2016

2015 Greenhouse Gas Emissions Inventory for Chatham County, North Carolina

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EXECUTIVE SUMMARY

The purpose of this report is to outline the work accomplished in assisting Chatham County, North Carolina with compiling a greenhouse gas emissions inventory. It updates and expands upon a 2010 greenhouse gas emissions inventory that was completed for Chatham County to reflect the most up-to-date data. The report presents an introduction to the best practices and guidelines to reference when completing a greenhouse gas emissions inventory; updated emissions calculations and values; strengths and limitations of the analysis, recommendations to improve the emissions inventory; and concludes with a set of stakeholder considerations when designing policy interventions.

This report updates the 2010 methodology with best practices that have emerged since its original publication. These best practices include the methodology of both the International Council for Local Environmental Initiatives – Local Governments for Sustainability (ICLEI) and the International Panel on Climate Change (IPCC). The ICLEI guidelines focus on emissions that the government can most directly control, the emissions that come from public operations. These emissions are called Scope 1 emissions and can include emissions from stationary combustion to produce energy, mobile combustion of fuels (such as tailpipe emissions from vehicles), process emissions from physical or chemical processing, fugitive emissions that result from production, processing, transmission, storage and use of fuels. To create the most robust analysis, ICLEI guidelines suggest collecting data from each of these emissions sources associated with government operations. IPCC recommends designing an iterative process to maintain a comprehensive, cross-sectional database of emissions over time, with the scope of the inventory defining the type of data collected.

With these guidelines, this report updates the 2010 emissions inventory using 2015 from the industrial, residential, commercial, transportation, and agricultural sectors of Chatham County. This report finds that the primary contributor to GHG emissions in Chatham County is the transportation sector, emitting 1,240,857.67 metric tons of CO_2 equivalents, which constitutes almost 74% of the total 1,677,501.55 metric tons of CO_2 equivalents emitted from all sectors (Table 1). Overall, the analysis in this report reflects a change in the distribution of GHG emissions across all sectors (Figure 1).

Table 1: Distribution of CO_2 eq. emissions across major sectors in Chatham Country, NC.

SECTOR	METRIC TONS OF CO2e	Percent of Total
Residential	163492.02	9.75
Commercial	73521.13	4.38
Industrial	112562.13	6.71
Transportation	1240857.67	73.97
Government	963.00	0.06
Agriculture	86105.6	5.13
Total	1677501.55	100.00

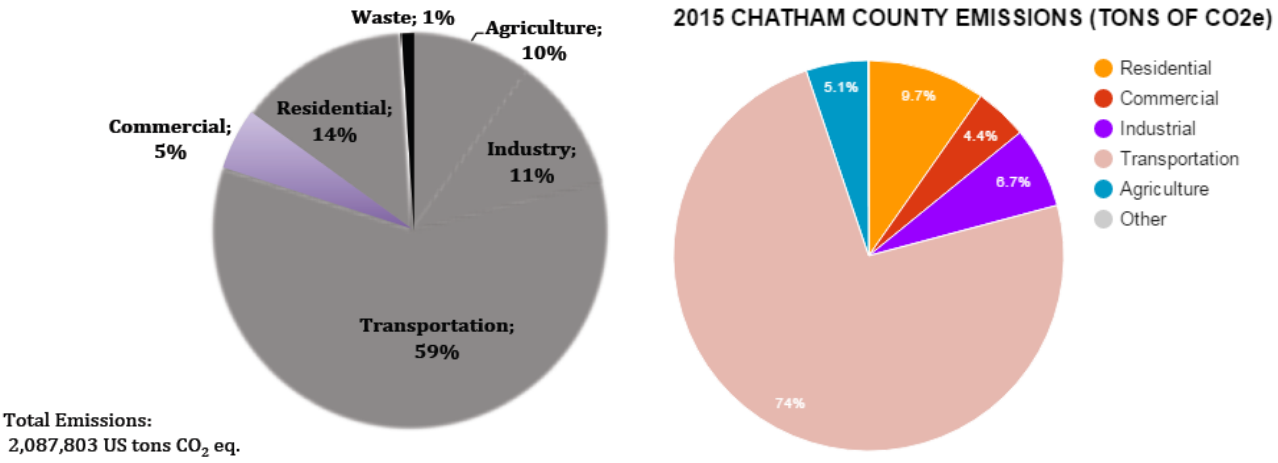

Figure 1: The distribution of GHG emissions in 2010 (left, grey) versus in 2015 (right, color).

This analysis is the first update of the initial GHG emissions inventory and, with the establishment of a ClearPath account, has been incorporated into an official Chatham County account that will be used to collect and update data in the future.

INTRODUCTION

In April 2010, a baseline greenhouse gas (GHG) inventory was produced for Chatham County, North Carolina by Beth McCorkle with assistance from the Nicholas School of the Environment at Duke University. This report utilized formulae available through ICLEI Local Governments for Sustainability software to estimate the emissions of GHG associated with the residential, commercial, industrial, agricultural, transportation, and waste sectors of Chatham County. It found that the total GHG emissions from the activities of these sectors was 2,087,803 US tons of CO_2 equivalents and the majority of emissions attributable to the transportation sector (Figure 2).

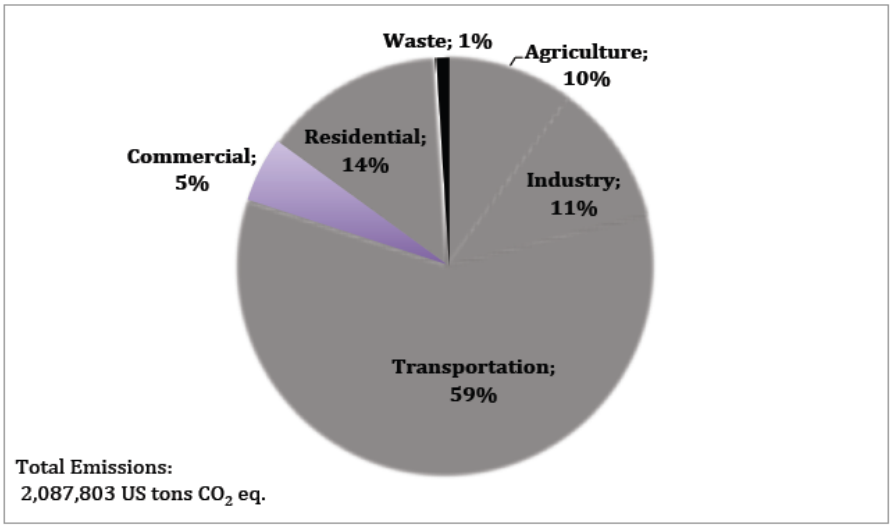

Figure 2: Chatham County GHG emissions by sector according to the 2010 GHG Inventory

CO_2 equivalents were used to standardize the atmospheric warming potential of multiple types of GHGs. This measure provides a universal standard against which the impact of different types of emissions can be compared. For the most common GHG emissions, the CO_2 equivalents are:

- 1 CO_2 (carbon dioxide) = 1 CO_2 eq
- 1 CH_4 (methane) = 25 CO_2 eq
- 1 N_2O (nitrous oxide) = 298 CO_2 eq

The 2010 McCorkle Report was updated using similar methodology and the same practice of converting emissions to CO_2 eq. All measures are reported in tons (2000 lbs) of CO_2 eq.

This report goes beyond the McCorkle Report by first examining the best practices of a GHG inventory using institutional standards and guidelines. After updating the 2010 report, we examine the strengths and weaknesses of these inventories based upon the international guidelines and best practices established by existing GHG inventories. Considering these limitations, this report follows with a set of recommendations to improve the strength and validity of the GHG inventory analysis. It concludes with a set of stakeholder considerations when designing policies to address the current emissions values for various sectors.

Best Practices and Guidelines

The first step in the process was to collect guidelines and best practices materials from authoritative sources. The intent of this step is to supplement the 2010 report with information that has been collected or created since the reports' creation. The best practices and guidelines section relies on two primary sources:

ICLEI

ICLEI- Local Governments for Sustainability is a global network of cities, towns, and regions that promotes climate action at the local level by providing technical support to governments and community organizations. This technical support includes a framework for achieving a comprehensive GHG inventory. In general, the framework allows a local government to determine which emissions should be (or are feasible) to be inventoried, to organize the reporting of emissions by degree of control (according to Scope), and to avoid "double counting" emissions. The scope framework follows, from the documentation:

- **Scope 1:** The most direct control, this measures direct emissions from sources that the local government controls, owns, or operates. This includes stationary combustion to produce energy, mobile combustion of fuels (such as tailpipe emissions from vehicles), process emissions from physical or chemical processing, fugitive emissions that result from production, processing, transmission, storage and use of fuels.
- **Scope 2:** Indirect emissions associated with the consumption of electricity, steam, heating, or cooling that purchased from the outside utility. The McCorkle report utilizes Scope 2 level data extensively, pulling the kWh usage from the local utility companies.
- **Scope 3:** The least direct control, this measures all other emissions sources that hold policy relevance to the local government that can be measured and reported. Sources over which the local government does not have any financial or operational control would be accounted for here. Scope 3 emissions include tailpipe emissions from employee commutes, employee business travel, and emissions resulting from the decomposition of government-disposed waste.

ICLEI provides instruction and associated pre-loaded datasets to compile a greenhouse gas inventory. The primary objects of completing a greenhouse gas inventory is twofold: To create a baseline of emissions against which reduction targets and measures can be compared, and to provide insight into the scale of emissions from various sources within the operational purview of the local government.

To create a baseline of emissions, ICLEI defines different forms these emissions can take. Stationary or mobile combustion is the on-site combustion of fuels to generate heat, electricity, or to power vehicles and mobile equipment. Purchased electricity are emissions produced by the generation of power from utilities outside of the jurisdiction. Fugitive emissions result from unintentional release of GHG into the atmosphere. They often come from leaked refrigerant and methane from waste decomposition. Process emissions originate from the physical or chemical processing of materials (e.g. wastewater treatment).

ICLEI espouses the large role governments can play in the reduction of GHG emissions compared to other sectors, primarily because of the control it has over its own operations. Working from this philosophy, this report explores the contribution government operations make to the overall greenhouse gas emissions in Chatham County. However, it also goes beyond government operations to examine the contributions of other sectors and considers policies the Chatham County government could design to address these contributions.

IPCC

In 2006, the Intergovernmental Panel on Climate Change (IPCC) completed the *Guidelines for National Greenhouse Gas Inventories*. This report presents several methods to define the scope and improve the validity of data analysis in a GHG inventory. First, this resources suggests focusing early efforts on the data needed to improve estimates of key sectors which are the largest, have the greatest potential to change, or have the greatest uncertainty. Those hoping to complete an inventory should also choose data collection procedures that iteratively improve the quality of the inventory in line with the data quality objectives. If these procedures do not exist, the entity should put in place data collection activities (resource prioritization, planning, implementation, documentation, etc.) that lead to continuous improvement of the data sets used in the inventory. The collection of data and other information should be completed at a level of detail that is appropriate for the method used. The entity should review data collection activities and methodological needs on a regular basis, to guide progressive and efficient inventory improvement. Finally, the entity should introduce agreements with data suppliers to support consistent and continuing information flows (Eggleston, et. al., 2006).

UPDATES TO 2010 BASELINE GHG INVENTORY

The following section updates the baseline greenhouse gas inventory completed for Chatham County, North Carolina by Beth McCorkle in April 2010 with assistance from the Nicholas School of the Environment at Duke University.

Residential/Commercial/Industrial

In 2010, the original McCorkle report found that the residential sector accounted for 287,107 US tons of CO_2 equivalents, contributing 14% of Chatham County's greenhouse house emissions. The industrial sector contributed 222,784 US tons of CO_2 equivalents, or 11% of Chatham County's GHG emissions. The commercial sector contributed 112,721 US tons of CO_2

equivalents, accounting for 5% of the County's total GHG emissions. These totals were calculated using information from only the month of February provided by Duke Energy, and extrapolated out to estimate usage during the entire year.

The EPA e-Grid dataset contains information on the mix of fuel sources for electricity generation on a regional level. The main provider of electricity, Duke, did not provide their fuel mix for the kWh data relayed for 2015, so the e-Grid regional values were used in their stead. The e-Grid value approximates the fuel mix that Duke, Randolph, and Central likely used for the generation of electricity in 2015.

The updated calculations combine kWh usage for the 2015 year from three separate utilities: Duke Energy, Randolph Electric Membership Corp, and Central Electric. From kWh totals, MWh were calculated so that the EPA eGrid conversion factor of 937.9 lbs of CO_2 equivalents per MWh could be used (EPA EGRID, 2012).

It should be noted that data associated with government services was not able to be differentiated from the residential, commercial, and industrial values. In other words, the following residential, commercial, and industrial values include electricity that was bought and used for government services. Electric providers like Duke indicated that they would need the account numbers for all government service buildings to separate the values out. We present the following data with the understanding that for future updates some of this electricity should be apportioned to government services, and away from the residential, commercial, or industrial sectors.

Utility	***Residential***	***Commercial****	***Industrial ****
Duke Energy	321,539,955	158,640,258	245,998,739
Randolph Electric Membership Corp	15,474,010	474,197	474,197
Central Electric	47,289,794	13,704,047	18,115,200
Total kWh	384,303,759	172,818,502	264,588,136
Total MWh	384303.8	172818.5	264588.1
Lbs of CO_2 eq	360438495.6	162086472.6	248157212.3
Tons of CO_2 eq	163492	73521	112562

* Note that for Randolph, the "Comm. and Ind. 1000 KVA or less" were combined. We assumed a 50% split between commercial and industrial.

Since the completion of the 2010 report, the residential contribution to total GHG emissions in Chatham County has dropped to 9.75%. The industrial contribution has dropped to 6.71% from 11% in 2010. The commercial sector has experienced less change, dropping only from 5% in 2010 to 4.38% based on 2015 data. These changes could be due to energy efficiency initiatives in the County, but could also be attributed to more exact data. Because the month of February is darker and colder on average than other months, it is likely that using this data to extrapolate yearly energy use overestimated consumption.

Transportation

Total greenhouse gas emissions from transportation was approximated for Chatham County using the total VMT (Vehicle Miles Traveled) for the County, and then multiplied by an emission conversion factor to yield CO2 equivalent tonnage released. The McCorkle document reported that in 2007 there were 1.892 billion VMT in Chatham County. This was converted to MMBtu, and then finally to CO2 eq. Plugging updated values into the following equation will yield the new results for transportation. In the absence of a certified estimate for VMT in

Chatham County in 2015, the updated value is a linear extrapolation of the increase seen state-wide of VMT between 2005 and 2010 (Bureau of Transportation Statistics. 2010). Between 2005 and 2010 the state-wide VMT increased by approximately 1.01%. Applying a increase of 1.01% to the 2010 McCorkle value for VMT yields the following:

$$(1.910\ Billion\ VMT\ ) x \frac{8.13096\ x\ 10^{-6}\text{MMBtu}}{VMT}\ x\ \frac{0.0799\ tons\ of\ CO2\ eq}{MMBtu} = 1{,}240{,}857\ \text{tons of CO2eq}$$

Government Operations

Chatham Transit bought 108,404 gallons of gas in 2015. All vans and buses in the fleet use gasoline – none use diesel or biofuels. With this data, we can calculate total CO2 emissions from the combustion of this gasoline using ICLEI emission conversion factors:

$$108{,}404\ gallons\ x\ \frac{8.78\ kg\ of\ CO_2}{gallon}\ x\ \frac{0.00110231\ tons}{1\ kg} = 1049.16\ tons\ CO2e$$

Chatham Transit only represents a part of the government operations. The following section outlines some of the necessary data to get a more complete picture of the Chatham County Government contribution of GHG. Ideally, electricity usage for all government buildings and facilities (like wastewater treatment plants) would be collected and incorporated into the calculations.

Agriculture

With 37,000 head of cattle recorded in 2015, 10,000 swine in 2014, and almost 20 million chickens counted in 2014, agriculture is an important consideration when evaluating the GHG emissions of Chatham County (USDA, 2016). The methane emissions of both cattle and swine were calculate and converted to CO_2 equivalents using the emissions factors of the EPA. Methane emission factors associated with enteric fermentation have not been developed for poultry as they have for ruminants and monogastric livestock, like swine (Dong et al., 2006). However, the methane emissions associated with the manure management of poultry litter are calculable.

To calculate livestock emissions, we use the following equation (EPA, 2009):

$$EF = \frac{N * F}{2000\ lb/ton}$$

Where EF is CH_4 emissions for a livestock operation or facility; N is the number of animals of the operation; and F = the individual animal methane emission factor (EPA, 2009; Table 14.4-1) For our purposes, North Carolina is in the South Atlantic Zone according to Figure 14.4-1 (EPA, 2009). Mature dairy cattle in the South Atlantic Zone have an F value of 278.3 lb CH_4 per head-yr. Mature beef cattle in this zone have an F value of 154.0 lb CH4 per head-yr. Swine have an F value of 3.3 lbs CH_4/head/year.

$$\text{Dairy Cattle: } EF = \frac{N*F}{2000\ lb/ton} = \frac{1200*278.3}{2000} = 166.98\ ton\ CH4/yr$$

$$\text{Beef Cattle: } EF = \frac{N*F}{2000\ lb/ton} = \frac{14{,}600*154.0}{2000} = 1124.2\ ton\ CH4/yr$$

$$\text{Swine: } EF = \frac{N*F}{2000\ lb/ton} = \frac{10000*3.3}{2000} = 16.5\ ton\ CH4/yr$$

It should be noted that there were 37,000 cattle recorded in 2015, but only 15,800 are represented in the calculations above. According to the USDA agricultural statistics, there are 21,200 cattle in Chatham County that are not categorized as either dairy or beef cattle (USDA, 2016). It will be necessary to discern the use of these cattle to gain an accurate estimate of GHG emissions associated with agriculture as different types of cattle have different emissions factors (Table 14.4-1). For the purposes of this report, we will assume that these cattle follow the same distribution as the categorized cattle with 7.6% (1,611) being dairy cattle and 92.4% (19,589) being beef cattle.

$$\text{Dairy Cattle: } EF = \frac{N*F}{2000\ lb/ton} = \frac{1611*278.3}{2000} = 224.2\ ton\ CH4/yr$$

$$\text{Beef Cattle: } EF = \frac{N*F}{2000\ lb/ton} = \frac{19589*154.0}{2000} = 1{,}508.4\ ton\ CH4/yr$$

The IPCC has developed methane emissions factors associated with manure management for different types of climates. As an emissions factor has not been designed for poultry related to enteric fermentation, this manure management emissions factor will be used to assess the impact of the poultry population on Chatham County's overall GHG emissions (Dong et al., 2006). As of 2014, there were 19,300,000 broilers and 295,000 layers in Chatham County (USDA, 2016). With North Carolina's temperate climate putting Chatham County in the temperate block (15°C-25°C), the emissions factors of poultry livestock are:

Livestock Type	*Management Method*	*CH_4 emissions factor for a temperate region*
Layers	Dry	0.03
Layers	Wet	1.4
Broilers	N/A	0.02

Using the above calculation, the GHG emissions associated with manure management of poultry in Chatham County are:

$$\text{Layers (dry): } EF = \frac{N*F}{2000\ lb/ton} = \frac{295{,}000*0.03}{2000} = 4.425\ ton\ CH4/yr$$

$$\text{Layers (wet): } EF = \frac{N*F}{2000\ lb/ton} = \frac{295{,}000*1.4}{2000} = 206.5\ ton\ CH4/yr$$

$$\text{Broilers: } EF = \frac{N*F}{2000\ lb/ton} = \frac{19.300.000*0.02}{2000} = 193\ ton\ CH4/yr$$

In converting CH_4 to CO_2 equivalents, we find:

Livestock Type	CH_4 emissions factor (tons/year)	Conversion Factor	CO_2 equivalent
Dairy Cattle	391.2	25	9,780
Beef Cattle	2,632.6	25	65,815
Swine	16.5	25	412.5
Layers (dry)	4.425	25	110.6
Layers (wet)	206.5	25	5162.5
Broilers	193	25	4825
Total tons CO_2 equivalents/year			86,105.6
Total lbs CO_2 equivalents/year			172,211,200

In the 2010 report, agriculture accounted for 10% of GHG emissions in Chatham County. In this update, agriculture has a smaller contribution of 5.13%.

Carbon Offsets

i-Tree is a peer reviewed software suite provided by USDA Forest Service, available for free online (i-Tree, 2016). A boundary is input into the tool, and along with some input from the user, a rough land use classification is created for land within the area of study. Using locally calibrated conversion values, the software measures the amount of tree coverage on the site, and estimates various characteristics associated with their biochemical performance. For the purposes of this report, the CO_2eq sequestration value is valuable as an approximation of the total carbon that is sequestered in the ground. This carbon would be released in the case of clear-cutting or otherwise removing the tree.

Using i-Tree analysis and estimates, we have found that the carbon sequestration potential of the tree canopy that resides on land slated for development into Chatham Park is 30,415 tons of CO_2 annually. Additionally, this tree canopy stores approximately 749,671 tons of CO_2.

County-wide i-Tree found that Chatham County sequesters approximately 1,293,977 tons of CO_2eq annually.

STRENGTHS AND LIMITATIONS OF CURRENT ANALYSIS

With the 2010 data, and the 2015 update, this report has created the opportunity to monitor emissions over time, rather than at one time point. This adds value to policy considerations in the future, as stakeholders and policymakers can observe which sectors are growing in their emissions contributions versus which sectors are shrinking. The establishment of a ClearPath account will further allow the government sector to evaluate emissions over time.

However, there are considerable limitations to acknowledge in this analysis with respect to the type and resolution of the data used. To create a more robust analysis, future inventories will need to collect data on public facilities, including county owned buildings, water and wastewater treatment plants, solid waste facilities, and public lighting. Further analyses should also consider disaggregating residential, commercial, and industrial energy usage to determine what types facilities are using the most energy and when. The ability to access this type of information may be limited by the willingness of the utility to divulge it, but an effort should be made to obtain

more detailed energy usage data. Below, further recommendations are made to improve the scope and utility of the GHG inventory

Recommendations to Improve Inventory

To create a robust, valid analysis, the following recommendations concerning types of data and method of collection are made

Recommendation 1: Increase the resolution of the inventory – particularly for the Internal Government Emissions.

For many sectors of the report, the calculations rely on one or just a few variables for inventory. The resolution of the data collected could be improved for the implementation or creation of policy. Based on the ICLEI recommended government emissions sources, the next update should include data from:

- VMT for Chatham Transit Fleet – already have gallons of fuel. VMT will allow calculations for CAP (2015)
- Total VMT for Chatham County (2015) (Put in request with DOT) – reported as 1.892 billion in 2007, via McCorkle report.
- Fleet composition for Government Vehicles. Make/Model/Year. VMT traveled and fuel source (diesel, hybrid, electric, biofuel, etc). Total fuel consumed or bought (2015). Ideally, by department.
- Street Lights, Traffic Signals, and Other Public Lighting data – total kWh usage by year
- County Owned Building Electricity Data – total kWh usage by year
- Water Transport Facilities – total kWh usage by year
- Wastewater Treatment Facilities – total kWh usage by year
- Solid Waste Facilities – total kWh usage by year
- Power Generation Facilities – total kWh usage by year

Effectively, the 2010 report acts as a good baseline for GHG emissions in Chatham County. However, the 2010 study and this update report GHG emissions for government services solely in terms of electricity consumed by government buildings, and the gasoline consumed by County fleet vehicles. ICLEI calls for the inclusion of the following other data points, ranging from Scope 1 to Scope 3:

- Fugitive emissions from refrigerants and fire suppressants
- Vehicle Fleet
- Facilities
- Employee Commute
- Government Generated Waste
- Wastewater Treatment
- Solid Waste Landfills
- Power Generation Facilities
- Contracted Services

This inclusion of the above suggested data will improve the validity and utility of GHG inventories in the future.

Recommendation 2: Focus on scope 1 emissions to find emissions that are mostly (or entirely) under the direct control of Chatham County.

For example, the McCorkle report identified VMT within the County as one of the largest factors for transportation, and subsequently for the County as a whole. While these VMT are likely the largest contributor the overall GHG emissions for the County, it is a significant challenge for Chatham County in isolation to reduce VMT within the county. Reduction in VMT or increases in fuel efficiency are generally coming from the slow increase in fuel efficiency across the country through the Federal CAFE standards and increases in the relative number of hybrid and electric vehicles on the road. The large VMT is primarily a function of the size of the Chatham County. Government operations, on the other hand, are directly under financial and political control of the existing government.

Recommendation 3: Create a holistic and county-wide data acquisition methodology to institutionalize data acquisition processes. Create a centralized data bank that everyone can contribute to. Identify key personnel who will be the primary source of data in the future. Attempt to automate these systems when possible.

The potential for targeted policy recommendations is contingent on the consistent collection and analysis of the aforementioned data. A major obstacle to any GHG inventory is the significant time and resources needed to collect existing data. In most cases, and especially with the County's membership with ICLEI, the conversion factors and emission calculations are either automated or relatively simple to produce once the raw data has been collected. Thus, the challenge presented between governmental entities and is to create both a culture and the operational mechanisms of to facilitate the transfer of original data collection in a timely and consistent manner. It is likely that much of the requested data is being collected by someone, somewhere, but this is happening at various times throughout the year and within different departments. The challenge for this recommendation is to balance the current work-load on county staff with the additional work that this process would require. The emission inventory is only as good as the data that is collected, and as seen in this report, there is a wide range of uncertainty and data limitations that influence the accuracy of the inventory. More consistent and standardized data will form the basis of a good inventory in the future.

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