Greenhouse Gas Audit for the City of Dunedin, Florida: Recommendations towards a Net Zero Carbon Footprint Goal

Amanda Kardosh, Kimberly Rivas, Alana Price, Erin Duke, Matthew Hobbs, Aman Bhagvanjibhai Kansagara, Patrick Murphy, Michael Lemoine, Jeffrey Cox

Faculty Advisors

Dr. George Philippidis and Dr. Kebreab Ghebremichael

Patel College of Global Sustainability

University of South Florida

June 2018

Table of Contents

Executive Summary

The city of Dunedin is developing a sustainability plan to help improve their carbon footprint over the next fifty years. In order to help the city develop an effective Climate Action Plan (CAP) that will guide them towards achieving their carbon footprint reduction goals, USF graduate students from the Patel College of Global Sustainability conducted a greenhouse gas (GHG) audit. The audit is intended to give the city an understanding of the current GHG emissions and the sources. This report summarizes the GHG inventory for 2017 from government operations in five categories: buildings and facilities, employee commute, vehicle fleet, solid waste, and water and wastewater facilities. Based on the results of the audit, the water and wastewater treatment facilities were the largest producers of CO_2 emissions, totaling 4,801 metric tons in 2017. The next largest contributor was solid waste operations with 3,585 metric tons of CO_2, followed by Dunedin's vehicle fleet operations and buildings/facilities, totaling 1,407 and 1,294 metric tons of CO_2, respectively. Finally, the CO_2 emissions by the city's employee commute was 626 metric tons.

Based on these findings several recommendations were made to help the city reduce its GHG footprint. They include replacing inefficient energy systems (such as air conditioning units, incandescent light bulbs) within the large municipal buildings, including the library, replacing diesel fuel, which is currently used by fleet vehicles, with alternative fuels such as biodiesel, increasing recycling of solid waste, incentivizing ride sharing among employees, installing electric charging stations at municipal buildings, investigating the potential to install photovoltaic solar panels and anaerobic digesters at the wastewater facility, and taking steps to conserve water and practice water loss reduction.

Although implementation of some of these recommendations could be challenging, taking steps in at least the major categories (sources of GHG) will help the City of Dunedin achieve a substantial reduction in GHG emissions over the coming years.

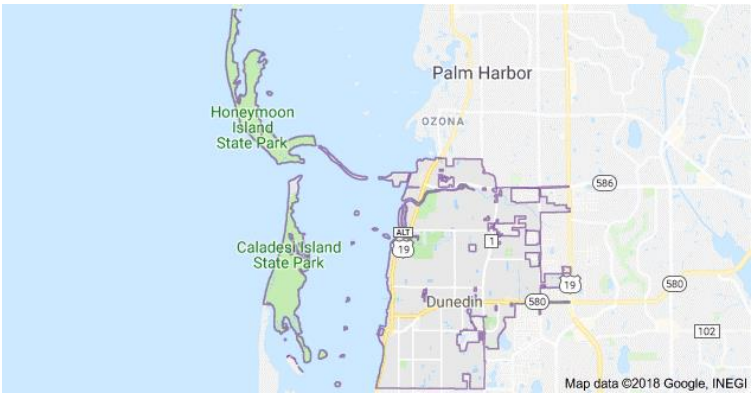
Introduction

As civilization marches forward with an ever-increasing global population, resource utilization, and growing concerns over worldwide ecosystems, leaders on all levels of government and business are now developing an understanding of the relationship among the three pillars of sustainable development: people, environment, and economy. In the pursuit of sustainable expansion, leaders must strive to develop an integrated approach between economic growth, environmental protection, and social progress. Whether development decisions are made by the heads of the largest countries or directors of the smallest municipalities, the limits of the "environmental carrying capacity" must be addressed to assure that people continue to prosper. The small coastal city of Dunedin, Florida is one such municipality.

This report presents a study on the Green House Gas emissions (GHG) inventory for the City of Dunedin with a focus on government operations. The GHG emissions from each source and recommendations to reduce the overall carbon footprint can be used to help the city reduce its contribution to climate change and meet its sustainability objectives.

About Dunedin

The City of Dunedin sits in the heart of Pinellas County on Central Florida's West Coast. The village-like town, with a rich Scottish heritage, is one of Florida's oldest settlements. Established initially around 1859 as an important trading post (Montes, 2015), and incorporated two decades later, it has seen growth as an agricultural center, a railroad hub, an economic region for citrus concentrate production, and a tourist focal point (Pinellas County Historical Background, 2008). However, as with many cities across the nation, by the 1960s and 1970s, commercial growth and urban sprawl had taken commerce away from downtown Dunedin. By the 1980s city officials took charge and revived Dunedin by renovating and improving landscaping and pedestrian facilities and restoring historic city sites. Further, officials facilitated a surge in new construction in commercial, public and private sectors (Pinellas County Historical Background, 2008).



Today, the City of Dunedin has a population of over 36,000 residents and is part of the larger community known as the Greater Tampa Bay Area, a top 20 metropolitan region in the United States with a collective population of 2.8 million (Tampa Bay, 2011). Due to the city's growth, new concerns have been identified such as land use, possible water and energy shortages, and the contribution of Dunedin's carbon footprint to climate change. These are the challenges city officials have targeted for future resolution.

Scope of the audit

In response to current concerns, Dunedin officials are now in the beginning stage of developing a sustainability plan to be included in the city's upcoming comprehensive plan. To obtain a clear picture of where the city stands ecologically in 2018, city officials have partnered with the University of South Florida (USF) through the Community Sustainability Partnership Program (CSPP) to perform a study pertaining to Dunedin's carbon footprint. The city intends to use the outcome of this inventory as a baseline to formulate short-term (5-year) and long-term (50-year) sustainability goals (Perez, 2017).

The scope of this report deals with Dunedin's carbon footprint quantified through a GHG gas audit of government operations only. Graduate students at the USF's Patel College of Global Sustainability estimated GHG emissions from government operations for the year 2017, in five different areas. The areas included emissions from the city's building and facilities, vehicle fleet, employee commutes, water and wastewater treatment facilities, and solid waste generation. By means of this analysis, the city will be able to determine and understand the GHG emissions contributed by the individual sources audited in this report. Furthermore, based on recommendations offered by the authors of this report, the city can develop a Climate Action Plan (CAP) with specific goals and strategies to abate source of GHG emissions, formulate a methodology to further reduce Dunedin's carbon footprint through assessment of city codes, policies and daily operations, and to develop a platform to educate the city's staff, residents, and business owners about their participation in reducing Dunedin's carbon footprint (Perez, 2017).

Once the audit information is presented and an action plan is prepared for Dunedin's comprehensive plan, city officials can implement a more comprehensive environmental study (to include residential and commercial operations) and begin reduction of GHG emissions at each identified source in order to decrease Dunedin's carbon footprint over the next half century.

Rationale

Municipalities represent perhaps the best opportunity for innovative climate related solutions because they can accurately and readily account for their GHG footprint and implement measures within their own boundaries. Increased environmental pressures brought about by human activities are primarily due to energy-related GHG emissions. Today, it is reported that cities account for 70 percent of energy related emissions and with anticipated urban growth that will account for two-thirds of the world's population by mid-century, ownership of emissions by cities is likely to increase (Fong, 2014).

Considered a starting point, a GHG audit provides a baseline assessment of a city's environmental performance and an overall understanding of its ecological carbon footprint. Comprehensive emissions and reporting standards are being developed on a global scale with the World Resource Institute and the climate research group C40 Cities cooperatively pioneering the way towards a sustainable future integrated with robust climate action. The Global protocol for Community-Scale Greenhouse Gas Emission Inventories (GPC), considered an industry leader, is an adaptive framework for cities and local governments to identify and report on city related emissions (Fong, 2014). The city of Dunedin is taking the initiative to adopt this framework in their operations as a way to track and reduce the city's emissions and mitigate climate related issues.

As part of the Community Sustainability Partnership Program, the city of Dunedin is attempting to more accurately understand its ecological carbon footprint through a GHG audit. Working synergistically with the surrounding communities, the city of Dunedin's vision for a sustainable future will enhance the overall performance of the Greater Tampa Bay Area. In the language of sustainability, the city of Dunedin is thinking globally and acting locally, a message that sustainable development leaders often advocate. In order to secure the vote of confidence from the community, the city of Dunedin must first display successful adaptation of sustainability initiatives at the governmental (internal) level before branching out into the community. Utilizing the GPC tool at a government operations scale, Dunedin will be able to accurately and transparently report on emissions related progress. This GHG audit will serve as the starting point in the city's fifty-year oversight plan for incorporating sustainability into both government-level and community-wide operations.

Objectives

The city of Dunedin's population has been steadily increasing over time at an average rate of 0.4% per year. This continuous growth in population makes the government's role in achieving sustainable and environmentally friendly development even more crucial. Developing ways to combat GHG emissions within the city becomes substantially more difficult with a growing population. However, there are many ways that the city's government can facilitate more effective use of the natural resources.

The goal of Dunedin's partnership with USF is to build on the city's existing infrastructure within the previously mentioned five key areas. These actions and recommendations will give rise to real solutions that aim to enhance current policy framework, as well as suggest other environmentally friendly energy sources for the future. The city of Dunedin should be commended for recognizing the importance of becoming more sustainable by adopting greener practices.

The overall objective of this project was to estimate the GHG emissions from the different government operations of the City of Dunedin. The specific objectives include:

- Conduct an accurate GHG audit across the buildings/facilities, solid waste, water/wastewater, vehicle fleet, and employee commute sectors of the city of Dunedin.
- Provide realistic recommendations to the city in order to lower GHG emissions.
- Help educate Dunedin government officials on the process of GHG auditing so that future audits can be conducted.

Methodology

The GHG auditing methodology for this report was based on the ClearPath™ software, which is managed by the International Council for Local Environmental Initiatives (ICLEI). ICLEI is a worldwide community with a purpose of assisting local governments pursue a sustainable future. It is a global network involving over 1500 cities, towns, and regions. It helps local government leaders connect to share ideas, policies, and new technologies that will assist local governments achieve their sustainability initiatives. The City of Dunedin has recently become a member of ICLEI and has access to all the benefits this community has to offer, including free webinars, access to congressional events, connections with leaders in the local government initiatives, and most importantly full access to the ClearPath™ software.

ClearPath™ is an online software platform created by ICLEI that allows for cities to calculate and track GHG emissions that are produced from both government operations and the community at large. For government operations, a city is able to track the electricity used in all government-owned buildings and facilities, the emissions from fuel burned by government-owned vehicle fleets, the emissions contributed by government employees when traveling to and from work, the emissions created through water and wastewater treatment and distribution, and the emissions from solid waste generation from all government facilities. Once the sector information is entered into ClearPath™, the information is analyzed, and the CO_2 equivalent for each sector is calculated. The results establish a current baseline and can also be used to help predict future emissions based on any initiatives that are implemented. In turn, a city can see what emissions it can control and reduce on its own. With this information, the inventory helps set both short and long-term goals that will empower the city to lead the rest of the community by example.

For the community inventory it is important to identify, calculate, and report on city-wide GHG emissions. The community inventory encompasses both emissions produced within the city and also emissions produced outside the city that are associated with activities taking place within the city limits. For example, solid waste that is produced within the city is taken into account even if it is taken outside of city limits for disposal. The community track allows the city to gain a full understanding of where most of the emissions are occurring and the best routes it can take to reduce emissions. It also helps the city government set regulations, improve building efficiency, and improve local transportation.

GHG emissions are estimated based on the amount of carbon dioxide (CO_2), methane (CH_4) and nitrous oxide (N_2O) released from various activities related to government operations of the city. These total GHG emissions are reported in terms of CO_2 equivalent (CO_2e), as CH_4 and N_2O quantities are converted to a CO_2e basis using established conversion factors. In this project the conversion factors embedded in ClearPath™ have been used.

Audit Results

Electricity for the City of Dunedin is mainly provided by Duke Energy. In all the five categories included in this study, electricity data were obtained from the City's Duke Energy Electric bills and categorized by address. Duke Energy provides electricity from a variety of sources including natural gas, oil, and coal. ClearPath™ calculates the different amounts of GHG emissions from each source and presents the total GHG values in CO_2e.

The total annual GHG emissions from government operations in 2017 was estimated to be 11,713 metric tons. The largest GHG emissions came from the water and wastewater treatment facilities, followed by solid waste, vehicle fleet, buildings, and employee commute, respectively. The estimated CO2e emissions from water and wastewater facilities was 4,801 metric tons, whereas emissions from solid waste operations, vehicle fleet, buildings and employee commute were 3,585, 1,407, 1,294, and 626, respectively.

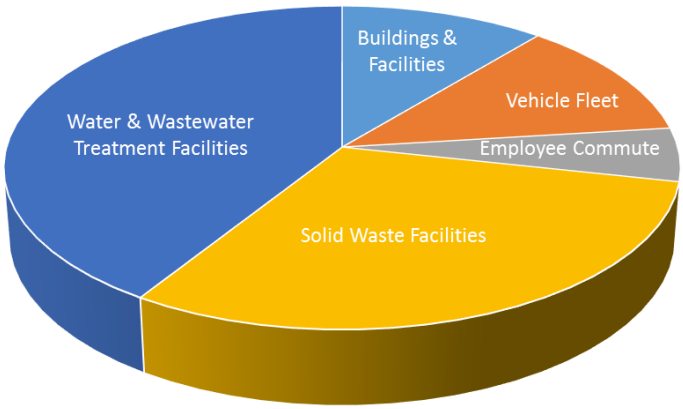


Figure 1. Overall GHG emissions from five categories of government operations

Building and Facilities

Duke Energy electric bills for each of the city buildings and facilities for 2017 were used to estimate GHG emissions in this category. The Duke Energy bills were analyzed and the yearly energy consumption in kilowatts hours (kWh) for each location was calculated. Once the yearly consumption data were finalized, a factor set was created in ClearPath™ to assist in calculating the greenhouse gas emissions per location based on the annual kWh usage. The factor used to calculate grid electricity emissions was based on a 2016 report by Duke Energy regarding environmental performance metrics as well as the 2016 EPA Factors, which contained a summary table for GHG emissions rates. This factor set allowed ClearPath™ to calculate the

total emission rate for CH_4, CO_2 and N_2O and CO_2e per location. After the factor set was in place, each address was listed separately as an inventory record in ClearPath™ allowing the data to reflect the energy consumption at each individual location.

Accordingly, the energy consumption in the city's buildings and facilities generate 1,295 metric tons of CO_2e annually, which is 11% of the total GHG emissions from government operations. Approximately 60% of this comes from energy consumption in just four buildings: the Library, the Planning & Development/Engineering/ Pinellas County Sheriff Department, the Martin Luther King (MLK) building, and Hale Senior Activity Center. The Library consumed 603,300 kWh of electricity in 2017 and produced 265.4 metric tons of CO_2 equivalent. The Planning & Development/Engineering/ Pinellas County Sheriff Department building was the second leading consumer of grid electricity with a yearly usage of 498,840 kWh, producing 219.5 metric tons of CO_2e. The Martin Luther King (MLK) building consumed 313,680 kWh of grid electricity with an annual emission rate of 138 metric tons of CO_2e. Lastly, the Hale Senior Activity Center consumed 311,040 kWh and emitted 136.8 metric tons of CO_2e. Comparative percentages of building energy consumption are shown in Figures 2 and 3.

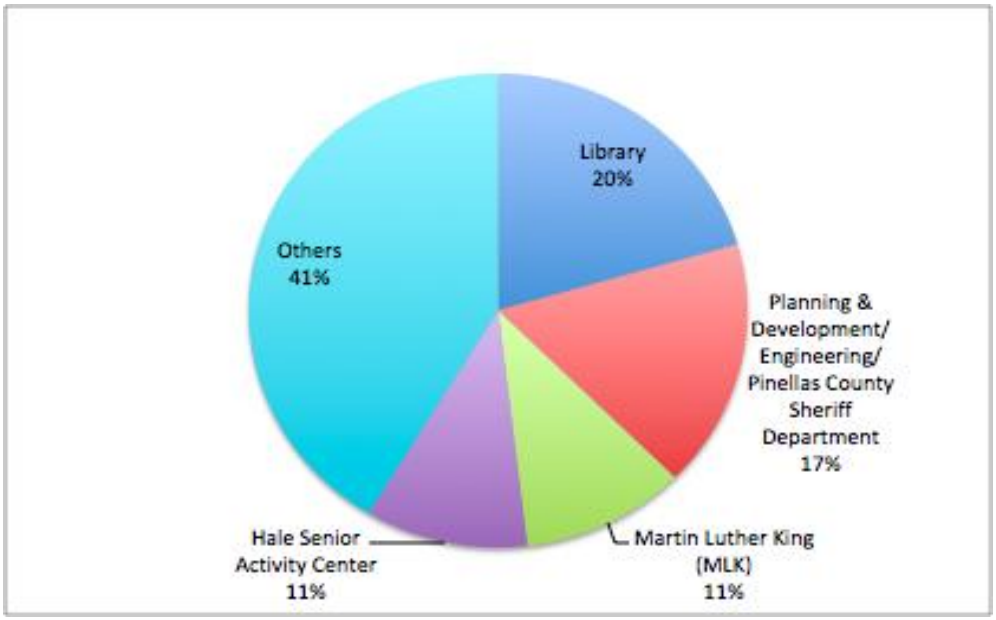


Figure 2. 2017 Energy Consumption of Buildings and Facilities

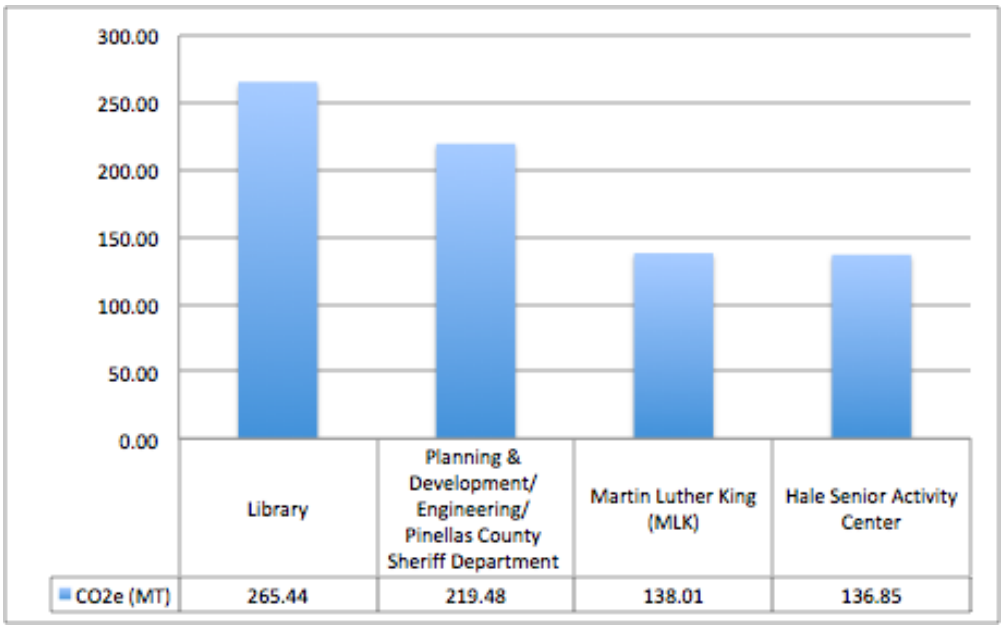


Figure 3. 2017 Energy Consumption of Buildings and Facilities

Transportation - Employee Commute

In order to secure a more accurate and transparent grasp of the city of Dunedin's GHG emissions, an employee commute sector was developed and analyzed as an indirect source of GHG emissions for the city of Dunedin. The GHG emissions from this category was estimated to be 626 metric tons CO_2e based on estimates of annual Vehicle Miles Traveled (VMT) and an assumption of an average on-road vehicle miles per gallon (MPG) of 25.5. The total annual fuel consumption was estimated to be 70,843 gallons of gasoline. Accounting for 5.3% of the city of Dunedin's overall CO_2e emissions, the employee commute sector represents the smallest portion of GHG emissions for which the City of Dunedin is responsible. Due to the indirect nature of GHG that this category represents, the recommendations to reduce GHG emission in this sector are based on a framework of behavioral measures.

Transportation - Vehicle Fleet

The annual GHG emissions from fleet services was estimated to be 1,404 metric tons of CO_2e, the majority of which comes from diesel based vehicles (967 metric tons). Upon further analysis, garbage trucks consumed about two-thirds of the total diesel used in 2017, which is slightly over 60,000 gallons of diesel. The data shows that the City uses fifteen Ford Escape sport utility passenger SUVs that consume about 4,376 gallons of fuel annually. The leading category for unleaded gasoline consumption was the heavy trucks, which were mostly comprised of Ford

utility trucks and Ford F250/Crew Cabs. The fuel consumption for these heavy vehicles was about 35,450 gallons in 2017, which resulted in 313 metric tons of CO_2e. The categorization of all these vehicles was based on federal regulations by vehicle weight. For example, if a truck weighs up to 6,000 pounds, it is considered a light duty truck. The light duty gasoline trucks accounted for 14,148 gallons of fuel, which resulted in 124 metric tons of CO_2e. The percentage of metric tons of CO_2e emitted from employee commute vehicles and Dunedin fleet vehicles are shown in Figure 4.

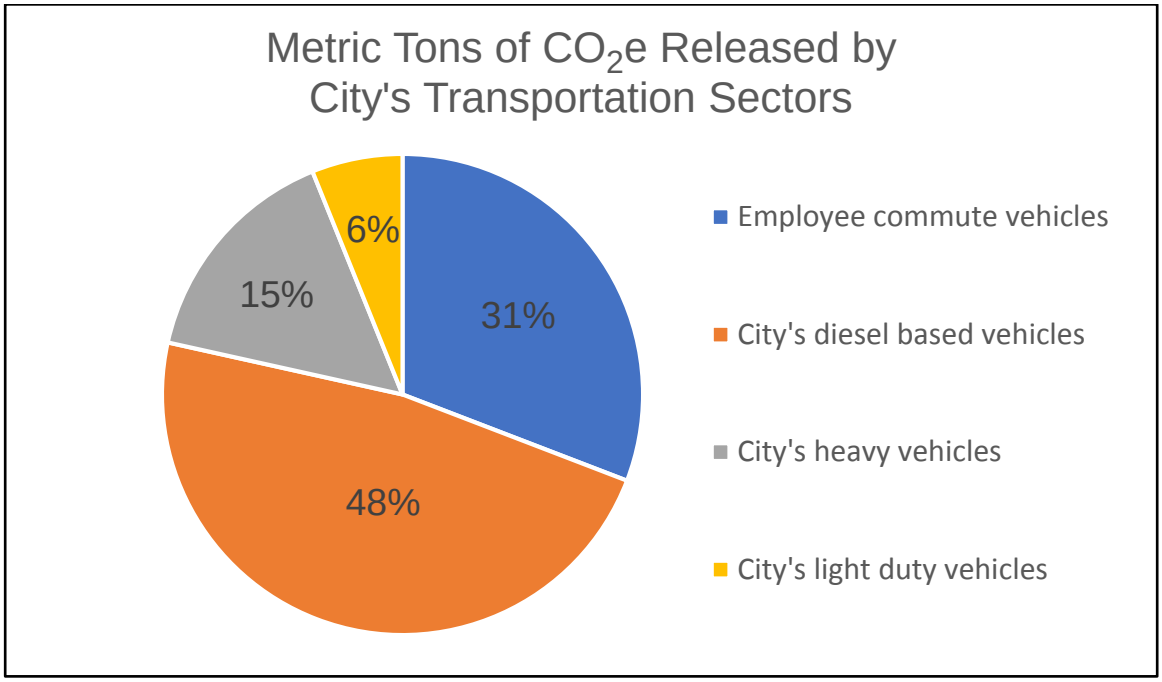


Figure 4. The percentage of CO_2e emitted from city employee commute and fleet vehicles

Solid Waste

The Municipal Solid Waste (MSW) Report completed by the FDEP revealed that Pinellas county generated over 2 million tons of waste in 2016, alone, and only approximately 54% of that was recycled (FDEP, 2016). In the city of Dunedin, all waste generated from commercial, single and multi-family homes, grit from wastewater treatment plants, and mulch debris is transported to the Pinellas county landfill 15.5 miles away from the city. Bulk furniture and yard debris are transported to the Angelos landfill 8.6 miles away, and all brush is transported to a consolidated location 14.2 miles away. Combining the waste disposed at each location, in total, the city generated over 34,000 tons of solid waste in 2017. Solid waste from municipal operations was estimated to be approximately 781 tons (less than 3% of the total solid waste produced in the

city). This estimation does not include the amount of solid waste that was recycled by the city. If Dunedin's recycle rate mirrors Pinellas County's rate, then it can be estimated that the city recycled approximately 422 tons of MSW in 2017.

After entering the total tons of solid waste produced into the ClearPath™ program, it revealed that solid waste from government operations emitted 3,585 metric tons of CO_2e in 2017 or approximately 28% of the total greenhouse gas emissions. Working towards reducing MSW will help lower the total value of waste transported to landfills and may persuade citizens to start taking initiatives on reducing consumption in their daily lives. Dunedin's solid waste emissions for the year studied is shown in Figure 5.

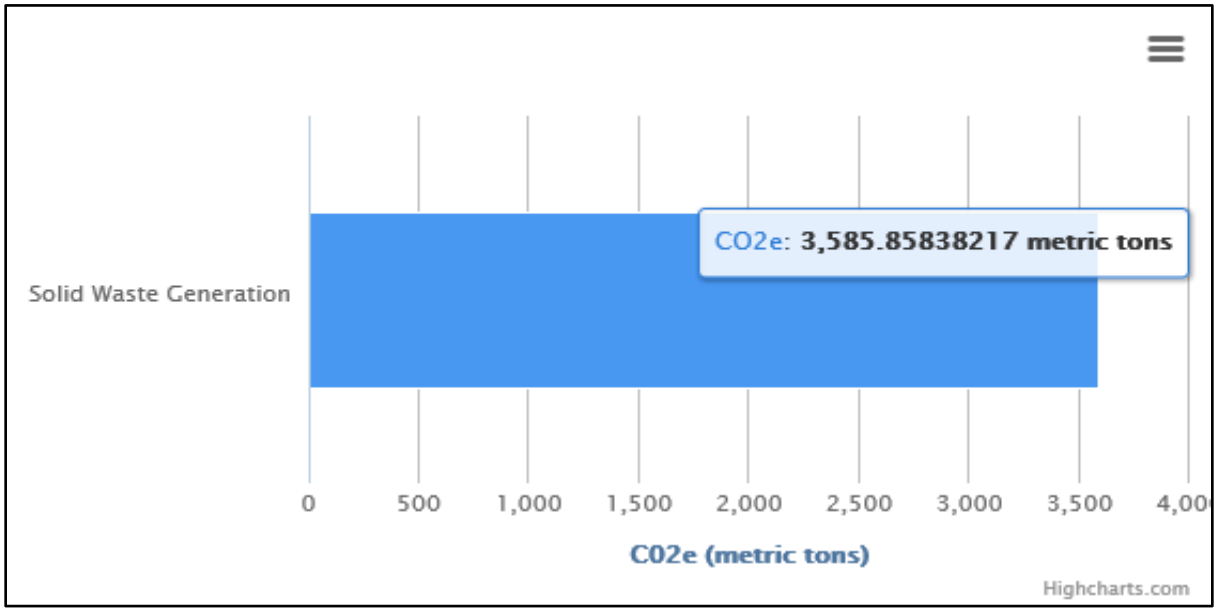


Figure 5. 2017 Solid Waste CO2e Emissions

Water and Wastewater Treatment Facilities

Dunedin's Department of Public Works and Utilities includes the divisions of potable water and wastewater. In this category the following facilities were included in the GHG emissions inventory: the potable water and wastewater plants, 42 Lifts, 4 Pumping Stations, 17 wells, and 2 off-site reclaimed water storage facilities. Data for grid energy use, for all water and wastewater transfer components, was supplied by the city of Dunedin's Duke Energy electric bills for 2017. An excel spreadsheet was used to list monthly meter usage for each component, which allowed the calculation of total annual kilowatt hour (kWh) usage.

A comparison of kilowatt hours used in 2017 by each component of the water and wastewater facilities is shown in Figure 6.

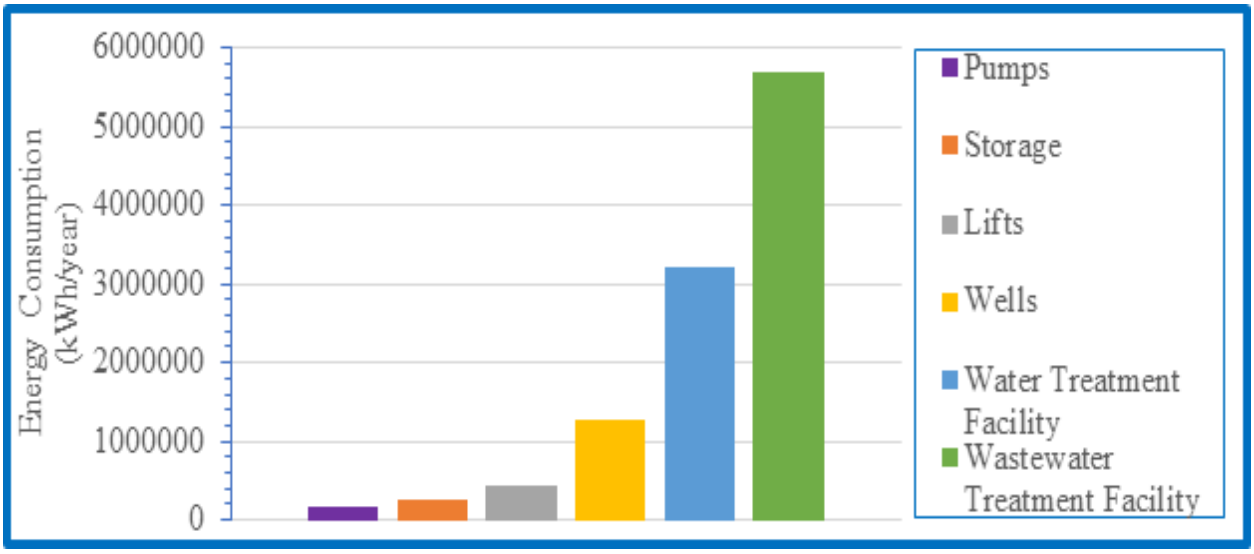


Figure 6. 2017 Energy Consumption of Water Transfer Components

The CO_2e estimates, expressed in metric tons per year (MT/year) are shown in Figure 7. The emissions for each component in the water and wastewater facilities for 2017 were calculated based on energy consumption and conversion factors in the ClearPath™ software.

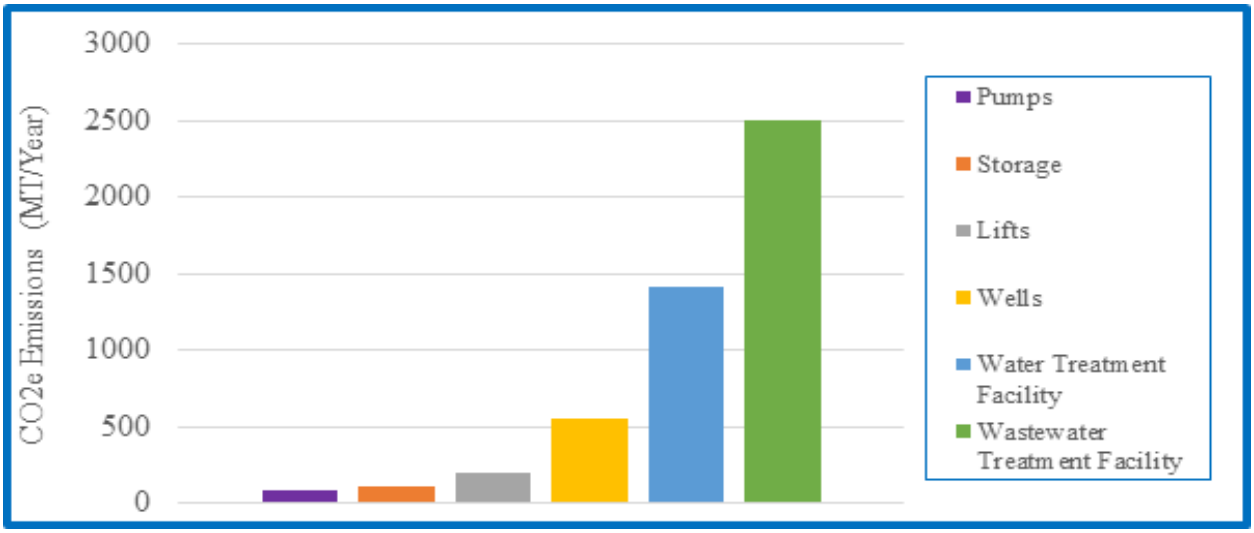


Figure 7. 2017 CO_2 Equivalent Emissions from Water Transfer Components

The total GHG emissions from the city of Dunedin's water transfer components was 4,849 MT/year. The city's pumps, storage facilities, lifts, and wells together contributed about 938

MT/year or 19% of the total water and wastewater GHG inventory. The two largest GHG emission contributors were the water treatment and wastewater treatment facilities with 1,408 MT/year (29%) and 2,503 MT/year (52%), respectively. According to Paul Stanek (2018), Dunedin's Director of Water and Wastewater and Assistant Utilities Director, both facilities have multiple levels of equipment all constantly using electricity. The water treatment facility operates a reverse osmosis (RO) process to achieve high quality water and even though it stores water during off-peak hours to reduce electricity use, it still takes a great deal of electricity to operate (Stanek, 2018). The wastewater treatment facility employs an advanced biological nutrient removal process and consumes about 23% more electricity than the potable water treatment plant.

Recommendations

After successfully analyzing the raw data and completing the GHG calculations in the ClearPath™ program to ascertain each sector's emissions, a comprehensive action plan to reduce the city's emissions rate was assembled. Since each sector of government operations has its own effect on the total GHG emissions of the city, appropriate recommendations to reduce GHG emissions for each sector were developed. Some recommendations were based on human behavioral measures, while others were based on operations.

Building and Facilities

In order for the city of Dunedin to be able to reduce energy consumption and emissions in this sector, the city should first promote energy efficiency training providing education on the subject to all government employees. Often, with simple tips and behavioral change, it is possible to reduce energy consumption, which can result in financial savings and emissions reduction. After the awareness campaign, a competition can be held between buildings/facilities, where part of the energy savings could be invested in benefits for the winner.

The city should also adopt a program that facilitates a more energy efficient design for the four largest energy consuming buildings. They could be retrofitted with energy efficient technologies, such as new air conditioning units, energy efficient light bulbs (LED), double-pane heat insulated windows, and environmentally friendly insulation on rooftops. The largest use of energy in buildings and facilities is the HVAC system. Heating and cooling utilizes roughly 47% of energy use (Desjardins, 2016). Therefore, routine maintenance on City HVAC systems will be critical for efficient energy use. The City of Dunedin should also be conscious of the temperature being maintained in buildings. A change of just a few degrees utilizes a substantial amount of energy to heat or cool a building. When installing new units or retrofitting old buildings, the city should place priority on energy efficient technologies.

Retrofitting incandescent lighting with light-emitting diode (LED) lighting is one of the low hanging fruits that should be seriously considered. LED bulbs use less energy and have a much longer lifespan that would result in significant energy/money savings. Where applicable, the lights should be equipped with dimmers or sensors to allow automatic turn-off or dimming when no one is occupying a certain section of a building. Another small change that may assist in saving energy in certain buildings would be turning off equipment, such as computers, when not

in use or overnight. An appliance, even when not in use consumes energy by just being plugged in.

Since the City is already developing a study to install solar PV panels on some of its municipal buildings, it may be an ideal time to prioritize the buildings with higher energy consumption and higher emissions for inclusion, starting with the library and the wastewater treatment facility. Although solar systems have a large upfront cost, there are various financing options available and the cost savings in monthly utility bills typically offset the upfront cost within just a few years.

Furthermore, the City of Dunedin should keep its commitment to LEED (Leadership in Energy and Environmental Design) standards for all newly constructed City buildings to guarantee a lower emission inventory from construction to operation. LEED is a voluntary green building certification program that requires energy and water efficiency, sustainable materials, and construction practices. It is important to emphasize that Dunedin already has two LEED certified buildings, which are the Community Center and Dunedin Fine Arts Center. The Fire Station on Michigan Avenue is also a Green Globe certified building.

Transportation - Employee Commute

A very simple and easy way to get cars off the road and reduce GHG emissions is to focus on ways to get employees to carpool throughout the work week. This can be done by providing benefits to employees who embrace a rideshare program. The city can experiment with incentives for employees to change their commuting practices. “The information you collect can help you manage your commuter benefits program more effectively by helping you measure changes in employee travel patterns over time and increasing your understanding of the benefits that are most important to employees” (BWC, 2018). The belief is that people will change if they benefit from making changes, so turning the program into a competition with prizes for teams who log the most carpool trips or miles is a great incentive. Parking cash-outs, restaurant gift cards, cash prizes or even raffle prize drawings are all proven ways to increase levels of participation.

In the city there are 17,258 households (DATAUSA, 2018). Although information on the mode of travel is not available, there are possible solutions to reduce carbon emission by improving bicycle transportation. Although this focuses more on the community rather than government

operations, it is something that should be looked at going forward with any concept plan that may be initiated. The city can seize an opportunity to implement a bike share program based on the experience from the two programs already in effect in the Tampa Bay area. The Coast Bike program that is currently underway in the Tampa Bay area and the USF bike share are two successful programs that are currently operating in a localized area. The USF Share-A-Bull Bike program allows students, faculty, and staff to check out bikes. This is a great way to get around campus, get some exercise, improve health, and give students a means of transportation when they might not have one. According to USF, since July 1 2017 operation of the Share-A-Bull Bike program is managed by CycleHop, the largest "Smart Bike" bike-share operator in North America. CycleHop also operates the Coast Bike Share in Downtown Tampa and St. Petersburg. The City of Tampa's bike share program has multiple conveniently located stations throughout the greater part of downtown and the Riverwalk area that are easily accessible and a fun way to conduct the daily commute or to tour the city.

The opportunity to have Dunedin embrace this concept would be a rather inexpensive solution to having not only high school students commute, but also city employees and government personnel, who want a more cost-effective and eco-friendly way to commute to work. Dunedin already embraces a bicycle community and the city was recently named Florida's first official trail town under a new program administered by the Office of Greenways and Trails, part of the Florida Department of Environmental Protection (TBO, 2018). With the use of the existing trail network, Dunedin residents as well as the workforce have boosted local businesses around the trails.

The Coast bike-share program in Tampa and St Petersburg have been operating better than expected and the success rate is something that can be duplicated by many cities, including Dunedin. In St. Petersburg the program has been operational for just over a year and bike share members in the City of St. Petersburg have travelled 86,643 miles on the bikes, which equates to approximately 3,465,720 calories burned and 76,246 pounds of carbon emissions saved (Kerry, 2018). The numbers are exceptional for a community that has utilized the program for such a short time. The city of Tampa has even higher numbers. In three years, Coast Bike Share members have traveled 516,471 miles on the bicycles, burning 20,658,874 calories and reducing 455,434 pounds of carbon emissions (Kerry, 2018).

As previously mentioned, a bike share program would be a great way to lower emissions on a community scale and give a viable option to employees who commute a very short distance to work. When the numbers were calculated on the employee commute times, we noticed that out of the 418 vehicles that were reported as employee vehicles 37% of them or 155 total vehicles resided in the Dunedin zip code of 34968. An exact distance cannot be calculated due to not knowing personal addresses, but it is estimated that these vehicles travel less than three miles each way to work. The bike program could reduce single car traffic on the roads, which would mean less congestion and fewer carbon emissions.

Transportation - Vehicle Fleet

A solution to lowering the amount of CO_2 emitted from the City's vehicle fleet (mainly from garbage trucks) would be to retrofit them with alternative fuel lines that can run on biodiesel. Biodiesel is readily miscible with diesel and comes in various blends ranging from B5 all the way to B20. If the current garbage trucks were running a blend of B5, that would bring the CO_2 emission down to 1,376 metric tons per year; and if they were running B20, it would fall to 1,283 metric tons per year. Cities all across the USA are making their garbage trucks less pollutant, from San Francisco all the way to New York. In 2007, New York City Mayor Bill de Blasio launched a citywide B5 blend mandate for all their garbage trucks as part of a multi-decade long approach to reducing GHG emissions (Keating, 2016). Dunedin has had issues with biodiesel in the past, but it appears that the problems were associated with inappropriate maintenance, as fuel filters should be changed at a higher frequency during the first year of operation on biodiesel. Optimus Technologies retrofits vehicles and claims to reduce lifecycle emissions by up to 80% ("Pittsburgh Expands", 2015). The Optimus Vector system is the only EPA approved biodiesel conversion system that is designed for medium and heavy duty trucks (Vector System & Installation, n.d.). This system attaches onto existing diesel engines and can run on 100% biodiesel. It has a specially designed fuel filter just for biodiesel.

Another recommendation would be for the City of Dunedin to upgrade their idling software. Currently, Dunedin has technology that notifies an individual when a vehicle has been idling for an extended period. This idling technology is good, but there are more updated versions available on the market. Derive Systems software is an easy to use idling software that lowers the RPM of an idling vehicle, which results in lower fuel consumption. Outside of RPM control, this software allows users to set maximum speed levels, as well as optimization of "active fuel management", which deals with activating and deactivating a vehicle's cylinders at the right

times. Their website allows for quick calculations of fuel savings. This software is optimized for pickup trucks, utility trucks, SUVs, and vans. Its installation appears to be quick (10 minutes per vehicle) and it reportedly helps reduce fuel consumption annually by up to 30% (Derive, n.d.).

Some local governments in Florida have adopted this technology and reported positive results. Port St. Lucie and the City of Lakeland police departments have installed the software to help manage fuel economy along with throttle response. Last year the City of Orlando installed this software on their police vehicles and saved up to 400,000 gallons of fuel in one year ("Orlando Cuts Fuel Use," n.d.). According to Orlando officials, they expect to see a payback time of just 6-9 months ("Orlando Cuts Fuel Use," n.d.).

An additional recommendation would be to introduce hybrid garbage trucks into the fleet. These hybrid trucks utilize hydraulic pressure that builds up whenever the vehicles brakes. According to Mark Schlueb of the Orlando Sentinel "The hybrid trucks are powered by the hydraulic system virtually the entire time they're being driven, and only switch to diesel power at speeds above 45 mph, when they head to the landfill, for instance." (Schlueb, 2013) This kind of technology results in significant savings in fuel consumption and costs. The City of Orlando is currently utilizing this technology. They expect to cut half the amount of fuel they use as well as cut down on the maintenance required. Because the technology behind the braking system is so advanced, the amount of maintenance required on the brakes is quite low. Although the hybrid system trucks are more expensive than typical diesel garbage trucks, according to Schlueb, "new trucks are expected to pay for themselves in about 5 years" (Schlueb, 2013). The City of Miami also adopted this technology and has seen good results. They paid for this project through EPA funding that was part of the Clean Diesel and DERA (Diesel Emissions Reduction Act) program.

If biodiesel is not readily available for the city to use, CNG (compressed natural gas) would be a good alternative. Although CNG is technically not sustainable, it has lower CO_2 emissions than biodiesel. Currently the City of Tampa has taken this approach and brought in 65 CNG vehicles to help offset the emissions from diesel (Tampagov.net). The cost of one of these CNG trucks is reported to be around $375,000 (Comas, 2017). A report based on three Clean Cities projects found that the average payback period for a CNG fleet conversion was 3-8 years that includes the vehicles and fueling infrastructure (Laughlin & Burnham, 2014). This report also found that there were fuel savings of as much as 50% on average, when using CNG. The funding came in

the form of a competitive project for Clean Cities program, which garnered funds through the Recovery Act.

There are also opportunities to employ electric and more energy efficient cars, perhaps of hybrid nature. A slow transition to plug-in hybrid SUVs would be a possible solution to reduce emissions. The average plug in hybrid will travel around 20 miles on electric alone. The 20-mile limit should cover a typical daily commute for a city owned vehicle. The only issue here is where the electric vehicle is getting its power from. The source of power should be based off something renewable, such as solar panels. So, until those are put in place, electric vehicles should be looked at with caution. It should be noted that several of these recommendations can be combined for a large reduction in emissions.

Solid Waste

One of the ways to combat climate change is to minimize waste generation through reuse and recycling. Further, to build upon the already present recycling system in city buildings, a three-bin garbage system should be considered. Three bins can be purchased as a single unit that will separate the inorganic, organic and recyclable waste. This will assist the city operations in further recycling efforts as well as provide the ability to utilize organic waste matter and reduce the amount of inorganic solid waste being sent to the landfills.

In offices or buildings where organic matter is not a factor, there are three bin systems that focus on separating paper, newspaper, and bottles from the other solid waste. Limiting the quantity of inorganic solid waste will also assist in landfill costs. If more waste is being separated into recycled organic and inorganic fractions, the quantity of waste being sent to the landfills will decrease, resulting in lower solid waste disposal fees. The city may be able to influence its citizens to follow its lead and recycle daily items that would have normally been destined for a landfill.

It would be beneficial for the City to accurately calculate the amount of times waste needs to be collected, determined by the average amount of waste produced at each location. This would allow for a reduction in the number of times solid waste is collected for public facilities, but also for residential and commercial. The garbage trucks run on diesel, which is a major contributor of greenhouse gas emissions in the city, therefore reducing pick-up frequency would be very beneficial.

While recycling is an important feat when becoming more sustainable, the most important initiative a city can implement is preventing waste from being generated in the first place. Using limited resources more efficiently is crucial to reducing the amount of MSW and corresponding energy needed for collection and transportation. When purchasing products, the City should continue to buy in bulk whenever possible to reduce unnecessary plastic and cardboard waste and become mindful of eco-labels for cleaning and landscaping products. The City should also continue to pursue paperless operations whenever possible to drastically reduce the production of paper waste and subsequent cost of having to continuously purchase new products.

Another option to reduce waste is to install automatic hand dryers in all government restrooms to eliminate the use of paper towels. According to The Energy Co-Op, 13 billion pounds of paper towels are used per year in the United States, which is about 45 pounds of paper towels per person (The Energy Co-Op, 2014). A restroom with medium usage (approximately 100 per day) uses at least one package of paper towels each day. With an average U.S. cost of $2.50 per package, this equates to over $900 spent on paper towels per bathroom each year (Quarters, 2017). The Dunedin Library has three bathrooms, which would equate to a cost of almost $3,000 every year on paper towels alone, assuming the location reflects the U.S. average.

The initial capital cost of installing automatic dryers will range depending on the type. However, here we will use as example the World Dryer SMARTdri Plus. This dryer uses 40% less energy than other competitive dryers, has the lowest energy consumption in all classes, and works three times faster (Worldwide Janitor, 2014). The SMARTdri Plus sells for a maximum price of $516 per unit, but may be cheaper through economies of scale. The library will have two dryers in each of the three bathrooms for an estimated cost of $3,096 plus tax, with an additional cost of $200-$500 each for installation, or about $6,000 total for all units. An average hand dryer uses approximately 0.03 kWh of electricity per use but would be less for dryers like the SMARTdri Plus (Quarters, 2017). Assuming 100 washes per day at $0.11/ kWh, each restroom would cost only $0.33 cents per day, or approximately $120 per year. This equates to an annual cost of only around $361 each year for all three restrooms. It is estimated that after three years, the Dunedin Library would spend almost $9,000 on paper towels alone, assuming no heightened use of the facilities. Including the initial capital cost of purchase and installation plus the annual energy costs, automatic hand dryers would cost slightly over $7,000 in the first three years. This means that the City would save almost $2,000 in three years, and over $2,500 every

subsequent year, not including the money saved from having to transport this waste to landfills. The initial capital cost of purchase and installation may seem high, however the money saved over time from having to continuously refill the containers and transport the associated waste will offset this cost. The average life of an automatic hand dryer is between 8-10 years, which could equate to savings over $19,000 in ten years.

There are many other options for automatic hand dryers available for purchase, but it is recommended that both the price and the energy efficiency are considered when making a choice. Overall, the annual energy cost of these dryers is very low, leading to a quick return on the investment for the City.

Water and Wastewater Treatment Facilities

Reduction of GHG emissions can be achieved in several ways in the sector of water and wastewater treatment facilities. Initially, measures should be taken to ensure that steps for water conservation, water loss prevention, and storm water collection are in place. An example of water conservation the City of Dunedin could utilize is the retrofit of municipal buildings with rainwater harvesting and treatment systems, such as the one currently used at USF's Patel Center for Global Solutions. Such a sustainable system allows collected rainwater to be used for toilet flushing. City officials could also review the installation of sensor-equipped low flow toilets and sinks in buildings and at the Dunedin Blue Jays stadium. Furthermore, water and wastewater facility officials and crews need to make frequent checks of system lifts, pumps, and wells to assure they all are in good working order and that needed repairs are made to the City's sewer system to prevent groundwater infiltration.

Other recommendations include retrofitting Dunedin's existing water and wastewater plant buildings with more energy efficient windows, doors, and insulation. The facilities can also be retrofitted with photovoltaic (PV) solar panels to produce energy on site, while connected to the Duke Energy grid to assure there is never a shortage of power to run Dunedin's vital water and wastewater facilities. The City should also consider building integrated photovoltaics (BIPV) for the planned 25-million-dollar redesign to the current water plant, while partnering with other municipalities in Pinellas County to work with Duke Energy to build a new plant with solar generated electricity to power the entire City and all its water transfer components.

Dunedin officials should also consider the installation of anaerobic digesters that generate methane in the wastewater facility to produce combined heat and power (CHP) (Eastern Research Group, 2006). A CHP system produces electricity and thermal energy from burning methane, which is produced on site from waste to heat and power the plant.

Limitations and recommendations for data collection

After successfully analyzing the data and using it in the ClearPath™ system, it was evident that there were some limitations on the data. Some of the limitations were due to the restricted amount of time available to perform the GHG audit and analyze data collected within the time frame. Other limitations were experienced within the ClearPath™ system. Some of audit's collected data could not be used because there was no area for input. If ClearPath™ had allowed for the input of all gathered information, data analyzation would have been supported allowing for the development of more comprehensive solutions.

The City of Dunedin may want to include more fields of analysis in future studies.

Taking these limitations into consideration, some data collection recommendations for the city of Dunedin were developed

Building and Facilities

Limitations

ClearPath™ allows the user to specify the daily occupancy of each building, whose emissions are being calculated as well as the operating hours and building square footage. Having such data for each of the buildings and facilities is not required; however, it allows a more in-depth calculation of GHG and better insight into the data. It could inform how long electricity is running in certain buildings compared to others and how long a building is occupied or not, with the electricity running. However, without that information the data was limited to the basic greenhouse gas emissions from each building. As a baseline data year, this information was sufficient for this report.

Recommendations

The city may want to utilize the daily occupancy, operating hours, and building square footage of city buildings to better calculate the emissions. This will allow the city to see if electricity is running outside of normal business hours, in which case, modifications could be made.

Transportation - Employee Commute

Limitations:

Regarding the employee commute data, limitations were encountered regarding what type of vehicles the employees drive. The assumption within the calculation was that the employee vehicle fleet was comprised of 100% "passenger vehicles." The Clearpath™ software referred to a passenger vehicles as four-door sedans and SUVs, with a different category for trucks and diesel vehicles. The Clearpath™ software uses this assumption to calculate Employee

Commute CO_2e. The data was also calculated based on employee zip codes rather than exact addresses. Therefore, the total miles traveled is a rough estimate based on employee commute to the center of Dunedin from the general area of the zip code.

Recommendations:

The uncertainty surrounding vehicle type and accuracy of employee commute distance can be solved through a simple survey. It is recommended that the City of Dunedin request that employees share with the City their personal vehicle's MPG and their average round trip commute distance. Using these numbers, a more accurate annual employee Vehicle Mile Travelled (VMT) and annual fuel consumption can be obtained to better determine employee commute CO_2e.

Transportation - Vehicle Fleet

Limitations

There are several limitations when it comes to this data. There were several generators and off-road vehicles (lawn mowers) that were not accounted for based on missing fuel data. These vehicles had reference ID numbers that did not show up in the annual fuel usage report.

Recommendations

It is recommended that fuel logs become categorized into sections of diesel and gasoline. From those sections, more in depth breakdowns such as passenger, light, and heavy duty vehicles can be devised. These vehicles could also be broken down into "vehicle jobs". There could be individual vehicle sections, such as garbage trucks and police cars. This breakdown would make inputting data into ClearPath™ easier in the future. It would also allow the City fleet manager to quickly assess where the majority of fuel consumption is going as well as costs.

Solid Waste

Limitations

The initial data received for solid waste was not separated by commercial, residential or city owned properties. Instead, a total metric tonnage from each garbage truck was measured once it arrived at the solid waste facility. In order to estimate the solid waste generated by facilities of government operations, the size of individual waste containers at each public facility was determined, the total amount of solid waste generated from each building was calculated by the size of the container, multiplied by the number of times it was emptied over the course of 2017 calendar year, and then this new total tonnage was used in ClearPath™ to generate the total metric tons of CO_2e.

The limitation to this form of data collection is the amount of solid waste contained in each waste container. The container may not have been completely full when the solid waste was collected - the final calculation is in turn overestimated. The factor set was determined to be 100% mixed solid waste because the breakdown of solid waste was not determined. To make this calculation more precise, these factors should be more specific and include mixed solid waste (non-recyclable materials), newspaper, office paper, cardboard, magazines and third-class mail, food waste, grass, leaves, branches, and dimensional lumber. A more accurate determination of the waste contents would allow for a better calculation of CO_2e generated.

Recommendations

Concrete data for solid waste generation will be needed instead of overestimating based on the size of the waste container multiplied by the number of times it was emptied over a given calendar year. It is known that the City of Dunedin has implemented a detailed recycling program, and the lack of information determining the amount that was recycled over the given calendar year skewed the data. The contracted recycling company, WastePro, should be able to give an accurate tonnage of recycled material that is produced. Within the public facilities and based on the specific locations, separate recycling bins that collect paper, food waste, plastic, and metal should be implemented.

There was no data received concerning methane capture nor combustion of solid waste, yet Pinellas County Solid Waste landfill is the most advanced landfill in the southeastern U.S. If methane capture could be added to the landfill's process of solid waste combustion, the total metric tons of CO_2e would be reduced. In turn, a full understanding of all factors that are involved in solid waste would give the City of Dunedin a more accurate GHG emissions produced and assist in deducing that specific amount.

Water and Wastewater Treatment Facilities

Limitations

The GHG emissions estimates for the water and wastewater facilities in this report was based on water consumption and wastewater generation for the entire city. It was not possible to get data specific to the government operations.

Recommendations

Although outside the scope of this project, the City of Dunedin should consider utilizing both the government and community based tracks in ClearPath™ for future calculations. The community path will allow auditors to calculate the emissions from wastewater treatment energy use specifically, which cannot be done using the government track. In addition to the grid energy usage, water bills showing total water consumption/quantity of water passing through each location would be useful to estimate GHG emissions from water consumption and wastewater generation from municipal facilities.

Conclusions

The 2017 Greenhouse Gas Inventory is the first one developed for the City of Dunedin and serves as a guide to help it develop objectives of conserving resources, creating a sustainable community, and reducing GHG emissions. It provides the city with an overview of GHG emission sources throughout the government operations. This audit also serves as a baseline in order to compare with future annual inventories and help create actionable goals. The baseline and consequent inventories will guide Dunedin's officials as the City establishes emissions reduction targets.

Based on the results of the inventory, recommendations have been identified and suggested by sector, to assist Dunedin in the development of an action plan, setting reduction targets, and taking actions to achieve those targets. For the following years, it is also important that the City of Dunedin improve the way data are collected, especially in sectors such as waste generation and employee commute, in order to make more accurate estimates of GHG emissions.

Emissions from Dunedin's municipal operations are miniscule relative to the world's annual emissions, and minor compared to emissions from other cities' municipal operations. However, it is important that the City of Dunedin continue to tackle its GHG emissions in order to demonstrate what is possible with leadership and innovation. Completing a municipal GHG inventory not only gives the City a metric for measuring the GHG reduction impacts of those policies and projects from municipal emissions, but also demonstrates a best practice in GHG management that every entity in Dunedin should follow, enabling City officials to lead by example.

References

American Planning Association: Florida Chapter. (n.d.). Solid Waste Management & Recycling. Retrieved from http://www.floridaplanning.org/sustainability-homepage/solid-waste-management-and-recycling/

BWC (2018). Guide to Employer Commuter Surveying. Retrieved from Best Workplaces for Commuters: https://www.bestworkplaces.org/pdf/survey-guidelines-faq.pdf

ClearPath™ Software. (2018). Government Operations/Inventory: Dunedin GHG Inventory. Retrieved from https://clearpath.icleiusa.org/goverment_operations/inventory_years/3669/categories/18

Comas, M. E. (2017, July 30). Seminole switching to natural-gas garbage trucks. Retrieved April 01, 2018, from http://www.orlandosentinel.com/news/seminole/os-seminole-county-waste-natural-gas-20170727-story.html

Dorsey, J (n.d.). *Concepts of Sustainability, Sustainable Development and Related Definitions.* Personal Collection of Dr. Joseph Dorsey, University of South Florida, Tampa, Florida, personal communications

DATAUSA (2018). US Census. Retrieved from American Community Survey (ACS): https://datausa.io/profile/geo/dunedin-fl/

Derive Systems (n.d.). Increase fleet fuel efficiency, save money, and limit top speed. Retrieved April 01, 2018, from https://derivesystems.com/efficiency

Desjardins, J. (2016). What Uses the Most Energy in Your Home? Retrieved April 13, 2018, from http://www.visualcapitalist.com/what-uses-the-most-energy-home/

Eastern Research Group. (2006). Opportunities for and Benefits of Combined Heat and Power At Wastewater Treatment Facilities. Retrieved from https://www.americanbiogascouncil org/pdf/EPA-Benefits%20of%20CHP%20at%20WWTPs.pdf

USEPA (2018). ’s Emissions and Generation Resource Integrated Database: eGRID Summary Tables 2016. Retrieved from: https://www.epa.gov/sites/production/files/2018-02/documents/egrid2016_summarytables.pdf

Florida Department of Environmental Protection (FDEP). (2014). Annual Report, Solid Waste Management in Florida. Retrieved from http://www.dep.state.fl.us/waste/categories /recycling/SWreportdata/14_data.htm

Florida Department of Environmental Protection (FDEP). (2016). MSW Collected by Generator Type. Retrieved from https://floridadep.gov/sites/default/files/2016_MSW_Collected_by_Generator_Type.pdf

Fong, W. K. (2014). Global Protocol for Community-Scale Greenhouse Gas Emission Inventories. Retrieved from http://www.ghgprotocol.org/sites/default/files/ghgp/standards/GHGP_GPC_0.pdf

Grant, M., & Ecola, L. (2001, September). Carpool Incentive Programs: Commuter Choice Leadership Initiative. Retrieved from Environmental Protection Agency: http://www.cleanairpartnerstx.org/resources/Carpool%20Incentive%20Programs%20-%20EPA.pdf

Keating, M. (n.d.). Clean biodiesel fuels NYC garbage trucks. Retrieved March 19, 2018, from http://americancityandcounty.com/products-work/clean-biodiesel-fuels-nyc-garbage-trucks

Keep Florida Beautiful, Inc. (2018). Solid Waste Reduction. Retrieved from https://www.keepfloridabeautiful.org/initiatives/solid-waste-reduction

Kerry. (2018). Coast Bike Share. Retrieved from http://coastbikeshare.com/news-release-coast-bike-share-announces-a-lively-program-of-events-for-florida-bike-month-in-march/

Laughlin, M., & Burnham, A. (2014). Case-Study Compressed Natural Gas Refuse Fleets. Retrieved April 01, 2018, from https://www.afdc.energy.gov/uploads/publication/casestudy_cng_refuse_feb2014.pdf

Montes, Geoff. (2015). Dunedin, Florida: Historic Coastal Getaway with a Scottish Twist. *National Trust for Historic Preservation.* Retrieved from https://savingplaces.org/stories/dunedin-florida-historic-coastal-getaway-with-a-scottish-twist/#.Wmjhy 7enEdU

Orland city (n.d.) Orlando Cuts Fuel Use from Idling. Retrieved April 01, 2018, from https://www.government-fleet.com/channel/law-enforcement/news/story/2017/01 /orlando-cuts-fuel-use-from-idling.aspx

Pinellas County Historical Background. (2008). Retrieved from www.pinellascounty.org/Plan/pdf_files/PCHB.pdf

Perez, C. (2017). University of South Florida-Dunedin, FL Community Sustainability Partnership Program: Carbon Footprint/Greenhouse Gas Audit. Dunedin, FL: City of Dunedin

Pittsburgh Expands Use of Optimus Technologies' Biofuel Conversion Systems. (2015). Retrieved April 01, 2018, from https://www.businesswire.com/news/home /20150311005057/en/Pittsburgh-Expands-Optimus-Technologies'-Biofuel-Conversion Systems

Quarters, C. (2017). Cost Benefit of Paper Towels Vs. Hand Dryers. Small Business- Chron Schlueb, M. (2013,). Orlando switching to hybrid garbage trucks. Retrieved March 17, 2018, from http://articles.orlandosentinel.com/2013-12-21/news/os-hybrid-garbage-trucks-20131221_1_trucks-big-fuel-savings-garbage

Tampa Bay in Top 20 of Metro Population Ranking. (2011). Retrieved from https://www.bizjournatls.co/tampabay/news/2011/06/24/tampa-bay-in-top-20-of-metro.html

The Energy Co-op. (2014.) Get Clean Energy Now. Retrieved from https://www.theenergy.coop/electricity.

TBO. (2018). State honors Dunedin for Pinellas Trail and more. Retrieved from Tampa Bay Times: http://www.tbo.com/news/localgovernment/State-honors-Dunedin-for- Pinellas-Trail-and-more_165966431

University of South Florida. (n.d.). A department of student affairs and student success. Retrieved from Campus Recreation: Retrieved from http://www.usf.edu/student-affairs/campus-rec/outdoor-recreation/share-a-bull- bikes.aspx

U.S. Census Bureau. (2017). QuickFacts: Dunedin City, Florida. Retrieved from https://www.census.gov/quickfacts/fact/table/dunedincityflorida/PST045217

Vector System & Installation. (n.d.). Retrieved April 01, 2018, from https://www.optimustec.com/vectorsystem

ICLEI (n.d.) Who we are. Retrieved from http://www.iclei.org/about/who-is-iclei.html 2017

Worldwide Janitor. (2014). Paper Towels or Hand Dryers in Public Restrooms? Retrieved from https://worldwidejanitor.com/library/pater-towels-or-hand-dryers-in-public-restrooms/