DOVER CITY COUNCIL UPDATE

7/11/2018

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Introduction

As a result of this project, Dover will become the first city to establish a combined greenhouse gas (GHG) and nitrogen inventory for its local government operations

Definitions:

The following is a list of definitions for important terms included in this update.

- **Carbon footprint:** Total amount of greenhouse gases produced to directly and indirectly support human activities. Values are normalized using equivalent tons of carbon dioxide (CO_2e).[1]
- **Nitrogen footprint:** The amount of reactive nitrogen released to the environment as a result of an organization's resource consumption. Reactive nitrogen refers to compounds such as nitrous oxide, nitrite, ammonia, and ammonium. The two main sectors releasing reactive nitrogen are the consumption and production of food and fossil fuel combustion.[2]
- **Footprint baseline:** Selected time period to which future footprints are compared. Essential for setting reduction goals and evaluating emission sources.[3]

Project Overview:

This project will yield a carbon and nitrogen footprint baseline for the City of Dover's municipal operations. The completion of a baseline study is a necessary first step that will allow the City to set reduction goals and execute them in a cost effective manner. This baseline will be compiled using two online tools, EPA's Portfolio Manager and the University of New Hampshire's Sustainability Indicator Management and Analysis Platform (SIMAP).[4,5] Portfolio Manager will allow for energy, water use, and the resulting greenhouse gas emission (GHG) to be tracked for individual properties and utilities. Portfolio Manager also allows the user to set baselines for the City's properties, to which later data can be compared on an individual or collective basis. SIMAP, which is currently designed for campus analysis, will allow for the calculation of a cumulative carbon and nitrogen footprint baseline. The SIMAP tool allows the user to input emissions sources in three categories of scope (Table 1).[3]

Table 1. Definitions for scope 1, 2 and 3 emissions categories.

Scope	Description
1	Emissions from sources that are directly owned or controlled by the organization. Example: combustion of fossil fuels for heating or operation of municipal vehicle
2	Emissions from the consumption of purchased electricity
3	Emissions that are a consequence of the organization's operations. Example: Employee commuting or business travel.

Furthermore, SIMAP offers features allowing the user to track nitrogen footprints from sources such as fertilizer use or food waste from the Dover school system.

LGO Baseline Benefits:

The following is a list of benefits attributed to establishing a local government operations (LGO) GHG and nitrogen footprint baseline.[3]

- Leads to the identification of opportunities to improve energy efficiency.
- Demonstrates climate change leadership.
- Allows reduction targets to be set and executed in a cost effective manner.
- Increases the general transparency and consistency of GHG accounting and reporting among institutions.

Project Goals:

The goals of this project include the following.

- **A completed EPA Portfolio Manager profile** for the City and School operated facilities.
- **Baseline carbon and nitrogen footprint calculations** for the City of Dover's municipal operations via Portfolio Manager and the SIMAP tool.
- **Reports**, including recommended goals, to be presented to City leaders, staff and the general public.
- **Recommendations for adaptations to SIMAP** methodologies and the user interface to allow a version that can support municipal calculations while being aligned with the Greenhouse Gas Protocols best practices for LGOs.

Methodology

Overarching Structure:

The inventory produced from this project will align with the guidance provided by Appendix B of the Greenhouse Gas Protocol: Inventories for local government operations. Thus, the procedure for conducting Dover's inventory requires the implementation of five overarching steps (Figure 1).[3] At this stage in the project:

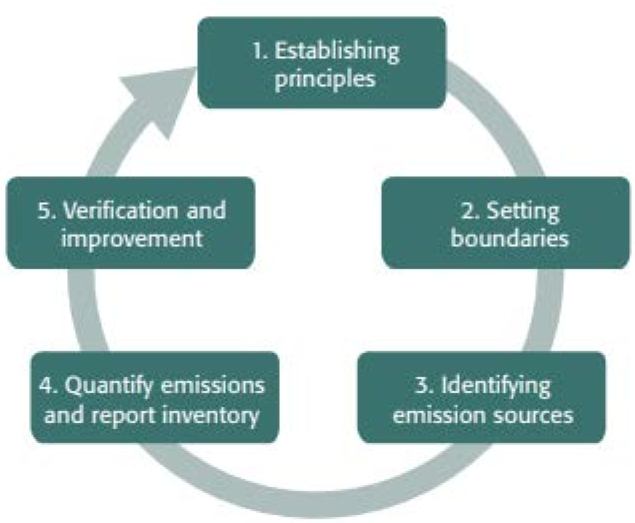

Figure 1. GHG Protocols five major steps for conducting a local government operations inventory.

1. Principles have been established as are presented in the Climate Adaptation Chapter of Dover's Master Plan.
2. Boundaries have been selected so that the resulting inventory will include both municipal and school operations.
3. Emissions sources have been identified that align with the selected boundaries.
4. Emissions are in the process of being quantified and will be formally presented in the form of a completed inventory report by the end of the project period.
5. Once the resulting baseline is verified, future improvements to LGO can be made in terms of energy efficiency, cost, and emissions reductions.

Data Processing:

The following map outlines the general methodology in place for the quantification of a carbon and nitrogen footprint baseline.

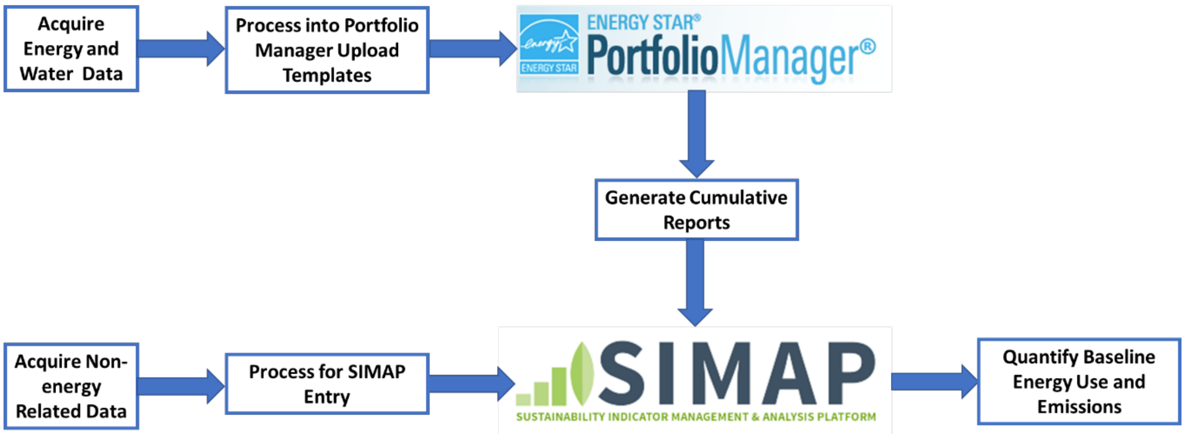

Figure 2. General methodology displaying the steps between data acquisition and baseline quantifications.

At this time there is also a document in the works titled Guide to Maintaining Portfolio Manager which includes a list of contacts from which relevant data was acquired and a standard operating procedure (SOP) for data processing. The goal of this document will be to ensure a smooth transition for the next Portfolio Manager user for the City of Dover.

Results to Date

Note: Calendar years were used to quantify results as the hope is that eventually a full community inventory will be conducted. Using calendar years will allow for an easier comparison between the LGO footprint and that of the community as a whole.

Energy Usage:

Quantifying energy use is an essential step in establishing a footprint baseline. Here the contributions of each energy source are made apparent, via normalization, through the conversion to million British Thermal Units (MMBTU) (Figure 3). For reference one BTU is the amount of energy it takes to raise a pound of water one degree Fahrenheit. The total usage was 104,800 MMBtu in 2016 and 102,670 MMBtu in 2017 yielding a 2% reduction. Electricity and natural gas account for approximately 47% and 46% respectively of the total usage. The remaining 7% is distributed almost evenly between diesel, No. 2 oil and propane for both 2016 and 2017.

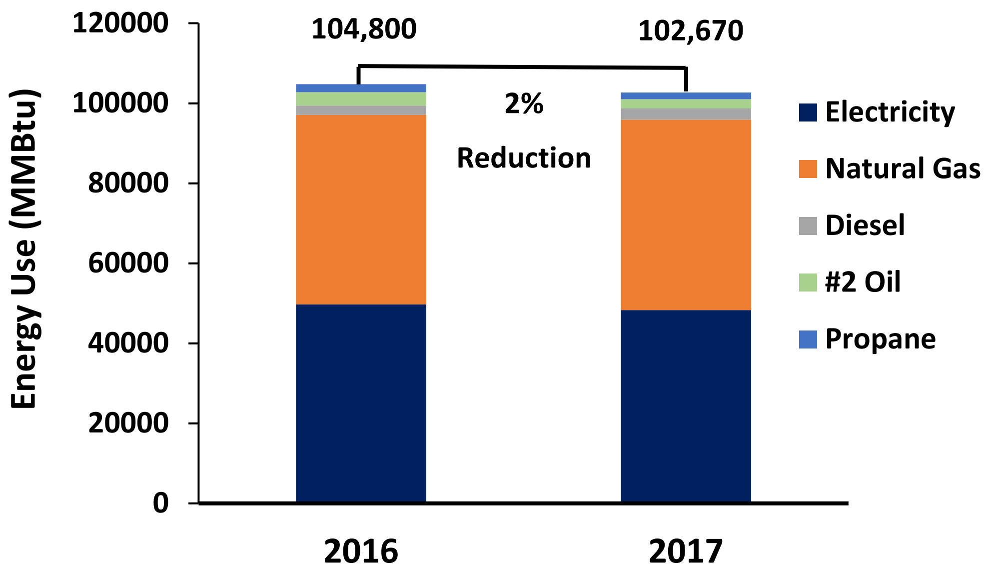

Figure 3. A comparison of Dover's energy use by source between 2016 and 2017.

As is displayed in Table 2 the overall two percent reduction can be contributed to a decrease in electric, No.2 oil and propane usage.

Table 2. Breakdown of Dover's LGO energy use and the percent changes between 2016 and 2017.

Energy Use Source	Energy Use Totals (MMBtu)		Percent Change
	2016	2017	
Electricity	49,760	48,329	-2.9
Natural Gas	47,310	47,523	0.4
Diesel	2,327	2,804	18.6
No. 2 Oil	3,375	2,373	-34.9
Propane	2,028	1,641	-21.1
Cumulative	104,800	102,670	-2.1

Energy Cost:

Energy cost is a useful metric to track as it allows for the identification of sources which result in the highest contributions. Furthermore, including cost in a baseline analysis allows for future LGO implementations to be compared in terms either increased savings or spending. The total energy cost in 2016 was $2.36M and in 2017 was $2.59M, yielding a 9.3% increase.

Electricity is by far the highest contributor to energy cost, making up 74% in 2016 and 75% in 2017. Natural gas remained constant at 21% between the two years. The remaining 4-5% is distributed almost evenly between diesel, No. 2 fuel oil and propane with diesel moving from 1% to 2% and vice versa for No. 2 fuel oil.

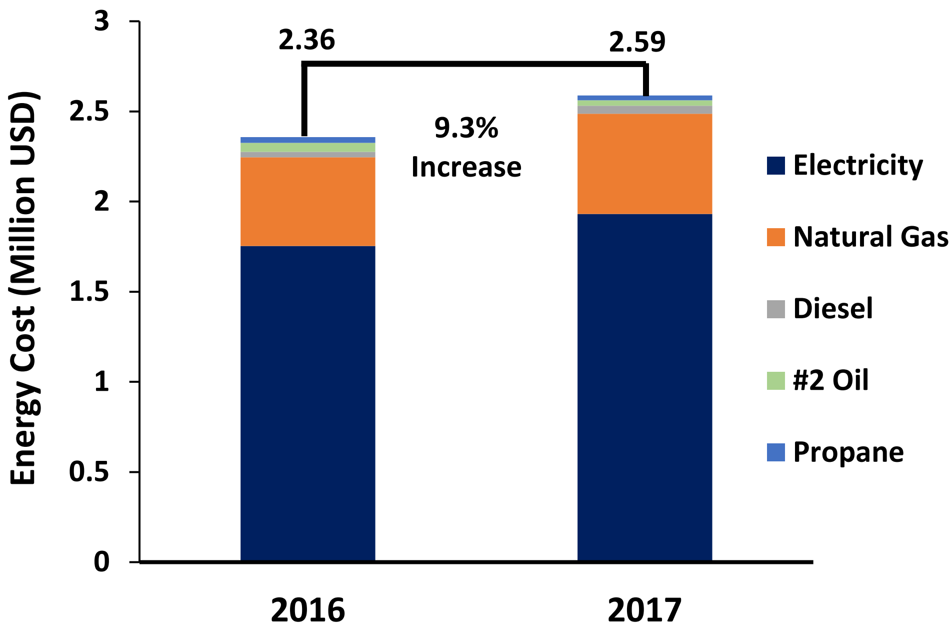

Figure 4. A comparison of Dover's energy cost by source between 2016 and 2017.

As displayed in Table 3, the increase in spending between 2016 and 2017 can be contributed to a spike in electric, natural gas and diesel costs. Electricity is the only source which saw a decrease in overall usage but an increase in the resulting cost. This is a result of continually climbing electricity supply rates.

Table 3. Breakdown of Dover's LGO energy use and the percent changes between 2016 and 2017.

Energy Use Source	Cost Totals ($)		Percent Change
	2016	2017	
Electricity	1,754,003	1,931,308	9.6
Natural Gas	490,727	556,055	12.5
Diesel	30,576	43,368	34.6
No. 2 Oil	49,385	30,375	-47.7
Propane	32,837	26,580	-21.1
Cumulative	2,357,527	2,587,686	9.3

Streetlights to LED:

In November of 2017, the City completed the retrofitting of 1,781 streetlights with LED fixtures. These lights are outfitted with smart controls, which allow the lights to be remotely monitored and adjusted. The results of the retrofit become very apparent when comparing the block of time from November 2016 to April 2017 with November 2017 to April 2018 (Figure 5). The cumulative usage during this period decreased by approximately 199,150 kWh, resulting in almost $39,400 in savings. Furthermore, the GHG emissions declined by approximately 148 MT CO_2e.

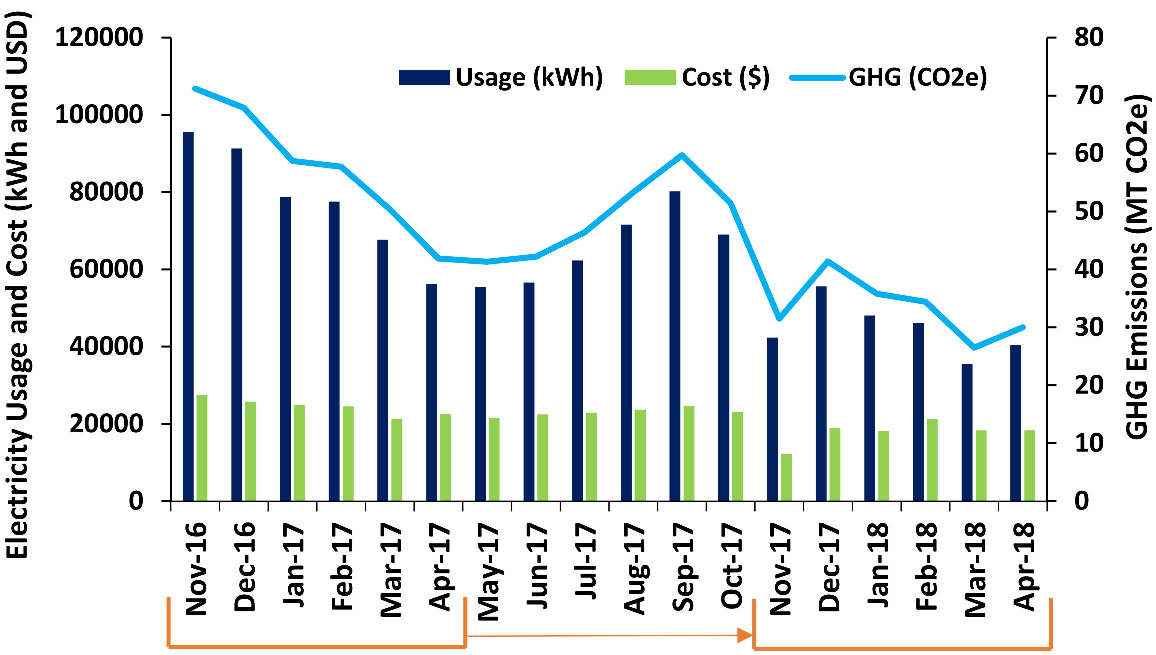

Figure 5. Impact of streetlight LED retrofit.

GHG Emissions:

Cumulative energy totals for 2016 and 2017 were entered by source into SIMAP. Using the appropriate emissions factors related to each fuel source, SIMAP generated annual GHG emissions totals, normalized by carbon dioxide equivalence and broken down into GHG type (Figure 6). In 2016 and 2017, carbon dioxide (CO_2) made up more than 99% of the total GHG emissions and thus methane (CH_4) and nitrous oxide (N_2O) combined were less than 1%. Between 2016 and 2017 there was a 9% reduction in total GHG emissions. This is result of less propane and fuel oil No. 2 consumption in 2017. Note that the scale is shifted in Figure 6 so that the methane and nitrous oxide contributions are apparent.

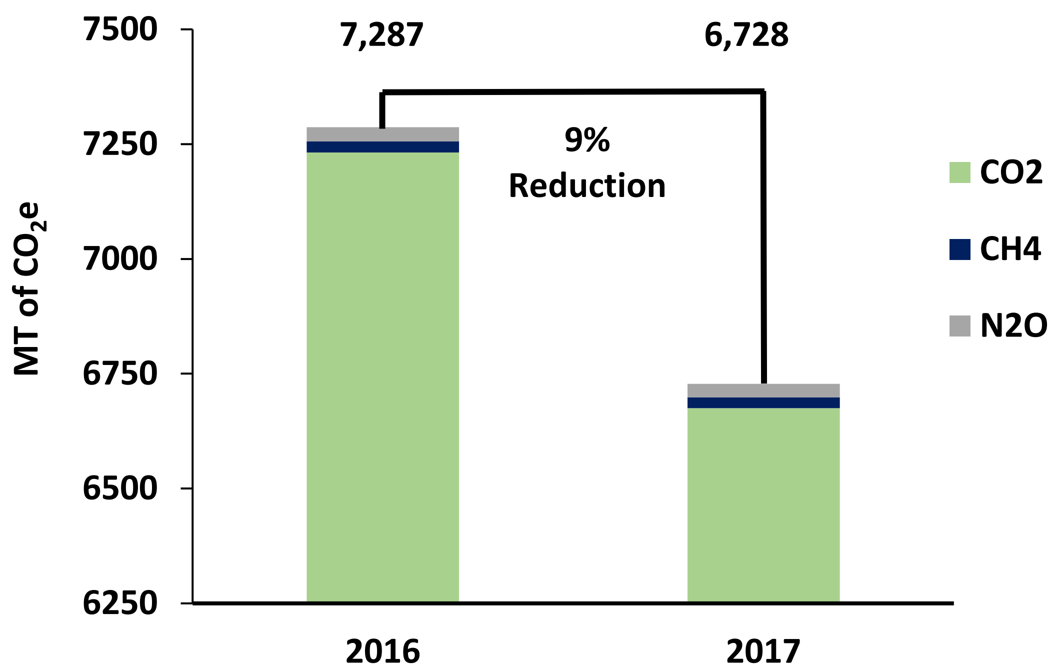

Figure 6. Total GHG emissions normalized by carbon dioxide equivalence for 2016 and 2017 as a result of Dover's LGO.

Making MTs of CO_2 Relatable

It can be difficult to grasp the scale of GHG emissions when they are presented in terms of carbon dioxide equivalencies. The following conversions help to make MTs of CO_2 more relatable:

- A single MT of CO_2 is enough to fill the volume of an average two story home, approximately 1400 ft^2.[6]
- A total of 7,925 acres of fully developed forest would be required to sequester Dover's 2017 LGO GHG emissions.[7]
- 7,925 acres, or 12.4 mi^2, of forest is equivalent to approximately 43% of Dover's total land area.

Future Work

The following is a list of remaining work to be completed by the end of this project.

- Input food use and fertilizer data into SIMAP
- Input employee commuting and travel information
- Generate a complete carbon and nitrogen footprint baseline using SIMAP
- Draft GHG and nitrogen inventory report
- Identify and suggest improvements to SIMAP so it better suits municipalities
- Analyze and review reduction scenarios
- Work with City leaders to establish reduction targets

References

1. Time for Change. What is a carbon footprint – definition. https://timeforchange.org/what-is-a-carbon-footprint-definition (accessed June 15, 2018)

2. Galloway, J. N.; Winiwarter, W.; Leip, A.; Leach, A. M.; Bleeker, A.; Erisman, J. W.; Nitrogen footprints: past, present and future. *Environ. Res. Lett.* **2014,** 9.

3. Fong, W. K.; Sotos, M.; Doust, M.; Schultz, S.; Marques, A.; Deng-Beck, C.; *Global Protocol for Community-Scale Greenhouse Gas Emission Inventories.*

4. Energy Star Portfolio Manager. https://www.energystar.gov/buildings/facility-owners-and-managers/existing-buildings/use-portfolio-manager (accessed June 8, 2018).

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6. AECOM. *City of Somerville Greenhouse Gas Inventory Report.* Somerville, MA, 2017.

7. Greenhouse Gas Equivalencies Calculator. https://www.epa.gov/energy/greenhouse-gas-equivalencies-calculator. (accessed July 6, 2018)