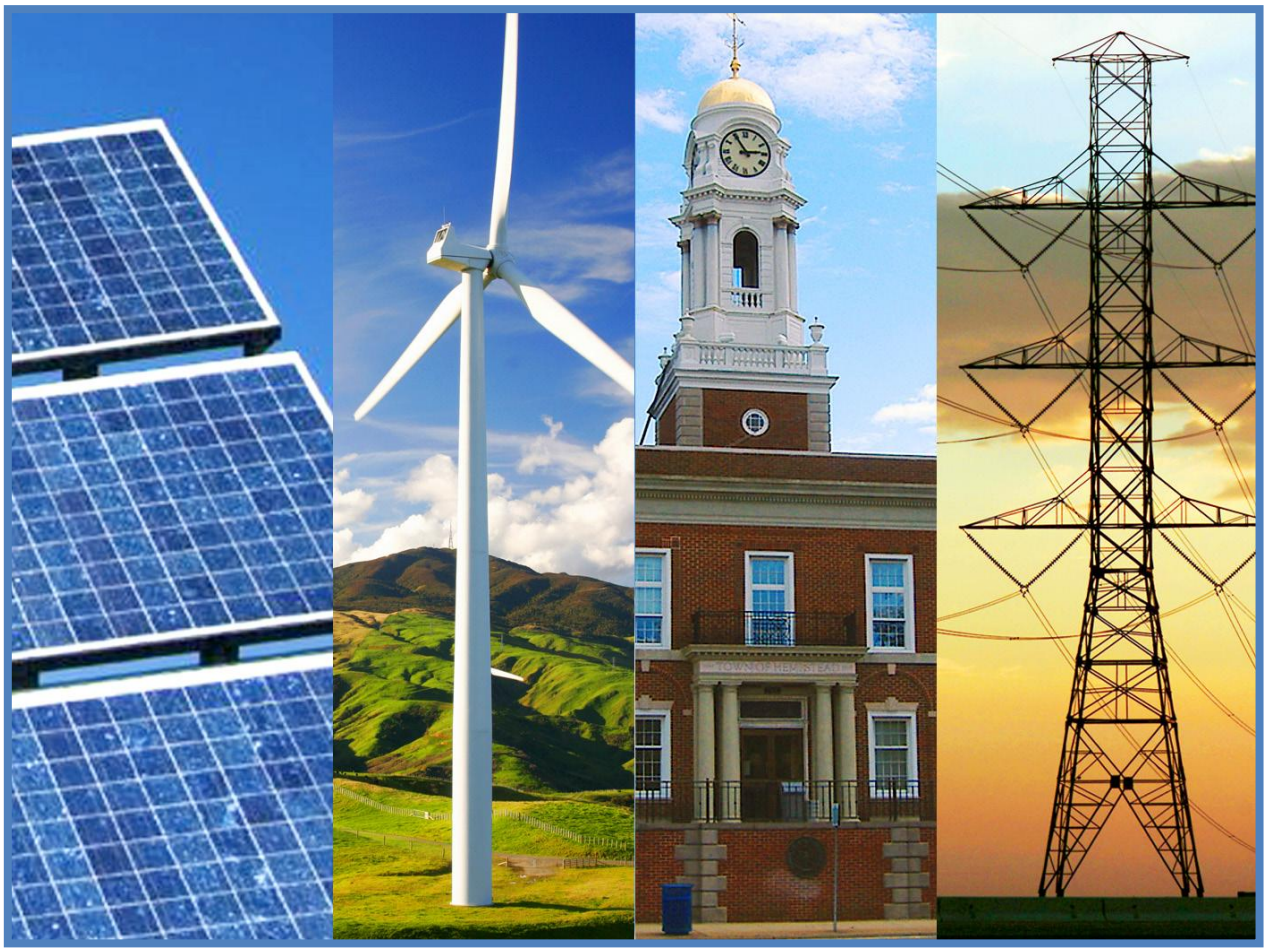
AECOM

Greenhouse Gas Inventory Report

Town of Hempstead Energy and Sustainability Master Plan



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Glossary of Terms

GHG – Greenhouse Gas: a gas that, when in the atmosphere, absorbs and emits radiation within the thermal infrared range. This process is the fundamental cause of the greenhouse effect.

ESMP – Energy & Sustainability Master Plan

ICLEI – International Council for Local Environmental Initiatives

LIPA – Long Island Power Authority

LGOP – Local Government Operations Protocol

ECIR – Energy Consumption Inventory & Report

CARB – California Air Resources Board

IPCC – Intergovernmental Panel on Climate Change

CO_2 – Carbon Dioxide

CH_4 - Methane

N_2O – Nitrous Oxide

$CO2_e$ – Carbon Dioxide Equivalents

kWh – Kilowatt Hour

MWh – Megawatt Hour

1 Introduction

This Greenhouse Gas (GHG) emissions inventory and report is a component of the Town of Hempstead's Energy and Sustainability Master Plan (ESMP) funded by the Town's Energy Efficiency and Conservation Block Grant (EECBG) and developed in 2011/12 under the direction of the Town's Department of Conservation and Waterways. The ESMP will provide the framework for the Town's long-term strategic vision for energy and sustainability by helping to identify the key steps needed to realize that vision. In doing so, the ESMP will incorporate an inventory of the Town's energy consuming assets and historical consumption, evaluate the current energy procurement program, create a GHG emissions inventory, provide direction for sustainability policy, and outline long term energy strategic planning. The ESMP has four primary components; Energy Use and Procurement Program, Energy and GHG Inventory, Environmental Sustainability, and Strategic Policy Development. This report addresses the GHG inventory component of the ESMP and captures the GHG emissions and emission sources relating to the Town's energy consumption and fleet efficiency inventories. Building on the fuel consumption data and structure outlined in the Energy Consumption Inventory & Report (ECIR), this report covers the selection and application of an appropriate GHG reporting protocol, translating the Town's fuel consumption inventory in both a GHG and total Carbon Dioxide Equivalent (CO_2e) basis, and provides guidance on reducing GHG emissions.

The Energy Consumption Inventory & Report, which this report builds on, encompasses the inventory of energy use associated with Town buildings and the Town vehicle fleet. The energy consumption inventory was developed by creating a comprehensive list of all Town energy using assets based on data provided by the Town including utility bills, survey responses, fleet lists, fleet fuel consumption data and data from Long Island Power Authority (LIPA), National Grid and Freeport Electric, the Town's utilities. The inventory developed for the Town encompasses over two years worth of data (April 2009 through May 2011). In alignment with the baseline selected for the ECIR, this Energy and Greenhouse Gas Inventory uses the 2010 calendar year as the baseline for greenhouse gas emissions from the Town. Reporting GHG inventories on a calendar year basis is considered standard internationally by most GHG reporting protocols and aligns with the Town's fiscal year.

There is international, federal, state and local guidance for GHG emissions reporting. Various US and international protocols were reviewed to determine the most appropriate GHG reporting protocol for this study. Considering the Town of Hempstead's organizational and operational boundaries, AECOM selected the Local Government Operations Protocol (LGOP) as the most appropriate guidance for GHG reporting, as it is designed to provide a standardized set of guidelines to assist local governments in quantifying and reporting GHG emissions associated with their government operations. The protocol was developed in partnership by the California Air Resources Board (CARB), California Climate Action Registry (CCAR), and the Intergovernmental Council for Local Environmental Initiatives (ICLEI) – Local Governments for Sustainability, in collaboration with The Climate Action Registry and dozens of stakeholders.

2 Greenhouse Gas Emission Classification

In accordance with the LGOP introduced above, GHG emission sources are classified as direct, indirect or miscellaneous indirect. To help further define these classifications and to improve reporting transparency, LGOP defines three "scopes" (i.e. Scope 1, Scope 2, Scope 3) for GHG accounting and reporting purposes. The purpose of classifying GHG emissions into different categories is to ensure clarity with regards to the responsibility for control and development of GHG emission reduction strategies. GHG emission scopes are summarized below and further defined in the following sections:

- **Scope 1** – All direct GHG emissions (with the exception of CO_2 emissions from biogenic sources).
- **Scope 2** – Indirect GHG emissions associated with the consumption of purchased or acquired electricity, steam, heating, or cooling.
- **Scope 3** – All other indirect emissions not covered in Scope 2, such as emissions resulting from the extraction and production of purchased materials and fuels, transport-related activities in vehicles not owned or controlled by the Town, outsourced activities, waste disposal, etc.

Together the three scopes provide a comprehensive accounting framework for managing and reducing direct and indirect emissions.

Based on a review of these emission scope classifications in the context of the Town's operations, all emission sources can be classified as either Scope 1 or Scope 2. The following sections provide additional context and explanation of each of the emissions scope classifications.

2.1 Scope 1: Direct Emissions

Direct emissions are emissions from sources within the local government's organizational boundaries that the local government owns or controls and include:

- *Stationary combustion* to produce electricity, steam, heat or power using equipment in a fixed location
- *Mobile combustion* of fuels in fleet transportation sources (i.e. cars, trucks, marine vessels and planes) and emissions from off-road equipment such as in construction, agriculture and forestry
- *Process emissions* from physical or chemical processing, other than fuel combustion
- *Fugitive emissions* resulting from intentional or unintentional releases, i.e., equipment leaks from joints, seals, packing, and gaskets. While there are likely to be small intermittent leaks from Town facilities, they would be insignificant when compared with the magnitude of the Town's operations, this data is not captured by the town and these emissions are not considered within the scope of this study

In the context of this GHG study, emissions due to the combustion of natural gas, fuel oil, vehicle gasoline, and vehicle diesel within the Town's organizational boundaries or within equipment owned or controlled by the Town encompasses Scope 1 emissions for this project.

Consideration was also given to the CH_4 (methane) emissions from the municipal landfills that the town operates. The Town owns two landfills; the Oceanside and Merrick landfills. Both produce landfill gas and the Oceanside landfill captures this gas and combusts it in an engine generator, producing electricity. In accordance with LGOP protocol, direct CH_4 emissions vented from landfills, or the CH_4 and N_2O (nitrous oxide) components of combustion emissions from landfill gas are included in Scope 1 emissions. CO_2 is included in Scope 3 Information Items when this activity is reported. However, due to lack of adequate data for this emissions activity, the landfill emissions are not included in this inventory.

Scope 2: Indirect Emissions Scope 2 is a special category of indirect emissions and refers only to indirect emissions associated with the consumption of purchased electricity, steam, heating, or cooling within the Town's organizational boundaries. Indirect emissions are the consequence of activities which take place within the Town's organizational boundaries, but that occur at sources owned or controlled by another entity.

Scope 2 emissions typically encompass the largest share of a local government's emission portfolio and as such, present a significant opportunity for GHG management and reduction.

In the context of this GHG study, electricity consumed to support and sustain the Town's operations encompasses Scope 2 emissions for this project.

2.2 Scope 3: Indirect Emissions (Other)

In addition to Scope 1 and Scope 2 emission sources, a number of additional emission sources of potential policy relevance to local government operations can be measured and reported. These include emission sources related to local government operations, but for which local governments do not have financial or operational control. Scope 3 includes emissions resulting from the extraction and production of purchased materials and fuels, transport-related activities in vehicles not owned or controlled by the Town, outsourced activities, waste disposal, etc.

Though the LGOP protocol encourages the reporting of Scope 3 emissions where possible, data availability and reliability may influence which, if any, of these emissions are included in the GHG inventory. Based on the level of detail of information available at the time of this study, no emissions associated with the Town's activities can be categorized as Scope 3.

3 Data Collection and Organization

The source and structure of consumption data used for GHG computations follows the data structure established in the fuel consumption inventory for consistency in associating consumption with GHG emissions. In the future, the Town will be utilizing a database to capture and input building related energy consumption & correlating GHG emissions and will capture fleet fuel consumption in the FuelMaster program, which can be used in conjunction with the fleet related factors developed in the GHG inventorying and this report to capture the GHG emissions related to the fleet.

3.1 GHG Data Organization and Operational Boundaries

It is strongly recommended by the LGOP to utilize an operational control approach when defining the organizational boundaries of the GHG inventory. A local government has operational control over an operation if the local government has the full authority to introduce and implement its operating policies of the operation. The Town of Hempstead's operational boundaries are considered to be the facilities and vehicles operated by six municipal departments of the Town. These departments consist of:

1. Highway Department
2. Department of Sanitation
3. Department of Parks and Recreation
4. Department of Conservation & Waterways
5. Department of General Services
6. Department of Water

It should be noted that many department's[1] activities are included in the Department of General Services inventory. Along with these departmental boundaries, data was delineated as stationary sources (i.e. facility use of electricity or natural gas for boilers) and mobile sources (i.e. vehicle fleet use of diesel fuel or gasoline). This is to better communicate the results of the inventory and to more easily identify opportunities for reductions.

RECOMMENDATION:

The Town operates several arrays of solar panels and 2 wind turbines, producing carbon free, renewable energy. The total annual generation from these installations is net metered by the utility and not all installations have aggregate data available. The net metering reflects the reduction in GHG emissions per kWh of consumption that the solar panels and wind turbines provide but the exact breakdown is not ascertainable for all installations[2]. It is recommended that the town installs electric sub-meters to track energy generation from current renewable to better understand the contributions they make in reducing GHG emissions from the Town.

[1] A list of departments that are maintained under the Department of General Services for the purpose of preparing the emissions inventory is located in the appendices, pg. 25.
[2] The available renewable energy generation data from the Town and equivalent GHG emissions is available in appendix 7.3.

3.2 Data Collection

Consumption data is the relevant measurement of energy use for GHG generating processes. This data for the Town of Hempstead includes fleet fuel consumption records and also natural gas, electricity and approximated fuel oil consumption for facilities, using the baseline 2010 consumption data as the base year for the GHG inventory. The town data for facility energy consumption comes from monthly utility bills. Town-wide, there are 216 accounts for electricity, 91 accounts for natural gas and 4 accounts for heating oil purchases. It should be noted that fuel oil records are purchase records, not combustion but will be used to approximate combustion for purposes of this inventory as was done for the energy consumption inventory.

The 2010 year was the most current year for which the Town had comprehensive data at the time of the studies. However, there are several data gaps that required proxy data in order to more accurately estimate GHG emissions. One area that will benefit from improved data collection is the fuel consumption data from the Town's vehicle fleet. The Town provided vehicle fuel consumption data as well as aggregate vehicle fuel purchased data for the years analyzed in this study. It should be noted that in 2010 the consumption data provided was significantly less than the amount of fuel purchased for the Towns' vehicle fleet and while AECOM cannot confirm that all the purchased fuel was combusted in vehicles, there is likely to be additional GHG emissions from the fleet once comprehensive tracking is established.

RECOMMENDATION:

Though consumption data was used for this report, due to the variation between fuel purchased and what was recorded as consumption, it is recommended that the Town revisit this inventory once more comprehensive fleet consumption data is available.

Table 1. Town of Hempstead Fleet Vehicle Inventory

Department (total # vehicles)		Number of Vehicles w/consumption data	Gallons Consumed	Gallons Purchased	% consumed vs. purchased
Highway (496)	Diesel	241	67,465	202,321	33%
	Gasoline	124	21,829	65,953	33%
Parks & Recreation (384)	Diesel	6	593	14,162	4%
	Gasoline	0	120	90,735	1%
Conservation & Waterways (858)	Diesel	150	18,689	25,884	72%
	Gasoline	156	28,153	35,804	78%
General Services (272)	Diesel	36	36,012	40,067	90%
	Gasoline	189	123,903	129,863	95%
Water (87)	Diesel	12	930	16,449	6%
	Gasoline	69	32,114	37,153	84%
Totals (2408)	**Diesel**	**445**	**123,686**	**298,883**	**43%**
	Gasoline	**538**	**204,914**	**359,508**	**57%**

Table 1 above shows the total number of vehicles operated by each department in parenthesis. The data is filtered down to the number of vehicles with consumption data and the total amount of fuel recorded as being

consumed and purchased for both diesel and gasoline fleet use to provide perspective on how the available consumption data impacts the assessment of GHG emissions.

Because of variations in data collection and record keeping between the different departments of the Town, some data gaps exist that AECOM accounted for with approximate data. Vehicle fuel usage for the 2010 base years was not available monthly for the Department of General Services, which owns and operates 272 vehicles and has fuel consumption data for 225 vehicles. The aggregate fuel consumption for 2010 and 2011 was provided by the department and divided in two for use as a proxy for the 2010 data. The Department of Highways did not have fuel consumption data available for 2010. Only records of fuel consumption for the months of March through August 2011 were available for the Highway vehicle fleet. This 2011 data was used as a proxy for 2010 data by assuming the fuel consumption for the 2011 year was typical and applying those same consumption values to 2010. The Water Department began reporting fuel consumption in August of 2010. Fuel consumption reported for the month of January 2011 through July 2011 was used to supplement the 2010 for the Water Department.

4 GHG Emission Calculations

In this section of the GHG inventory analysis, the Town of Hempstead consumption data for each emissions source is analyzed and translated to GHG emissions utilizing the corresponding GHG based calculation methodologies and appropriate emissions factors as indicated by the LGOP. For each analysis, the corresponding methodologies, assumptions, conversion factors and emissions factors utilized are outlined. Finally, the appropriate Global Warming Potential (GWP) factors are applied to the calculated values to obtain the carbon dioxide equivalent (CO_2e) value. The following sections detail the information and methodologies utilized for calculating the GHG emissions associated with the Town of Hempstead.

4.1 GHG Emissions Inventory

The inventory guidance of LGOP requires the accounting and reporting of all six internationally recognized GHGs regulated under the Kyoto Protocol:

- Carbon Dioxide (CO_2)
- Methane (CH_4)
- Nitrous Oxide (N_2O)
- Hydrofluorocarbons (HFCs)
- Perfluorocarbons (PFCs)
- Sulfur hexafluoride (SF_6)

CO_2, CH_4, N_2O are the primary GHGs that emanate from stationary or mobile sources. CO_2 accounts for the majority of the GHG emissions from most stationary combustion units. When weighted by their GWPs, CO_2 typically represents over 99 percent of the GHG emissions from the stationary combustion of fossil fuels (i.e. when combusting a single gallon of gasoline or diesel fuel, 99% of the GHG emissions by mass will be CO_2 and other GHG's will make up the remaining 1%). HFCs and PFCs are typically associated with fugitive emissions from air conditioning and refrigerant systems and fire suppression systems. PFCs are typically associated with aluminum production and SF_6 is a gas normally used for electrical insulation, arc quenching, and current interruption equipment used to transmit and distribute electricity. Because these are nominal components of the total emissions inventory and the required data records necessary to complete these calculations are not available, this report will focus on the main GHGs; CO_2, CH_4, N_2O.

4.2 GHG Emission Factors

GHG emission factors are values for scaling the emissions per unit of fuel consumed to a quantity (typically mass) of GHGs produced. These factors vary by type of fuel used (i.e. gasoline vs. diesel fuel will have different CO_2 emission rates per gallon of fuel consumed). Table 2 provides the individual emission factors for each fuel type or activity. The factors are provided in the LGOP manual and are derived from internationally recognized GHG

reporting standards. Emissions from Scope 2, electricity consumption, are calculated using an emissions factor that is developed by the U.S. Environmental Protection Agency and specific for the Long Island region. This emissions factor is provided in the LGOP.

Table 2. Emissions Factors by Fuel Type

Fuel Type	CO_2 (kg/gallon)	CH_4 (kg/gallon)	N_2O (kg/gallon)
Fuel Oil Emission Factors			
No. 2 Fuel Oil	10.21	0.0015	0.0001
Motor Diesel	10.21	n/a	n/a
Motor Gasoline	8.78	n/a	n/a
Emission Factors for Electricity Use			
Source	**CO_2 (kg/mmBtu)**	**CH_4 (kg/mmBtu)**	**N_2O (kg/mmBtu)**
Natural Gas	53.02	0.005	0.0001
Emission Factors for Electricity Use			
Source	**CO_2 (kg/kWh)**	**CH_4 (kg/kWh)**	**N_2O (kg/kWh)**
eGrid Long Island	0.6435	0.0411	0.0059
Emission Factors for Combustion of Landfill Gas[3]			
Source	**CO_2 (kg/mmBtu)**	**CH_4 (kg/mmBtu)**	**N_2O (kg/mmBtu)**
Landfill Gas	52.07	0.0032	0.00063

4.3 Global Warming Potential

All GHGs have what is referred to as a Global Warming Potential (GWP). This value is used to compare the ability of different GHGs to trap heat in the atmosphere. Multiplying individual GHG gas emissions by their GWP will produce the Carbon Dioxide Equivalent (CO_2e) for that GHG, which is the relative impact each GHG species has compared with that of CO_2. These GWPs are based on the heat-absorbing potential of each gas relative to that of carbon-dioxide, as well as the decay rate of each gas (the amount removed from the atmosphere over a given number of years). GWPs can also be used to define the impact greenhouse gases will have on global warming over different time periods. These periods are usually 20 years, 100 years and 500 years. For most GHGs, the GWP declines as the time horizon increases because the greenhouse gas is gradually removed from the atmosphere through natural mechanisms and its greenhouse-effect influence declines. This is based on heat-absorptive factors of each GHG and the atmospheric lifetime potential of each GHG. Generally the horizon for lifetime impacts is calculated over a 100 year period.

Assigning a GWP value allows policy makers to compare the impacts of emissions and the potential benefits of reducing different gases. For instance, methane (CH_4) is a significant contributor to the greenhouse effect and has a GWP of 21. This means CH_4 is has 21 times the global warming impact per unit mass than that of CO_2.

Table 3 below summarizes the GWPs that are used in this GHG inventory analysis. The GWPs were developed by the Intergovernmental Panel on Climate Change (IPCC) in the Second Assessment Report (SAR). These GWP values are still used by convention to maintain consistency in GHG reporting.

[3] Calculations of the Town of Hempstead landfill GHG emissions not included but emissions factors included for future use.

Table 3. Global Warming Potentials	
Compound	GWP
CO_2	1
CH_4	21
N_2O	310
HFCs	140-11,700
PFCs	6,500-9,200
SF_6	23,900

4.4 GHG emissions Quantification Steps

The calculation of GHG emissions entail the collection consumption data in the form of quantity of fuel consumed for combustion purposes, as well as emission factor data. The following steps summarize the process followed for the quantification of GHG emissions:

- Step 1 – *Collect data on the quantity of fuel combusted on a volume, mass or energy basis.*
- Step 2 – *Multiply the quantity of fuel combusted or energy consumed by the appropriate emission factors from Table 2 to produce the mass emitted for each greenhouse gas compound.*
- Step 3 – *Normalize the GHG emissions from the different compounds to CO_2e by applying the GWP from Table 3.*
- Step 4 – *Sum the normalized CO_2e emissions. This is the Total CO_2e emissions for each fuel consumption activity.*

Calculations for CH_4 and N_2O emissions from vehicle usage require the miles driven during the baseline year for the basis of these species emissions calculations. This data was not available for the majority of the Town vehicle fleet[4] and as CH_4 and N_2O are normally less than 1% of total emissions per mile based on typical vehicle fuel economy, these constituents were not included in vehicle GHG inventory.

Below is a sample calculation for emissions resulting from 1,000 kilowatt-hours[5] (the equivalent of 1 MWh) of electricity consumption:

	Emissions Factors	*GWP*
CO_2 -	*0.6435 kg CO_2/kWh*	*1*
CH_4 -	*0.0411 kg CH_4/kWh*	*21*
N_2O -	*0.0059 kg N_2O/kWh*	*310*

[4] Only 15.8% of the Town's fleet had mileage within the possible range for the vehicle types captured. Data available in the Energy Consumption & Inventory Report.
[5] A kilowatt hour is a unit of energy equal to 1000 watt hours (the product of power in watts and time in hours). The kWh is a common billing unit for energy delivered to consumers by electric utilities such as LIPA.

Emissions Calculation:

CO_2 Emissions: 1,000 kWh x 0.6435 kg CO_2/kWh = 644 kg CO_2

CH_4 Emissions: 1,000 kWh x 0.0411 kg CH_4/kWh = 41 kg CH_4

N_2O Emissions: 1,000 kWh x 0.0059 kg N_2O/kWh = 5.9 kg N_2O

CO_2e Calculation:

CO_2: 643.5 kg x 1 GWP = 644 kg CO_2e

CH_4: 41.1 kg CH_4 x 21 GWP = 863 kg CO_2e

N_2O: 5.9 kg N_2O x 310 GWP = 1,829 kg CO_2e

Total Emissions:

Total CO_2e emissions = 643.5 kg + 863.1 kg + 1,829 kg = 3,336 kg CO_2e

In metric tons this is: 3,336 kg ÷ 1,000 kg/ton = 3.33 metric tons CO_2e

5 Town of Hempstead Greenhouse Gas Inventory

The following section provides the results of the greenhouse gas inventory calculations based on the data from 2010. The following three subsections organize the results in terms of scope, department and fuel source.

- Section 5.1 Scope 1 Emissions:
  - By department
  - By fuel source
- Section 5.2 Scope 2 Emissions:
  - By department
  - By fuel source
- Section 5.3 Scopes 1 & 2 emissions by department & fuel source

The data is presented in metric tons[6] per year by each component GHG and then as the total CO_2e for the sum of the GHGs. The town-wide emissions summary is given below in Table 4.

[6] 1 metric ton equals 2,204 pounds.

Table 4. 2010 Town-Wide Total GHG Emissions

Scope	CO_2 (tons)	CH_4 (tons)	N_2O (tons)	CO_2e (tons)
Scope 1	9,359	1	0	9,377
Scope 2	37,723	2,406	348	196,236
Total Town GHG Emissions	**47,083**	**2,407**	**348**	**205,613**

Figures 1& 2 summarize the Scope 1 & 2 emissions, showing total town-wide GHG emissions for each department and fuel source. Figure 1 shows both Scope 1 & 2 emissions and splits electric use (Scope 2) between street lights and facilities. This figure illustrates the magnitude of GHG emissions associated with electricity consumption as compared to fuel oil or natural gas consumption. Figure 2 shows only Scope 1 emissions so that the magnitude of electricity usage (Scope 2 emissions) doesn't obscure the GHG emission from fuel being consumed by each department.

Figure 1. Town-Wide Scope 1 & 2 CO_2e Emissions (Tons/Year)

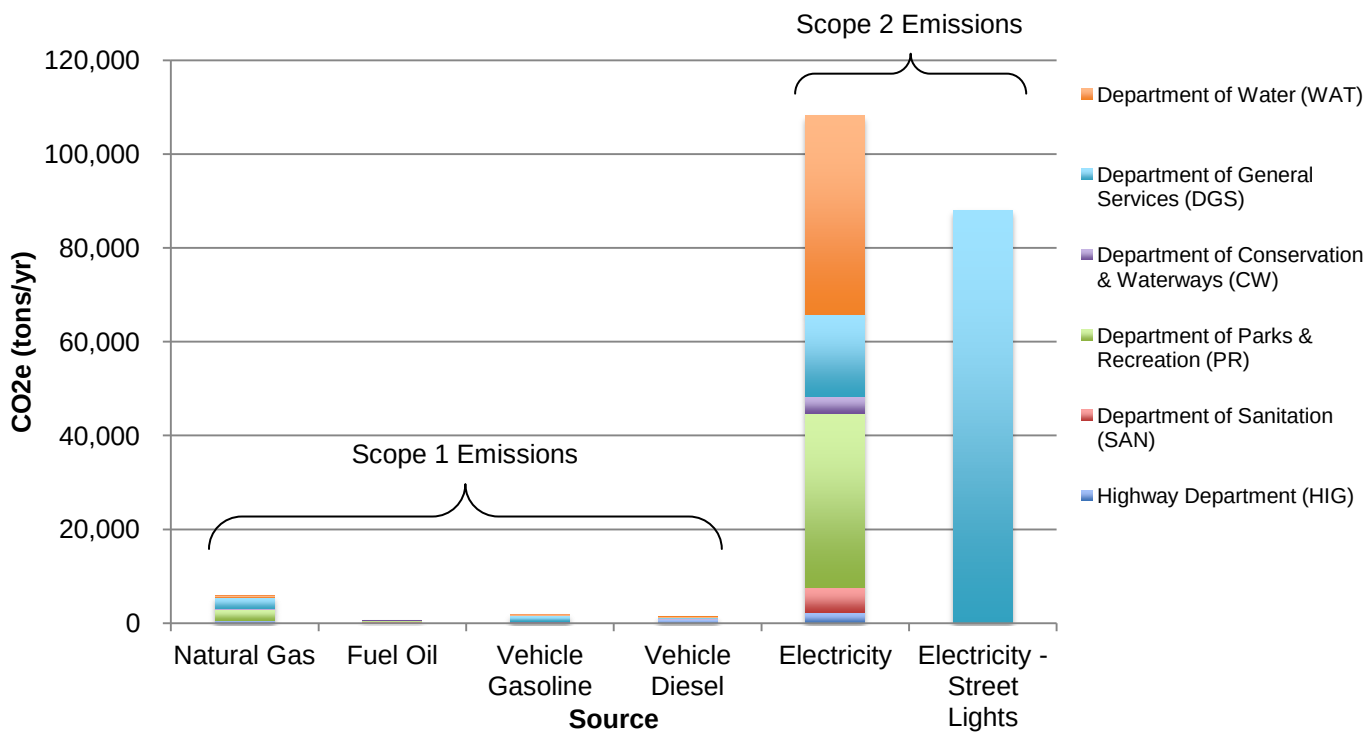
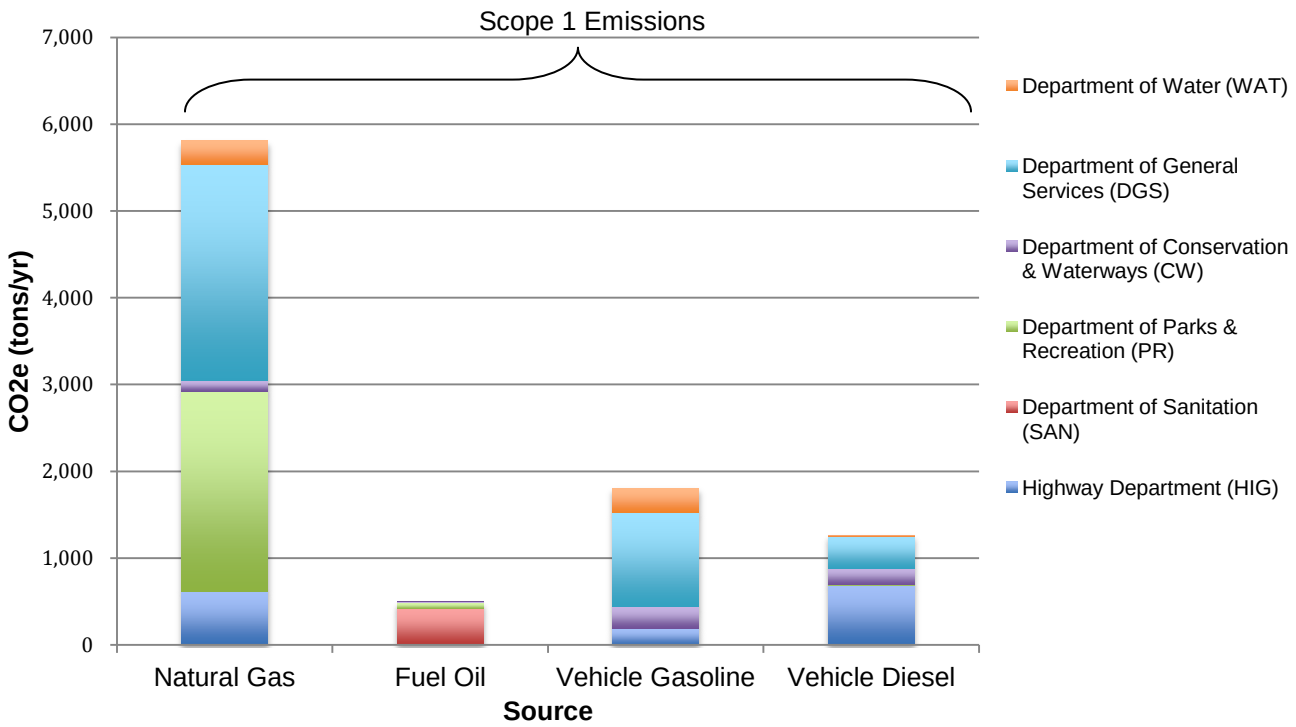


Figure 2. Town-Wide Scope 1 CO_2e Emissions (Tons/Year)



5.1 Town-wide Scope 1 Direct Emissions

Scope 1 direct emissions include stationary and mobile combustion of fuels with the exception of CO_2 from biogenic sources[7]. Table 5 provides the total GHG emissions by department in terms of the three primary GHGs and as CO_2e. Figure 3 provides total CO_2e by department as a pie chart graphic to emphasize each department's contribution to the Town's total GHG emissions.

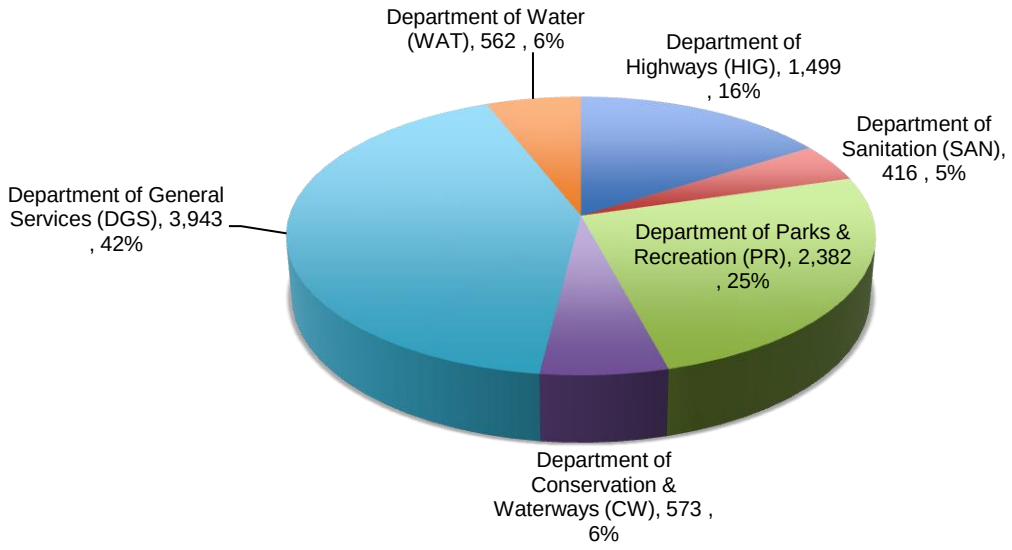
*As mentioned in section 2.1, for the Town, **Scope 1** includes the combustion of natural gas, fuel oil, vehicle gasoline & vehicle diesel and landfill methane[8].*

[7] Biogenic sources of GHG are those that result from combustion of any fuel source that come from recently living organic matter such as wood, landfill gas, ethanol, etc.
[8] The town operates two landfills. The Oceanside landfill operates an engine generator with landfill gas. The CH_4 and N_2O emissions from the combustion of this gas are considered Scope 1 but are not included in this report because not enough data was available to perform this calculation.

Table 5. 2010 Scope 1 Emissions by Department

Department	CO_2 (tons)	CH_4 (tons)	N_2O (tons)	CO_2e (tons)
Department of Highways (HIG)	1,835	0	0	1,837
Department of Sanitation (SAN)	420	0	0	422
Department of Parks & Recreation (PR)	2,447	0	0	2,453
Department of Conservation & Waterways (CW)	602	0	0	602
Department of General Services (DGS)	3,633	0	0	3,640
Department of Water (WAT)	422	0	0	423
TOTAL Town of Hempstead SCOPE 1 Emissions	**9,359**	**1**	**0**	**9,377**

Figure 3. 2010 Scope 1 CO_2e Emissions by Department (Tons/Year)



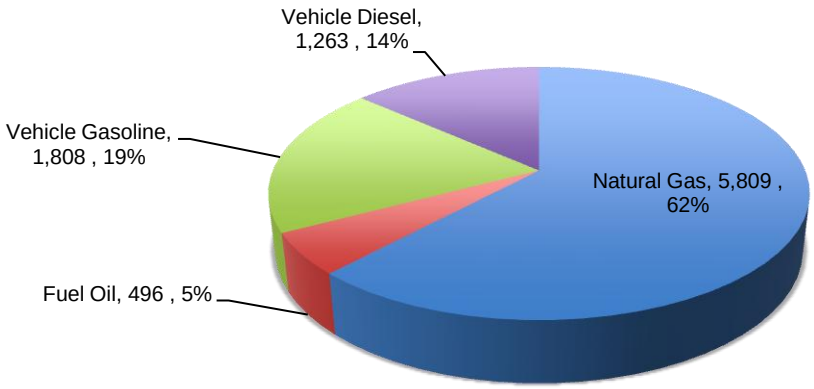
5.2 Town-wide Scope 1 Emissions by Fuel Source

The total Town Scope 1 emissions can be examined by the fuel type associated with those emissions. Within Scope 1 emissions, the Town's largest source of emissions are the derives from the consumption of natural gas for facility operation, its likely primary end use being space heating and domestic hot water. Table 6 provides the total Scope 1 emissions by source for each of the primary GHGs in tons/year. Figure 2 shows the proportionate emissions in total CO_2e from each fuel source.

Table 6. 2010 Town of Hempstead Total Scope 1 Emissions by Source

Source	CO_2 (tons)	CH_4 (tons)	N_2O (tons)	CO_2e (tons)
Natural Gas	5,794	1	0	5,809
Fuel Oil	493	0	0	496
Vehicle Gasoline	1,810	0	0	1,810
Vehicle Diesel	1,263	0	0	1,263
TOTAL SCOPE 1 Emissions	**9,359**	**1**	**0**	**9,377**

Figure 4. 2010 Town of Hempstead Total Scope 1 Emissions by Source (Tons/Year)



5.3 Town-wide Scope 2 Indirect Emissions

Scope 2 indirect emissions include emissions associated with the consumption of purchased or acquired electricity, steam, heating, or cooling. These are emissions that occur outside of the organizational boundary of the Town but are a result of activities from within the Town.

*As mentioned earlier, for the Town of Hempstead, **Scope 2** emissions are from electricity utilized in municipal buildings[9] as show in Table 7.*

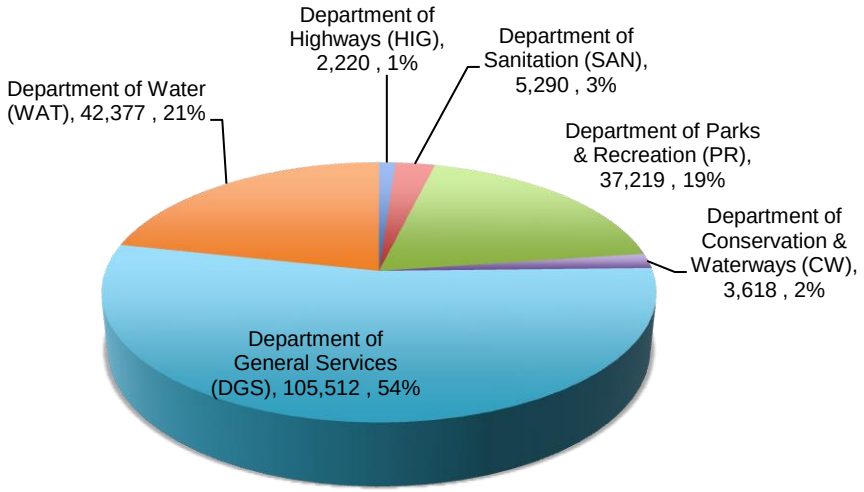
Table 7 provides Scope 2 emissions associated with each town department in terms of the primary GHGs and then as the total CO_2e. Total CO_2e is displayed below, by department, in pie chart to show the proportion of town-wide Scope 2 GHG emissions for each department. It should be noted that street lighting electricity consumption is attributed to DGS and is approximately 69% of DGS total electricity consumption.

[9] Appendix 7.2 contains a table that provides a count of the number of buildings operated by each department and the total square feet of area for these buildings as was reported in the Energy Consumption Inventory.

Table 7. 2010 Scope 2 Emissions by Department

Department	CO_2 (tons)	CH_4 (tons)	N_2O (tons)	CO_2e (tons)
Department of Highways (HIG)	427	27	4	2,220
Department of Sanitation (SAN)	1,017	65	9	5,290
Department of Parks & Recreation (PR)	7,155	456	66	37,219
Department of Conservation & Waterways (CW)	696	44	6	3,618
Department of General Services (DGS)	20,283	1,294	187	105,512
Department of Water (WAT)	8,146	520	75	42,377
TOTAL Town of Hempstead SCOPE 2 Emissions	**37,723**	**2,406**	**348**	**196,236**

Figure 5. 2010 Town of Hempstead Total Scope 2 Emissions by Department (Tons/Year)



5.4 Scope 1 & 2 Emissions by Department and Source

Standard practice for LGOP reporting of GHG emissions categorizes GHG emissions into local government sectors. The local government sectors are:

- Buildings and other facilities
- Streetlights and traffic signals
- Water delivery facilities
- Port facilities
- Airport facilities
- Vehicle fleet
- Transit fleet
- Power generation facilities
- Solid waste facilities
- Wastewater facilities
- Other process and fugitive emissions

This report however, categories emissions by department, scope and consumption activity. This is done to provide the Town with greater detail in understanding the sources and scales of emissions and allow for each department to better coordinate their efforts for future emission mitigation strategies. The consumption activity categories will identify the LGOP standard reporting categories within each department. For example, vehicle gasoline & vehicle diesel fuel emissions will be each department's vehicle fleet emissions and fuel oil and natural gas emissions will be building and facility emissions. This is done to help the Town understand how the department/fuel source emissions correlate to the standardized reporting structure.

As stated previously, the finest reporting granularity that the Town's available data allows for is GHGs emitted by department from each fuel source. This section breaks out each department and more closely examines each individual GHG profile by fuel source. The following subsections detail emissions for each department by fuel source. The source with the greatest global warming impact and therefore the greatest impact if reduced will be the source with the highest total CO_2e emissions.

5.4.1 Highway Department

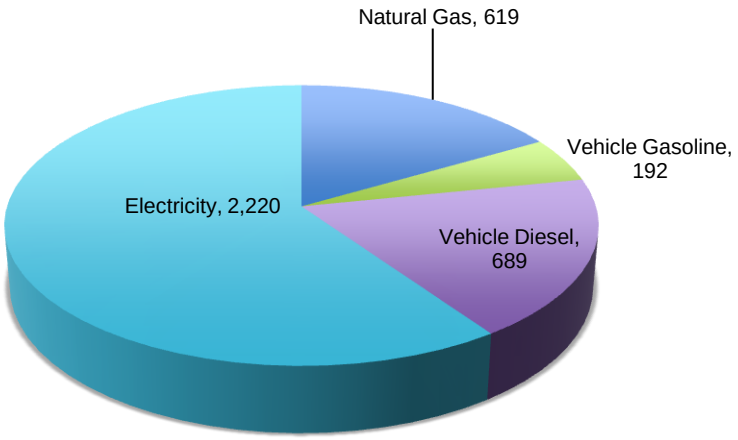
The Highway department has twelve accounts for electricity consumption (Scope 2 emissions). Of those twelve, the main garage of the Roosevelt Yard comprises 73% of the entire electric consumption resulting in 58% of the total GHG emissions of the Highway Department

Table 8. Highway Department (HIG)

Source	CO_2 (tons)	CH_4 (tons)	N_2O (tons)	CO_2e (tons)
SCOPE 1 Emissions				
Natural Gas	617	0	0	619
Fuel Oil	0	0	0	0
Vehicle Gasoline	529	0	0	529
Vehicle Diesel	689	0	0	689
TOTAL SCOPE 1 Emissions	*1,835*	*0*	*0*	*1,837*
SCOPE 2 Emissions				
Electricity	*427*	*27*	*4*	*2,220*
TOTAL SCOPE 1 & 2 Emissions	**2,262**	**27**	**4**	**4,057**

Vehicle gasoline (Scope 1) usage by the Highway Department was not available for the baseline year (2010). The only available data for vehicle gasoline usage by the Highway Department is for the period of January 2011 through August 2011. This data was used as a proxy for vehicle fuel consumption in this baseline analysis. Figure 6 provide a graphical representation of the total CO_2e values from Table 8.

Figure 6. 2010 Highway Dept Scope 1 & 2 GHG Emissions (Tons/Year)



5.4.2 Department of Sanitation

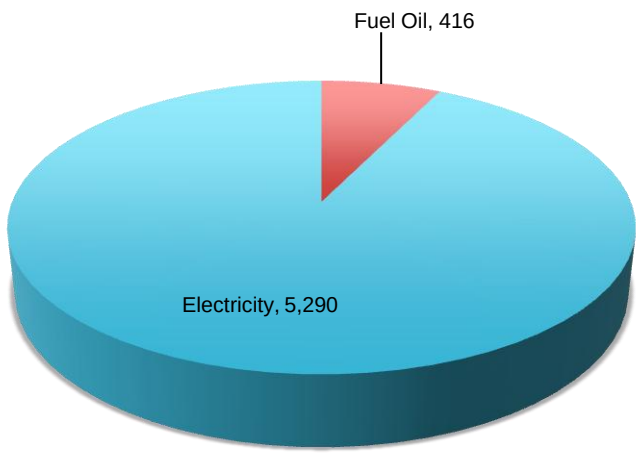
The majority of the Department of Sanitation (SAN) emissions from Scope 2 emissions are related to electricity consumption. There are two SAN facilities that are associated with this consumption; the Merrick Refuse Disposal Plant (71% of consumption and emissions) and the Oceanside Refuse Disposal Plant (29% of consumption and emissions). Both sites consumption activities are listed as administrative offices in the Energy Consumption Inventory.

Table 9. Department of Sanitation (SAN)

Source	CO_2 (tons)	CH_4 (tons)	N_2O (tons)	CO_2e (tons)
SCOPE 1 Emissions				
Natural Gas	0	0	0	0
Fuel Oil	414	0	0	416
Vehicle Gasoline	6	0	0	6
Vehicle Diesel	0	0	0	0
TOTAL SCOPE 1 Emissions	*420*	*0*	*0*	*422*
SCOPE 2 Emissions				
Electricity	*1,017*	*65*	*9*	*5,290*
TOTAL SCOPE 1 & 2 Emissions	**1,436**	**65**	**9**	**5,712**

The Department of Sanitation does not list any vehicle fuel consumption in the consumption data that was provided by the Town. After reviewing records of purchased vehicle fuel for the Department of Sanitation, it is evident that this data is incomplete. Another emissions activity that is not reflected in table 9 is emissions related to the combustion or venting of landfill gas from the Town's landfills due to the lack of available data.

Figure 7. 2010 Dept of Sanitation Scope 1 & 2 GHG Emissions (Tons/Year)



5.4.3 Department of Parks & Recreation

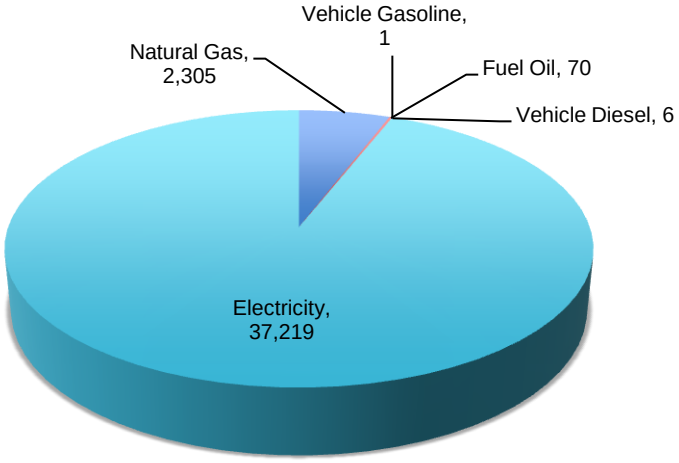
The Department of Parks & Recreation's (PR) GHG emissions total is 39,601 tons of CO_2e annually with electricity consumption (Scope 2) being the largest contributor (94%). There are 138 accounts associated with electricity consumption within PR. Of these accounts, the Echo Park pool complex administration building and the Newbridge Road Park each contribute 13% of the total Scope 2 emissions.

Table 10. Department of Parks & Recreation (PR)

Source	CO_2 (tons)	CH_4 (tons)	N_2O (tons)	CO_2e (tons)
SCOPE 1 Emissions				
Natural Gas	2,299	0	0	2,305
Fuel Oil	69	0	0	70
Vehicle Gasoline	72	0	0	72
Vehicle Diesel	6	0	0	6
TOTAL SCOPE 1 Emissions	*2,447*	*0*	*0*	*2,453*
SCOPE 2 Emissions				
Electricity	*7,155*	*456*	*66*	*37,219*
TOTAL SCOPE 1 & 2 Emissions	**9,602**	**457**	**66**	**39,672**

PR reported very little fuel consumption from the vehicle fleet, leading to almost no related emissions as shown in the above table. This minimal fuel consumption is not in agreement with records of purchased fuel by PR for the time period this report analyzes.

Figure 8. 2010 Dept of Parks & Recreation Scope 1 & 2 GHG Emissions (Tons/Year)



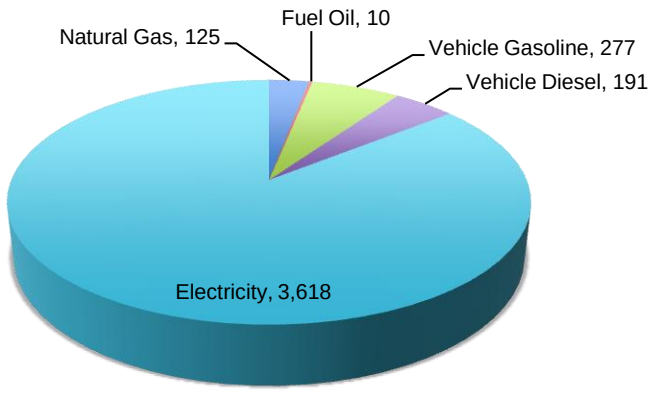
5.4.4 Department of Conservation & Waterways

Electricity consumption (Scope 2) contributes the majority (86%) of all GHG emissions from the Department of Conservation & Waterways (C&W). The major contributors within the department to the emissions resulting from electricity consumption are the Guy Lombardo Marina (29%) and the East Marina (20%). Vehicle emissions comprise the majority (70%) of Scope 1 emissions from the department, though Scope 1 emissions only make up 14% of total C&W emissions.

Table 11. Department of Conservation & Waterways (C&W)

Source	CO_2 (tons)	CH_4 (tons)	N_2O (tons)	CO_2e (tons)
SCOPE 1 Emissions				
Natural Gas	124	0	0	125
Fuel Oil	10	0	0	10
Vehicle Gasoline	277	0	0	277
Vehicle Diesel	191	0	0	191
TOTAL SCOPE 1 Emissions	*602*	*0*	*0*	*602*
SCOPE 2 Emissions				
Electricity	*696*	*44*	*6*	*3,618*
TOTAL SCOPE 1 & 2 Emissions	**1,297**	**44**	**6**	**4,220**

Figure 9. 2010 Dept of Conservation & Waterways Scope 1 & 2 GHG Emissions (Tons/Year)



5.4.5 Department of General Services

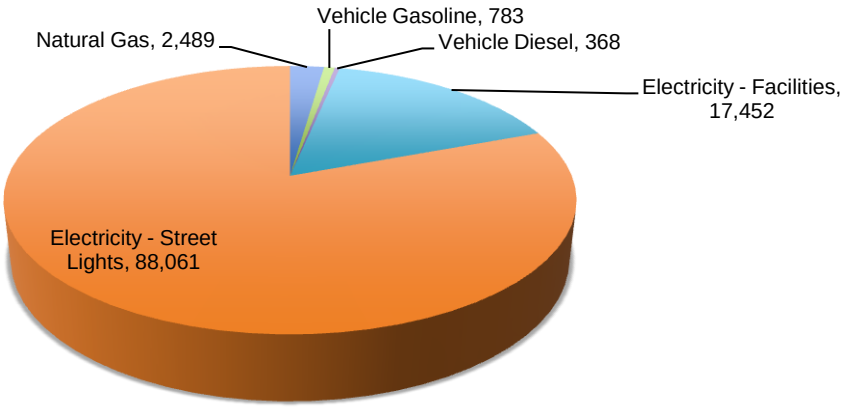
The Department of General Services (DGS) electricity accounts also include the electricity consumed by streetlights. This is the majority of electricity consumed by the department and a major component (43%) of the Towns total electricity related GHG emissions (Scope 2). Facility heating through the consumption of natural gas is a major contributor to Scope 1 emissions while vehicle fleet emissions comprise the remaining Scope 1 emissions. The following table shows DGS emissions by source and scope.

Table 12. Department of General Services (DGS)

Source	CO_2 (tons)	CH_4 (tons)	N_2O (tons)	CO_2e (tons)
SCOPE 1 Emissions				
Natural Gas	2,483	0	0	2,489
Fuel Oil	0	0	0	0
Vehicle Gasoline	783	0	0	783
Vehicle Diesel	368	0	0	368
TOTAL SCOPE 1 Emissions	*3,633*	*0*	*0*	*3,640*
SCOPE 2 Emissions				
Electricity - Facilities	3,355	214	31	17,452
Electricity - Street Lights	16,928	1,080	156	88,061
TOTAL SCOPE 2 Emissions	*3,355*	*214*	*31*	*105,512*
TOTAL SCOPE 1 & 2 Emissions	**6,988**	**214**	**31**	**109,152**

The DGS provided vehicle fuel usage as an aggregate sum of vehicle gasoline and diesel used from the period of August 2009 through August 2011 for each vehicle. This data was divided to yield a monthly equivalent to the baseline 2010 but may not reflect actual vehicle fuel usage for 2010.

Figure 10. 2010 Dept of General Services Scope 1 & 2 GHG Emissions (Tons/Year)



5.4.6 Department of Water

The Department of Water has 33 accounts associated with electricity consumption, the major consumers being well houses that operate large pumps. 97% of the CO_2e emissions resulting from the Department of Water's activities are associated with electricity consumption (Scope 2). Facility heating through the use of natural gas produces the majority of WAT Scope 1 emissions with the remaining Scope 1 emissions emanating from gasoline consumption in the vehicle fleet. Table 13 provides the related Scope 1 and Scope 2 GHG emissions from the department.

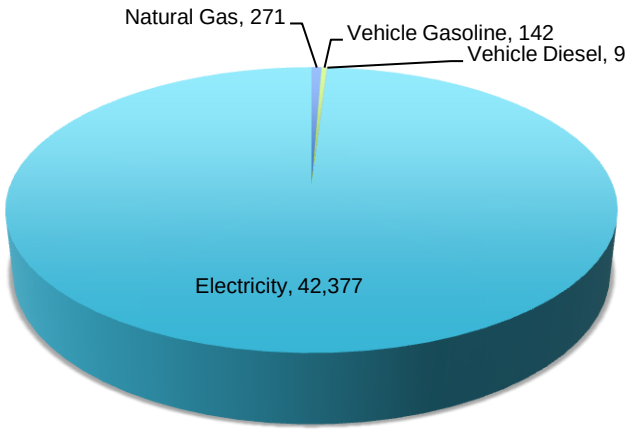
Table 13. Department of Water (WAT)

Source	CO_2 (tons)	CH_4 (tons)	N_2O (tons)	CO_2e (tons)
SCOPE 1 Emissions				
Natural Gas	270	0	0	271
Fuel Oil	0	0	0	0
Vehicle Gasoline	142	0	0	142
Vehicle Diesel	9	0	0	9
TOTAL SCOPE 1 Emissions	*422*	*0*	*0*	*423*
SCOPE 2 Emissions				
Electricity	*8,146*	*520*	*75*	*42,377*
TOTAL SCOPE 2 Emissions	**8,569**	**520**	**75**	**42,800**

Vehicle gasoline consumption data for WAT was not available for all of 2010 as they began tracking in August of 2010 via FuelMaster. To account for vehicle use in this baseline, 2011 data vehicle gasoline consumption data from January-July 2011 was used as a proxy for the January-July 2010 data. The 2011 data was collected using the FuelMaster system which allows for consistent and accurate fuel tracking. This 2011 activity is considered to

be representative of typical annual fuel consumption. Figure 11 illustrates the proportionate contributions of each fuel use type to the overall GHG emissions of the department.

Figure 11. 2010 Dept of Water Scope 1 & 2 GHG Emissions (Tons/Year)



6 GHG Emissions Reduction Planning/Recommendations

For the Town of Hempstead, determining the carbon footprint of the Town operations is the first key step in the development of a GHG emission reduction program. With the completion of the GHG emissions inventory presented in this study, the next task for the Town of Hempstead is to implement a program that will progressively monitor, report and reduce its GHG emissions in accordance with internal targets and future government mandates. This process of carbon accounting is a continuous process that must be standardized and will require routine updating over time.

The framework necessary for establishing activities that will contribute to this GHG reduction will be fully addressed in the ESMP. It will build off findings from the Energy Consumption & Inventory Report and GHG analysis within this report.

6.1 GHG Reduction Opportunities

Reduction approaches vary based on scope and source. In summary, the reduction opportunities that exist in each scope are as follows:

Scope 1

- Improve fuel consumption monitoring programs for all (i.e. buildings, fleet, renewable power generation, landfill methane)
- Improve fleet vehicle fuel efficiencies
- Reduce natural gas and fuel oil consumption within buildings

Scope 2

- Improve efficiency of electricity consuming equipment within Town facilities
- Upgrade street lights to highest efficiencies available and water pumps to highest efficiency available
- Provide monitoring of building energy use to better manage building energy systems

The following sections will outline reduction opportunities based on the finding of this analysis broken down to scope and consumption activity.

6.1.1 Scope 1 Direct Emissions Reduction

The Scope 1 direct emissions related to fuel consumption activities that occur within the Town governments' operational boundaries. The total Scope 1 CO_2e emissions for the baseline year are:

Baseline (2010) Total Scope 1 Emissions: **9,375 tons CO_2e**

Scope 1 emissions constitute 5%[10] of the Town's annual GHG emissions. There are opportunities for emissions reductions through reduction of fuel consumption in Scope 1 activities but the impact on overall GHG emissions will be minimal. The following subsections will delineate the contributions of each fuel type on the overall Town emissions and what potential reductions strategies may be viable for each activity. The areas of greatest impact for each department were identified in section 5.4.

6.1.1.1 Natural Gas

Natural gas consumption contributes 5,809 tons of CO_2e to the Town's overall annual emissions baseline. This is 62% of Scope 1 emissions and 3% of total Town emissions. While the natural gas consumption of most individual buildings has been captured in the Energy Consumption Inventory & Report, the actual end-use for natural gas within each of the Town's buildings is not discernible with the data available for this inventory. A more comprehensive consumption monitoring program would help define what inefficiencies currently exist within the Town's natural gas consumption and a mitigation strategy could stem from that. Recommendations for sub-metering and building energy audits will be included in the ESMP to facilitate this.

6.1.1.2 Fuel Oil

Fuel oil consumption contributes 496 tons of CO_2e to the Town's overall annual emissions baseline. This is 5% of Scope 1 emissions and less than 1% of total Town emissions. The use of fuel oil, according to the consumption data, is attributed to four accounts. Two accounts are within the Department of Sanitation, one is with the Department of Conservation & Waterways and the last is with the Department of Parks and Recreation. How the fuel is used is not specified but because of the cyclical peak in fuel usage in the winter months it can be inferred that the fuel is being used for weather dependent heating (building heating). Reductions in fuel consumption and subsequent reduction in GHG emissions could potentially be made from a condition assessment and energy efficiency improvement study of building energy systems but because of the minor contribution to overall GHG emissions, the reduction in town-wide GHG emissions would be negligible.

[10] These percentages are based on the data captured in the Energy Consumption Inventory Report which reflected 90% confidence in the accuracy of the building consumption data but only 15.8% of the vehicle fleet had potentially viable data, yielding limited confidence in the emissions relating to the fleet.

Fuel switching for building energy systems may also lead to reductions in GHG emissions. Natural gas combustion produces 27% less CO_2, 53% less CH_4, and 86% less N_2O per equivalent heating value of fuel oil. A study that provides a detailed inventory of building energy systems and the feasibility of switching to natural gas fired boilers/heaters would outline these improvements.

6.1.1.3 Vehicle Gasoline

Vehicle gasoline consumption contributes 1,808 tons of CO_2e to the Town's overall annual emissions baseline. This is 19% of Scope 1 emissions and 1% of total Town emissions. From the Energy Consumption Inventory Report analysis of the vehicle fleet, there is a potential for increased efficiency and reduced vehicle gasoline consumption throughout the Town through the proper management of fleet purchasing and purposing. This will be further explored in the ESMP with the fleet data tracking, operating efficiency and right sizing recommendations.

6.1.1.4 Vehicle Diesel

Vehicle diesel consumption contributes 1,263 tons of CO_2e to the Town's overall annual emissions baseline. This is 13% of Scope 1 emissions and 1% of total Town emissions. Vehicle diesel fuel is often used for purpose-specific vehicles and typically utility vehicles. Actions that lead to GHG emission reductions for this source will be further explored in the ESMP with the fleet data tracking, operating efficiency and right sizing recommendations.

6.1.2 Scope 2 Indirect Emissions Reduction

The Scope 2 indirect emissions for the Town of Hempstead are solely resulting from electricity consumption. This is an indirect emission where the end use occurs within the town but the emissions occur outside the Town boundary. The total Scope 2 CO_2e emissions for the baseline year are:

Baseline (2010) Total Scope 2 Emissions: **196,236 tons CO_2e**

Scope 2 emissions constitute 95% of the Town's annual GHG emissions. There is a great amount of potential for GHG emissions reduction through end-use efficiency improvements but also through generation and purchasing of renewable or less-carbon intensive energy. The following subsections break down electricity consumption into the major end-users and describe potential savings opportunities.

6.1.2.1 Facility Electricity

Facility electric consumption contributes 108,175 tons of CO_2e to the Town's overall annual emissions baseline. This is 55% of Scope 2 emissions and 52% of total Town emissions. Because emissions related to facility electricity consumption are such a large percentage of the Town's overall emissions, significant opportunities may exist to reduce town-wide GHG emissions by implementing measure to curtail facility carbon-intensive electricity consumption. These measures could include:

Facility Electric GHG Reduction Recommendations

- Better tracking of building energy performance through proper data collection, such as the use of submetering on a building or at equipment level
- Improvements to facility energy performance by identifying opportunities through energy performance audits of town buildings/facilities
- Retrofitting inefficient equipment and through improved building management
- Purchasing renewable or less carbon-intensive electricity
- Installing and metering renewable energy systems at Town facilities

Shifting to alternative energy electricity could be achieved by purchasing through ESCO's that procure energy from wind/solar/etc, as these sources will lead to lower carbon intensity with each consumed kWh of electricity by the Town. The ESMP will include alternative procurement recommendations though it's not known at this time which, if any, ESCO's offer energy from renewable sources.

6.1.2.2 Streetlight Electricity

Streetlight electric consumption contributes 88,061 tons of CO_2e to the Town's overall annual emissions baseline. This is 45% of Scope 2 emissions and 43% of total Town emissions. This represents a large percentage of town-wide emissions and also has a large potential for emissions reduction with proper retrofitting of existing lighting fixtures. Street lights within the town are classified under a different billing rate than the rest of the electricity accounts within the Town. The street lights are owned by the LIPA electric utility and are unmetered. Annual consumption for street lights is estimated based on the quantity, type, wattage of bulb and ballast and estimated operating hours. A revision of this rate contract with LIPA is recommended in conjunction to energy efficiency retrofits made to the street lights. Recommendations to upgrade current street light infrastructure will be included in the ESMP.

7 Appendix

7.1 Organizational List of offices by Department

7.2 Number of buildings and square feet of building space by department

7.3 Renewable Energy Generation GHG Offsets

7.1 Organizational List of offices by Department

Department of General Services (GS)

Agnecies Included	Offices
General Services	*Town Hall* *Animal Shelter* *Cemetaries* *Reproduction* *Traffic Control* *Urban Renewal* *Street Lighting*
Buildings	
Comptroller	*Purchasing*
Engineering	*Admin 1st Fl* *Admin 2nd Fl* *1580 Merrick Road*
Information and Technology	
Planning and Economic Development	
Public Safety	*Administration* *Field*
Senior Enrichment	*Baldwin Senior Center* *Bellmore Senior Center* *Cedarhurst Senior Center* *East Meadown Senior Center* *Elmont Senior Center* *Franklin Squire Senior Center* *Green Acres Senior Center* *Hempstead Senior Center* *Levittown Senior Center* *Merrick Senior Center* *Oceanside Senior Center* *Roosevelt Senior Center* *Salisbury Senior Center* *Uniondale-Hempstead Senior Center* *Uniondale-Merrick Senior Center* *Wantagh Senior Center*
Town Attorney	*Real Estate*
Civil Service Commission	
Communications and Information	
Human Resources	
Receiver of Taxes	
Town Clerk	*Archives* *Licensing* *Birth and Death Certificates* *Vital Statistics*

Department of Conservation and Waterways (C&W)

Agnecies Included	Offices
CW	*Admin* *Bay Constables* *Laboratory* *E. Marina* *Hanse Avenue* *Inwood Marina* *Guy Lombardo Marina* *Point Lookout* *W. Marina* *W. Marine Clam Plant* *Marne Nature Study Area* *Waterways Bldg*

Highway Department (H)

Agnecies Included	Offices
Highway	*Admin 1st Fl*
	Admin 2nd Fl
	Sidewalk Division
	Roosevelt Yard
	Franklin Sq. Yard
	Inwood Yard
	Road Crews (9 listed)

Department of Parks and Recreation (P&R)

Agnecies Included	Offices
P&R	*Administration*
	Atlantic Beach Estates
	Averill Blvd Park (pool & rec office)
	Baldwin Park (Ball field, court, skating park, public parks area)
	Cedar Street Park
	Coes Neck Park
	Dutch Broadway Park
	East Atlantic Beach
	East Bay Park
	Echo Park Pool Complex
	Elmont Road Park
	Forest City Community Park
	Garden City S. Community Park
	Harbor Isle Park
	Hendrickson Avenue Park
	Hewlett Point Park
	Joint Community Hall & Pool District
	Levittown Hall
	Levittown Pools
	Harlold A. Walker Memorial (park & pool)
	Lido Beach Town Park
	Lido West
	Merrick Road Park (Golf) / Senior Center
	Newbridge Road Park (admin, pool, recreation, ice rink)
	Oceanside Park (admin, pool)
	Point Lookout
	Rath
	Rock Hall Museum
	Roosevelt Pool
	Salisbury Park Drive
	Seamans Neck Park
	Shell Creek Park
	Smith Street Park
	Speno Park
	Terrace Gardens Community Park
	Town Park (Pt. Lookout, Camp Anchor, Malibu, Lido beach)
	Uniondale Park
	Veterans Memorial (East Meadows)

Department of Sanitation (S)

Agnecies Included	Offices
Sanitation	*Administration*
	Auto Maint
	Code Enforcement
	Collection
	Special Collections
	Homeowner's Drop Off
	Levy Park
	Merrick Refuse Disposal Plant
	S.T.O.P. Program & Inspectors
	Transfer Station

Department of Water (W)

Agnecies Included	Offices
Water	

7.2 Number of buildings and square feet of building space by department

	Number of Building	Sum of Sq. Ft.
Department of Conservation & Waterways (CW)	14	53889
Department of General Services (DGS)	13	263894
Department of Parks & Recreation (PR)	98	298505
Department of Water (WAT)	41	50776
Highway Department (HIG)	10	79138
Department of Sanitation (SAN)	25	298187
Grand Total	201	1044389

**It should be noted that the number of buildings represents unique building names provided by the Town and the total area associated with all buildings listed. Several facilities that a unique building name was provided for may not have included information about the buildings' area.*

7.3 Renewable Energy Generation GHG Offsets

The following table provides the generation data available for renewable energy generated by the town which can be considered a GHG offset to emissions resulting from the production of grid electricity. Because the Town net meters it's energy consumption, this amount of GHG reduction is already included in the Town's inventory. This chart simply shows the available data for renewable generation and the GHG equivalent in emissions from grid electricity.

Department of Conservation & Waterways (CW)		**2010 kWh**
Administration Building (Wind)		9949.00
West Marina (Wind + Solar)		15234.12
Administration Building (Solar)		1242.72
East Marina (Solar)		0.00
Laboratory (Solar)		0.00
Department of General Services (DGS)		
New Town Hall (Solar)		0.00
Total		**26425.84**
GHG offsets	**Tons**	**CO2e tons (w/GWP)**
CO2	17.01	17.01
CH4	1.09	22.81
N2O	0.16	48.33
CO2e		88.15