Community Sustainability Partnership Program (CSPP)

Greenhouse Gas Audit for Manatee County, FL and suggestions towards a net zero carbon footprint goal

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Executive summary

Manatee County is developing a sustainability plan to improve their carbon footprint. In order to help the county achieve that goal, USF graduate students from the Patel College of Global Sustainability (PCGS) conducted a greenhouse gas (GHG) emissions audit. The goal of the audit is to help the county better understand the amount and sources of their current GHG emissions. The outcome of this project is a GHG inventory for 2018 from government operations in the following categories: (i) buildings and facilities; (ii) solid waste facilities; (iii) electric power production; (iv) water and wastewater facilities; (v) process and fugitive emissions; and (vi) transportation (vehicle fleet, transit fleet, employee commute). Based on the output from the CleaPath™ software, the process and fugitive emissions were the largest county GHG emission components, totaling 62,314 metric tons CO_2 equivalent annually. The next largest contributor was water & wastewater treatment facilities with 24,176 metric tons CO_2 equivalent, followed by electric power production, vehicle fleet, building &facilities, transit fleet, employee commute, solid waste facilities, and street & traffic lights with 16,205, 12,302, 10,263, 2,944, 2,521, 1,790 and 325 metric tons CO_2 equivalent, respectively.

Based on these findings, various recommendations are made to help Manatee County reduce its GHG emissions. Overall, Manatee county has been doing a good job in reducing their GHG emissions over the past decade, but still there is significant room for improvement. Specifically, attention should be paid to their process and fugitive emissions, since they account for most of their total CO_2 emissions. Even a modest reduction of 20% would decrease total CO_2 emissions by 18,000 tons per year.

Although implementation of some of these suggestions may be challenging, it is important for Manatee County to take some steps to reduce emissions at least in the major sources of GHG. This way they will get on a path of progressive GHG emission reductions over the near term.

Objectives of the audit

In response to current environmental concerns, Manatee County is now at the beginning stage of developing a sustainability plan in order to understand and reduce its greenhouse gas emissions. ClearPath™ Onward Software was used to quantify the emissions of the county and provide suggestions for reduction. The overall objective of this project was to estimate the GHG emissions for Manatee County, which was accomplished by carrying out the following tasks:

- Identify and quantify GHG emissions from the various government operation facilities for base year 2018
- Provide realistic suggestions to reduce those emissions in order to decrease the County's carbon footprint

Manatee County with the help of this report can devise a comprehensive plan to reduce their carbon footprint over years to come. The scope of this project focused on Manatee County's carbon footprint quantified through a GHG audit of government operations. The estimation of GHG emissions was applied for the year of 2018 in various operation areas that included the county's building and facilities, water and wastewater treatment facilities, solid waste facilities, transit fleet, vehicle fleet, street and traffic lights, electric power production, process and fugitive emissions and employee commute.

Rationale

Greenhouse gases (carbon dioxide, methane, nitrous oxide, and fluorinated gases) are the major contributor to climate change. In the U.S. the total emissions in 2017 were 6,457 million metric tons of CO_2 equivalent. From those 82% was carbon dioxide, 10% methane, 6% nitrous oxide and 3% fluorinated gases. Human activities are primarily responsible for the increase in GHG emissions in the atmosphere over the last 150 years. The highest percentages of GHG emissions from human activities in the U.S in 2017 are from transportation (29%), electricity (28%), and industry (22%). Local communities and governments are working towards reducing those emissions in order to prevent critical impacts to the environment and quality of life **[1,2]**

Manatee County is one of the regions that has begun to investigate ways to make its activities more sustainable by reducing its GHG emissions. This inventory will assist the county to effectively reduce GHG emissions. The suggestions made as a result of this project could have a positive impact on the public health and economic well-being of the citizens of Manatee County. Considered a starting point, a GHG audit provides a baseline assessment of a county's environmental performance and an overall understanding of its ecological carbon footprint. Manatee County can use the audit as a way to track and reduce the county's emissions and mitigate climate related issues.

Background

Manatee County

General information and demographics

Manatee County is located on the Gulf Coast of West Central Florida and encompasses 740 square miles of land (Figure 1). The total population of the county is 377,826 and Table 1 breaks down the population by the six different municipalities located within the County. The County seat and the largest city is the City of Bradenton. In recent years Manatee County government has shifted towards sustainability and environmental stewardship. The county owns and operates a number of facilities providing water, wastewater and reclaimed water services to its constituents. Also, each municipality of

the county is responsible for providing or contracting of solid waste collection services. These facilities and the collection services combined with the storm water management facilities are termed “Utility System”. **[3,4]**

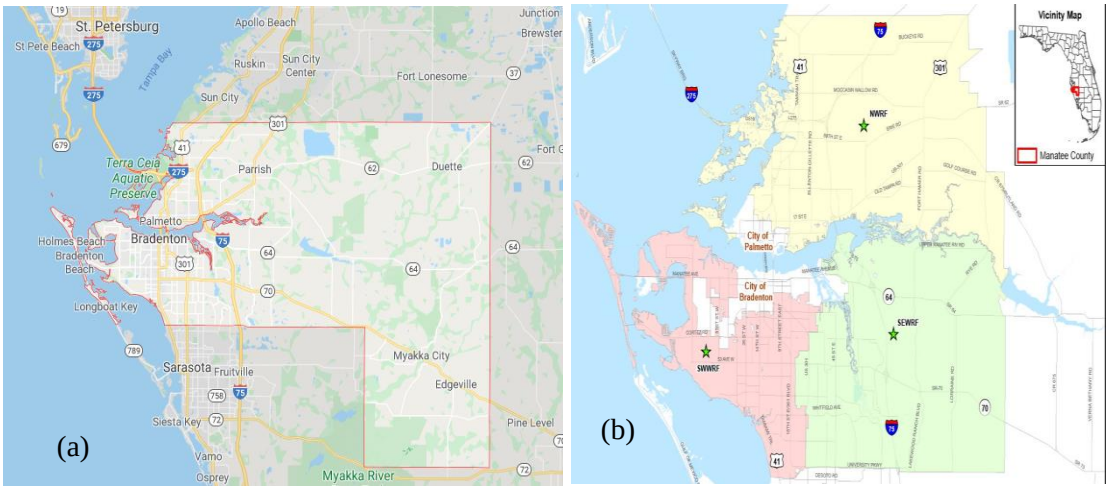

Figure 1: (a) Manatee County map and (b) locations of wastewater facilities in Manatee County

Table 1: Population Estimates

Jurisdiction	**Population**
Unincorporated Manatee County	299,207
Anna Maria	1,599
Bradenton	56,157
Bradenton Beach	1,194
Holmes Beach	3,934
Longboat Key (part)	2,428
Palmetto	13,307
Manatee County (total)	**377,826**

Wastewater system

The county’s original wastewater collection system was constructed in multiple phases from 1974 to 1978. County has three water reclamation facilities for wastewater treatment where the water is collected there by using gravity collection pipelines, wastewater pump stations and pressurized force main transmission pipelines. The systems consist of 1,400 miles of pipeline and more than 600 lift stations. As shown in Figure 1, the county has three main wastewater treatment plants with combined permitted capacity of 33.5 million gallons per day (mgd). The facilities are North Reginal Water Reclamation

Facility (NRWRF) which is located in northern Manatee county and has a permitted capacity of 7.5 mgd, Southwest Water Reclamation Facility (SWWRF) which is located in southwest Manatee and has a permitted capacity of 15 mgd and Southeast Water Reclamation Facility (SEWRF), which is located in southeastern Manatee county and has a permitted capacity of 11 mgd. **[4]**

Solid waste system

The county provides solid waste collection services to over 140,000 residential and 6,000 commercial accounts in the unincorporated area, and the Lena Road Landfill manages over 417,000 tons of material per a year from Manatee County. The landfill is a 1,200-acre site and is the only permitted landfill in the county. The landfill includes a clay slurry wall leachate containment and collection system; a landfill gas collection and conveyance system (GCCS). The landfill gas (LFG) is burned by flaring in the GCCS which can be seen in Figure 2. A portion of LFG is utilized in the county's gas fired bio-solids dryer, offsetting the purchase of natural gas. Another portion of LFG is also used in a gas to energy (GTE) facility which uses the LFG to generate 1.6 MW of electricity to power the adjacent wastewater facility. **[3]**

Figure 2: Landfill gas flare station

Policy context

In less than two decades the US shifted from recognizing the threat of GHG emissions to the health and welfare of current and future generations to denying the seriousness of climate change by both withdrawing from the Paris Agreement and promulgating that the U.S. Environmental Protection Agency (EPA) does not have the statutory authority to regulate GHG emissions under the Clean Air Act. Before the enaction of the Paris Agreement, the U.S. signed and ratified the United Nations Framework Convention on Climate Change (UNFCCC) in 1992. The UNFCCC requires each country to develop, periodically update, publish and make available national inventories of anthropogenic emissions and their sources and removals by sinks of all GHG not controlled by the Montreal Protocol, using comparable methodologies. Following the adoption of the UNFCCC treaty, the U.S. developed and submitted national GHG emissions inventories. The emissions and removals were organized using source and sink categories and calculated using internationally accepted methods provided by the Intergovernmental Panel on

Climate Change (IPCC), which can be found in the 2006 IPCC Guidelines for National Greenhouse Gas Inventories. Similar to the UNFCCC, the Paris Agreement is an international treaty that binds participating nations around the world to respond to the threat of climate change. The goal of the Paris Agreement is to stabilize the increase in global average temperature to 1.5 - 2°C above preindustrial levels, stimulating and funding low GHG emissions measures. Unfortunately, on November 4, 2019, the U.S. government notified the United Nations of its decision to withdraw from the Paris Agreement, which will take effect on November 4, 2020. In 2007, the U.S. Supreme Court found that carbon dioxide is a pollutant under the Clean Air Act and declared that the EPA can regulate it. However, on September 6, 2019, the EPA repealed the Clean Power Plan (CPP) because it determined that the CPP exceeded the EPA's statutory authority under the Clean Air Act (CAA) (US Environmental Protection Agency, 2020). At this point in time, the EPA climate policy, including GHG emissions regulations, under the current administration has moved from industry-wide regulation to plant-by-plant / business-by-business regulation, limiting their ability to establish tougher controls of sources of GHG emissions. On a state level, Florida has adopted and incorporated federal regulations, specifically Title 40 Part 98 of the Code of Regulations (CFR), also referred to as the EPA Greenhouse Gas Reporting Program (GHGRP). The GHGRP applies to direct GHG emitters, fossil fuel suppliers, industrial gas suppliers, and facilities that inject CO_2 underground for sequestration or other reasons, and requires reporting by sources or suppliers in 41 industrial categories. The threshold for reporting is 25,000 metric tons or more of CO_2e per year. **[5,6,7,8]**

The problem: greenhouse gas emissions and Manatee County

Urban areas and cities provide unique challenges and opportunities for sustainability and emission reduction as they include the confluence of climate change mitigation, sustainable development, and urban resilience. Currently, cities account for more than 71% of energy-related global greenhouse gases, and some statements have suggested that 80% of the global anthropogenic greenhouse gas emissions can be linked to cities. With changing weather patterns due to climate change, the county has taken more action to equip and educate residents to address local challenges in energy, sustainability, and resiliency. These actions have included solar trash bins, solar energy generation plants, energy tracking metrics, and a reduced energy cooling method. Through the goals and objectives of this project, Manatee County will have tools and data to support operational and behavioral changes to address climate resilience and sustainability. **[9,10,11]**

Methodology

- **ClearPath™ online platform**

For this project, the emissions management software ClearPath™ (ICLEI-USA) was utilized to calculate emissions. ICLEI is a global network active in more than 100 countries that promotes sustainable policies and drive local action for emissions mitigation and equitable circular development. ClearPath™ software has two modules that can be used to estimate GHG emissions: the community track and government track. Based upon produced emissions from municipally owned buildings, the government track will be used to accurately calculate county emissions. ClearPath™ uses Global Warming Potential (GWP) factors for non-CO_2 gases to analyze the relative strength of their GHG effect in the atmosphere. ClearPath™ utilizes GWPs as presented by the Intergovernmental Panel on Climate Change (IPCC). The GHG inventory is set up into three scopes which will be further explained in detail. After data was entered into ClearPath™ and computed, an analysis and recommendations were provided for the County to cut back on emissions and generate a more sustainable community. Suggestions incorporate discoveries, correlations with current trends, and recommendations from a global and local perspective. Analysis, research, and recommendations were provided to the County to develop forecasts, planning, monitoring, and reporting.

- **Government track**

The appropriate track for this project is the government track, used for calculating Government Operational Accounting. ClearPath™ allows users to execute inventories as the basis to develop emissions forecasting and Climate Actions Plans for local governments. After the data inventory was entered, the county can then use the "Forecasts" step to estimate the projected greenhouse gas emissions in the future. This will be calculated using the growth rate factor sets that are entered. The planning step can then be used to create a new reduction strategy and then, a planning scenario. This project solely utilizes the inventories section of ClearPath™. This will prepare Manatee County government to use the other steps as they deem fit in the future.

Parameter and scopes:

For the inventory parameter set, the year 2018 was selected as the baseline year for which the County can account for GHG emissions to forecast and plan future reductions and formulate future policies. The common sources of government GHG emissions are separated into three scopes:

- Scope 1: Emissions from fugitive emission, on-site landfill and wastewater treatment, vehicles, and transportation owned by Manatee County.

- Scope 2: Emissions from the consumption of purchased electricity for Manatee County-owned and operated building, facilities, streetlight, traffic signals, solid waste facilities, and wastewater treatment facilities.
- Scope 3: Emissions from County's employee commute and the contracted solid waste that Manatee County collects.

Factor set:

- Transportation:

The factors of transportation's greenhouse gas emissions used the ClearPath™ 2018 U.S. national default setting.

- Waste characterization:

Manatee County does not have information on detailed waste characterization. Therefore, the data was obtained from "Florida and the 2020 75% recycling goal: 2019 status report by the Florida Department of Environmental Protection" **[12]**. The characterization of Florida municipal solid waste collected in 2018 is shown in Table 2.

Table 2: Characterization of Florida municipal solid waste in 2018

Year	2018
% Mixed MSW	67.41
% Newspaper	1.73
% Office Paper	1.33
% Corrugated Cardboard	5.64
% Magazines/ Third Class Mail	7.26
% Food Scraps	6.59
% Grass	5.02
% Leaves	5.02
% Branches	--

- Grid electricity:

Factor sets data for grid electricity were used from the United State Environmental Protection Agency (EPA) eGrid 2018 summary Tables, Florida Reliability Coordinating Council **[13]**. The total output CO_2, CH_4, and N_2O emission rates (lb./MWh) from grid electricity in 2018 were 931.8, 0.000066, and 0.000009, respectively.

Inventories data entry:

- **Buildings and facilities:**

The electricity usage (kWh/year) and building square footage for Manatee County-owned and operated buildings and facilities were calculated using energy data provided by county representatives and available meter readings from the year 2018 were analyzed and grouped according to three types of facilities: regular, water/wastewater treatment, and solid waste. A total of 72 buildings were identified based on available meter readings, however 3 were eventually removed due to incomplete data, i.e. more than 50% of data is missing. Eventually, only 69 buildings had complete meter readings for 2018. Out of the 69, 4 buildings are related to water and wastewater treatment plants and 1 building is the Lena Landfill, which were recorded separately under corresponding sections in ClearPath™; the remaining 64 were entered into ClearPath™ under "Buildings & Facilities" section. Due to the differences in recorded meter reading dates, the readings taken in the month of January 2018 (i.e. be it 5th or 20th of the month) is recorded as the first energy consumption record. The meter readings from the rest of the year were then recorded in the same excel spreadsheet. If a building has had more than one-meter present on site, the energy consumption from different meters were combined so as to record only one entry per building. A few meters were missing readings from the last or last two month. An assumption was made to ensure the data for a full year was well-captured: the energy consumption pattern is similar for each month despite different calendar year due to similar seasonal usage patterns; thus, if a particular building meter is missing an entry, the reading from previous year was used to substitute, so as to capture a complete 12-month consumption. For meters that only had readings for one or two months, decisions were made to not include them. The GHG emissions from the grid electricity system were then calculated by the ClearPath™ software according to the grid electricity factor set.

- **Solid waste facilities:**

Government-owned dumpster size, pick-up frequency, annual cost, and the locations were given by Manatee County. The average ton per cubic yard for the commercial and residential level was obtained from the 2016 EPA report "volume to weight conversion factors". The total waste landfilled was calculated by the formula below:

$$Annual\ Cost \div \frac{\$21.03}{Cubic\ yard} \times \frac{Avg.tonne}{Cubic\ yard} = Total\ waste\ landfilled$$

The GHG emissions were then computed by the default setting provided by ClearPath™. Data for the total landfill gas (LFG) flow generated and subsequent treatment were provided by the Manatee County. Details can be found in the results section. The electricity usage data for Lena landfill was also provided by the county. The transmission and distribution (T&D) losses were calculated by the T&D loss factor. Emissions due to electricity consumption were then computed according to the grid

electricity factor set. Based on data from the county, the amount of landfill gas (LFG) into flaring was entered into the inventories. The CH_4 percentage and destruction efficiency were assumed at 50% and 99%, respectively. The greenhouse gas emissions were then computed by the ClearPath™ software default setting.

- **Water and wastewater treatment**:

Three wastewater treatment plants (NRWRF, SWWRF, SERWRF) and one drinking water purification plant are located in Manatee county. The electricity usage for each water treatment plant was provided by the county. The electricity T&D losses for all four plants were calculated with the loss factor, 4.87%. The emissions due to electricity consumption of the water treatment plants were computed by the grid electricity factor set in ClearPath™.

To quantify the emissions due to nitrification, denitrification and effluent discharge of the facilities, the permits for each facility and monitoring water quality data obtained from the Florida Department of Environmental Protection were used. The population served by each facility was estimated based on the percent of the average daily flow and total population of Manatee County. This calculation assumed that each individual residing in Manatee County was served by one of the facilities, which is likely not true with septic tanks and decentralized systems. A summary with the average daily flow, percentage, and estimated population is shown in Table 3.

Table 3: Average daily flow, percentage and estimated population

Facility	**Average Flow**	**Percentage of Total Flow/Population**	**Estimated Population Served**
North Regional WRF	3.8 MGD	18%	72,000 people
Southeast Regional WRF	6.6 MGD	32%	125,000 people
Southwest Regional WRF	10.4 MGD	50%	198,000 people

In order to calculate the nitrous oxide (N_2O) emissions from wastewater treatment, the treatment permit of each facility was reviewed to determine whether they had nitrification and denitrification processes. NRWRF operates an oxidation ditch for the biological treatment of wastewater **[14]**; with that process, they will achieve both nitrification and denitrification with the aerobic and anoxic zones in the reactor. SERWRF operates a conventional activated sludge basin with both an anoxic and aerobic basin

[15]; while some denitrification could occur in the anoxic basin, they are likely not achieving sufficient conversion of nitrate to nitrogen gas. Therefore, the conclusion was drawn that the facility had nitrification but not denitrification. SWRWRF currently operates a conventional activated sludge basin, with anoxic and aerobic zones, but plans to convert the process to Modified Ludzack-Ettinger, which achieves nitrification, denitrification, and good removal of nitrogen through the internal recycle **[16].** Based on these permits, the conclusion was made that the project has not been completed and that the plant currently has nitrification but not denitrification. To quantify the total N_2O emissions for discharged effluent, ClearPath™ required the input of the daily nitrogen load (kg TN/day). This value was calculated using monitoring data obtained on the FDEP website **[17]** for each facility in 2018 and GHG emissions were computed by ClearPath™. A biosolids dryer was constructed at the SEWFR and it operates using almost 100% landfill gas. The annual tonnage of sludge over the 2018 was 25,315.76, representing a 19.34% increase from 2017. For calculation inputs into ClearPath™, the daily quantity of sludge produced was 25,315.76 tons divided by 365 days to equal 69.36 metric tons per day. This data was entered into the inventory section and the CO_2e was calculated by ClearPath™.

- **Electric power production:**

There is no government-owned power plant within the Manatee County area. Electricity is provided by Florida Power and Light (FPL). Lena landfill is the only landfill operating in the County currently. The amount of annual landfill gas (in standard cubic feet, scf) which was used for energy production (22% of the total landfill gas) was provided by the County. CO_2 and CH_4 emission (metric tons) were calculated from combustion reactions assuming 90% efficiency.

- **Streetlights and traffic signals:**

The total electricity usage for streetlights and traffic signals was provided by Manatee County, which is 733465 kWh. The electricity transmission and distribution (T&D) losses between devices and power stations were calculated using the T&D loss factor was found from EPA emissions and generation resource integrated database, 4.87%. The emission data for both entries were then computed by ClearPath™ software according to the grid electricity factor set.

- **Vehicle fleet:**

From the fuel information provided by Manatee County, the gasoline and diesel consumptions for 2018 (in gallons) were 47,427.1 and 1,085,308.4 respectively. However, there is no specific breakdown for vehicle fuel usage. According to the Manatee sheriff's office official website **[18]**, around 8.3 million miles were driven for sheriff's vehicles, which was assumed to be included among the total fuel that the County has consumed. The GHG emissions were calculated by ClearPath™ online platform using the default U.S. national transportation factor set.

- **Transit fleet:**

Manatee Area Transit (MCAT) is owned and operated by the County. The annual miles traveled in 2018 provided by Manatee County were 1,537,680. MCAT buses run on clean-diesel and diesel-electric hybrid according to the global transit guidebook by HARTride 2012. The annual fuel usage (gallons) was calculated using 6 gallons per mile, which was found in the National Renewable Energy Laboratory (NREL) 2016 report **[19]**. The emissions were then computed using the default U.S. national transportation factor set in ClearPath™.

- **Employee commute:**

The total number of Manatee County government employees is 1,788, but this number does not include employees from other government organizations, such as the fire department, tax collector, and property appraiser. The employee commute survey sent out to the County staff consisted of the below questions pertaining to vehicle type, fuel, type, commute days per week and VMT. A total of 393 employees answered the survey. This equals 22% out of 1,788 total employees for the county and provided a rather sizable data set to estimate for the total staff population.

Survey Questions:

1. Do you commute? Yes / No
2. In what ZIP code is your home located?
3. What is your primary work location (Manatee County location)?
4. How many days do you commute per week?
5. On average, how many miles do you commute per day (to and from work)? In Miles.
6. Which method of transportation do you use to commute to work? Drive alone / Carpool / Bike or skateboard / Motorcycle or scooter / Public transit
7. What type of vehicle do you use to commute? SUV / Sedan / Coupe / Truck or pick up / Hatchback / Minivan / Wagon
8. What type of fuel does your transportation method use to commute? Regular gas / Hybrid / Diesel / Flex fuel (ethanol blend) / Electric / None

The survey results and GHG emission calculation is presented in the results section.

The County does not have a record of all County-funded air travel for employees, due to frequent traveling by various departments for training each year. In the Sustainability Department alone, an average of 5 employees fly to at least 3 out-of-state conferences a year. While this is good information, it is difficult to make any air-travel related entries into ClearPath™ with these non-conclusive data.

- **Process and fugitive emissions:**

Total fugitive emissions (scf) from the Lena landfill were provided by Manatee County. As shown before in solid waste facilities section, 25% total landfill gas was release into the air, which is

255,012,506 scf in 2018. The escaped landfill gas composition was estimated to be 50% CO_2 and 50% CH_4. The total gas quantity and carbon dioxide equivalent (CO_2e) emissions were calculated by unit conversion and entered into ClearPath™.

Audit results

Overall GHG emissions

Electricity for Manatee County is provided by Florida Power & Light (FPL) company. In all the categories included in this project, electricity data was obtained from FPL. ClearPath™ calculates the different amount of GHG emissions from each source and presents the total GHG values in CO2e.

The total GHG emissions for the year of 2018 from government operations were calculated to be 132,840 metric tons. The highest GHG emissions came from process & fugitive emissions, followed by water & wastewater treatment facilities, electric power generation, vehicle fleet, buildings & facilities, transit fleet, employee commute, solid waste facilities and street & traffic lights. The estimated CO_2e emissions from process & fugitive emissions were 62,314 metric tons, whereas emissions for water & wastewater treatment facilities, electric power generation, vehicle fleet, building & facilities, transit fleet, employee commute, solid waste facilities, and street & traffic lights were 24,176, 16,205, 12,302, 10,263, 2,944, 2,521, 1,790 and 325, respectively. The overall GHG emissions for the different categories are shown in Figure 3. GHG emissions by scope are shown in Figure 4 and the GHG distribution by sectors for each scope are shown in Figure 5.

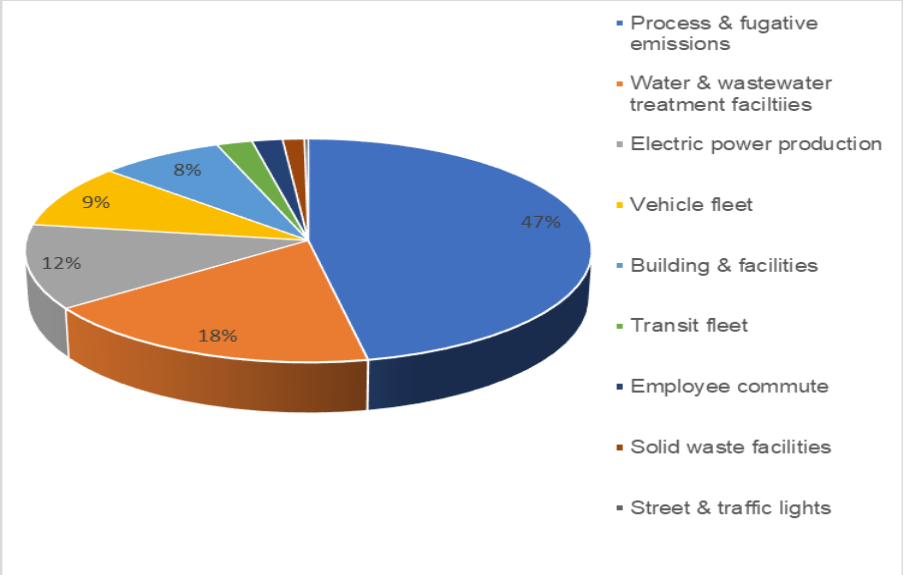

Figure 3: Overall GHG emissions

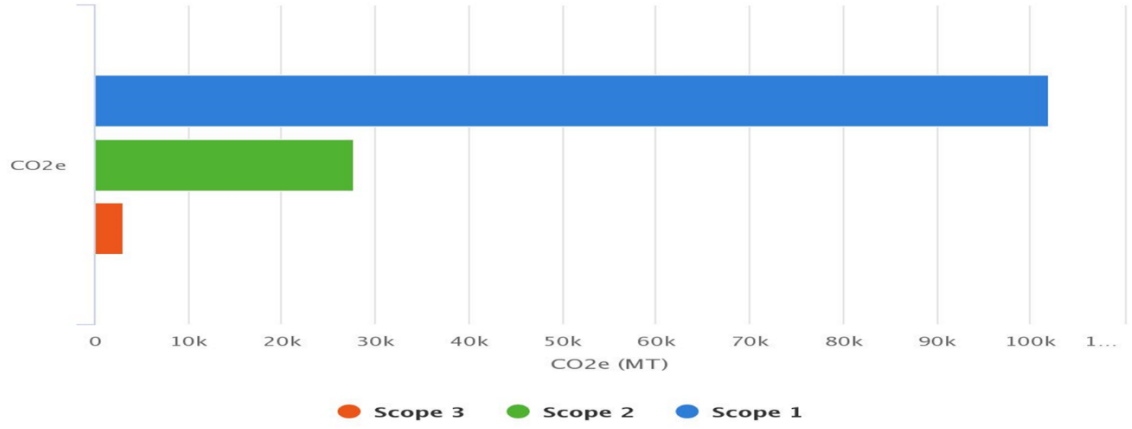

Figure 4: GHG emissions by scope

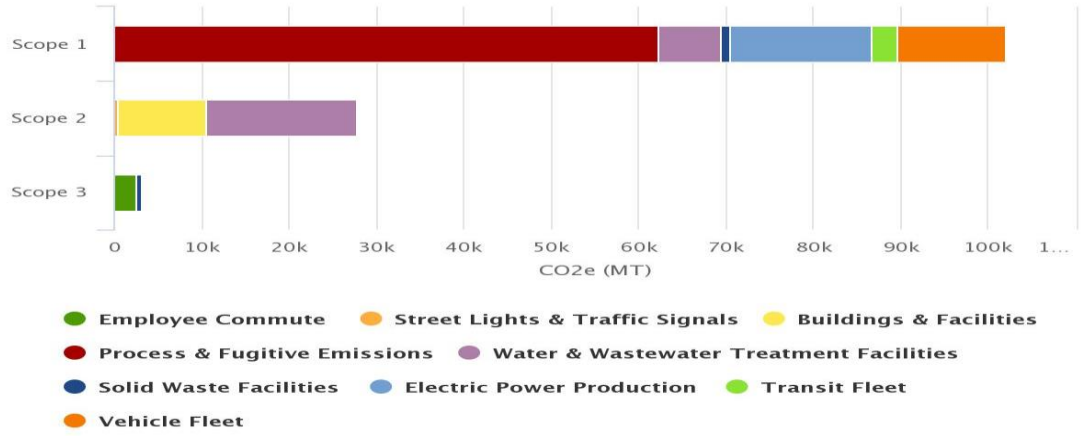

Figure 5: GHG emissions by scope and sector

Emissions from water and wastewater treatment facilities

As mentioned above, Manatee County has three wastewater facilities and one water treatment plant. The NRWRF consumed 8,042,000 kWh of electricity in 2018 and produced 3,399 metric tons of CO_2 equivalent. The SWWRF consumed 11,608,800 kWh of electricity in 2018 and produced 4,907 metric tons of CO_2 equivalent. The SEWRF consumed 3,473,266 kWh of electricity in 2018 and produced 1,468 metric tons of CO_2 equivalent. The PW water treatment plant consumed 15,489,600 kWh of electricity in 2018 and produced 6,547 metric tons of CO_2 equivalent. Furthermore, all the water and wastewater facilities produced 795 metric tons of CO_2 equivalent from electric power transmission and distribution losses. In all the wastewater facilities nitrification is a step at the treatment processes. Total Nitrification was calculated for MC's three wastewater facilities: Southwest Water Reclamation Facility (SWWRF), North Regional Water Reclamation Facility (NRWRF), and Southeast Water Reclamation Facility (SEWRF) which

produced 210,196 and 133 metric tons of CO_2 equivalent, respectively. Finally, a wastewater treatment plant facility uses a combination of physical, chemical, and biological processes to remove pollutants and treat wastewater. Sludge can be a potentially hazardous residue generated from the treatment process; it also has high energy demand and treatment costs. In MC, a biosolids dryer was constructed in 2009 at the SEWRF. The dryer operates using almost 100% landfill gas (methane) and processes wastewater sludge from all three wastewater facilities. This process produces 6,049 metric tons of CO_2e. Figure 6 presents the total CO_2e for each of water & wastewater facility while in Figure 7 is separated by the various contributors.

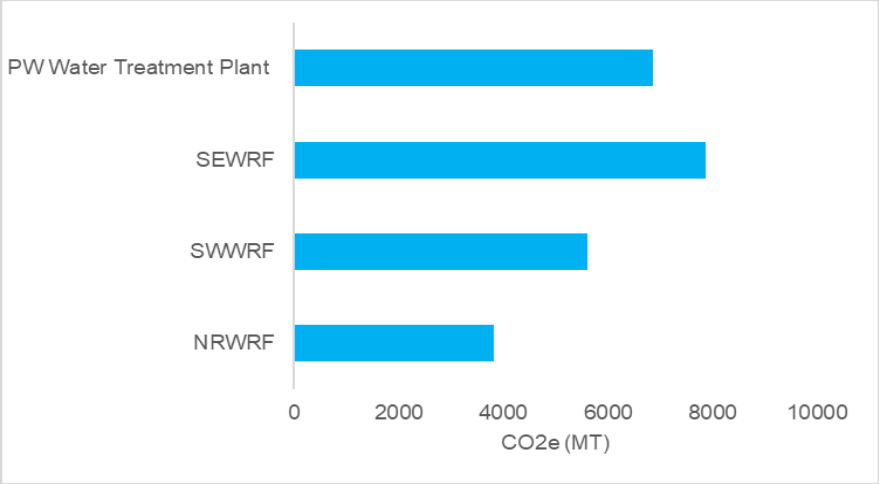

Figure 6:Total CO_2e for each of water & wastewater facility

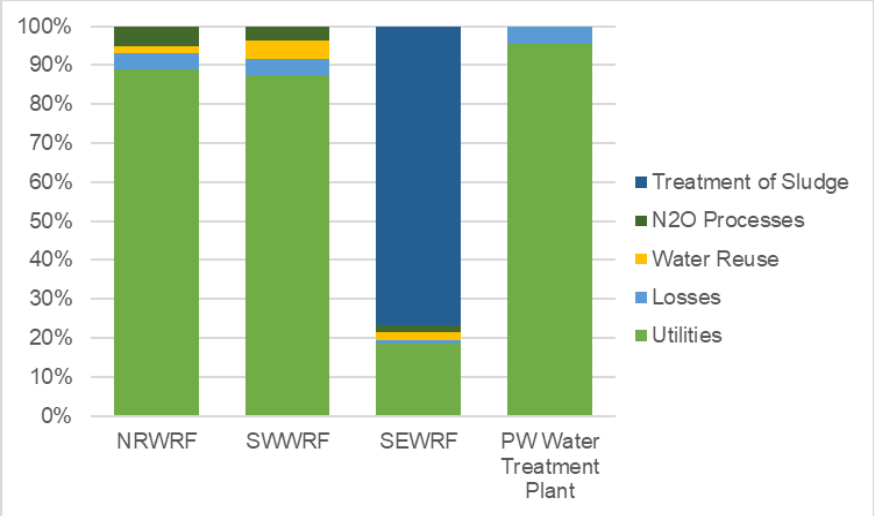

Figure 7: Distribution of GHG contributors in water & wastewater facilities

Emissions from solid waste facilities

Solid waste generation from government owned operations was estimated to be around 1,585.65 tons which produced 649 metric tons of CO_2e. Lena Road Landfill has a flare to burn the gas where in 2018 the landfill gas captured was 1,191,371 cubic feet/day which produced 1,141 metric tons of CO_2e. From the ClearPath™ results, it was revealed that solid waste from government operations emitted 1,790 metric tons of CO_2e in 2018 which is 1.35 % of the total greenhouse gas emissions. It was obvious that the landfill flaring produced around 64% of the total GHG emissions from solid waste facilities. Figure 8 presents the Lena landfill 2018 solid waste breakdown and Figure 9 shows how the LFG from Lena Landfill is used or released. Around 75% of the LFG was collected and sent to different treatment methods. 43% of LFG was directly used for flaring. 10% of the LFG was used as one of the heating sources for the sludge dryer at SEWWTP. About 22% was sent to an engine generator and the rest of the LFG was released in the air.

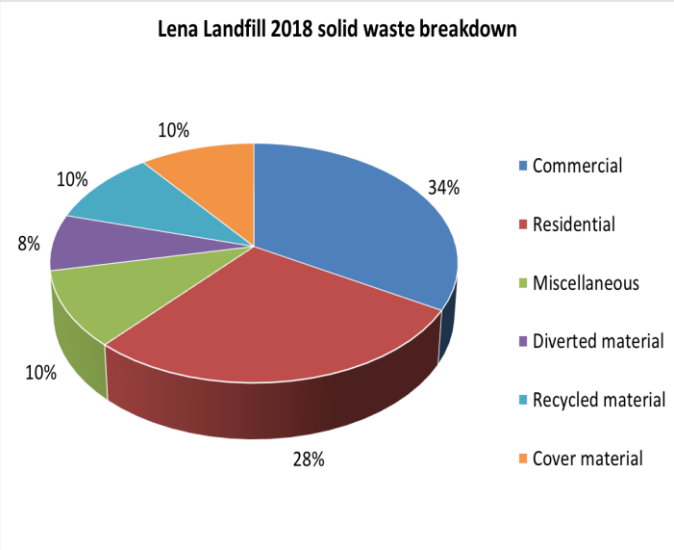

Figure 8: Lena Landfill 2018 solid waste breakdown

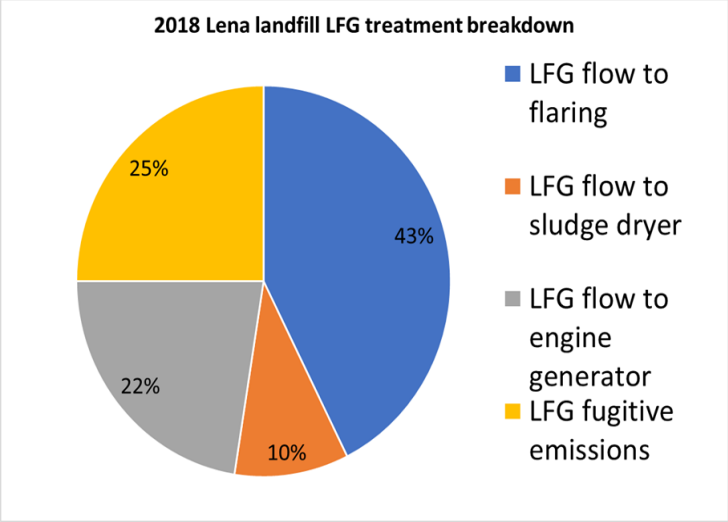

Figure 9: 2018 Lena landfill LFG treatment breakdown

Emissions from process and fugitive emissions & electric power production

According to the results from ClearPath™, the main source of GHG emissions were landfill fugitive emissions. The CO_2e emitted was 62,314 metric tons, which equals the 47 % of the total county's GHG emissions. Landfill gas is used in a gas-to-energy (GTE) facility to produce electric power. The landfill gas that is used contains 50% CO_2 and 50% CH_4. The CO_2 emissions produced equal 10,545 metric tons, and the CH_4 emissions produced equal 202 metric tons. The electric power production produces 16,205 metric tons of CO_2 equivalent which is 12% of the total GHG emissions. Figure 10 presents Lena Landfill LFG treatment methods CO_2e distribution.

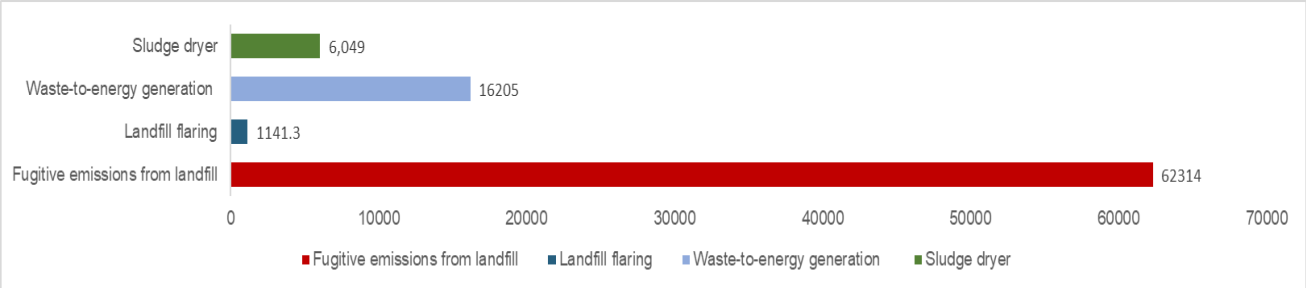

Figure 10: CO_2e distribution from Lena Landfill LFG according to the different treatment methods

Emissions from transportation

- Fleet vehicles

Total fuel consumption for county-owned fleet vehicles for the year 2018 was 474,271.1 gallons of gasoline and 1,085,308.4 gallons of diesel. It is assumed that a portion of the diesel (288,242 gallons) was used for the operation of MCAT buses which is represented in the next section, thus, to avoid double

counting of GHG emissions, the estimated amount of diesel consumed for fleet vehicles was calculated to be 797,066.4gallons. Figure 11 shows the GHG emissions in CO_2e for the two fuel types. The total GHG emissions was calculated to be 12,302 MT CO_2e.

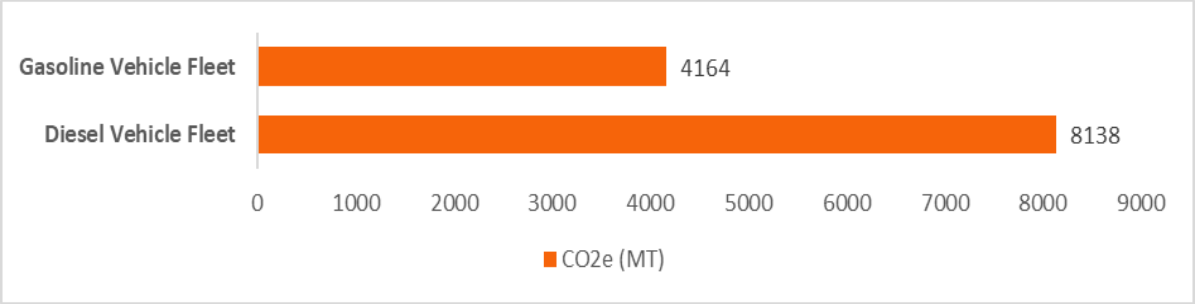

Figure 11: GHG emissions from Gasoline & diesel vehicle fleet

While the annual fuel use by type was provided, a break-down of vehicle types, mileage, and fuel use purposes, i.e. for on-road or off-road vehicles, were not. The only information given was that the county owns 2 to 3 hybrid vehicles, and no natural gas vehicles and this is non-representative of the full picture.

- Transit fleet

The county owns 38 buses under the Manatee County Area Transit (MCAT) bus system, which is the major public transportation provided within Manatee County and serves the Bradenton, Ellenton, Palmetto and Gulf Beach regions. With a daily pull of 23 buses, a total of 1,527,680 vehicle miles traveled (VMT) was reported in 2018. An assumption was made that all MCAT buses employed in 2018 used conventional diesel. Based on an average 5.3 gallons per diesel gallon equivalent **[20],** the total diesel used was estimated to be 384,420 gallons of diesel for the whole year. Accordingly, the GHG emissions from transit fleet based on ClearPath™ was estimated to be 2,944 metric tons CO_2e as shown in Figure 12.

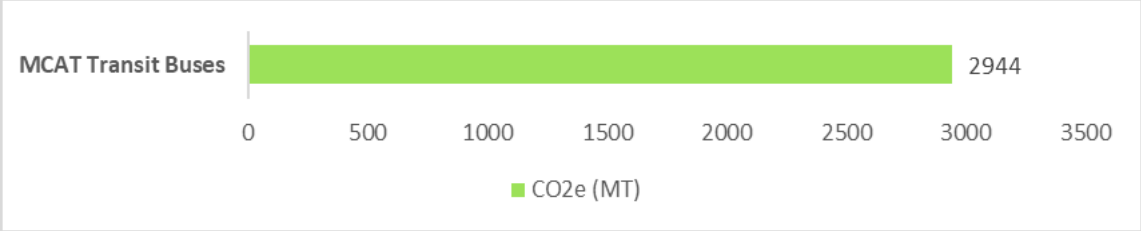

Figure 12: Transit fleet CO_2e

Emissions from purchased electricity

- Buildings, water & wastewater treatment, and solid waste facilities

From the energy data provided by county representatives, available meter readings in 2018 were analyzed and grouped according to three types of facilities: regular, water/wastewater treatment, and solid waste. A total of 69 buildings were identified based on available meter readings. 4 buildings are related to water and wastewater treatment plants and 1 building was for the Lena Landfill, which were recorded

separately under corresponding sections in ClearPath™; the remaining 64 were entered into ClearPath™ under the "Buildings & Facilities" section. The total amount of purchased electricity by Manatee County government in 2018 was 67,116,038 kWh which gives an emission estimate of 26,606 MT CO2e (Figure 13)

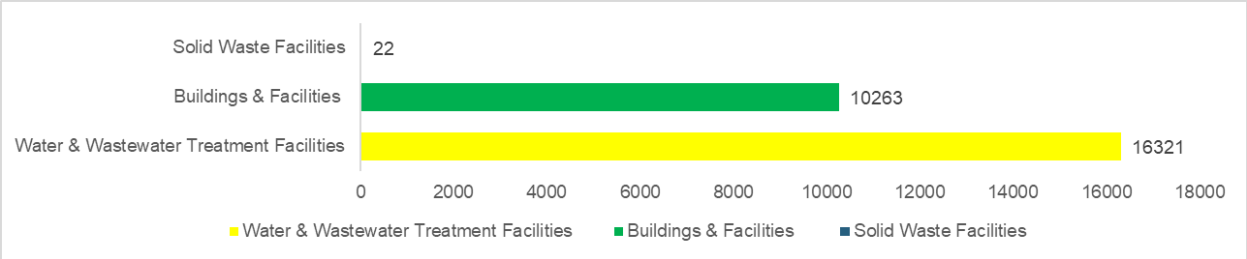

Figure 13: Total amount of GHG emissions from purchased electricity

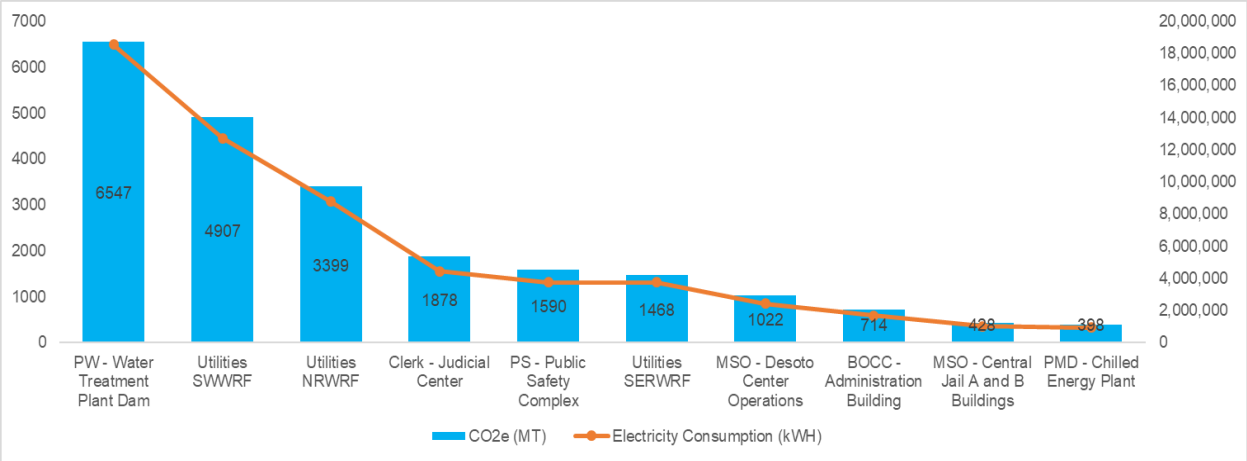

Figure 14: Top 10 Manatee County facilities by electricity consumption and GHG emissions

Figure 14 illustrates the top 10 Manatee County facilities with the highest electricity consumption and GHG emissions. The water related facilities such as the Water Treatment Plant Dam and the three wastewater treatment facilities contribute to much higher emissions than other types of buildings. The top energy consumption from non-water related facilities are Judicial Center, Public Safety Complex and the Desoto Center.

- <u>Streetlights & traffic signals</u>

As part of Scope 2 emissions, streetlights and traffic signals were also included. Total traffic signal electricity consumption was 733,465 kWh. Figure 15 shows that the CO_2 emissions of powering the traffic signals was about 310 CO_2e.

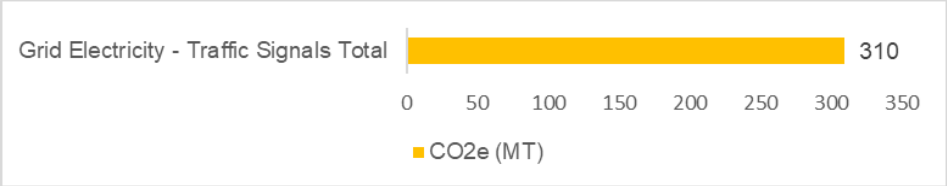

Figure 15: CO_2 emissions of powering the traffic signals

Emissions from employee commute

There are a total of 1788 employees working within Manatee County government. A survey was designed to gather information from the employees regarding their commute patterns to and from work. A sizable number of employees, 393, completed the survey and the results were then analyzed and extrapolated to find the total vehicle miles traveled by various transportation modes and their corresponding fuel types. The total GHG emissions from employee commute was estimated to be 2,459 MT CO_2e (See Figure 16).

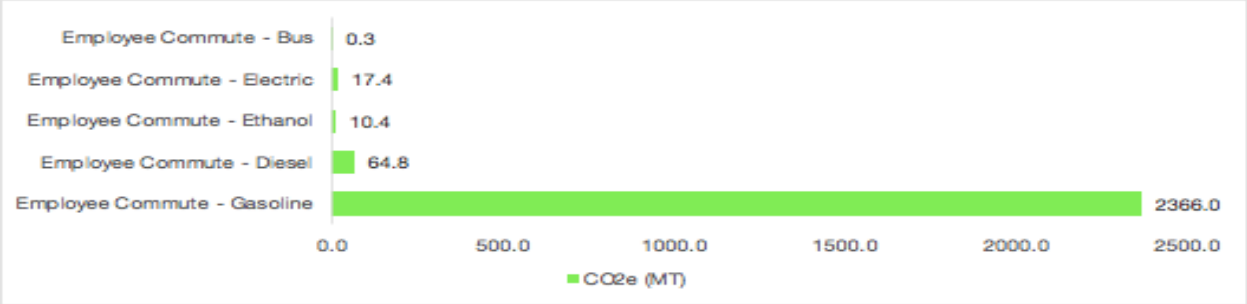

Figure 16: GHG emissions from employee commute

Survey results:

Some key findings include the split of transportation mode: 96% of employees drive alone, 3% carpool, 1% ride a bicycle or skateboard, 0.25% ride a motorcycle or scooter, and 0.25% use public transit; and of those who drive alone, 92% drive a regular gas vehicle, only 1% are on electric or flex fuel vehicles as shown in Figure 17.

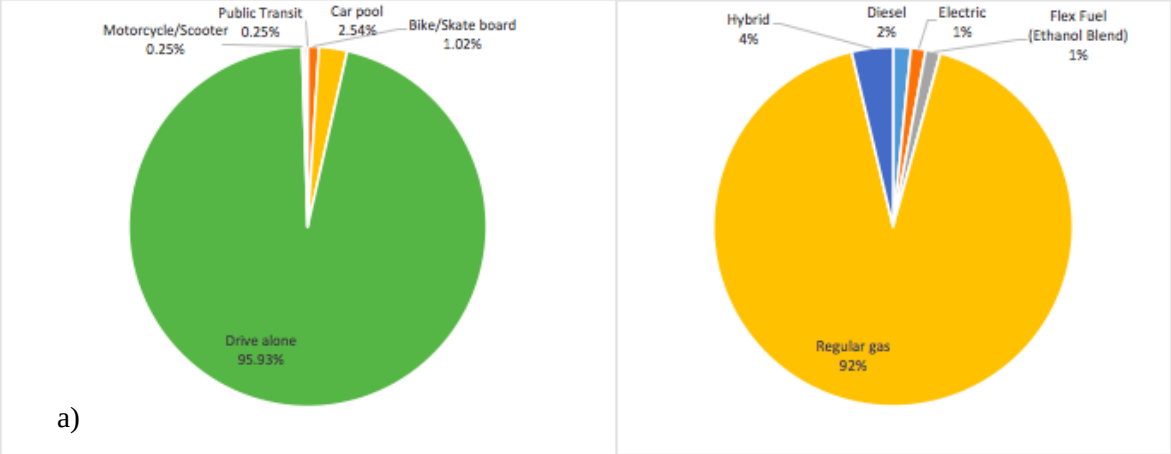

Figure 17: (a) Type of commute in %, (b) Type of fuel used by employees who drive alone in %

A more in depth look at the survey responses analysis is presented as follows. The initial calculation made was to determine the VMT per year per person using the following equation based on the 393 survey responses.

$$VMT = \frac{\#\ of\ days\ of\ commute}{a\ week} \times (miles\ to\ work\ \times 2\ way) \times 4\ weeks\ \times\ 12\ months$$

Then, the types of vehicles were classified into the following categories based on the vehicle types: passenger car and light trucks. A preliminary split between data like types of commute, vehicle type, and fuel usage were quickly identified (Table 4).

Table 4: Vehicle type and total VMT per year split for county employees who drive alone

	Diesel		Electric		Flex Fuel (Ethanol Blend)		Hybrid		Regular gas	
Vehicle Type	Employee Count	Sum VMT per year	Employee Count	Sum VMT per year	Employee Count	Sum VMT per year	Employee Count	Sum VMT per year	Employee Count	Sum VMT per year
Light Trucks	14	76023	0	0	5	27151	9	43442	303	1151211
Passenger Car	14	53216	23	58212	18	81454	54	238931	1267	4649805
Grand Total	**27**	**129240**	**23**	**58212**	**23**	**108605**	**63**	**282372**	**1570**	**5801015**

For employee commute under ClearPath™, there are only four options of fuel types: gasoline, diesel, electric, and ethanol. Therefore, hybrid vehicles had to be split up into gasoline and electric vehicles according to this ratio: 1 hybrid to 1 gasoline and 1 electric in terms of vehicle count; VMT is then halved for each record. For ethanol fuel type, an assumption of 85% ethanol (E85) was used in all relevant vehicles.

Furthermore, since there was no way to capture carpooling on ClearPath™, carpool vehicles were represented as “drive alone” vehicles by grouping the carpool employees together. According to the Manatee County MCAT Transit Development Plan 2019 - 2028 Major Update Report (2018), 2-person

carpool is the most common for journey-to-work at 6.8% probability as compared to 3-person carpool at 1.4%, and 4+-person carpool at 1.4%. An assumption that all carpools made by county employees were 2-person journeys was made to give the final breakdown of vehicle types and their corresponding VMT for input into ClearPath™ is shown in Table 5.

Table 5: Final employee commute calculations entered for ClearPath™ input.

Clearpath™ Entry Title	CO2e (MT)	Employee Annual VMT	Fuel Type	Percent of Biofuel in Blend	Percent VMT in Passenger Car (%)	Percent VMT in Light Trucks (%)	Percent VMT in Heavy Trucks (%)	Total Employee
Employee Commute - Gasoline	2366.0	6031697	Gasoline		81	19	0	1691
Employee Commute - Diesel	64.8	129240	Diesel		40	57	0	28
Employee Commute - Ethanol	10.4	108605	Ethanol	85 -assume	72	24	0	24
Employee Commute - Electric	17.4	200191	Electric					58
Employee Commute - Bus	0.3	6000	Diesel					5

Power transmission and distribution losses

The power transmission and distribution losses were calculated for the following modules on ClearPath™: Buildings and Facilities, Water & Wastewater Treatment, Solid Waste, and Street Lights & Traffic Signals. According to the EPA, the Grid Gross Loss in Eastern US was 4.88% in 2018 **[22]**. This percentage was used as the factor set in ClearPath™ as an exact grid-loss factor wasn't provided by FPL to Manatee County representatives and is not a public information. Based on the grid electricity consumed for each category, emissions were estimated as shown in Figure 18.

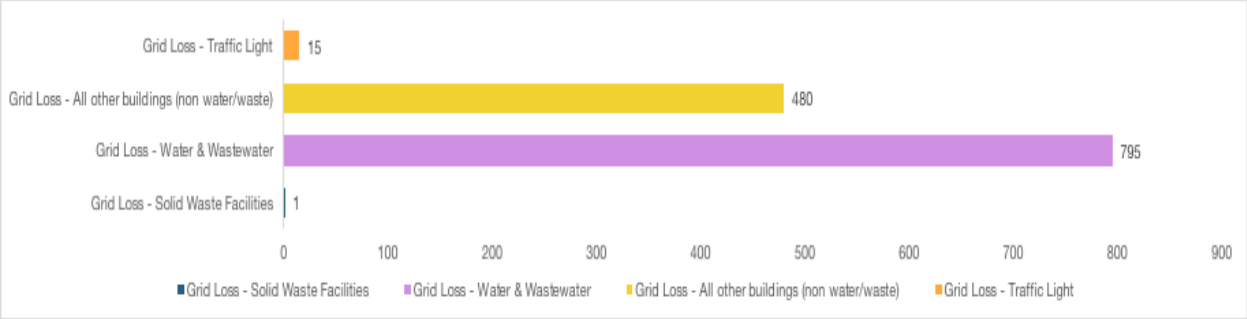

Figure 18: GHG emissions from power transmission and distribution losses by different category

Limitations to this audit

The first limitation to this audit pertains to Scope 1. Electric power is purchased from FPL, however the source of generation is unknown, making emission estimates unattainable. In the evaluation of Solid Waste Facilities in Scope 1, the primary limitation to this audit was the lack of methane collection data. Without methane data, an accurate calculation of emissions by Solid Waste Facilities could not be made.

For Scope 2 regarding building electricity usage, the limitations are related to the quality of data provided. Of the 94 county buildings, only 76 have available data. From those 76 buildings, several of them do not have complete meter entry data for the year 2018; some have one month of missing data, while others have 11 months of missing data. This data limitation has restricted the outcome of the analysis, as estimations may not be entirely accurate. Concerning Solid Waste Facilities, Florida Power and Light, Manatee County's electricity provider, could not provide a utility-specific Grid Loss Factor to aid in the calculation of electric power transmission and distribution losses. Because of this, the national average Grid Loss Factor of 4.88% as determined by the U.S. Energy Information Administration was used in the calculations. However, this may not accurately represent distribution losses within Manatee County.

With regards to solid waste within Scope 3, not all county buildings are accounted for in the "waste generated" data provided. For the buildings which utilize waste containers with unspecified or unknown capacities, estimations of tons of waste generated for the year of 2018 could not be made. Due to a lack of data concerning exact tons of waste generated per building, estimations were made by multiplying the average capacity of each building's dumpster by how frequently they collected that container in 2018. These estimations were made assuming each dumpster was at full capacity each time it was taken off site to be sent to the landfill.

The final limitations under Scope 3 are related to employee commute. For employee commute under ClearPath™, there are only 4 options for fuel types: gasoline, diesel, electric, and ethanol. Therefore, hybrid vehicles were accounted for in ClearPath™ by considering them as 1 electric and 1 gasoline car. Resulting vehicle miles traveled were then halved for improved accuracy. Furthermore, carpool calculations were made by combining employees who reportedly carpool to work into one "drive alone" vehicle. This was done based on the assumption that there were 2 passengers per carpool vehicle, as a 2-person carpool is reportedly the most common journey-to-work carpool option according to the Manatee County MCAT Transit Development Plan at nearly 7%, as compared to a 3 or 4 person carpool, each at 1% probability. This assumption may not be accurate, however, because the number of employees per carpool was unspecified in the survey.

Lastly, according to Manatee County, department employees frequently travel to attend various trainings each year. A complete record of county-funded air travel, however, was not available. In the Sustainability Department alone, an average of 5 employees fly to at least 3 out of state conferences a year. While this is good information, it is difficult to make any air-travel related estimations on ClearPath™ because distance traveled, exact frequency of travel, and exact number of employees who traveled were unspecified.

Recommendations

GHG emission reduction

In order to target net-zero emissions in the future, Manatee County will need to urgently focus on efforts and projects to make this a possibility. The graph depicted below was created to give a hypothetical visual of what Manatee County's GHG emissions would look like if they continued "business as usual," or without emissions reductions, and what their emissions would look like if they made consistent efforts from now until 2040 to decrease their county footprint. Data from Skagit County, Washington was used to generate this graph. Skagit established "business-as-usual" predictions at 148% growth from 2006 levels to 2050, which equals a roughly 4% increase in emissions annually **[23]**. For Manatee County, the recommended timeline to reach "net zero" is 2018 to 2040, or a period of 22 years. Using 2018 as a baseline year, this would require a reduction effort of nearly 3,000 MT CO2e per year in order to achieve net-zero by 2040. In Figure 19 the orange line represents reduction efforts of greenhouse gases, and the blue line represents business as usual emissions projected at 148%. The difference between the two lines depicts the total reduction that Manatee County needs to achieve net-zero by 2040.

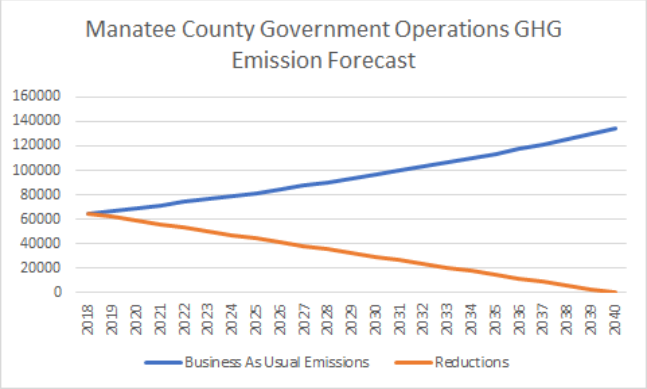

Figure 19: Manatee County GHG Emission Forecast

Based upon data analysis, buildings and facilities, water and wastewater treatment, and electric power production are the three largest categories for MC GHG emissions. Within the water and wastewater sector, a possible option could be to capture and treat emissions in the form of gaseous steam. Other ways to address emissions from water facilities is to maximize the quality and volume of biogas produced and focus on energy efficiency and/or consumption reductions **[24]**. For buildings and facilities, implementing smart technology and building according to LEED standards can improve emissions reduction. Investing in renewable energy can decrease emissions within the Electric Power Production sector for the county. This can be done by the county itself, or partnerships can be created between the county and their third-party energy providers.

Process & fugitive emissions

The total quantity of landfill fugitive emissions in 2018 was 8416 metric tons while the gas in CO_2 equivalent was 62,315 metric tons. This is one of the largest problem areas of CO_2 emissions that need to be addressed. North Dakota, Texas, and other states have reported that the high fugitive emissions are predominately associated with leaks and other unintended releases in landfills **[25]**. Improvements can be made by developing a directed inspection and maintenance program which has been well proven to achieve an average of 70% reduction in fugitive gas emissions. This would ensure the proper working order for all the valves, connectors, seals, and other components. It has also been suggested that methane can be recovered from the vents by utilizing the existing vapor recovery unit, which can aid in reducing up to 45% of methane emissions **[26]**.

Composting facility

The development of a composting facility would provide an alternative option for the handling of food and lawn waste produced by Manatee County **[27]**. A composting facility would reduce methane, the primary GHG produced by landfills as a byproduct of decomposing organic material, while also supplying the County with high-quality compost for soil amendment. A study done by the Institute for Local Self-Reliance (ILSR) found that 78 million tons of municipal organic waste, such as food scraps, yard trimmings, and paper, arrive in landfills across the United States annually, when "21 million tons of usable compost material could be recovered and utilized"**[28]**. The ILSR concluded in *State of Composting in the US* that composting operations sustain more jobs than landfills and incinerators on a per-ton and per-dollar capital investment basis. Their research found that "landfills sustain two jobs per 10,000 tons per year landfilled, [while] composting operations sustain four jobs for every 10,000 tons per year they handle" **[29]**.

Fertilizer pellet revenue spending

From the biosolids dryer process, the sludge cake tonnage produced 3,394.52 tons of fertilizer pellets sold at $33 per ton, which contributed to producing $125,400 of revenue in 2018 as the FY operating costs were around $28.31 per ton of arriving sludge **[3]**. After turning a profit from initial investment, the revenue produced from the pellets could be used for funding sustainable future projects, such as renewable power investment, creating a fleet of electronic MC owned vehicles, or possibly developing a light rail system for the community as another source of public transportation.

Third party participation

The fight to become sustainable does not fall under one municipality's responsibility alone. Governments and energy-providing companies can work together and form partnerships that benefit each participant. In Montgomery County, MD, the government has entered a partnership with Duke Energy that has taken two high energy-using buildings off of the grid. The county is installing micro-grid systems that will remain onsite for the buildings. "It's a first-of-its-kind move for the county, bringing environmental and other benefits and protecting the county from power outages, said Eric Coffman, chief of the county's office of energy and sustainability. The micro-grids will generate clean power using solar energy systems and natural gas generators. The public safety buildings will operate independent of the electrical grid, which will enable the county to replace aging equipment, install stiffer security measures and ensure uninterrupted service, Coffman said" **[30]**.

In addition, these systems erase the need for power provided to the buildings to travel long distances, which will cut back on grid loss. Local and large governments must continue to encourage their third-party providers to join the sustainability movement in order to have total participation from all sectors.

Transportation - vehicle & transit fleet

Transitioning the County's transit fleet to electric vehicles (EV) would noticeably reduce municipal GHG emissions, given that the County's transit fleet currently accounting for 2,386 tons CO_2e. In order to achieve lower operating and fuel costs as well as reduced carbon emissions, selection of the correct technology "that doesn't compromise the operational needs of drivers" **[31]** and identifying which fleet vehicles are the best candidates for EV adoption are key (para. 1). In addition to reducing harmful emissions, an EV fleet would cut fuel costs while requiring less maintenance than a fleet of conventional vehicles. To confirm a positive return on investment, Manatee County could begin by converting a few vehicles in their fleet to EVs, then expand based on the outcome **[32]**.

Transportation accounts for 30 percent of energy demand in the U.S., and now is the leading source of greenhouse gas emissions in the United States. By replacing gas-powered vehicles such as police cars, city vehicles and trolleys, with engines that run on electricity, Manatee County would see a major difference in reduced emissions of CO_2. As of March 2020, there are 15 public electric vehicle charging stations. For the average electric vehicle, 1 full up equates to a 70mile range. Being that Manatee County has an area of 893 mi^2, the average electric vehicle will surely have access to one of the 15 local public electric vehicle charging stations **[33]**.

The Manatee County Area Transit (MCAT) system is an ideal place to reduce energy consumption. Given that in 2018, MCAT was awarded $1.9 million by the U.S. Department of Transportation Federal

Transit Administration to replace or rehabilitate their fleet of buses, MCAT could now convert diesel ran buses to biodiesel blends which is a direct replacement for petroleum diesel and can be used in any existing diesel engine without modifications **[34]**. Biodiesels produces 78% less CO_2 than diesel fuel. Biodiesels produces 2661 grams of CO_2 per gallon, compared to 12,360 grams of CO_2 per gallon for petroleum diesel fuel. If the MCAT busses used B50, then they would reduce their CO_2 emissions by several hundred metric tons.

In addition to vehicle fleet, garbage trucks are considered one of the least efficient vehicles. Powered by diesel fuel, they average just 3 miles per gallon and emit 20 times the carbon emissions of an average US home. Manatee County should target this lane by investing in hybrid hydraulic pressured garbage trucks. These hybrids would capture and store energy that otherwise would be wasted during the vehicle's normal operation, then use that energy when needed to reduce fuel consumption. This typically takes the form of regenerative braking, in which the hybrid system captures and stores the vehicle's kinetic energy, rather than dissipating it as friction **[35]**. Officials from the City of Miami and Miami-Dade County have reported savings of 51% and 45%, respectively. Manatee County could also consider biodiesel blends as opposed to diesel. Switching the diesel vehicle fleet to B50 would reduce their CO_2 emissions by several thousand metric tons.

Future inventory development

To further assist with creating more accurate emission calculations, the county should also audit the community wide GHG emissions in addition to the government operations. It is important to fill in the missing information, especially more specific information. For example, fleet vehicle data can be separated by category (bus vs trolley percentages) to create a more accurate GHG emission total. Additionally, having complete methane data as produced by County landfill operations is essential to understand the true GHG impact of municipal solid waste facilities.

If possible, establishing data sharing agreements with FPL for the input of energy losses can create more complete information. Furthermore, another recommendation could be to create incentives such as the opportunity to enter to win a gift-card if employees fill out a commuter survey in order to increase number of participants and obtain more accurate commute information.

Net-zero and net-positive fixtures

Improving energy building efficiency and lowering carbon emissions is a key strategy for mitigating climate change effects and reducing the carbon footprint associated with local government operations. Net-zero energy buildings (NZEBs) have gained high recognition to create self-sufficient

energy, such as the use of solar power connected to a power grid. A climate action plan to set targets of becoming net-zero can be a great tool to create a framework for energy efficiency, utilizing increased LEED certified buildings and renewable energy power mix. Based upon high risk potential for climate change effects for Manatee County, it would be advised to target around 2040 to achieve net-zero.

Wastewater treatment plants can be a good place to begin on moving individual facilities towards net zero. Food waste could be used as feed stock along with wastewater sludge to produce biogas through the co-digestion. An award-winning wastewater facility in Singapore that applies co-digestion of food waste and sludge has been able to produce triple the amount of biogas compared to treating wastewater sludge alone **[36]**. Biogas can be used for enhancing thermal efficiency and production of electricity which would be able to power the plant itself. Excess electricity produced can be directed back to the grid or stored in a micro-grid for powering nearby facilities.

Solar street lightings and surveillance could also be considered as a way to reduce dependency on grid electricity and cutting down GHG emissions on the road. This type of lighting/public surveillance involves a solar panel and battery attached to the usual pole and light. While it is shown that installation of solar LED streetlights is more expensive than a conventional streetlight, the overall cost of solar LED lighting is more affordable due to the fact that there will be zero spending on grid electricity each year. The typical lifespan for solar streetlight is also 5 to 7 times more than conventional streetlights **[37]**. Excess energy generated from solar lighting and surveillance poles can also be stored and repurposed for other energy requirements.

LEED certified buildings

According to the Global Alliance for Buildings and Certifications, buildings account for one-fourth of total GHG emissions **[38]**. LEED is a program that approaches building design and construction with energy efficiency, water usage, air quality, choice of building materials, proximity to public transportation, and responsible land use in mind. According to the United States Green Building Council (USGBC), LEED certified buildings may qualify for tax rebates and zoning allowances and ultimately have higher property values than conventional buildings. LEED-certified buildings are not only more efficient but demonstrate environmental responsibility and "represent an ethical system for sustainability". **[39]**

Building and facilities

Manatee County has already made a commitment to designing and operating their buildings in a sustainable way. They have been an Energy Star Partner since 2013. The partnership offers experience and resources, and with these, they have been able to track energy data for their buildings, implement policies

that encourage sustainability amongst government workers, as well as train those workers on sustainability practices **[40]**. Even with all this progress, there is always room for improvement. According to the US Energy Information Administration, lighting, refrigeration, cooling and ventilation are the top electricity usages in commercial buildings. Concentrating on these four categories of building operations alone can make an impact on over half of the total electricity usage **[41]**. High efficiency models for HVAC systems and energy efficient light bulbs can be installed, and if maintained properly, will result in energy savings. Automatic light sensors will turn on and off as each room is used and can also save energy. Blinds and awnings can be installed on windows to create shade and help keep room temperatures at the desired level. Solar panels, if installed, can make buildings independent for their electricity needs. There are copious amounts of strategies and installments that can be used when designing and operating buildings and many new options currently are being created.

Of the top 3 buildings in Manatee County with the largest energy consumption, the Judicial Center is deemed the most efficient with a usage of 9.7 kWh per sqft while the PSC and DCO facilities are at a 32.9 and 26.13 kWh per sqft usage rate, respectfully. Given that the Judicial Center was designed with high performance elements, such as a high-efficiency HVAC system, passive solar shading, and daylighting strategies, Manatee County should use the design of this building as a model for revamping the PSC and Desoto Center of Operations facilities which would drastically reduce the energy consumption for these much smaller buildings.

With energy efficient technologies such as light-emitting diodes (LED) lighting and double-pane heat insulated windows, Manatee County could witness reduction in energy-related expenditures for their buildings. LED lighting use less energy with a much longer lifespan & double-pane heat insulted windows help maintain a constant temperature. To extract the most use of LED lighting, Manatee County could also install sensors to the lights for an automatic on and off feature when there is no one in the area. As for double pane windows, this would allow the workload of the HVAC to be drastically reduced which would minimize its energy consumption.

Behavior change

In order for Manatee County to lower energy consumption, the county should launch an energy efficiency training program to educate all current and future on boarders. All participating employees will be provided with simple tips and techniques to reduce the consumption of energy. This prioritized energy efficiency training will bring awareness of GHG to all, and with awareness comes accountability. Holding each employee accountable for turning off appliances and unplugging instruments when they aren't being used, will precisely cut cost and reduce energy release and consumption.

Behavior change amongst government employees is something that can be done immediately to reduce emissions. Changing thermostats at night and on the weekends and turning off electronics when offices are not in use are ways to save electricity within buildings. Turning the water off while you wash your hands and reporting leaky sinks quickly so they can be fixed are ways to save water. Teaching how-to and the importance of recycling and composting may encourage more employees to use the bins that are available to them. These practices may not add up to a substantial amount of energy, water, or resources saving, but every little effort adds up. Over time, the small efforts become a noticeable difference.

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