures Implementation Timeline – Net-Zero 2022 Scenario

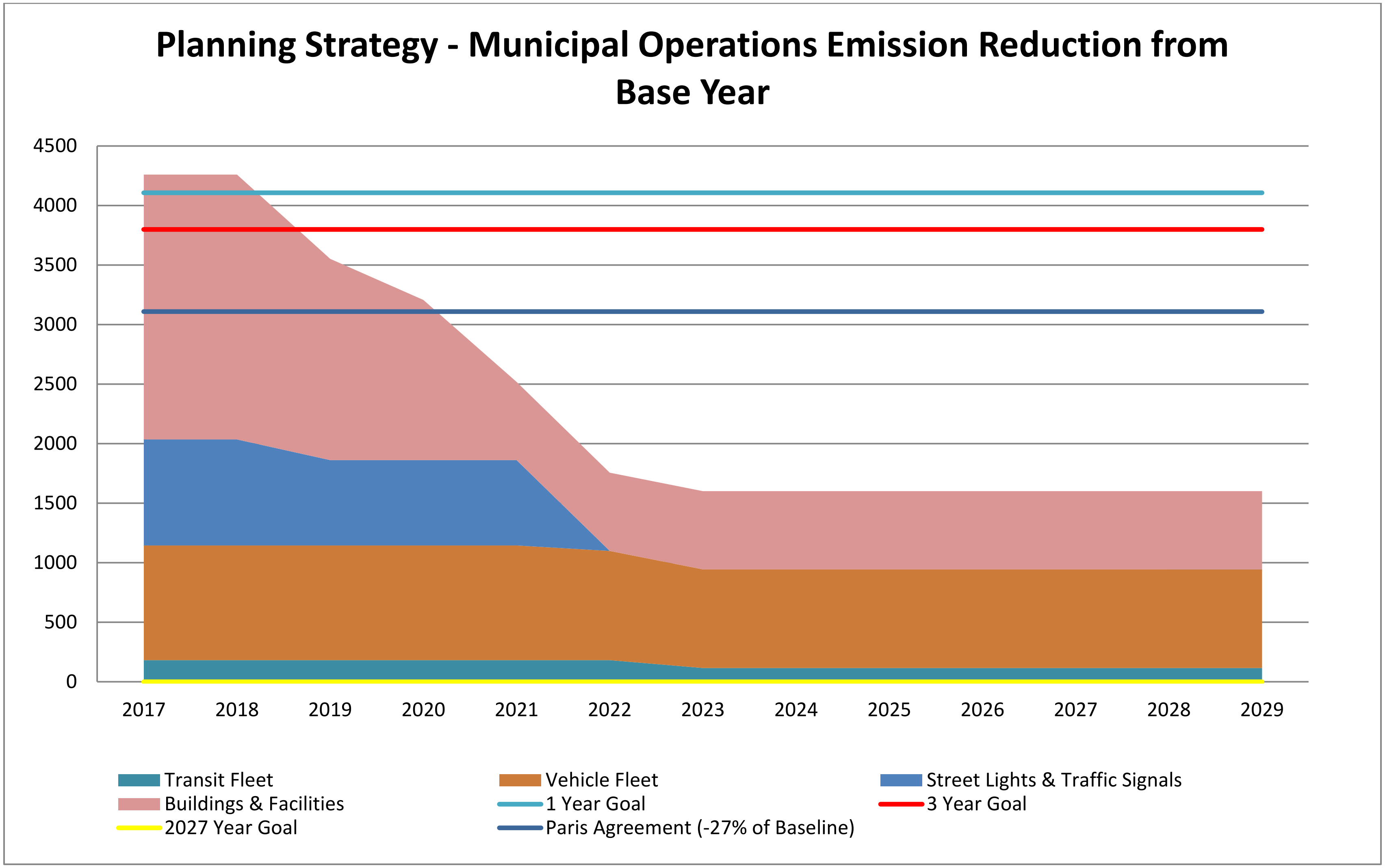
Reduction Measure	Implementation Start Year	Implementation End Year	Forecast End Year
Municipal Power Purchase Agreement - 19.5% Baseline	2019	2020	2029
City Hall Building retrofit - Direct Install	2019	2029	2029
Multi-Building retrofit - Direct Install	2019	2029	2029
LED Traffic Lights Retrofit	2020	2029	2029
LED Streetlights Retrofit	2020	2029	2029
Rooftop Solar PV Installation	2020	2021	2029
Municipal Power Purchase Agreement - 100% Consumption	2022	2029	2029
City Car Fleet - Hybrid Vehicles	2022	2029	2029
HPU Car Fleet - Hybrid/Electric Vehicles	2023	2029	2029
HOP Fleet Fuel Switch - CNG	2023	2029	2029

Table 22: GHG Emission Reduction Plan – Net Zero 2022 Scenario

	2017	2018	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029
Transit Fleet	182	182	182	182	182	182	116	116	116	116	116	116	116
Vehicle Fleet	963	963	963	963	963	917	828	828	828	828	828	828	828
Street Lights & Traffic Signals	890	890	716.45	716.45	716.45	0	0	0	0	0	0	0	0
Buildings & Facilities	2224	2224	1690	1345	657	657	657	657	657	657	657	657	657
Total Emissions	4,259	4,259	3,551	3,206	2,518	1,756	1,601	1,601	1,601	1,601	1,601	1,601	1,601
Reduction to 2017 Baseline	0	0.0%	-16.6%	-24.7%	-40.9%	-58.8%	-62.4%	-62.4%	-62.4%	-62.4%	-62.4%	-62.4%	-62.4%
1 Year Goal	4,106	4,106	4,106	4,106	4,106	4,106	4,106	4,106	4,106	4,106	4,106	4,106	4,106
3 Year Goal	3,799	3,799	3,799	3,799	3,799	3,799	3,799	3,799	3,799	3,799	3,799	3,799	3,799
Paris Agreement (-16% of Baseline)	3,578	3,578	3,578	3,578	3,578	3,578	3,578	3,578	3,578	3,578	3,578	3,578	3,578

The emissions reductions are calculated according to the 2017 baseline. The results in the table show that the reduction measures are implemented according to a more aggressive schedule. The reduction goals achieved sooner than in the previous scenario, exceeding the three-year goal (10.8 percent) in the year 1 (2019) and the Paris agreement (-16 percent by 2025) already in year 2020. The Scope 2 emissions are minimized by 2022, the year when the 100 percent PPA agreement on the residual electricity consumption becomes active.

Figure 14: GHG Emission Reduction Plan – Net-Zero 2022 Scenario



9. Uncertainty Assessment and Quality Assurance

With regard to a GHG Inventory, quality refers to the general accuracy and consistency between an organization's actual emissions and quantified emissions. The difference between actual and quantified emissions results from uncertainty and error introduced by activities such as data collection, data management, calculations, and reporting. Inventory quality is impacted as data progresses from individual sources to the final report.

The inventory contains reporting uncertainty resulting from the potential for errors to be introduced in certain activities. Overall uncertainties are as follows:

- Not all data was received from primary sources (i.e., invoices) and backup data was not provided for the information recorded. Thus, errors present in the initial data will be transferred to errors in the emission calculations.
- Default emission factors, though used as a best practice, may present a level of uncertainty from the actual emissions.

10. Verification of this Report

This report, the information it contains, and the data it is based upon have not been verified by an external third party.

Appendix 1

Detailed schedule of properties – City of Hoboken

ID	Location	Type	Sq. Ft.	Floors	Year Built
22918	94 Washington St	Municipal Building	22500	4	1900
22919	250-254 Fifth St	Library	6575	4	1900
22920	55 Madison St	Madison Fire House	2380	3	1960
22921	1313 Washington St	Uptown Fire House	3300	3	1960
22922	801 Clinton St	Fire House	2700	3	1970
22923	201-205 Jefferson St	Fire Headquarters	10625	3	1970
22924	111 Jefferson St	Recreation Department	2500	1	1970
22925	213 Bloomfield St	Exempt Hall, Fire House Museum	1500	2	1970
22926	401 Hudson St	Stevens Park, Little League Building	400	2	1980
22927	400-422 Garden St	Church Square Park - Gazebo	100	1	1990
22928	10th & 11 St on Hudson	Elysian Park - Storage Hut	125	1	1980
22929	120-134 Grand St	Multi Skill Community Center	40000	2	1970
22930	120-134 Grand St	Skating Rink	0	0	1900
22931	116-118 Jackson St	Jackson Street Park	5000	1	1970
22932	106-124 Hudson St	Police Station	23242	2	1960
22933	Sinatra Park at 4th & Sinatra Drive	Frank Sinatra Field House	1600	1	1980
22934	56-66 Park Ave a/k/a 256 Observer Highway	Service Garage	24712	2	1970
22935	1301 Hudson St	Hoboken Museum - Contents Only	2000	1	1960
22936	112-134 River St	Garage B	226434	6	1980
22937	210-222 River St	Garage D	128275	6	1980
22938	310-322 River St	Garage G	128275	6	1980
22939	916 Garden St	916 Automated Parking Facility	10246	5	1980

ID	Location	Type	Sq. Ft.	Floors	Year Built
22940	259-265 11th St	Open Lot #1 Park & Lock - Liability Only	7200	0	1970
22941	200 Willow Avenue	Open Lot #2 Park & Lock - Liability Only	7200	0	1970
22942	304-330 Clinton St	Midtown Garage	21862	5	1970
22943	Castle Point Park, 7th St at Sinatra Drive	Gazebo	200	1	1970
22944	Maxwell Place Boathouse, 11th St at Sinatra Drive	Boathouse	1000	1	1970
22945	Hoboken Cove Park 15th St & Park Avenue	Playground (equipment) & Walkway	84868	1	2009
22946	Pier A Park, 1st St at Sinatra Drive	Gazebo, Amphitheater, Bike Trail & Tree Grove	278901	1	1980
22947	1015-1129 Sinatra Drive North	Liab Only - Maxwell Place Park (License Arrangement w/ outside entity)	5000	0	
22948	1221 Willow Avenue	Legion Park - Liability Only	5063	0	1970
22949	300-304 Madison Street	Madison Street Park - Liab Only	7500	0	1980
22950	1601 Willow Ave	1600 Park	15352	0	1900
22951	16th Street Pier	Pier - Liab Only	20000	0	1900
22952	East of Park Avenue	Pier - Liability Only	27930	0	1900
22953	North of 14th Street	Pier - Liability Only	300000	0	1900
22954	315 Sinatra Drive	Pier 1	252747	0	2011
22955	458 2nd St	Parking for Fire HQ	5000	0	1960
22956	229-233 Jackson St	Land - Liability Only	7500	0	1970
22957	85-91 Sinatra Drive	Walkway - Liability Only	8470	0	1960
22958	201 Sinatra Drive	Esplanade/Walkway - Liability Only	51420	0	1970
22959	Foot of Newark St	Walkway off Lot 3 - Liability Only	1250	0	1960

ID	Location	Type	Sq. Ft.	Floors	Year Built
22960	1601-1623 Willow Avenue	Land - Liability Only	48024	0	1960
22961	1015-1129 Sinatra Drive North	Land - Liability Only	10000	0	1970
22962	1011-1125 Sinatra Drive North	Row Streets - Liability Only	2500	0	1970
22963	514-526 Madison St	Land Lease - Liability Only	17500	0	1980
22964	Park Avenue	LIABILITY ONLY	20000	0	2000
22965	109 Jefferson Park	Playground Boys & Girls Club	2500	0	1970
22966	1501 Park Avenue	Harborside Park	0	0	
22967	River Road	Waterfront	0	0	
22968	58 Jackson St	Southwest Park	0	0	
24571	256 5th St	Public Library	2735	2	

HOBOKEN