Greenhouse Gas Emissions Inventory and 10-Year Forecast for the Government Operations Activities Year 2017 Town of Dover, New York

December 2018

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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
GWP – global warming potential
HFC - hydrofluorocarbon
IMP – Inventory Management Plan
IPCC - Intergovernmental Panel on Climate Change
LPG – liquid petroleum gas (propane)
t – metric tonnes
MSW – municipal solid waste
MWh – Mega Watt hour
N_2O – Nitrous Oxide
NYS – New York State
NYSEG - New York State Electric and Gas Corporation
NYSERDA – New York State Energy Research and Development Authority
PE – Pledge Element
PFC - perfluorocarbon
SF_6 – sulfur hexafluoride
TCR – The Climate Registry
the Town – Town of Dover
US EPA - United States Environmental Protection Agency
UNFCCC – United Nations Framework Convention on Climate Change

Executive Summary

First Environment, Inc. (First Environment) was retained by the Town of Dover (Dover or the Town) to prepare a greenhouse gas (GHG) emissions inventory for the government operations activities of year 2017. The GHG inventory was prepared in accordance with the Local Governments for Sustainability (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.

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 inventory demonstrates the Town's recognition of its relationship to both the local and global environment. It allows the Town to better understand and take responsibility for its activities and their climate impacts. Accordingly, the inventory provides a foundation and starting point for the Town's efforts to reduce greenhouse gas emissions from its activities and demonstrate environmental stewardship. The inventory serves as a reference point to guide the development of policies, programs, and projects as the Town pursues its environmental objectives.

The scope of the inventory included all emissions sources under the Town's operational control. This consisted of the Town's Scope 1 "direct" emissions from stationary combustion, mobile combustion, and fugitive gas (e.g., refrigerant) releases, as well as Scope 2 "indirect" emissions from the purchase of electricity. The inventory did not quantify the Town 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). 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 CO_2e using Global Warming Potentials (GWPs), a standard conversion factor, from the Intergovernmental Panel on Climate Change's (IPCC) Fifth Assessment Report (AR5).

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	Town of Dover 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)

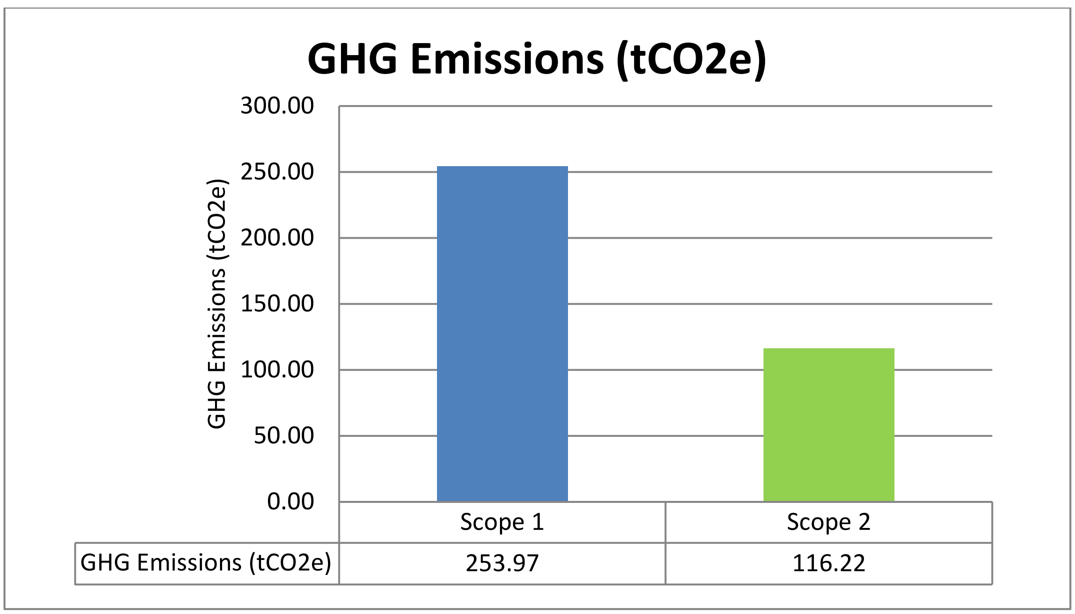
The Town's total Scope 1 GHG emissions for 2017 amounted to 253.97 metric tonnes carbon dioxide equivalents (tCO_2e). These total emissions consist of stationary combustion such as fuel oil, gas heating, and mobile combustion, such as diesel consumption by the Town fleet vehicles, with an additional small amount associated with refrigerant releases from refrigeration or air conditioning systems. As a point of reference, 253.97 t CO_2e is approximately equivalent to the GHG emissions produced by an average passenger vehicle driven 622,475 miles, according to the US EPA's Greenhouse Gas Equivalencies Calculator.

The Town's total Scope 2 GHG emissions for 2017 amounted to 116.22 metric tons carbon dioxide equivalents (t CO_2e). These emissions are associated with electricity usage by the Town and are roughly equivalent to the GHG produced from electricity use by 12.5 homes for one year.

Table 2: Total GHG Emissions by Scope (tCO_2e)

GHG Emissions	tCO_2e
Scope 1 Emissions	253.97
Scope 2 Emissions	116.22
Total	**370.19**

Figure 1: Total GHG Emissions by Scope (tCO_2e)



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

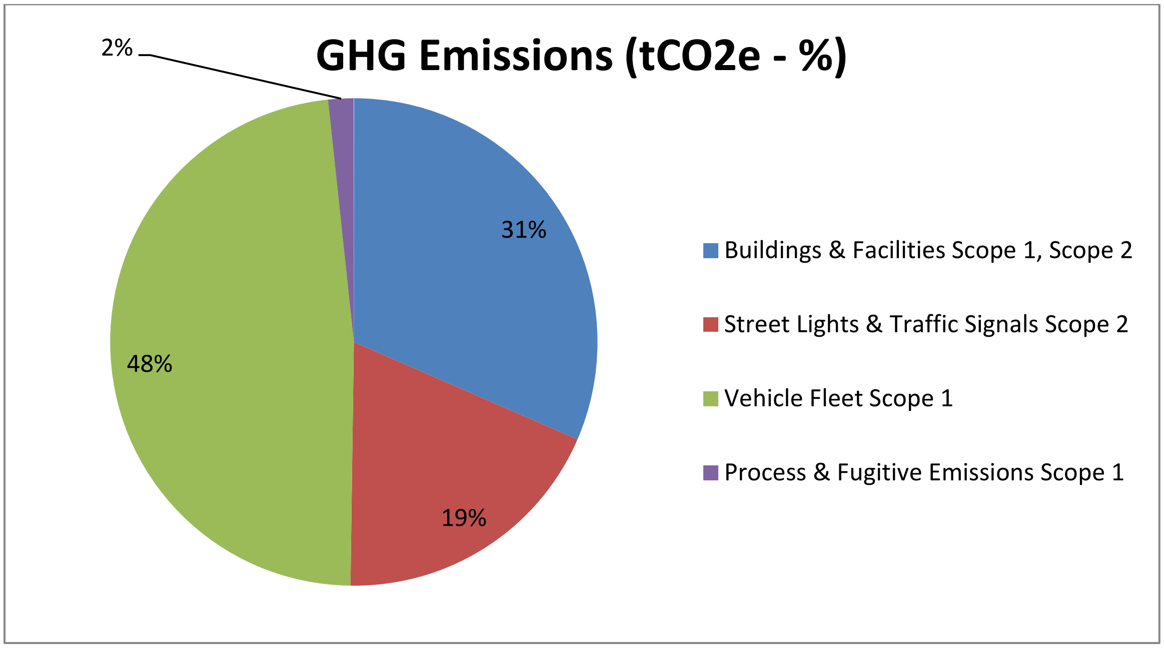
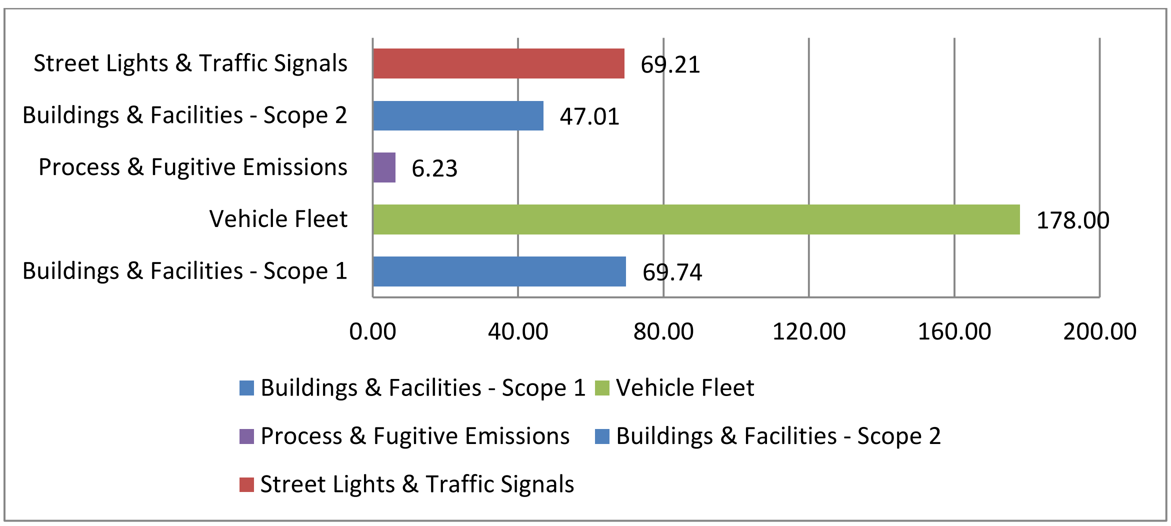


Figure 3: Total GHG Emissions by Sector (tCO_2e)



The results highlight the predominance of the vehicle fleet as the major source of GHG emissions. Scope 1 emissions (stationary fuel combustion) from buildings and facilities and electricity consumption by streetlights are almost equal, ranking as the next largest sources. Electricity consumption by buildings and facilities rank fourth, followed by a small amount of fugitive emissions (refrigerant releases from air conditioning/refrigeration equipment).

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 Town 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 conducted within the Town boundary, GHG emissions from waste and water treatment operations would also be included, but this is not the case for the Town of Dover.

The LGO inventory does not include GHG emissions generated by the Town 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). The Town of Dover Community GHG Inventory is not included in the scope of this report.

2. Overview of the Town of Dover

The Town of Dover is located in Dutchess County, New York, approximately 90 miles north of New York City and about the same distance south of Albany.

According to the United States Census Bureau[1], the town has a total area of 56.34 square miles, with a population of 8,699 as of the 2010 census data and of 8,456 estimated as of July 1, 2017. The Town territory borders with the state of Connecticut on the east side and with the municipalities of Pawling to the south, Beekman, Union Vale to the west, and Washington, Amenia on the north side. The Ten Mile River flows from the north through the center of town, then turns east into Connecticut and joins the Housatonic River.

The Town was founded after its separation from the Town of Pawling, New York in 1807 and is comprised of the unofficial hamlets of Dover Plains and Wingdale.

The Town operations consist of the Town administration, the Highway Maintenance department, and the Parks and Recreation department.

The Town government staff is composed of 35 employees, 15 of which work in Highway Maintenance and 5 in the Parks and Recreation departments.

The Town building and facilities are listed in the following table:

Table 3: Buildings and Facilities with the Town Operations

Building / Facility	Daily Occupancy	Daily Operating Hours	Building Square Footage
Dover Town Hall	15	10 hr/day (8 – 6, M - F)	8,000 sq. ft.
Town Highway Dept. Garage	15	8 hr/day (7 – 3, M - F)	7,000 sq. ft.
Town Highway Dept. Salt Shed	seasonal - 5 mos. a year	N/A	N/A
Tabor-Wing House	(events only)	5 hr/week (weekends)	N/A
Dover Plains Library	20	10 hr/day (M - Sat)	N/A
American Legion	20, twice per week	12 hr/week (9 – 3, M & Thu)	basement of library
Route 55 - Park (Recreation Office)	5	8 hr/day (8 – 4, M - F)	1,584 sq. ft.
Route 55 - Field	N/A	N/A	N/A
Route 55 - Ballfield	N/A	N/A	N/A

All the buildings and facilities listed are owned and operated by the Town. The utilities include electricity, fuel oil, and propane for heating.

In addition to the buildings and facilities listed above, the Town operations also include five street lighting districts, each one metered independently. The electricity for street lighting and for the building and facilities is provided by the same utility (NYSEG/Constellation).

[1] https://factfinder.census.gov/faces/tableservices/jsf/pages/productview.xhtml?src=bkmk

Table 4: Districts Lighting in GHG Inventory

Inventory Record	Number of Streetlights
District Lighting - Dogtail Corner	4
District Lighting - Dover Plains	68
District Lighting – Wingdale	77
District Lighting - Farm & Mitchell Dr.	12
District Lighting - Town Park	N/A

The Town does not operate waste disposal facilities or wastewater treatment facilities.

The Town operates a fleet of vehicles consisting primarily of pickups, heavy trucks, and equipment for the highway maintenance department, plus one passenger car for the Town Hall building and one pickup truck for the Parks and Recreation department. The fleet uses both diesel and gasoline fuel.

The Town does not operate any public transportation vehicles, nor police, fire department, or waste hauling vehicles.

2.1 Staff Responsible for the GHG Inventory

This GHG inventory was developed by First Environment through consultation with the Town staff including Katie Palmer-House, Town Clerk; and Linda French, Town Supervisor.

2.2 GHG Inventory Reporting Protocol

The Town of Dover 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 was to offer additional guidance to local governments on applying the Greenhouse Gas 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. 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 from the Town 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 Town 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 Town. The Town operations are conducted within the Town municipal boundary; the Town does not control or operate 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 Town 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 Town'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 Town, 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.

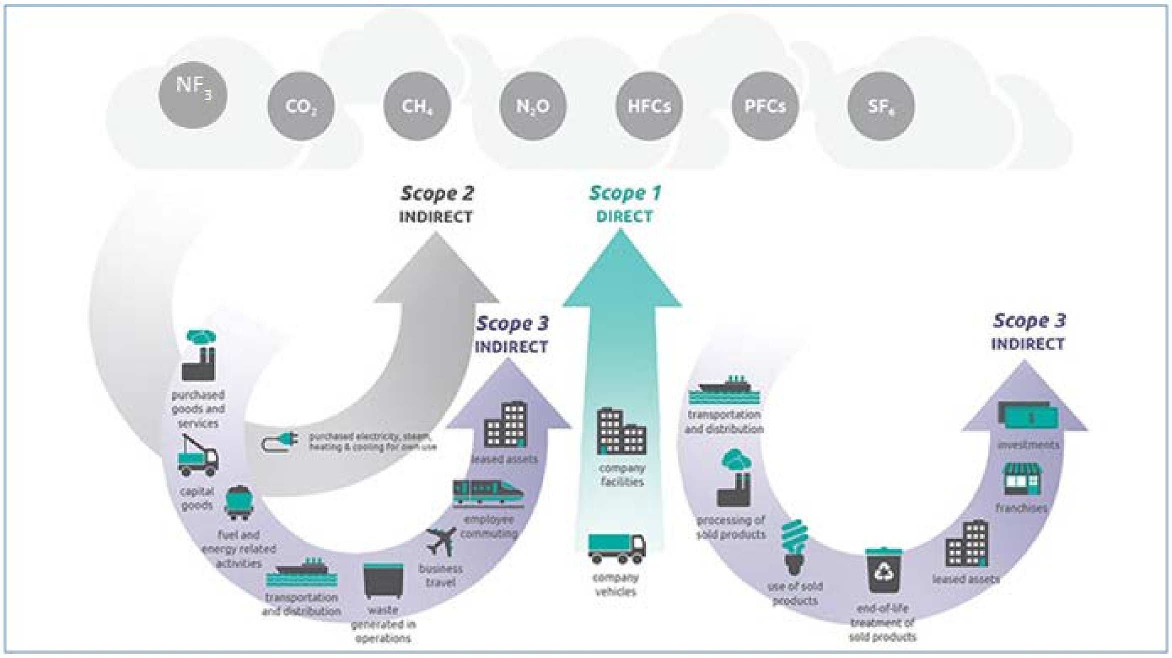
- Direct emissions (Scope 1): result from emission sources that are owned or operated by the organization.
- Indirect emissions (Scope 2, Scope 3): emissions that are due to an organization's activities but occur from sources owned or controlled by another organization.

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, and 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 Town GHG inventory are as follows:

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

The Town 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 Town 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 Town GHG inventory are listed in the following tables, organized by Scope and Sector.

2.6 Scope 1 - Direct Emissions

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

Table 5: Scope 1 Emission Sources

Scope	Source	Emission Category
Scope 1	Dover Town Hall	Emissions from Stationary Fuel Combustion
Scope 1	Town Highway Dept. Garage	Emissions from Stationary Fuel Combustion
Scope 1	Tabor-Wing House	Emissions from Stationary Fuel Combustion
Scope 1	Route 55 - Park	Emissions from Stationary Fuel Combustion
Scope 1	Highway - Non Road - Diesel	Emissions from Off Road Vehicles
Scope 1	Highway - Non Road - Gasoline	Emissions from Off Road Vehicles
Scope 1	Highway - Light Trucks - Gas	Fleet Vehicle Emissions
Scope 1	Highway - Light Trucks - Diesel	Fleet Vehicle Emissions
Scope 1	Light Truck - Rec. Dept.	Fleet Vehicle Emissions
Scope 1	Highway - Heavy Trucks	Fleet Vehicle Emissions
Scope 1	Passenger Vehicle - Town	Fleet Vehicle Emissions
Scope 1	Commercial A/C including Domestic Refrigeration	Hydrofluorocarbon & Refrigerant Emissions
Scope 1	Mobile Air Conditioning	Hydrofluorocarbon & Refrigerant Emissions

2.7 Scope 2 - Energy Indirect Emissions

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

Table 6: Scope 2 Emissions Sources

Scope	Source	Emission Category
Scope 2	Dover Town Hall	Emissions from Grid Electricity
Scope 2	Town Highway Dept. Garage	Emissions from Grid Electricity
Scope 2	Town Highway Dept. Salt Shed	Emissions from Grid Electricity
Scope 2	Tabor-Wing House	Emissions from Grid Electricity
Scope 2	American Legion	Emissions from Grid Electricity
Scope 2	Dover Plains Library	Emissions from Grid Electricity
Scope 2	Route 55 - Ballfield	Emissions from Grid Electricity
Scope 2	Route 55 - Field	Emissions from Grid Electricity
Scope 2	Route 55 - Park	Emissions from Grid Electricity
Scope 2	District Lighting - Dogtail Corner	Emissions from Grid Electricity
Scope 2	District Lighting - Dover Plains	Emissions from Grid Electricity
Scope 2	District Lighting - Farm & Mitchell Dr.	Emissions from Grid Electricity
Scope 2	District Lighting - Wingdale	Emissions from Grid Electricity
Scope 2	District Lighting - Town Park	Emissions from Grid Electricity

2.8 Source Exceptions

No sources of PFCs, NF_3 or SF_6 were identified in the Town inventory boundary.

Emissions from the American Legion and the Library were considered under the Town operational control, though technically these are separate entities located within the Town buildings.

2.9 Inventory Data Collection Methodologies

Two primary methodologies were utilized to collect data.

- Data was provided by the Town staff.
- In some cases when data were not available for a particular source, individuals with knowledge of the activities provided an estimate.

The collection methodology for each source is summarized below.

2.10 Scope 1 Emissions

2.10.1 Stationary Combustion

The Town provided an inventory of the building and facilities owned and or operated by the Town. Each building in the inventory, including the American Legion and Library buildings, were designated as being under the Town control. Therefore, the related fuel and electricity consumption are included in the inventory.

2.10.1.1 Fuel Oil

The Town staff provided the total No. 2 Fuel Oil consumption for heating in the Town buildings for year 2017 compiled from vendor's invoices, quantified in gallons of fuel. Total fuel oil usage in Town-controlled buildings was calculated and the appropriate emissions quantification methodology from the LGOP was applied to this value.

2.10.1.2 Propane

The Town staff provided the total propane fuel usage in the Town buildings for year 2017 compiled from vendor's invoices, quantified in gallons of fuel. Total propane usage in Town-controlled buildings was calculated and the appropriate GHG emissions quantification methodology from the LGOP was applied.

2.10.2 Mobile Combustion

The Town provided the updated fleet inventory of the vehicles owned and operated by the three main departments: Highway Department, Parks and Recreation Department, Town Hall Office. The Highway Department fleet includes both on-road and off-road vehicles such as backhoes, wood chipper, road grader, etc. The fleet inventory also included data on the vehicle age and odometer readings, which was used to estimate the annual mileage driven for each vehicle.

For simplicity, all the vehicles are aggregated by department and by fuel, further subdivided into on-road and off-road vehicles where applicable.

The Town's fleet vehicles are fueled either at the Highway department fueling pumps, managed by the FuelMaster software storing fueling information for each vehicle, or at the commercial gas station in Dover. For 2017, there were also a few months when the Fuel master was not operational and an additional auxiliary diesel tank was used. The Town provided both the Fuel Master records and the fuel purchasing records from the gas station, which were then reconciled to apportion as accurately as possible the fuel usage to each vehicle.

2.10.2.1 Gasoline

The Town staff provided a summary of 2017 gasoline usage in gallons attributable to Town's owned and operated vehicles. As previously described, gasoline fuel consumption was aggregated from FuelMaster and fuel vendors' records for each vehicle category and then the appropriate GHG emissions quantification methodology was applied.

2.10.2.2 Diesel

The Town staff provided a summary of 2017 diesel usage in gallons attributable to Town's owned and operated vehicles. As previously described, diesel fuel consumption was aggregated from FuelMaster and fuel vendors' records for each vehicle category and then the appropriate GHG emissions quantification methodology was applied.

2.10.3 Fugitive Emissions

2.10.3.1 Stationary Air Conditioning and Refrigeration Units

The Town staff provided an inventory of air conditioning and refrigeration equipment identifying any units in service and type of refrigerant. Unit information was aggregated by equipment types (e.g., domestic refrigeration) and refrigerant types and the quantification methodology was applied to this value. For simplicity, all units are assumed to use R410A refrigerant, with an average charge of 1.5 kg for air conditioning equipment and 0.5 kg for refrigeration equipment.

2.10.3.2 Mobile Air Conditioning Sources

The Town staff provided an inventory of the fleet vehicles and the number of vehicles equipped with air conditioning was estimated by excluding off-road vehicles and older trucks. The refrigerant charge for each vehicle was assumed 1 kg of R-134A and the appropriate GHG emission quantification methodology was applied to this value.

2.10.3.3 Fire Extinguishers

The Town staff provided an inventory of fire extinguishers but type and total charge information was not available. Because of the expected negligible contribution to the overall GHG emissions, this source was excluded from the inventory for 2017.

2.11 Scope 2 Emissions

2.11.1 Purchased Electricity

The Town staff provided all the utility invoices for year 2017 electricity consumption by Town buildings and district street lighting. 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

Not included in the GHG inventory.

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.
- NYSERDA - Department of Energy and Environmental Analysis – Statewide Electricity Emission Factor - 2014.
- 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

3.1.1.1 Fuel Oil

Emissions were calculated according to Equations 6.2 and 6.4 of LGOP by multiplying the total gallons of fuel oil 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 multiplying for the appropriate IPCC AR5 GWP factor for each GHG.

3.1.1.2 Propane

Emissions were calculated according to Equations 6.2, 6.4 and 6.6 of LGOP, by multiplying the total gallons of propane 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 multiplying for the appropriate IPCC AR5 GWP factor for each GHG.

3.1.2 Mobile Combustion

3.1.2.1 Gasoline

For on-road vehicles, 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.

A similar approach was used for non-road vehicles. GHG emissions were calculated according to Equation 7.2 of LGOP by multiplying the total gallons of gasoline usage by mobile sources by appropriate CO_2, 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 multiplying for the appropriate IPCC AR5 GWP factor for each GHG.

3.1.2.2 Diesel

For on-road vehicles, 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.

A similar approach was used for non-road vehicles. GHG emissions were calculated according to Equation 7.2 of LGOP by multiplying the total gallons of diesel usage by mobile sources by appropriate CO_2, 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 multiplying for the appropriate IPCC AR5 GWP factor for each GHG.

3.1.3 Fugitive Emissions

3.1.3.1 Refrigerants, Stationary Sources

Emissions were calculated according to LGOP's alternate estimation approach based on equipment inventory and refrigerant use and Equation 6.35 of LGOP. The required parameters and factors for each equipment type (e.g., domestic refrigeration) such as total refrigerant charge in kg, operating emission factor, recovery efficiency, etc. are provided in Table 6.4 of LGOP. The results of these calculations in metric tonnes of the specific refrigerant (e.g., R-410A) emissions were converted to metric tonnes of CO_2e by multiplying for the appropriate IPCC AR5 GWP factor for each GHG.

3.1.3.2 Refrigerants, Mobile Sources

Emissions were calculated according to the alternate estimation approach based on equipment inventory and refrigerant use and Equation 7.13 of LGOP. The required parameters and factors for each equipment type (e.g., domestic refrigeration) such as total refrigerant charge in kg, operating emission factor, recovery efficiency, etc. are provided in Table 7.13 of LGOP. The results of these calculations in metric tonnes of the specific refrigerant (e.g., R-134A) emissions were converted to metric tonnes of CO_2e by multiplying for the appropriate IPCC AR5 GWP factor for each GHG.

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 Town-controlled buildings and street lighting for the appropriate CO_2, CH_4, and N_2O electricity emission factors sourced from NYSERDA–NYS CSC. 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 Town 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.

Electric Power Transmission and Distribution Losses were also calculated, using the transmission and distribution losses factor for NYS from US EPA eGRID2016 databases.

3.3 Scope 3 Emissions

Scope 3 GHG emissions from Town 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 Town 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
Hydrofluorocarbons (HFCs), HFC blends and refrigerant blends		
R-410A		1924
R-134A		1300

3.5 Quantification of Emissions

3.5.1 Scope 1 GHG Emissions

The Town Total Scope 1 Emissions were quantified as 253.97 metric tonnes (t) CO_2e. The quantity includes contributions of the following GHGs:

Table 7: Scope 1 GHG Emissions

Greenhouse Gas	t GHG	t CO2e
Carbon Dioxide (CO_2)	247.03	247.03
Methane (CH_4)	0.0118	0.3301
Nitrous Oxide (N_2O)	0.0014	0.3830
Hydrofluorocarbons (HFCs)	0.0042	6.23
Total		253.97

The distribution of Scope 1 emissions by sector is shown in percentage and in tCO2e in the charts below.

Figure 5: Scope 1 Emissions by Sector, in Percentage

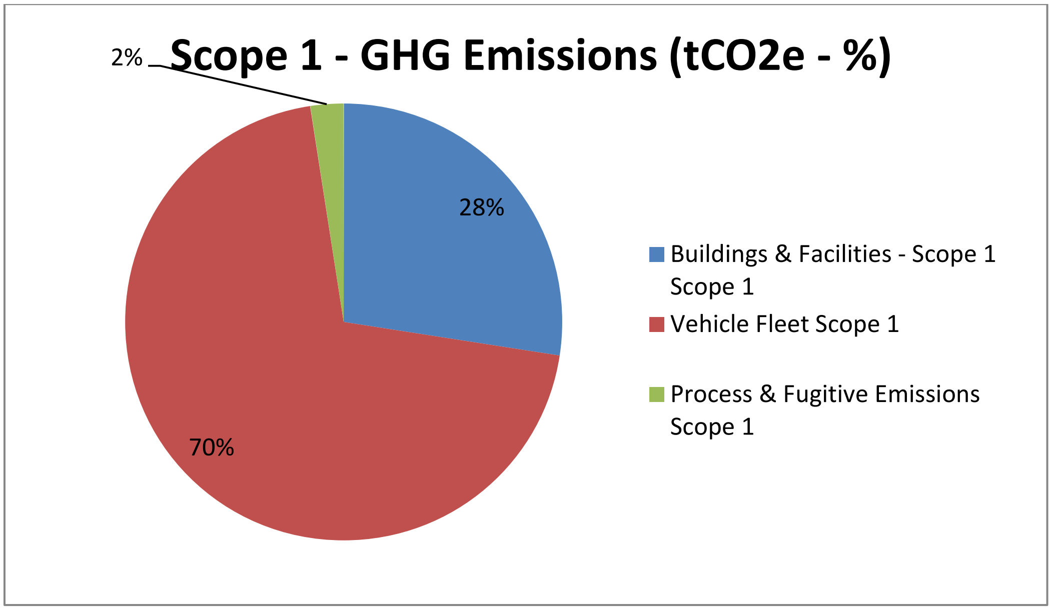
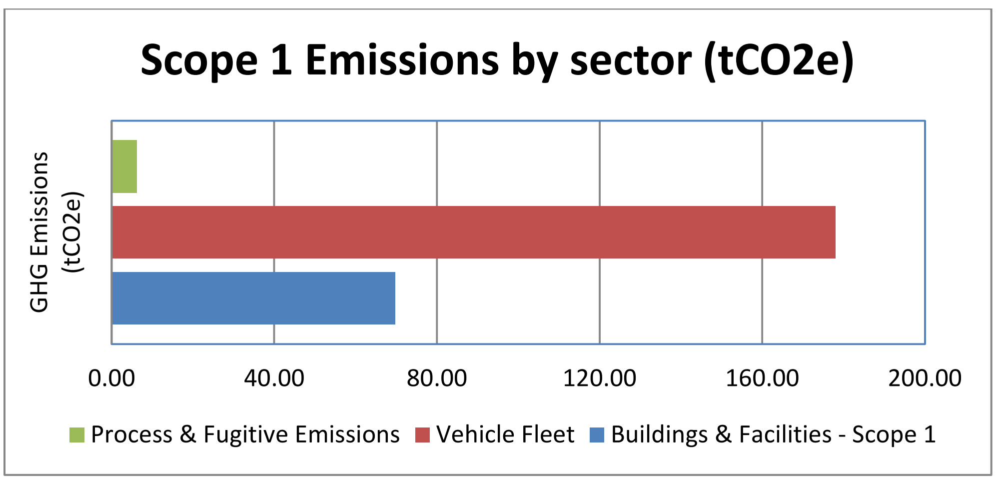


Figure 6: Scope 1 Emissions by Sector (tCO_2e)



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 small amount of fugitive emissions (refrigerant releases from air conditioning/refrigeration equipment).

The following paragraphs 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 Town direct stationary combustion emissions were quantified as 69.74 t CO_2e. This stationary combustion quantity includes contributions from the following fuels:

Table 8: Direct Stationary Combustion by Fuel

Stationary Combustion Emissions	
Fuel	t CO_2e
Fuel Oil	62.22
Propane	7.53
Total	**69.74**

3.5.3 Direct Mobile Combustion Emissions – Vehicle Fleet

The Town direct mobile combustion emissions were quantified as 178.00 t CO_2e. This mobile combustion quantity includes contributions from the following fuels:

Table 9: Direct Mobile Combustion Emissions by Fuel

Mobile Combustion Emissions	
Fuel	t CO_2e
Gasoline	24.73
Diesel	153.27
Total	**178.00**

3.5.4 Process & Fugitive Emissions

The Town direct fugitive emissions were quantified as 6.23 t CO_2e. The Town operations do not include any Process emissions.

The fugitive emissions quantity includes contributions from the following sources:

Table 10: Direct Fugitive Emissions by Source Type

Fugitive Source Type	**t CO_2e**
Commercial A/C including Domestic Refrigeration	2.33
Mobile Air Conditioning	3.90
Fire Extinguishers	Negligible
Total	**6.23**

3.5.4.1 Scope 1 Emissions by Source

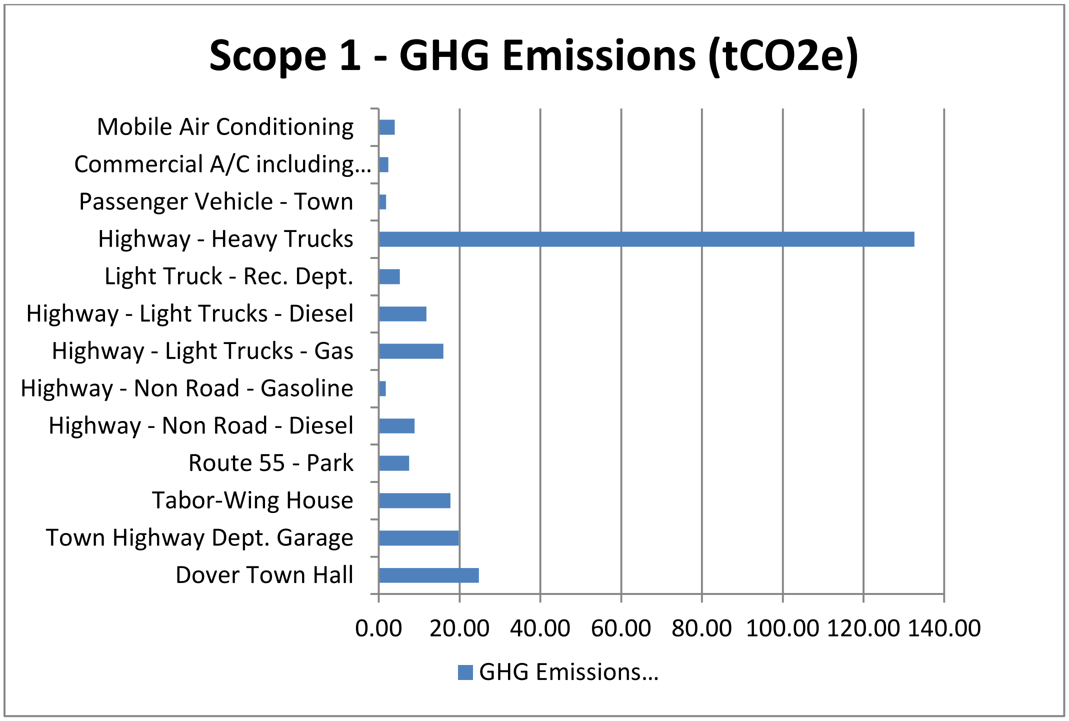
The following table and chart show the Scope 1 emissions from each specific source, as identified in the inventory. For each source, the energy usage responsible for the emissions is also reported, expressed in gallons for fuels and metric tonnes for refrigerants released.

Table 11: Scope 1 Emissions From Each Specific Source (tCO_2)

Source	Sector	Energy Use (Gal)	GHG Emissions (tCO_2e)
Dover Town Hall	Emissions from Stationary Fuel Combustion	2,411	24.78
Town Highway Dept. Garage	Emissions from Stationary Fuel Combustion	1,923	19.75
Tabor-Wing House	Emissions from Stationary Fuel Combustion	1,721	17.69
Route 55 - Park	Emissions from Stationary Fuel Combustion	1,333	7.53
Highway - Non Road - Diesel	Emissions from Off Road Vehicles	862	8.88
Highway - Non Road - Gasoline	Emissions from Off Road Vehicles	196	1.74
Highway - Light Trucks - Gas	Fleet Vehicle Emissions	1,813	15.97
Highway - Light Trucks - Diesel	Fleet Vehicle Emissions	1,153	11.78
Light Truck - Rec. Dept.	Fleet Vehicle Emissions	594	5.23
Highway - Heavy Trucks	Fleet Vehicle Emissions	12,983	132.62
Source	**Sector**	**Refrigerant (t)**	**GHG Emissions (tCO_2e)**
Commercial A/C incl. Domestic Refrigeration	Hydrofluorocarbon & Refrigerant Emissions	0.0012	2.33
Mobile Air Conditioning	Hydrofluorocarbon & Refrigerant Emissions	0.0030	3.90
		Total (tCO_2e)	**253.97**

The same results displayed in a bar diagram:

Figure 7: Scope 1 Emission by Source (tCO_2e)



The detailed breakdown above indicates the fleet of heavy trucks used by the maintenance departments as responsible for the largest share of emissions. The result is not surprising considering the large service area covered by the highway department due to the extension of the Town jurisdiction area.

3.6 Scope 2 GHG Emissions – Purchased Electricity

All Scope 2 emissions reported are from purchased electricity. Total Scope 2 Emissions were quantified as 116.22 metric tonnes t CO_2e, including contributions of the following GHGs:

Table 12: Scope 2 GHG Emissions

Greenhouse Gas	t GHG	t CO_2e
Carbon Dioxide (CO_2)	116.04	116.04
Methane (CH_4)	0.0046	0.1290
Nitrous Oxide (N_2O)	0.0002	0.0551
	Total	**116.22**

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

Figure 8: Scope 2 Emissions by Sector, in Percentage

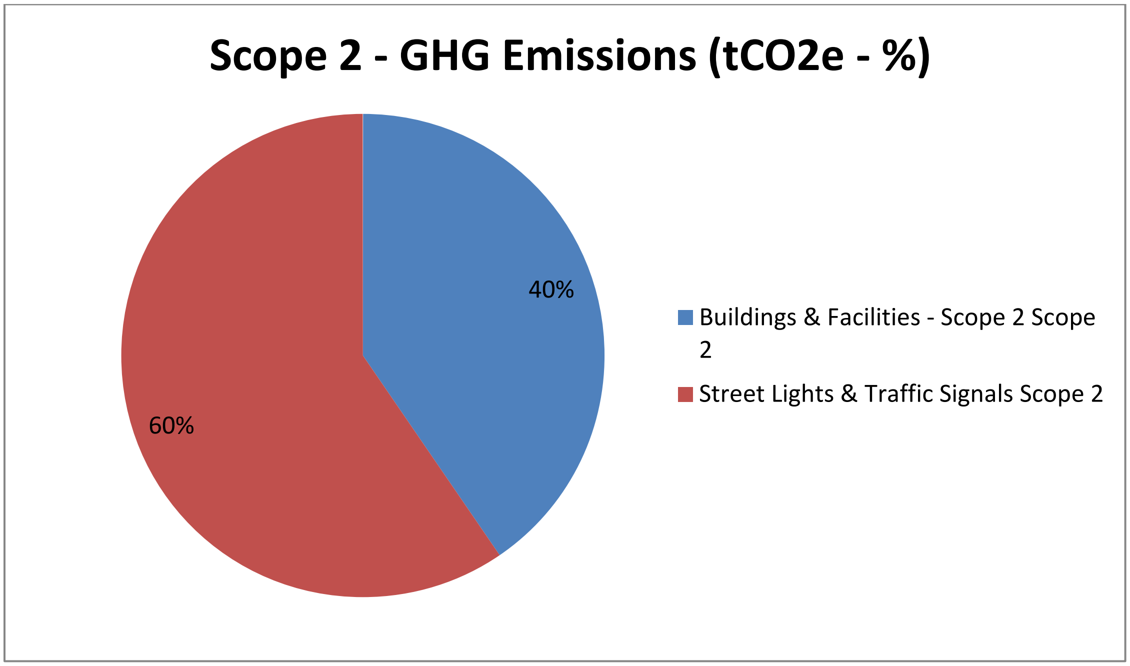
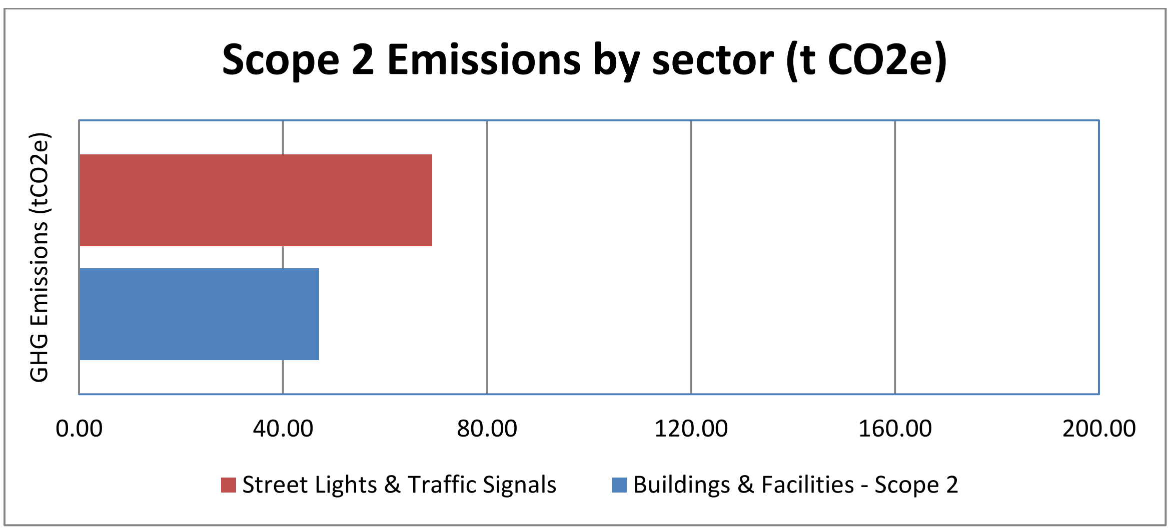


Figure 9: Scope 2 Emissions by Sector (t CO_2e)



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 Scope 2 Emissions by Source

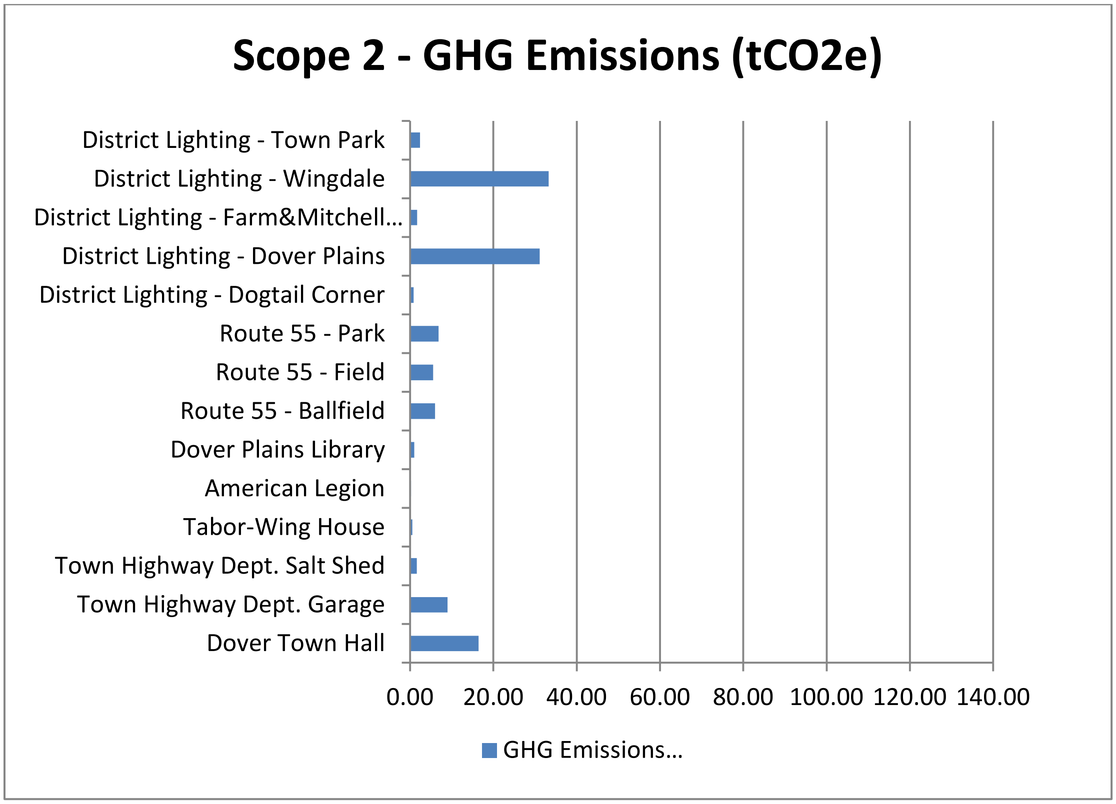
The following table and chart show the Scope 2 emissions from each specific source, as identified in the inventory. For each source, the energy usage responsible for the emissions is also reported, expressed in kWh of electricity used.

Table 13: Scope 2 Emissions From Each Specific Source (tCO_2)

Source	Sector	Energy Use (kWh)	GHG Emissions (tCO_2e)
Dover Town Hall	Emissions from Grid Electricity	57,781	16.41
Town Highway Dept. Garage	Emissions from Grid Electricity	31,524	8.95
Town Highway Dept. Salt Shed	Emissions from Grid Electricity	5,642	1.60
Tabor-Wing House	Emissions from Grid Electricity	1,926	0.55
American Legion	Emissions from Grid Electricity	719	0.20
Dover Plains Library	Emissions from Grid Electricity	3,459	0.98
Route 55 - Ballfield	Emissions from Grid Electricity	21,051	5.98
Route 55 - Field	Emissions from Grid Electricity	19,441	5.52
Route 55 - Park	Emissions from Grid Electricity	24,008	6.82
District Lighting - Dogtail Corner	Emissions from Grid Electricity	2,878	0.82
District Lighting - Dover Plains	Emissions from Grid Electricity	109,590	31.12
District Lighting – Farm & Mitchell Dr.	Emissions from Grid Electricity	5,836	1.66
District Lighting - Wingdale	Emissions from Grid Electricity	117,013	33.23
District Lighting - Town Park	Emissions from Grid Electricity	8,439	2.40
	Total (kWh - tCO2e)	**409,307**	**116.22**

The same results displayed in a bar diagram:

Figure 10: Scope 2 Emission by Source (tCO_2e)



The results show that two of the lighting districts are responsible for the majority of the Scope 2 emissions, followed by the Town Hall and Highway Maintenance garage. This leads to the conclusion 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 Town's reported emissions from purchased electricity were calculated using a location-based method by applying the NYSERDA NYS average grid emissions factor recommended by NYS CSC[2], in lieu of the US EPA eGRID emission factor for the NYUP sub-region.

The Town 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. 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:

[2] NYS Climate Smart Communities - New York Community and Regional GHG Inventory Guidance, September 2015, v1.0 – Page 13

Table 14: Location-based and Market-based and EFs and GHG Emissions

Location-based Method			
NYS Emission Factors	$lbCO_2/MWh$	$lbCH_4/GWh$	lbN_2O/GWh
	625	24.82	1.119
Emissions	CO_2 (tCO2e)	CH_4 (tCO_2e)	N_2O (tCO_2e)
	116.04	0.1290	0.0551
Market-based Method			
NYS Emission Factors	$lbCO_2/MWh$	$lbCH_4/GWh$	lbN_2O/GWh
	625	24.82	1.119
Emissions	CO_2 (tCO2e)	CH_4 (tCO_2e)	N_2O (tCO_2e)
	116.04	0.1290	0.0551

3.8 Scope 3 GHG Emissions

Total Scope 3 Emissions were not quantified for the GHG Inventory.

3.9 GHG Inventory Results

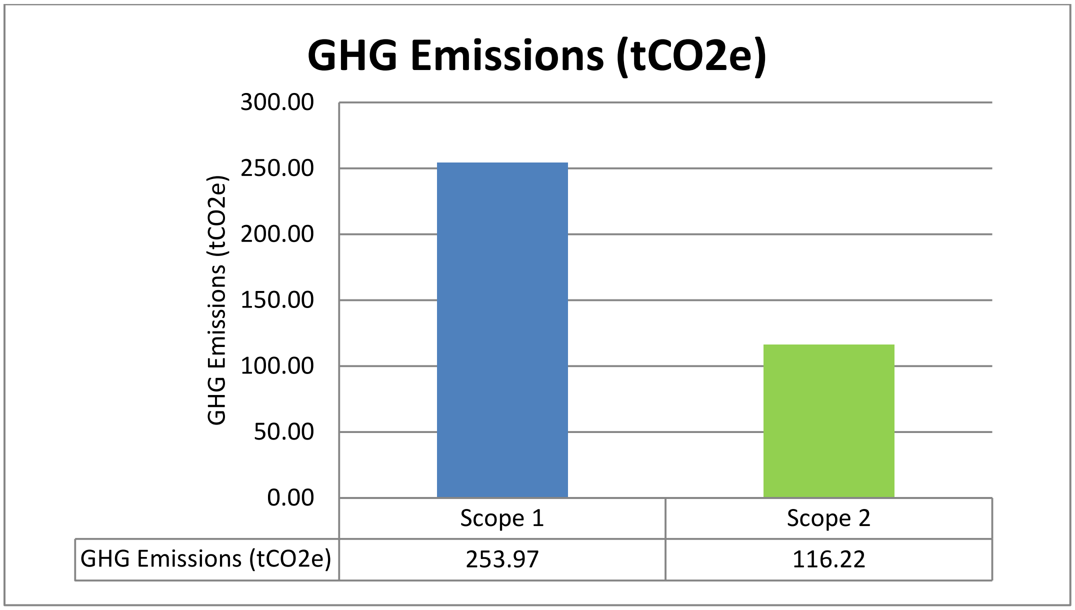
The Town's total Scope 1 GHG emissions for 2017 amounted to 253.97 metric tonnes carbon dioxide equivalents (t CO_2e). These total emissions consist of stationary combustion, such as fuel oil gas heating, and mobile combustion, such as diesel consumption by the Town fleet vehicles, with an additional small amount associated with refrigerant releases from refrigeration or air conditioning systems. As a point of reference, 253.97 t CO_2e is approximately equivalent to the GHG emissions produced by an average passenger vehicle driven 622,475 miles, according to the US EPA's Greenhouse Gas Equivalencies Calculator.

The Town's total Scope 2 GHG emissions for 2017 amounted to 116.22 metric tons carbon dioxide equivalents (t CO_2e). These emissions are associated with electricity usage by the Town and are roughly equivalent to the GHG produced from electricity use by 12.5 homes for one year.

Table 15: Total GHG Emissions by Scope (tCO_2e)

GHG Emissions	tCO_2e
Scope 1 Emissions	253.97
Scope 2 Emissions	116.22
Total	**370.19**

Figure 11: Total GHG Emissions by Scope (tCO_2e)



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

Figure 12: Total GHG Emissions by Sector in Percentage

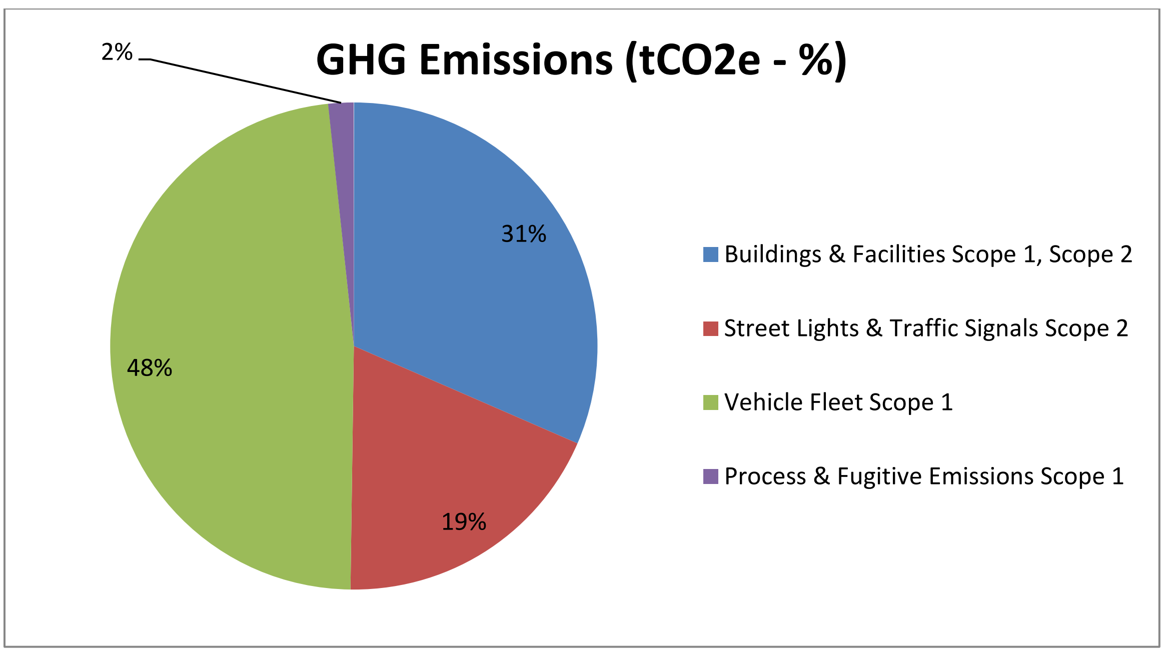
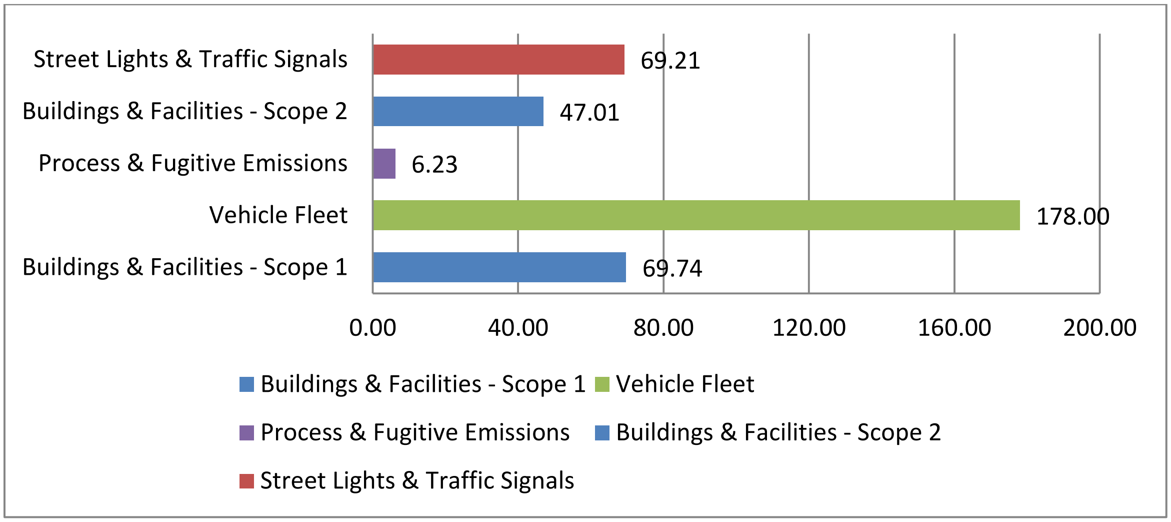


Figure 13: Total GHG Emissions by Sector (tCO_2e)



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 and electricity consumption by streetlights are almost equal, ranking as the next largest sources. Electricity consumption by buildings and facilities rank fourth, followed by a small amount of fugitive emissions (refrigerant releases from air conditioning/refrigeration equipment).

4. GHG Inventory Base Year

A 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 Town has selected year 2017 as the GHG inventory base year.

4.1 GHG Inventory Forecast

Once the Base Year has been selected, the next step is to select one or multiple future years by which the Town wishes to reach certain emissions reduction goals. The GHG emissions for that future year are estimated presuming Business As Usual (BAU) growth of emissions from the base year. BAU refers to a scenario where the Town pursues no measures or actions aimed at reducing energy consumption and GHG emissions.

The Town has selected to develop BAU projections of GHG emissions inventory at 1-, 5-, and 10-year intervals from the Base Year. Emissions forecast for each one of these target years will be used as baseline to select appropriate reduction targets and to evaluate the actual results that could be achieved by implementing various reduction measures.

In order to develop the BAU scenario, First Environment evaluated several factors that could affect the GHG emissions independently from any action planned and implemented by the town. Among the many possible factors, the following were reviewed for analysis and discussion:

- weather data normalization;
- Town of Dover Demographic Trends;
- energy use in NYS;
- carbon intensity of electric grid in NYS.

4.2 Weather Data Normalization

The Town's location in the Hudson Valley makes its energy and fuel use, as well as its GHG emissions in a given year, dependent upon the weather experienced during that year, both in terms of temperature and precipitation. Besides average temperature, the number of Heating Degree Days (HDD) and Cooling Degree Days (CDD) are useful parameters frequently used to compare energy usage in buildings. HDD is the number of degrees that a day's average temperature is below 65°F, which is the reference temperature below which buildings need to be heated. When the mean daily temperature is above 65°F, HDD is zero. Similarly, CDD data can be used to estimate the energy required for cooling and is defined as the number of degrees that a day's average temperature is above 65°degrees. When the mean daily temperature is lower than 65°F, CDD is zero.

4.2.1 2017 Weather Data for Dover, NY

To provide a point of reference to the weather the Town experienced during 2017, the following are the monthly heating degree days, cooling degree days, precipitation, and average temperature for 2017 for the weather station KNYWINGD2, in Wingdale, New York, US (73.57W; 41.65N). Historical averages for the same parameters for Wingdale were not available, so data for Millbrook, New York (73.67W; 41.85N), just a few miles northwest of Wingdale, were used. All weather and climate data were sourced from the Weather Underground, and the National Climatic Data Center (NCDC). NCDC maintains a dataset of climate normals that is updated every 10 years. The most recent dataset provides the average conditions experienced between 1981 and 2010.

Table 16: Wingdale, NY 2017 - Weather Data

2017 Weather Data – Average Monthly Data				
Month	**Total HDD**	**Total CDD**	**Precipitation (inches)**	**Avg. Temp (F)**
January	1001	0	3.45	32.7
February	826	3	1.73	35.6
March	984	0	2.12	33.2
April	393	38	3.21	52.6
May	287	58	5.62	57.6
June	100	179	4.67	67.6
July	34	249	3.22	71.9
August	64	194	2.76	69.2
September	111	128	3.06	64.7
October	253	69	4.75	59.1
November	742	4	0.81	40.5
December	1145	0	1.41	27.7

Table 17: Dutchess County, NY 2017 - Climate Averages

Climate Averages – Normals between 1981 and 2010				
Month	**Total HDD**	**Total CDD**	**Precipitation (inches)**	**Avg. Temp (F)**
January	1288	0	3.33	23.5
February	1090	0	2.92	26.1
March	941	0	3.75	34.7
April	567	2	3.91	46.2
May	279	14	4.35	56.5
June	70	85	4.59	65.5
July	17	174	4.65	70.1
August	28	130	4.22	68.3
September	171	37	4.47	60.5
October	507	3	4.22	48.7
November	801	0	3.79	38.3
December	1127	0	3.78	28.6

Table 16: Difference Between 2017 Averages and Climate Normal

Difference to NCDC Climate Normals				
Month	Total HDD	Total CDD	Precipitation (inches)	Avg. Temp (F)
January	-287	0	0.12	9.2
February	-264	3	-1.19	9.5
March	43	0	-1.63	-1.5
April	-174	36	-0.7	6.4
May	8	44	1.27	1.1
June	30	94	0.08	2.1
July	17	75	-1.43	1.8
August	36	64	-1.46	0.9
September	-60	91	-1.41	4.2
October	-254	66	0.53	10.4
November	-59	4	-2.98	2.2
December	18	0	-2.37	-0.9

The results in Table 17 show that on average the weather in 2017 was warmer than normal. The number of HDD in the fall-winter months (January, February, October) is considerably lower than normal averages, with slightly cooler temperature registered in December and March. CDD are overall higher for all spring-summer months into the fall, from April to October.

While at this time there isn't a methodology to normalize the GHG inventory results to HDD/CDD data, the analysis above nonetheless indicates that the energy usage in year 2017 was likely affected but warmer than usual temperatures. It could be expected, for example that emissions for building and facilities heating were lower than average, while probably electricity consumption for air conditioning in the warmer months were higher than normal, possibly balancing each other out..

One conclusion could be that using year 2017 could underestimate the baseline level of energy usage and GHG emissions (assuming that heating energy savings exceed the increased air conditioning usage). If the temperatures in the next few years move down closer to historical normals, heating energy consumption in the winter months could increase the overall annual emissions. On the other hand, if the trend of warming temperatures due to climate change will be observed in the coming years, then the 2017 baseline would correctly represent the departure from historical normal averages.

Due to the complexity of modeling the normalization to HDD/CDD and its possible effects on fuels, electricity consumption and therefore GHG emission, this discussion is only included as qualitative consideration, but no quantitative correction of the 2017 GHG inventory is being performed.

4.3 Town of Dover Demographic Trends

One factor that could indirectly affect the LGO GHG emissions could be the Town demographic trend in the next decades. While it is unlikely a direct relation, it is reasonable to link the GHG emissions to the demographic trends, assuming for example that a considerable increase in the Town population would lead to an increase in the size of the LGO infrastructure, service fleet, road maintenance and repairs services, Town staff, etc.

Demographic projections specific for Dover could not be sourced, so an estimate of actual population trend for the Town were inferred from a combination of Dutchess County population projections and Dover historical trend.

The following data is extracted from a study conducted by Cornell University, Program on Applied Demographics[3], providing projection of population growth in New York State from 2010 to 2035. The data is organized by County and the results for Dutchess County are reported in the table below.

Table 17: Dutchess County Population Growth Projections 2010 - 2035

Year	2010	2015	2020	2025	2030	2035	2040
Projected Population	297,488	303,374	309,985	316,091	320,734	323,935	326,402
Variation		5,886	6,611	6,106	4,643	3,201	2,467
Variation %		1.98%	2.18%	1.97%	1.47%	1.00%	0.76%
Variation %/year		0.40%	0.44%	0.39%	0.29%	0.20%	0.15%

The demographic projection show an increase in population in the county at an annual rate of ~0.4% until 2025 then decreasing to 0.2-0.15 percent.

The following US Census information for Dover illustrates the population trend from 1970 to 2015, showing population decreasing in the '80s and then increasing to a peak 8,775 in 2005 and then again slowly decreasing at 0.45-0.50 percent per year rate until 2016. For 2017, the population seems to be stable.

Table 20: Town of Dover Population Historical Data 1970 - 2035

Year	1970	1980	1990	2000	2005	2010	2015	2016	2017
Dover Population	8,475	7,261	7,778	8,565	8,775	8,699	8,500	8,457	8,456
Variation		-1,214	517	787	210	-76	-199	-43	-1
Variation %		-14.32%	7.12%	10.12%	2.45%	-0.87%	-2.29%	-0.51%	-0.01%
Variation %/year		-1.43%	0.71%	1.01%	0.49%	-0.17%	-0.46%	-0.51%	-0.01%

Source: U.S. Census Bureau, Estimates Program

The historical data seems to indicate that Town is not yet following the population growth projected for the County, though the recent 2017 estimate, if correct, could indicate that the

[3] https://pad.human.cornell.edu/counties/projections.cfm

decreasing trend is slowing or halted altogether. Nonetheless it does not seem like the potential Town's population change trend will be significant in the next 10 years and, as such, the demographic trends are not going to be included in the GHG inventory forecast.

4.4 Energy Consumption in NYS

The U.S. Energy Information Administration (EIA) provides a large amount of information on energy and fuel usage in the U.S., detailed according to numerous parameters, such as economic sectors, user categories, and geographic location. Both historic and forecast data is available and the latter was reviewed to extrapolate energy usage change trends that could be useful to project Town energy use and GHG emissions in the future.

In particular data from the "2018 EIA Energy Outlook[4]" detailing New England region projected energy consumption for 2016 to 2050[5] were reviewed and the CAGR calculated.

The following change rates were identified for use in the Town's GHG 10 year inventory forecast for the period from 2017 to 2028:

Table 21: EIA Energy Outlook Consumption for 2017 to 2028

GHG Inventory Sector	Energy Source	Projected Consumption Change Rate (%/year)	Information Source
Buildings and Facilities	Electricity Consumption	-1.04%	EIA Forecast for Residential Commercial Energy Use
Buildings and Facilities	Propane - Stationary	0.79%	EIA Forecast for Residential Commercial Energy Use
Buildings and Facilities	Distillate Fuel Oil - Stationary	-1.90%	EIA Forecast for Residential Commercial Energy Use
Fleet	Gasoline	-2.17%	EIA Forecast for Transportation Energy Use
Fleet	Diesel	-0.50%	EIA Forecast for Transportation Energy Use
Fleet	Construction	-0.50%	EIA Forecast for Transportation Energy Use

It can be observed that in general, the projected consumption trends show a decrease in energy usage in both stationary and mobile sources.

4.5 Carbon Intensity of Electricity Grid in NYS

Besides the data on energy consumption, key factors that will affect the GHG inventory result are the specific emission factors of the various energy sources included in the inventory.

In order to simplify the approach, we assumed that fuel emission factors would not change in the near future. This is reasonable since fuel emission factors are strictly linked to the chemical composition of fuels and these are not projected to change significantly in the near future.

The electricity grid emission factors are instead steadily decreasing due to increase of renewable energy generation and shift from coal to natural gas for the fossil fuel portion. The steady decrease of nuclear energy in the generation mix on the other hand could lead to a

[4] https://www.eia.gov/outlooks/aeo/
[5] https://www.eia.gov/outlooks/aeo/data/browser/

temporary increase in grid emissions before sufficient renewable energy is deployed to replace the lost generation power.

The forecast of the grid emission factor was based on the historical trend of the NYSERDA GHG factor for NYS, from 2010 to 2014, published in the CSC guidance for Community GHG inventories[6].

Table 18: NYSERDA New York Average Grid Carbon Intensity

Year	Grid Emission Factor (lbs CO_2e/MWh)	Annual Rate of change (%/year)
2010	826	-6.73%
2011	826	
2012	625	
2013	625	
2014	625	

The CAGR calculated for the short period was -6.73 percent, annual percent rate of decrease. Because of the short timeframe of historical data available and the significant rate decrease, the data was compared to NYSERDA's data on NYS GHG emissions from fuel combustion for electricity generation, from 1990 to 2015[7].

Table 19: NYS Estimated GHG Emissions from Fuel Combustion – Electricity Generation

Year	GHG Emissions (million tCO_2e)	Annual Rate of change (%/year)	Annual Rate applied in forecast
1990	63	-3.04%	**-2 %**
2015	29.1		

This more conservative rate of approximately 3 percent/year rate does not strictly reflect the decrease in grid carbon intensity, rather the overall decrease of GHG emissions for electricity generation. Nonetheless, this data confirms the steady decrease of GHG emissions from energy generation on a long time span of historical data. It must be also taken into account that during the same time span the overall electricity generation from fossil fuels in NYS decreased at approximately -1 percent/year[8]. Therefore, a compound rate equal to -2 percent/year is deemed more appropriate to reflect the decreasing trend of the electric grid carbon intensity and apply it to forecast the Town GHG Inventory for the next 10 years.

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6 http://www.dec.ny.gov/docs/administration_pdf/ghgguide.pdf

7 NYSERDA 2001-2015 Patterns and Trends - NYS Energy Profiles – Appendix A-1; https://www.nyserda.ny.gov/-/media/Files/Publications/Energy-Analysis/2001-2015-patterns-and-trends.pdf

8 NYSERDA 2001-2015 Patterns and Trends - NYS Energy Profiles – Table 3-5

5.0 GHG Inventory Forecast: Business as Usual Scenarios

As previously mentioned, a BAU forecast refers to a scenario where the Town pursues no measures or actions aimed at reducing energy consumption and GHG emissions. Following up to the discussion on significant factors affecting the BAU scenario, these three scenarios were identified for detailed analysis:

5.1 BAU – No Growth, No Electricity Grid Carbon Intensity Factor Variation

This scenario presumes no significant changes in Town emissions due to population trends, energy consumption growth, and changes in carbon intensity of the NYS electricity grid. In other words, it assumes that the Town's GHG emissions will remain constant for the forecast period. Since it was determined that population economic growth in the region would not directly affect the Town government operations in the short-term future (10 years), it seems reasonable to evaluate a BAU scenario where external factors (NYS trends in decreasing energy consumption, NYS grid electricity de-carbonization) have no effect on the Town emissions. Therefore, achieving the reduction targets will be entirely dependent on implementing effective energy and emission reduction measures.

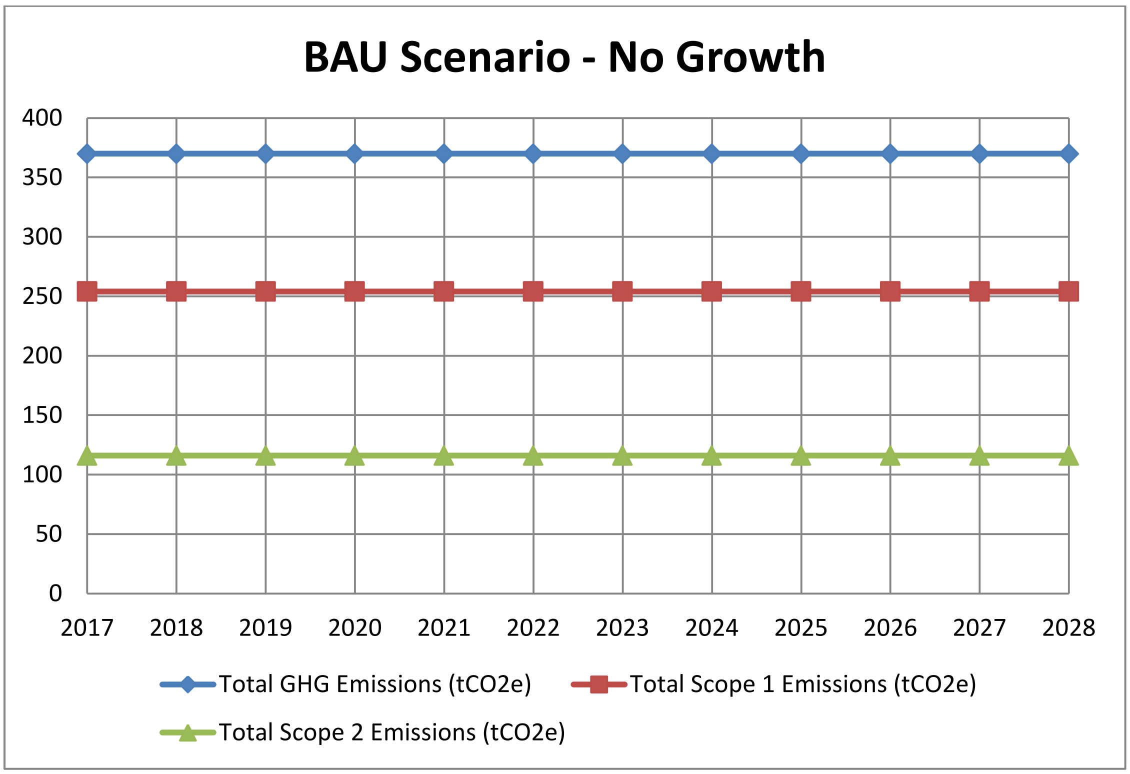
Table 20: BAU - No Growth - GHG Emissions 2017 – 2028 (tCO_2e)

Scope	Year/Source	2017	2018	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028
Scope 2	Buildings - Electricity Energy	47	47	47	47	47	47	47	47	47	47	47	47
Scope 1	Buildings - Propane	8	8	8	8	8	8	8	8	8	8	8	8
Scope 1	Buildings - Fuel Oil No. 2	62	62	62	62	62	62	62	62	62	62	62	62
Scope 1	Fugitives	6	6	6	6	6	6	6	6	6	6	6	6
Scope 2	Streetlights - Electricity Energy	69	69	69	69	69	69	69	69	69	69	69	69
Scope 1	Fleet Vehicle - Gasoline	23	23	23	23	23	23	23	23	23	23	23	23
Scope 1	Fleet Vehicle - Diesel	144	144	144	144	144	144	144	144	144	144	144	144
Scope 1	Fleet- Off Road Fuel Use	11	11	11	11	11	11	11	11	11	11	11	11

Table 21: BAU - No Growth - GHG Emissions 2017 – 2028 by Scope (tCO_2e)

Year/Scope	2017	2018	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028
Total Scope 1 Emissions (tCO2e)	254	254	254	254	254	254	254	254	254	254	254	254
Total Scope 2 Emissions (tCO2e)	116	116	116	116	116	116	116	116	116	116	116	116
Total GHG Emissions (tCO2e)	**370**	**370**	**370**	**370**	**370**	**370**	**370**	**370**	**370**	**370**	**370**	**370**

Figure 14: BAU - No Growth - GHG Emissions 2017 – 2028 by Scope (tCO_2e)



5.2 BAU – Electricity Grid Carbon Intensity Variation

This scenario presumes no significant changes in Town emissions due to population trends or energy consumption growth but takes into account the expected decrease in carbon intensity of the NYS electricity grid, projected at –2 percent/year, thus reducing the electricity grid EF. This scenario assumes that the Town will not take any significant action to decrease its government operations emission but will nonetheless benefit from the progressive de-carbonization of the NYS grid electricity. Therefore, achieving the reduction targets will be in part facilitated by the measures implemented by the electric utilities at state level. The reduction will be significant for Scope 2 emission, but it will have no effect on Scope 1 emissions.

Table 22: BAU – Electricity Grid EF - GHG Emissions 2017 – 2028 (tCO_2e)

Scope	Year/Source	2017	2018	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028
Scope 2	Buildings - Electricity Energy	47	46	45	44	43	42	42	41	40	39	38	38
Scope 1	Buildings - Propane	8	8	8	8	8	8	8	8	8	8	8	8
Scope 1	Buildings - Fuel Oil No. 2	62	62	62	62	62	62	62	62	62	62	62	62
Scope 1	Fugitives	6	6	6	6	6	6	6	6	6	6	6	6
Scope 2	Streetlights - Electricity Energy	69	68	66	65	64	63	61	60	59	58	57	55
Scope 1	Fleet Vehicle - Gasoline	23	23	23	23	23	23	23	23	23	23	23	23
Scope 1	Fleet Vehicle - Diesel	144	144	144	144	144	144	144	144	144	144	144	144
Scope 1	Fleet- Off Road Fuel Use	11	11	11	11	11	11	11	11	11	11	11	11

Table 23: BAU - Electricity Grid EF - GHG Emissions 2017 – 2028 by Scope (tCO_2e)

Year/Scope	2017	2018	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028
Total Scope 1 Emissions (tCO_2e)	254	254	254	254	254	254	254	254	254	254	254	254
Total Scope 2 Emissions (tCO_2e)	116	114	111	109	107	105	103	101	99	97	95	93
Total GHG Emissions (tCO_2e)	**370**	**368**	**365**	**363**	**361**	**359**	**357**	**355**	**353**	**351**	**349**	**347**

Table 24: BAU - Electricity Grid EF - GHG Emissions Variation to Base Year 2017 (%)

Year/ Scope	2018	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028
Scope 1 Emissions Change (%)	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
Scope 2 Emissions Change (%)	-1.7%	-4.3%	-6.0%	-7.8%	-9.5%	-11.2%	-12.9%	-14.7%	-16.4%	-18.1%	-19.8%
Total GHG Emissions Change (%)	-0.5%	-1.4%	-1.9%	-2.4%	-3.0%	-3.5%	-4.1%	-4.6%	-5.1%	-5.7%	-6.2%

The results of the forecast are also shown in the charts below:

Figure 15: BAU – Electricity Grid EF - GHG Emissions 2017 – 2028 (tCO_2e)

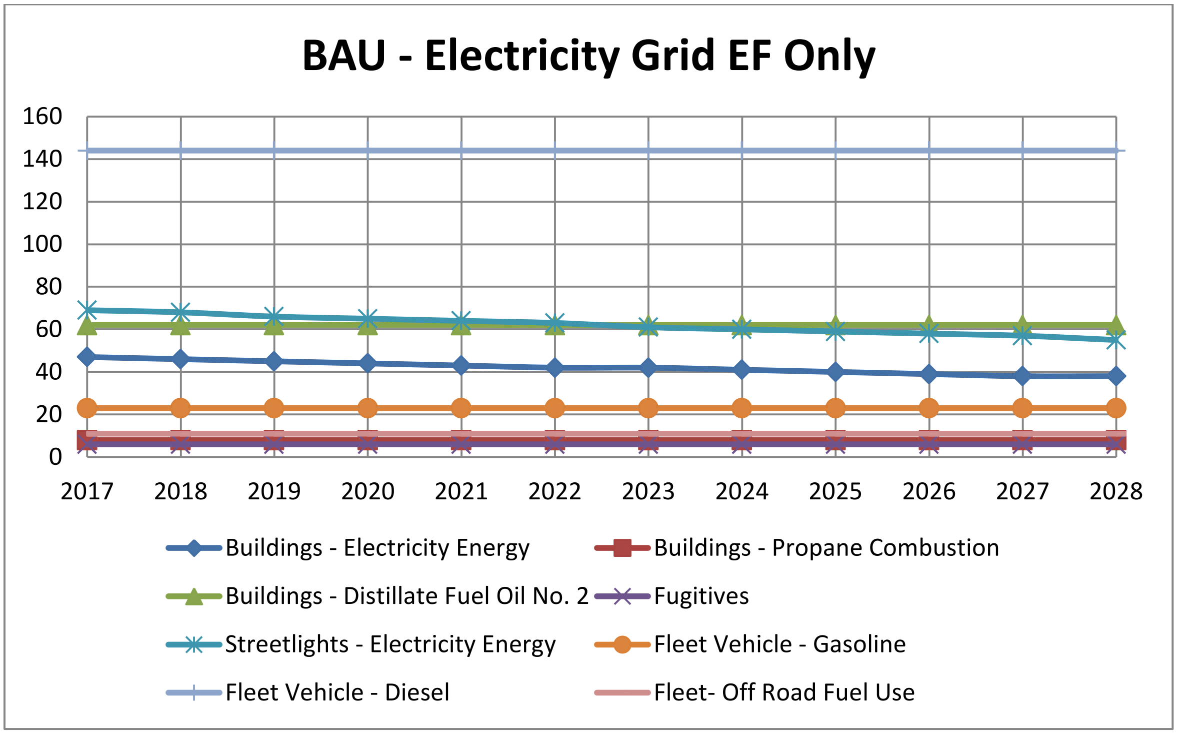


Figure 16: BAU - Electricity Grid EF - GHG Emissions 2017 – 2028 by Scope (tCO_2e)

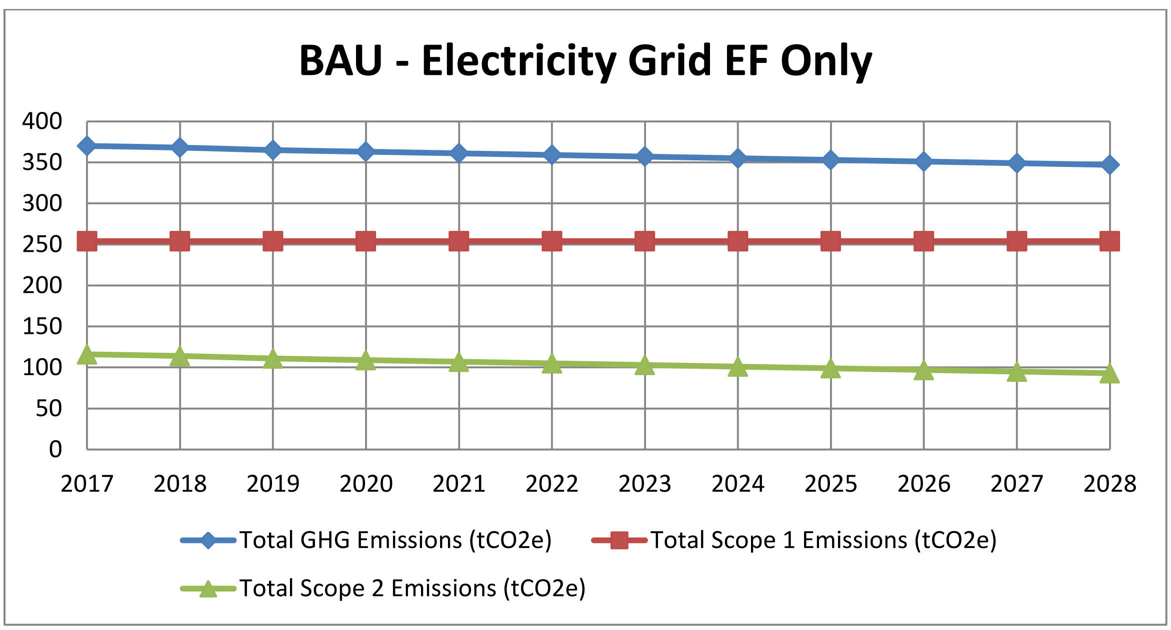
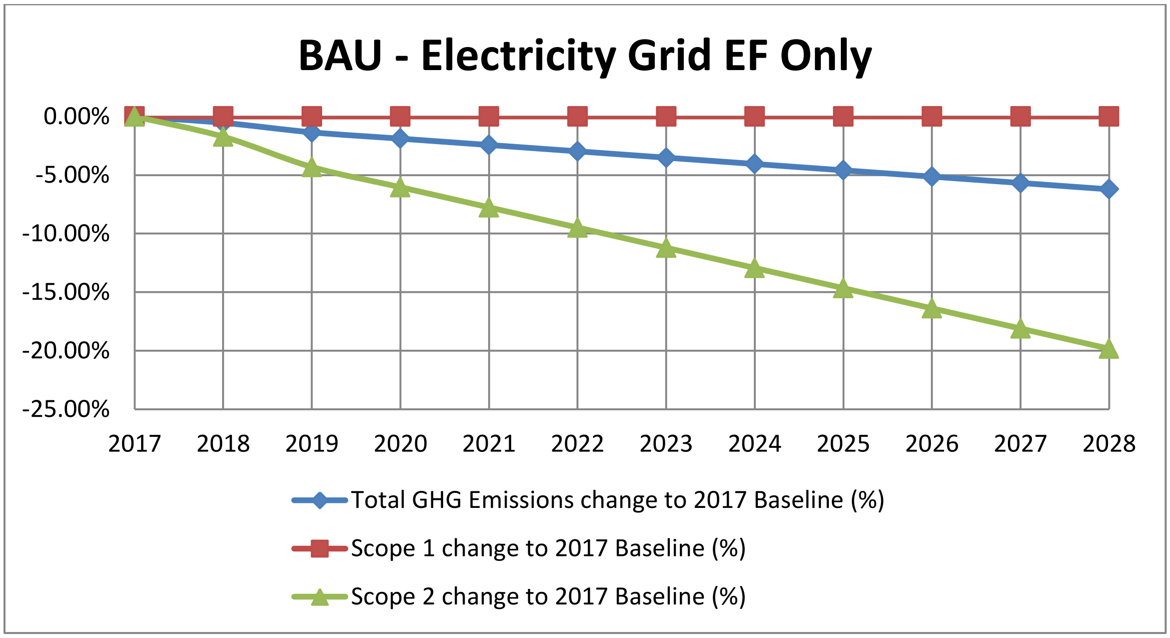


Figure 17: BAU - Electricity Grid EF - GHG Emissions Variation to Base Year 2017 (%)



The results show that total GHG emissions are expected to be reduced by 6 percent by 2028, with a decrease of approximately 20 percent for Scope 2 emissions, while Scope 1 remains unchanged. The decrease of Scope 2 is attributable to the electricity grid de-carbonization.

5.3 BAU – EIA Energy Consumption Trend, Electricity Grid Carbon Intensity Variation

This scenario applies the EIA 2016-2050 energy consumption outlook trends (mostly decreases, see page 29) to the various categories of energy and emissions included in the Town's GHG inventory base year. The scenario also takes into account the expected decrease in carbon intensity of the NYS electricity grid, projected at –2 percent/year, as described in the previous paragraph. While this scenario does not specify any specific reduction implemented by the Town government, the actions are somewhat implied within the EIA projections where the decrease in energy consumption and associated emissions is predicted as a consequence of technology advancement, mandated stricter energy efficiency, and emissions requirements at Local, State and Federal level, and behavioral changes by end-users in the community. This BAU scenario also benefits from the progressive de-carbonization of the NYS grid electricity. As such, this scenario should be interpreted as a prediction of the results that could be achieved by the Town if it correctly plans and implements measures in line with the expected trend in energy efficiency, renewable energy, and general technology advancement. The reduction will be significant for both Scope 1 and Scope 2 emissions, as shown in the tables and charts below.

Table 25: BAU – EIA Energy Consumption Trend, Electricity Grid EF Variation - GHG Emissions 2017 – 2028 (tCO_2e)

Scope	Year/Source	2017	2018	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028
Scope 2	Buildings - Electricity Energy	47	46	44	43	42	40	39	38	37	36	35	34
Scope 1	Buildings - Propane	8	8	8	8	8	8	8	8	8	8	8	8
Scope 1	Buildings - Fuel Oil No. 2	62	61	60	59	58	57	55	54	53	52	51	50
Scope 1	Fugitives	6	6	6	6	6	6	6	6	6	6	6	6
Scope 2	Streetlights - Electricity Energy	69	67	65	63	61	59	58	56	54	53	51	49
Scope 1	Fleet Vehicle - Gasoline	23	22	22	22	21	21	20	20	19	19	18	18
Scope 1	Fleet Vehicle - Diesel	144	144	143	142	142	141	140	139	139	138	137	137
Scope 1	Fleet- Off Road Fuel Use	11	11	11	10	10	10	10	10	10	10	10	10

Table 30: BAU - EIA Energy Consumption Trend, Electricity Grid EF Variation - GHG Emissions 2017 – 2028 by Scope (tCO_2e)

Year/Scope	2017	2018	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028
Total Scope 1 Emissions (tCO_2e)	254	252	250	247	245	243	239	237	235	233	230	229
Total Scope 2 Emissions (tCO_2e)	116	113	109	106	103	99	97	94	91	89	86	83
Total GHG Emissions (tCO_2e)	**370**	**365**	**359**	**353**	**348**	**342**	**336**	**331**	**326**	**322**	**316**	**312**

Table 31: BAU - EIA Energy Consumption Trend, Electricity Grid EF Factor Variation - GHG Emissions Variation to Base Year 2017 (%)

Year/Scope	2018	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028
Scope 1 Emissions Change (%)	-0.79%	-1.57%	-2.76%	-3.54%	-4.33%	-5.91%	-6.69%	-7.48%	-8.27%	-9.45%	-9.84%
Scope 2 Emissions Change (%)	-2.59%	-6.03%	-8.62%	-11.21%	-14.66%	-16.38%	-18.97%	-21.55%	-23.28%	-25.86%	-28.45%
Total GHG Emissions Change (%)	**-1.35%**	**-2.97%**	**-4.59%**	**-5.95%**	**-7.57%**	**-9.19%**	**-10.54%**	**-11.89%**	**-12.97%**	**-14.59%**	**-15.68%**

The results of the forecast are also shown in the charts below:

Figure 18: BAU – EIA Energy Consumption Trend, Electricity Grid EF Variation - GHG Emissions 2017 – 2028 (tCO_2e)

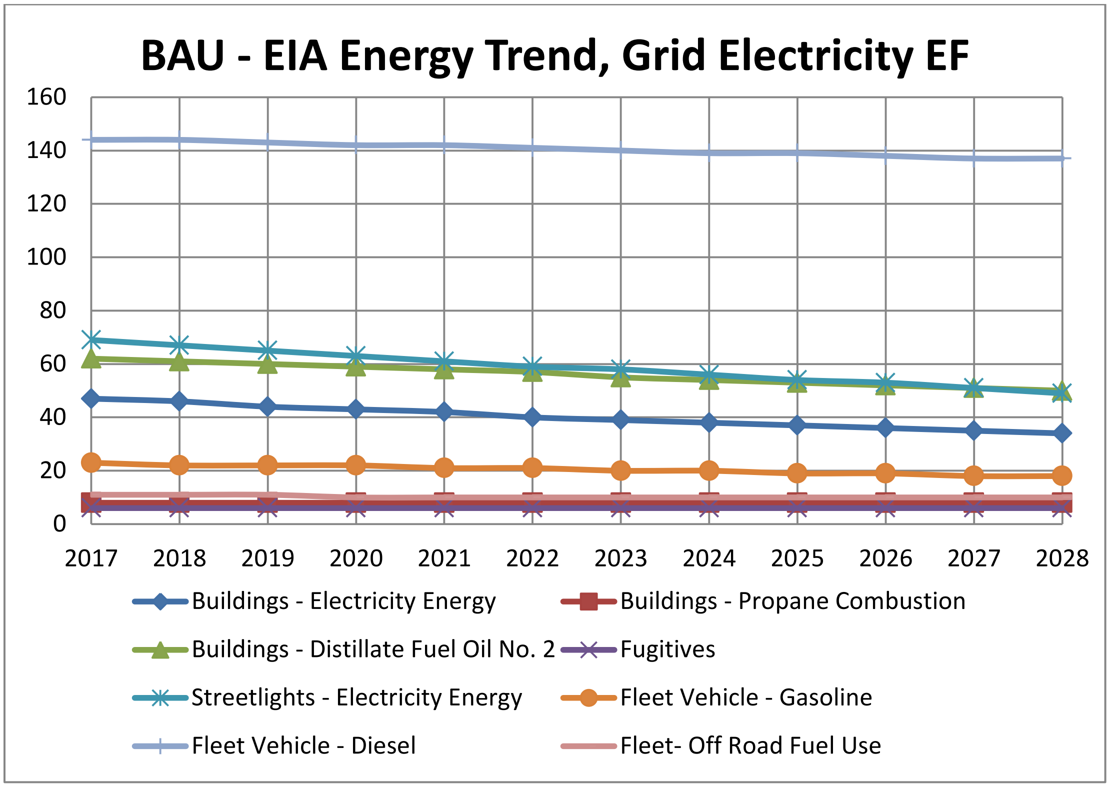


Figure 19: BAU - EIA Energy Consumption Trend, Electricity Grid EF Variation - GHG Emissions 2017 – 2028 by Scope (tCO_2e)

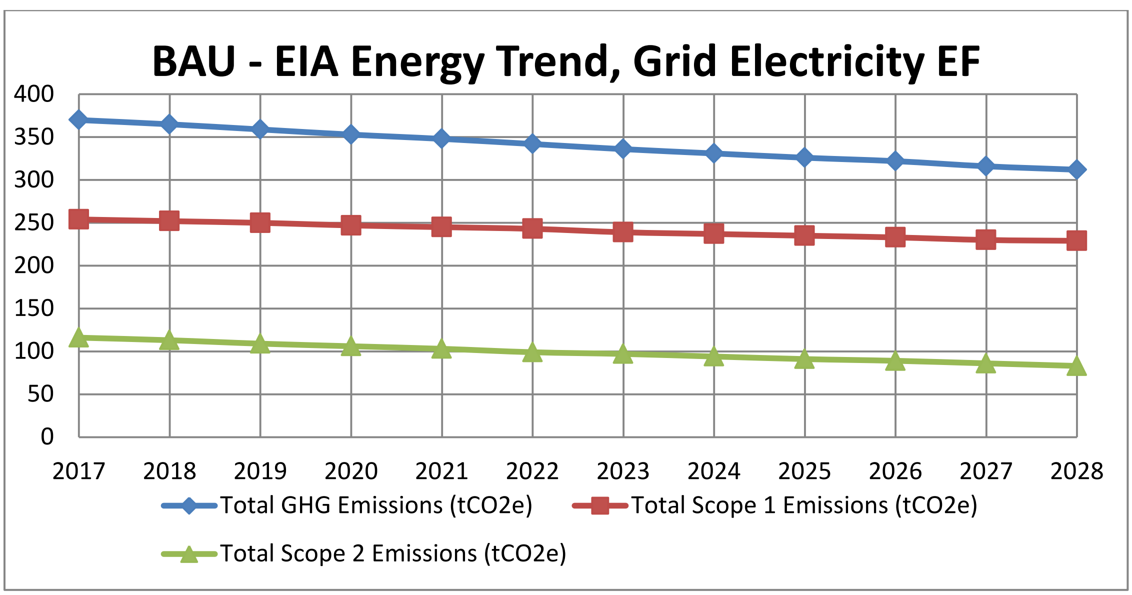
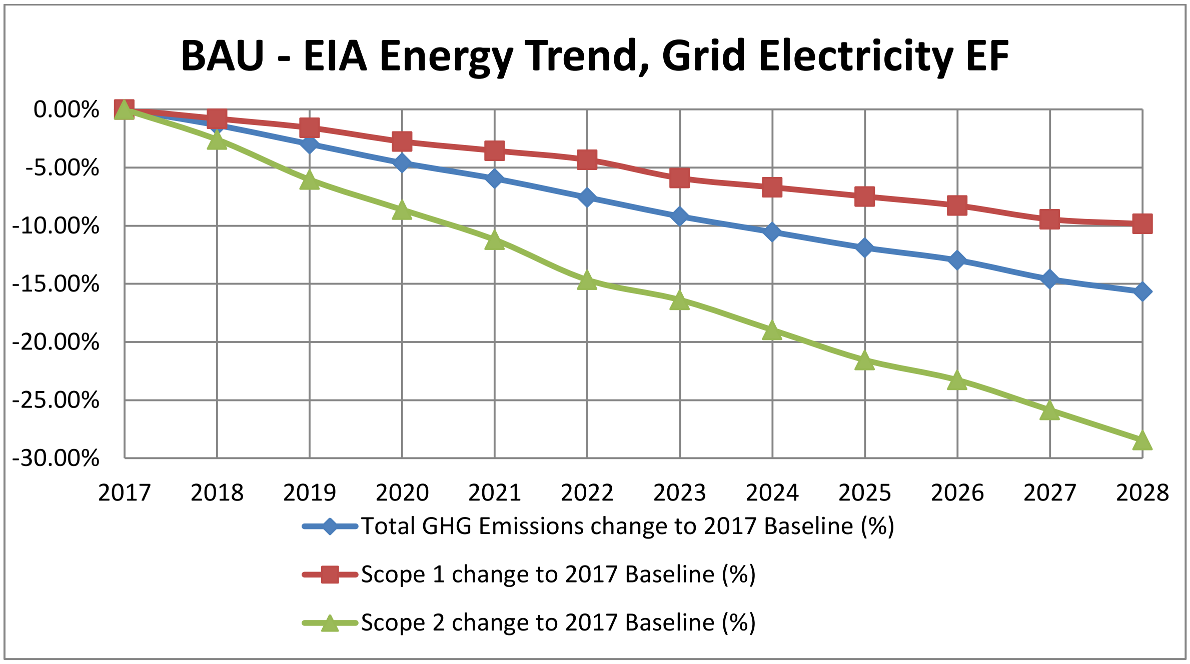


Figure 20: BAU - EIA Energy Consumption Trend, Electricity Grid EF Factor Variation - GHG Emissions Variation to Base Year 2017 (%)



The results show that total GHG emission are expected to be reduced by 15 percent by 2028, with a larger decrease (~28 percent) for Scope 2 emissions while Scope 1 could decrease by approximately 10 percent. The larger decrease of Scope 2 is attributable to the combined effect of reduction in energy consumption and electricity grid de-carbonization.

6. GHG Emission Reduction Goals

The results of the forecast discussed above provide the basis to establish appropriate reduction goals and targets that could be reasonably achievable by the Town. Such goals should be in line with the future trends of energy consumption and GHG emissions reductions expected to be mandated at State and Federal level, due to technology progress as well as voluntary operational and behavioral changes at Town and community level. The reduction goals are set in terms of a percentage reduction in emissions by a target year compared to the base year. The target years have been indicated by the Town as 1 year, 5 years, and 10 years from the base year. Because the inventory is completed in 2018 based on 2017 year data, we assume that the first year of implementation would end in 2019, the fifth year would be the end of 2023 and the tenth would be completed by the end of 2028.

Regarding the reduction goals, the results in Table 28 indicate that reductions of 2.97 percent by the end of 2019, 9.19 percent by 2023, and possibly 15.68 percent by 2028 could be reasonably expected according to the best case BAU forecasted. Based on these results, it seems reasonable to propose emission reduction goals of 3 percent by the end of 2019, 10 percent by 2023, and 20 percent by 2028, increasingly going above and beyond the best case BAU forecasted trends as more time is allowed for measures implemented by the Town to take effect.

In summary the proposed emission reduction goals are the following:

Table 26: 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%	11.1
Year 5	2023	10%	37
Year 10	2028	20%	74

7. GHG Emission Reduction Measures

In order to achieve the reduction goals described in the previous paragraph, the Town must identify a series of GHG emission reduction measures tailored at achieving such goals within the established timeline. The analysis of the Town 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 Town 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, the selected measures should be in line with the requirements of the NYS CSC, maximizing the points earned to achieve registration.

The review of the Scope 1 and Scope 2 emissions inventory results included at Paragraphs 5.1 and 5.2 highlighted that the largest contributions were identifiable in the diesel fuel consumption by the vehicle fleet (specifically the heavy trucks) and the districts' street lighting. 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:

Emission Reduction Measure	Target Scope and Sector	NYS CSC Action Item Reference	NYS CSC Action #	NYS CSC Points
Town Hall Lighting Sensors	Scope 2 – Electricity in Buildings	PE3 Action: Interior Lighting Upgrades	3.2	1-5
Town Hall retrofit - energy efficiency	Scope 2 – Electricity in Buildings Scope 1 – Stationary Combustion in Buildings	PE3 Action: HVAC Upgrades	3.3	1-5
Electric- Hybrid Vehicle	Scope 1 – Mobile Combustion	PE3 Action: Advanced Vehicles	3.12	2-10
Vehicle Fleet Rightsizing	Scope 1 – Mobile Combustion	PE3 Action: Fleet Rightsizing	3.11	1-3
LED Streetlight Replacement - Phases	Scope 2 – Electricity Street Lights	PE3 Action: LED Street Lights	3.15	5-10
Town Ballfield LED lights Replacement	Scope 2 – Electricity Facilities	PE3 Action: Outdoor Lighting Upgrades	3.18	1-4
Solar Energy – Power Purchase Agreement	Scope 2 – Electricity in Buildings, Street Lights	PE4 Action: Green Power Procurement Policy	4.1	2-4

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 2018-2028 period, allowing development of the best implementation strategy to maximize the benefits while distributing the costs of deploying each measure over the target period.

7.1 Town Hall Lighting Sensors

This is a relatively simple energy reduction measure requiring the installation of occupancy sensors in the Town administrative building. ClearPath provides an estimate of the potential savings according to the square footage area of the building and the destination use, based on past experience. An estimate of the implementation cost is also provided, according to building area, budgeted at $6,000. The Town may have the staff and resources to do the upgrade work in-house or may opt to hire a contractor. There might be opportunities to offset costs through rebates, financing, or incentives provided through local utilities or through NYSERDA or NYSEG. The measure could be combined with upgrades to the indoor lighting system and qualify for NYS CSC PE3 Action # 3.2, "Interior Lighting Upgrades." According to the US Department of Energy factor[9] provided by ClearPath, the installation of occupancy sensors could potentially reduce the lighting electricity consumption in the Town office by 35 percent, approximately 9,600 kWh/year. The overall benefits in terms of the GHG Inventory are estimated at 2-3 tCO2e/year.

Change Electricity Use (kWh/Year)	Emission Reduction (tCO_2e/year)	Estimated Cost	Electricity Savings ($/Year)
-9,604	-2	$6,000	$1,000

7.2 Town Hall Retrofit - Energy Efficiency

This measure follows the previous action by recommending additional improvements to the Town 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 NYS CSC PE3 action # 3.3 (HVAC Upgrades) and possibly # 3.5 (Building Energy Management System). Recommendations for possible HVAC upgrades will probably be the outcome of PE3 action # 3.1 (Government Building Energy Audits), in the process of being planned by the Town. ClearPath estimates a budget expense of $12,000 based on the Town building area, expecting to provide savings of ~10,000 kWh/year for electricity and 52 MMBtu in heating fuel (approximately 15 percent of current heating oil annual consumption). The expected overall GHG emission reduction is estimated at ~6 tCO2e/year. The estimate was conducted only for the main Town building but could be extended also to other Town facilities, potentially increasing the energy and emission reductions.

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)
-10,400	-52	-6	$12,000	$1,600	$1,650

[9] https://www1.eere.energy.gov/buildings/publications/pdfs/corporate/pnnl-15149_market_assessment.pdf - Table 2.11

7.3 Electric- Hybrid Vehicle

While the Town vehicle fleet is responsible for a large share of the GHG emission, the passenger vehicles in the fleet represent a very small portion of the fleet (currently one vehicle only). According to ClearPath estimates, replacing the current Town passenger vehicle with a hybrid engine model would more than double the fuel efficiency (from 23 mpg to 52 mpg) and save approximately 1.5 tCO_2e per year, at current level of miles driven. Emission reduction could be even higher if the Town opted for a full electric vehicle or a plug-in hybrid, where fuel use would be drastically reduced or eliminated. Because of the higher price of a hybrid or electric vehicle compared to conventional engines and the relative low miles driven per year (~5,000 according to the data provided), Town budget considerations would have to be weighed against the relatively small fuel cost savings and environmental benefits.

Change Fuel Use (Gal/Year)*	Emission Reduction (tCO_2e/year)	Estimated Cost	Fuel Savings ($/Year)*
-110	-1.5	TBD	$300

Based on 5,000 miles annually VMT

7.4 Vehicle Fleet Efficiency and Rightsizing

This measure combines the NYS CSC actions 3.9; 3.10, and 3.11 recommending the Town to conduct a complete fleet inventory, develop a fleet efficiency policy, and plan for review of the fleet composition, eliminating older, inefficient vehicles where possible. LGOs sometimes have more vehicles than needed in their local government fleets, and larger vehicles are often used for tasks that could be accomplished with smaller, more fuel-efficient vehicles. By monitoring the vehicle fleet composition and usage, the Town could identify opportunities to reduce fuel usage by matching the right vehicle with the right task, possibly consolidating the overall number of vehicles. ClearPath includes a module to simulate this measure, assuming a certain fuel mileage efficiency increase as a result of this action. For the diesel fleet, it was assumed that the combination of the actions described could lead to a 10 percent increase in fuel efficiency, raising the current fleet average consumption from 4.24 mpg to 4.66 mpg, saving approximately 1,400 gallons of fuel per year. This will reduce emissions by approximately 14 tCO_2e per year. A similar measure for the gasoline fuel fleet was estimated assuming an increase in efficiency of 5 percent due to the smaller size of the fleet (less opportunity to consolidate) and the lower average age of the fleet. The result is a potential saving of 130 gallons of fuel and 1.5 tCO_2e per year.

Fleet Fuel	Change Fuel Economy (%)	Change Fuel Use (Gal/Year)*	Emission Reduction (tCO_2e/year)	Estimated Cost	Fuel Savings ($/Year)*
Diesel	10	-14,000	-14.0	TBD	$4,240
Gasoline	5	-130	-1.5	TBD	$365

7.5 LED Streetlight Replacement

This measure is consistent with NYS CSC PE3 action #3.15: LED Street Lights, recommending the upgrade of the street lights within the Town boundary to advanced street light technology such as light-emitting diodes (LEDs). This measure can reduce street light energy use by as much as 70 percent. Besides saving energy and reducing electricity costs, the installation of efficient street lights is also a demonstration of the Town's commitment to resource conservation that can be seen by the community it serves.

Currently the Town does not own the 287 street lights installed in the five lighting districts within the jurisdiction. The lights are owned by the utility (NYSEG) and the Town pays a monthly fee for each light, plus the energy consumption. The fee per light varies from ~$4 to as high as ~$15, depending on the type and size of each light and on average the Town pays $1,700 in fees each month (~$20,600/year). The average electricity consumption is ~20,000 kWh per month, costing approximately an additional $2,000 per month. Since the Town 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 purchase its own LED streets lights and replace the utility-owned ones with municipally-owned LEDs. 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 Town's specification rather than going by the standard options offered by the utility. The Town should take advantage of NYS LED upgrades initiative promoted through NYSERDA, including the Mid-Hudson Street Light Consortium (MHSC), in order to explore the possible options, costs, and financing solutions for the implementation of this measure.

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 Town jurisdiction shows many different types and sizes of lights including mercury vapor (MRC), high pressure sodium (HPS), and metal halide (MHL):

Lighting District	Total Lights	100W MRC	175W MRC	250W MRC	400W MRC	50W HPS	70W HPS	100W HPS	150W HPS	250W HPS	400W HPS	250W HPS Flood	175W MHL
Dogtail Corner	**4**								4				
Dover Plains	**122**	24	50	5	6	3	2	11	2	16	2	1	
Wingdale	**137**		57	1	4	1	2	42	7	21	1		1
Farm & Mitchell Dr.	**17**					1	16						
Town Park	**7**				2				4	1			
	287	149				137				1			

ClearPath provides a suggested LED replacement for various light types and average wattage size currently installed. Default selections can be overridden and replacement sizes were selected according to the guidance provided by NYSEG and MHSC[10]. Due to the limitations of the tool, it was opted for an average 66W LED replacement 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 estimates found in literature. As such, the estimated cost of purchasing and

[10]http://courtneystrong.com/wp-content/uploads/2017/03/NYSEG_CASE_16E0710_MHSC_comments.pdf

replacing all the lights would be $88,700. The annual energy savings are estimated as 66 percent of the original consumption, or ~150,000 kWh, saving ~$16,000 in energy cost in addition to eliminating the ~$20,600 per year currently paid for street light fees. The GHG emission reduction is estimated at approximately 43 tCO_2e per year.

Change Electricity Use (kWh/Year)	Emission Reduction (tCO_2e/year)	Estimated Cost	Electricity Savings ($/Year)	Other Utility Fee Savings ($/year)*
-152,000	-43	$88,700	-$15,000	-20,000

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

7.6 Town Ballfield LED Lights Replacement

In line with the previous measure, the Town should also consider upgrading the outdoor lighting for the facilities it owns and operates. The two electricity accounts for the Route 55 Field and Route 55 Ballfield alone accounted for 40,500 kWh of electricity. This measure is consistent with NYS CSC PE3 action #3.18 - Outdoor Lighting Upgrade and possibly action #3.17 - Outdoor Lighting Reduction, if the measure consists of both upgrading and consolidating the existing lighting system. A precise inventory of the outdoor lighting was not available, but using the same approach adopted for the street lights, a reduction of ~66% for electricity consumption was estimated, adding approximately 8 tCO2e to the potential GHG emissions reduction. The cost estimated by ClearPath totals $12,400, with an annual saving of $4,200 in electricity cost alone. The higher saving is due to the fact the rate price for Town accounts (~14.8 cents/kWh) is higher than the rare for street lights accounts (~9.8 cents/kWh).

Change Electricity Use (kWh/Year)	Emission Reduction (tCO_2e/year)	Estimated Cost	Electricity Savings ($/Year)
-28,000	-8	$12,400	-$4,200

7.7 Solar Energy – Power Purchase Agreement

This measure is included in the NYS CSC checklist, PE4 - Shift to clean, renewable energy, Action #4.1 - Green Power Procurement Policy. The action recommends the adoption of a policy requiring the use of renewable energy to meet the Town's government operation demand.

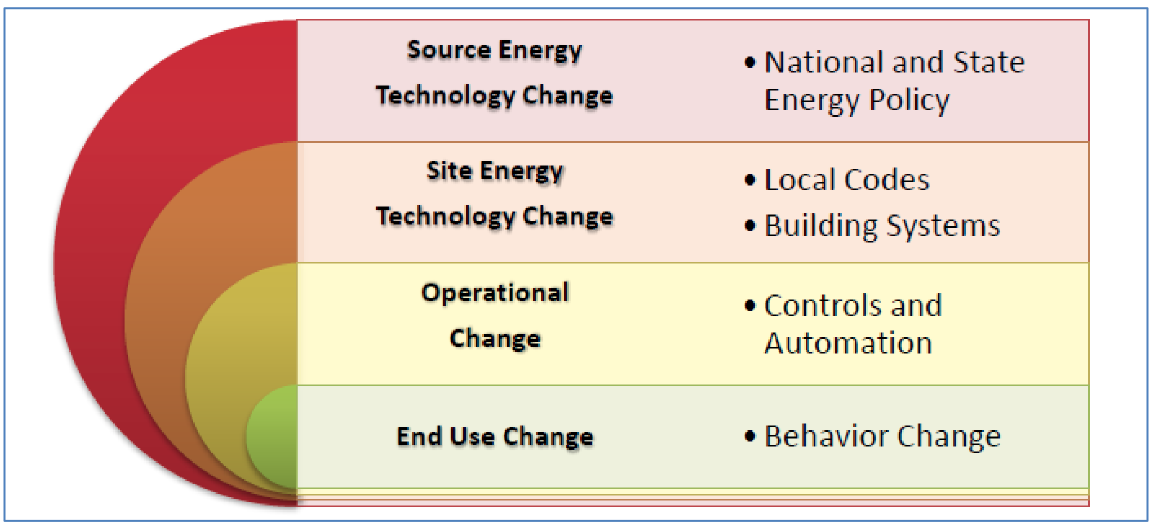
The policy should include a commitment to allocate funding for the purchase of renewable energy, renewable energy credits (RECs), and/or the installation of renewable energy systems. In the case of Dover, because of the close proximity with a solar photovoltaic farm currently under development by Cypress Creek Renewables, it seems a great opportunity that the Town explore the possibility or procuring a portion of the electricity demand from local renewable energy projects. For the estimate in ClearPath, we assumed that the Town procures 60,000 kWh per year, sufficient to supply the entire electricity annual consumption by the Town building. This is equivalent to reducing the GHG emissions by 16.5 tCO_2e per year. ClearPath does not provide an estimate of the probable additional cost of procuring renewable electricity only, but it was estimated that the rate increase could range between $0.03 and $0.05 per kWh, totaling ~$1,800-$3,000 per year.

Renewable Energy Purchase (kWh/Year)	Emission Reduction (tCO_2e/year)	Estimated Cost
60,000	-16	$1,800-$3,000

8. Emission Reduction Planning

ClearPath includes a planning module that allows evaluating the potential impacts of the emission reduction measures identified in the previous chapter. The module provides a tool for assessing the effectiveness of the proposed measures 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 choosing 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. For example, the street lights LED replacement previously described has been split into three phases, allowing for more flexibility in the implementation timeline and distributing the investment cost over a longer period. The objective is to plan the reduction actions in order to meet the reduction goals timeline, balancing the priority of achieving the emission as early as possible with costs and budget 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 replacing a heating furnace) 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 21: 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 27: Summary of GHG Emissions Reduction Measures

Reduction Measure	NYS CSC Action #	Expected GHG Emission Reduction ($tCO_2e/year$)	Priority	Comment
PPA - Solar Energy	4.1	-16	1	Simple implementation; Low-Medium Cost; Significant GHG emissions reduction
LED Streetlight Replacement	3.15	-43	1	Complex implementation; High Cost; Significant GHG emissions reduction
Diesel Fleet Rightsizing	3.11	-14	2	Medium complexity implementation; Low Cost; Significant GHG emissions reduction
LED Lights Replacement - Ballfield	3.18	-8	2	Medium complexity implementation; Medium Cost; Medium GHG emissions reduction
Gasoline Fleet Rightsizing	3.11	-1.5	3	Medium complexity implementation; Low Cost; Medium GHG emissions reduction
Town Hall Lighting Sensors	3.2	-2	3	Simple implementation; Low cost; Minor GHG emissions reduction
Electric-Hybrid Vehicle	3.12	-1.5	3	Simple complexity implementation; Medium Cost; Significant GHG emissions reduction
Town Hall retrofit - energy efficiency	3.3	-6	3	Medium complexity implementation; Medium Cost; Medium GHG emissions reduction

The priority order should also take into account the reduction goals at Year 1, 5 and 10, 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; due to the complexity of planning and implementation, the street lights LED replacement has been split in three phases and is planned to start only in 2020, allowing sufficient time for the Town to plan for the financing and implementation.

Table 28: GHG Emission Reduction Measures Implementation Timeline

Reduction Measure	Year of Implementation	End Year of Forecast
PPA - Solar Energy	2019	2028
Town Hall Lighting Sensors	2019	2028
LED Streetlight Replacement - Phase I	2020	2028
LED Streetlight Replacement - Phase II	2021	2028
LED Streetlight Replacement - Phase III	2022	2028
Diesel Fleet Rightsizing	2022	2028
Gasoline Fleet Rightsizing	2022	2028
LED Lights Replacement - Ballfield	2023	2028

Reduction Measure	Year of Implementation	End Year of Forecast
Electric- Hybrid Vehicle	2023	2028
Town Hall retrofit - energy efficiency	2024	2028

The planning of the reduction measures and the estimate of the emission reduction was conducted using the BAU scenarios described at paragraphs 8.1 and 8.2. The results are shown in the tables and charts below.

Table 29: GHG Emission Reduction Plan – BAU No Growth scenario (tCO_2e)

GHG Emissions ($t\ CO_2e$)	2017	2018	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028
Buildings & Facilities	117	117	97	97	97	97	97	94	94	94	94	94
Street Lights & Traffic Signals	69	69	69	56	42	26	18	18	18	18	18	18
Vehicle Fleet	178	178	178	178	178	163	162	162	162	162	162	162
Process & Fugitive Emissions	6	6	6	6	6	6	6	6	6	6	6	6
Total Emissions	370	370	350	337	323	292	283	280	280	280	280	280
Reduction to 2017 Baseline	0	0.0%	**-5.4%**	-8.9%	-12.7%	-21.1%	**-23.5%**	-24.3%	-24.3%	-24.3%	-24.3%	**-24.3%**
Reduction to BAU Scenario	0	0.0%	-5.4%	-8.9%	-12.7%	-21.1%	-23.5%	-24.3%	-24.3%	-24.3%	-24.3%	-24.3%
1 Year Goal: - 3%			358.9									
5 Year Goal: -10%							333					
10 Year Goal: -20%												296

This BAU scenario assumes that the base year GHG inventory does not change in the 10 years projection interval considered. As discussed in Paragraph 8.1, no significant drivers of emissions growth were identified for the Town, for the short term 10 years forecast. This assumption allows evaluating the absolute decrease in GHG emissions entirely attributable to the planned measures, not considering any additional changes in emissions resulting to activities and policies implemented at higher level, such as State, Federal. The results in the table show that the reduction measures are expected to achieve the planned reduction goals, actually potentially exceeding the 10 years goal of 20 percent reduction compared to 2017 baseline by 4.3 percent.

Figure 22: GHG Emission Reduction Plan – BAU No Growth scenario

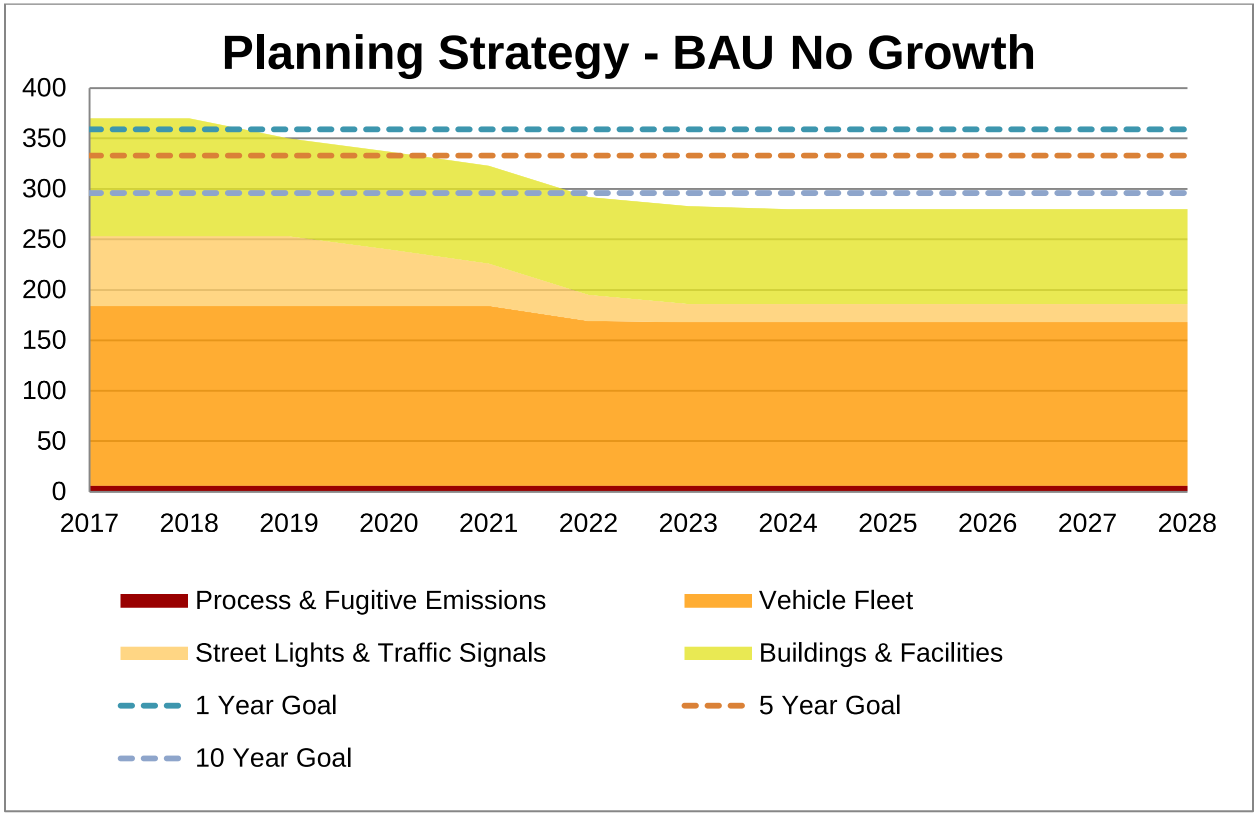
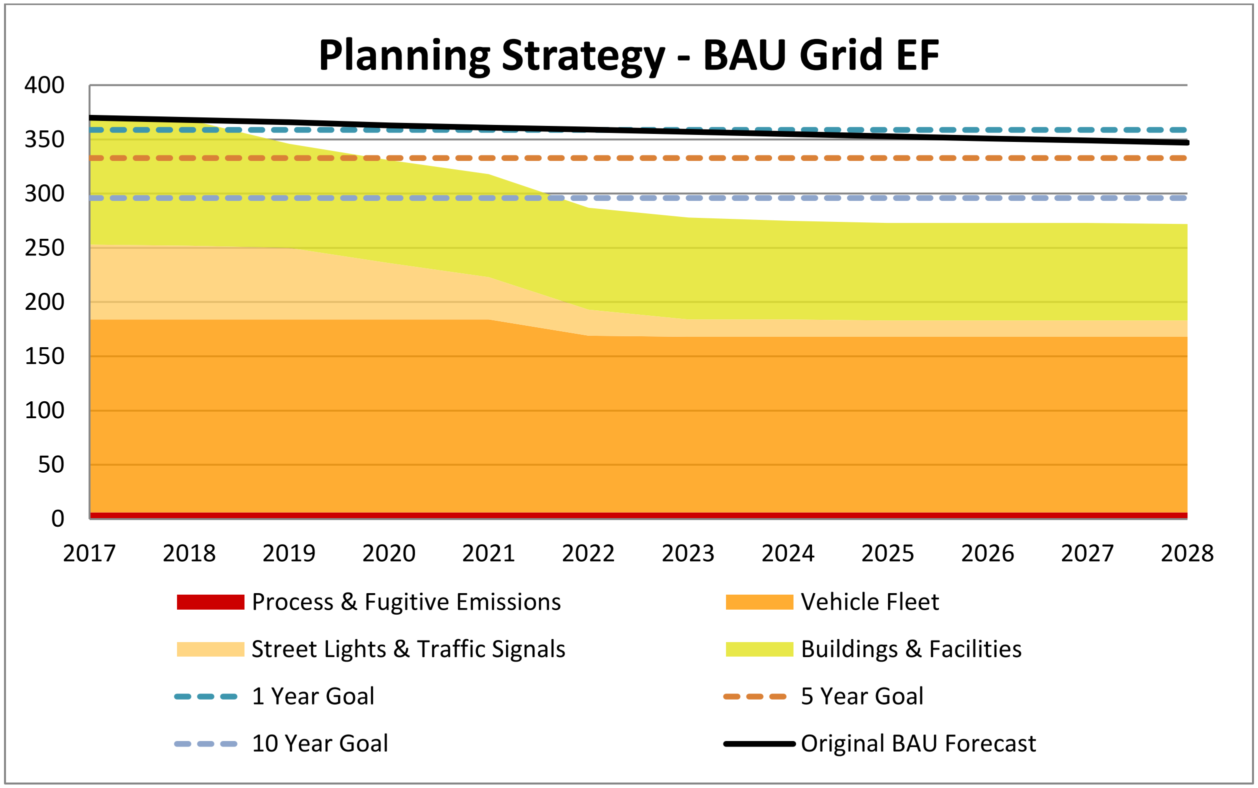


Table 30: GHG Emission Reduction Plan – BAU Grid EF

GHG Emissions ($t\ CO_2e$)	2017	2018	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028
Buildings & Facilities	117	116	96	95	95	94	94	91	90	90	90	89
Street Lights & Traffic Signals	69	68	66	52	39	24	16	16	15	15	15	15
Vehicle Fleet	178	178	178	178	178	163	162	162	162	162	162	162
Process & Fugitive Emissions	6	6	6	6	6	6	6	6	6	6	6	6
Total Emissions	370	368	346	331	318	287	278	275	273	273	273	272
Original BAU Forecast	370	368	366	363	361	359	357	355	353	351	349	347
Reduction to 2017 Baseline	0	-0.5%	**-6.5%**	-10.5%	-14.1%	-22.4%	**-24.9%**	-25.7%	-26.2%	-26.2%	-26.2%	**-26.5%**
Reduction to BAU Scenario	0	0.0%	-5.5%	-8.8%	-11.9%	-20.1%	-22.1%	-22.5%	-22.7%	-22.2%	-21.8%	-21.6%
1 Year Goal: - 3%			358.9									
5 Year Goal: -10%							333					
10 Year Goal: -20%												296

This BAU scenario assumes that the base year GHG inventory is progressively reduced due to the de-carbonization of the NYS electricity grid supply. Similar to the previous scenario, no significant drivers of emissions growth were identified for the Town, for the short term 10 years forecast. This scenario therefore evaluates the decrease in GHG emissions due to the combined effect of the planned measures and activities and policies implemented at higher level, such as State, Federal. The results in the table show that the overall impact is expected to achieve the planned reduction goals, actually potentially exceeding the 10 years goal of 20 percent reduction compared to 2017 baseline by 6.5 percent. The actual reduction compared to the decreasing BAU emissions is obviously lower, reaching 21.6 percent by 2028.

Figure 23: GHG Emission Reduction Plan – BAU Grid EF



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 were received from primary sources (i.e., invoices) and backup data were 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.