

**MONROE COUNTY, FLORIDA**  
**COMMUNITY-WIDE CY2010 GREENHOUSE GAS**  
**EMISSIONS INVENTORY REPORT**  
**VERSION 1.0**



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## Contents

	<b>Page</b>
1.0 INTRODUCTION	2
1.1 Protocol .....	2
1.2 Objective .....	3
1.3 Community Description .....	3
2.0 INVENTORY DESIGN	5
2.1 Temporal Boundary .....	5
2.2 Chemical Boundary .....	5
2.3 Geopolitical Boundary .....	6
2.4 Operational Boundary.....	7
3.0 METHODOLOGY	12
3.1 Community-Wide Data Collection.....	12
3.2 Quantification Methodologies.....	14
4.0 RESULTS AND ANALYSIS	20
4.1 Results - CY2010 Community-Wide Emissions.....	20
4.2 Analysis .....	21
5.0 RECOMMENDATIONS	23

## 1.0 INTRODUCTION

Cameron-Cole was contracted to prepare the Community-wide Calendar Year (CY) 2010 greenhouse gas (GHG) emissions inventory ("the Community-wide Inventory" or the "Inventory") for activities and sources that emit GHGs within the geopolitical boundary of Monroe County, Florida. The procedures and guidelines used to prepare the Inventory, along with the results and recommendations for improvements are presented in the sections that follow.

### 1.1 Protocol

Monroe County's Community-wide Inventory was created using the *Global Protocol for Community-Scale Greenhouse Gas Emissions* (GPC or community protocol), pilot version 1.0 (May 2012, prepared by C40 Cities Climate Leadership Group and ICLEI Local Governments for Sustainability, in collaboration with World Resources Institute, World Bank, UNEP, and UN-HABITAT). The GPC was developed using a consensus-based stakeholder-led process aimed at publishing community-level greenhouse gas accounting and reporting standards that would be internationally recognized and accepted. Prior to this process, there was no widely accepted protocol for developing a GHG inventory for an entire community, and the accounting methods for such a protocol – particularly those that would address cross-boundary emissions -- were a topic of vigorous debate.

The GPC builds upon the knowledge base and practical experience with previously published greenhouse gas inventory standards and protocols (that have been primarily oriented toward private sector entities and national governments) as well as other standards for sub-national level government entities such as counties and cities. Existing standards and protocols that specifically informed the development of the GPC include the following:

- *International Local Government GHG Emissions Analysis Protocol* (ICLEI);
- *Draft International Standard for Determining Greenhouse Gas Emissions for Cities* (UNEP/UN-HABITAT/WB);

- GHG Protocol Standards (WRI/WBCSD);
- *Baseline Emissions Inventory/Monitoring Emissions Inventory* methodology (EC-CoM JRC); and
- *Local Government Operations Protocol* (ICLEI-USA).

The GPC is now being tested across the globe and will be revised at the end of 2012. That said, it is likely to be the gold standard of sub-national inventories and its use to design and develop Monroe County's CY2010 Community-wide Inventory is therefore justified.

## **1.2 Objective**

The objective of the Monroe County CY2010 Community-wide Inventory is to quantify and analyze GHG emissions so that the results may be used by decision-makers in the community. This inventory is the third community-wide GHG inventory for Monroe County. Previous inventories include the baseline inventory developed in CY2005 and an update in CY2008, both of which were designed and developed using *Local Government Operations Protocol* (ICLEI-USA).

## **1.3 Community Description**

Monroe County is the southernmost county in Florida and the United States, consisting of the Florida Keys and portions of the Everglades National Park and Big Cypress National Preserve. These mainland parks remain mostly uninhabited. The most well-known geographical feature of Monroe County is the Florida Keys. The string of 1,700 islands is connected by U.S. Highway 1, which ends in Key West, 150 miles southwest of Miami.<sup>1</sup>

In total area, Monroe County is comprised of 3,737 square miles, 73% of which is water.<sup>2</sup>

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<sup>1</sup> <http://www.monroecounty-fl.gov>. "About Monroe County."

<sup>2</sup> Ibid

The Florida Keys proper are a curved arc-like chain of islands, 233 miles in length.<sup>3</sup> They extend from the southeastern tip of the Florida peninsula and create a border between the Gulf of Mexico and the Atlantic Ocean. Key West is the largest of the islands in the chain and controls a natural deep water harbor. The Atlantic side of the keys contains the only living coral reef in the continental United States.<sup>4</sup> Monroe County, and specifically the Florida Keys, is a part of the Southern Zone of the Gulf Coastal Lowlands physiographic province. The entirety of the County lies in a flood plain with an average elevation of less than 5 feet above sea level.<sup>5</sup>

According to the 2010 U.S. Census, Monroe County is home to 73,090 individuals representing an 8.2% population decrease since 2000.<sup>6</sup> The County, established in 1823, retains a diverse mixture of permanent and seasonal residents although the permanent population has been steadily decreasing largely due to the economic recession and the threat of hurricanes.

The County has five municipalities that are incorporated: City of Key West; City of Marathon; City of Key Colony Beach; City of Layton; and the Village of Islamorada. Unincorporated islands and areas are: Stock Island; Big Coppitt Key; Cudjoe Key; Big Pine Key; Duck Key; Tavernier; Key Largo; North Key Largo; Flamingo; Bay Point; and Sugarloaf Shores. The County has numerous parks, recreational areas and national wildlife refuges.

Economic activity in Monroe County, which is dominated by recreation and tourism, includes the following<sup>7</sup>:

- Agriculture, forestry, fishing and hunting, and mining;
- Construction;
- Manufacturing;
- Wholesale trade;

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<sup>3</sup> Monroe County Comprehensive Plan Update: Technical Document, April 5, 2011.

<sup>4</sup> Ibid

<sup>5</sup> Ibid

<sup>6</sup> U.S. Census Bureau. State and County Quick Facts, September 19, 2011.

<sup>7</sup> <http://factfinder2.census.gov/faces/tableservices/jsf/pages/productview.xhtml?src=bkmk>

- Retail trade;
- Transportation and warehousing, and utilities;
- Information;
- Finance and insurance, and real estate and rental and leasing;
- Professional, scientific, and management, and administrative and waste management services;
- Educational services, and health care and social assistance;
- Arts, entertainment, and recreation, and accommodation and food services;
- Other services, except public administration; and
- Public administration.

Monroe County has one major highway – U.S. Route 1 – that runs from the entrance to the Keys near Key Largo to its southern terminus in Key West. It also has over 50 marinas throughout the island chain, one deepwater harbor (Port of Key West) and one U.S. Naval Air Station, also in Key West.

## **2.0 INVENTORY DESIGN**

### **2.1 Temporal Boundary**

The temporal boundary for this Community-wide GHG Inventory is January 1, 2010 to December 31, 2010 (Calendar Year (CY) 2010).

### **2.2 Chemical Boundary**

The current version of the GPC requires that sub-national governments (including Counties) account for the following greenhouse gases:

- Carbon dioxide (CO<sub>2</sub>);
- Methane (CH<sub>4</sub>); and

- Nitrous oxide (N<sub>2</sub>O).

The GPC also requires that these gases be aggregated and reported as carbon dioxide equivalents (CO<sub>2</sub>e). All three gases, as well as the aggregated value in CO<sub>2</sub>e are included in Monroe County's Community-wide Inventory.

### **2.3 Geopolitical Boundary**

GHG accounting for corporate entities (e.g., the WRI/WBCSD GHG Protocol) requires such entities to define their "organizational boundary" which delineates the operations they own or control, depending on the consolidation approach taken (equity or control approach). To reflect the unique nature of sub-national government entities, however, the GPC requires a 'geopolitical boundary' be set along geographic and jurisdictional lines.

The use of a geopolitical boundary is aimed at addressing one complication in completing a community-wide inventory: the reality that some of the activities of, and services for, a community might (and typically do) result in emissions released outside the geopolitical boundary, as well as territorial emissions released within the boundary. The GPC standardized the accounting approach to address this issue by requiring the reporting of emissions that are the result of consumption patterns in the community, even if they result in emissions in another jurisdiction. This boundary definition allows for policy development aimed at the community's consumption over which it has some measure of control.

The geopolitical boundary for the purpose of this Community-wide Inventory is the total area within the limits of Monroe County, which comprises 2,740 square miles of water and 997 square miles of land for a total of 3,737 square miles. As described in section 1.3 of this document, governance of this area is divided among County and municipal government entities, but this Inventory consolidates their jurisdictions into one entity.

It is important to note that although the Naval Air Station in Key West is within the geographical area of Monroe County, it has been excluded from the geopolitical boundary of this Inventory. The U.S. Navy has been accounting for, analyzing and managing its GHG emissions for quite some time and is currently following its own Climate Change Roadmap<sup>8</sup>, covering the period from 2010

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<sup>8</sup> <http://www.navy.mil/navydata/documents/CCR.pdf>

to 2014. As the Navy's efforts are at the national level and are directed by the federal government, Cameron-Cole believes this exclusion is justified. One exception to this exclusion is the filling of federal government vehicles at commercial gas stations within Monroe County. The data sets for gasoline and diesel fuel purchases were not granular enough to extract the amounts purchased for such vehicles.

## **2.4 Operational Boundary**

The GPC defines the emissions sources and categories within sectors for a community-scale GHG inventory in order to standardize GHG inventories between communities and within a community over time. Emissions sources and categories within sectors reflect the unique nature of sub-national governments and their emissions profiles. These include emissions from: 1) Stationary Units, 2) Mobile Units, 3) Waste, and 4) Industrial Process and Product Use sectors. Sub-sector classifications are also provided in the GPC. For conformance with the GPC, sub-national governments are expected to provide information (i.e., quantified emissions) for every source category indicated in this list, if possible.

Further, the GPC adopted the 'scope approach' from the WRI/WBCSD GHG Protocol to reflect varying tiers of what the community can control. These are:

**Scope 1 emissions:** All direct emission sources from activities taking place within the community's geopolitical boundary.

**Scope 2 emissions:** Energy-related indirect emissions that result as a consequence of consumption of grid-supplied electricity, heating and/or cooling, within the community's geopolitical boundary.

**Scope 3 emissions:** All other indirect emissions that occur as a result of activities within the community's geopolitical boundary.

The primary categories and scopes are illustrated in table entitled "2012 Accounting Standard" on the following page.

2012 Accounting Standard								
GPC No.	GHG Emission Sources	IPCC Code	Scope	Accounting Approach	Gases (tonnes)			
					CO2	CH4	N2O	CO2e
<b>I Stationary Units</b>								
<b>I.1 Residential Buildings</b>								
I.1.i	Direct Emissions	1A4b	Scope1	In-Boundary				
I.1.ii	Energy Indirect Emissions	-	Scope2	In-Boundary				
<b>I.2 Commercial/Institutional Facilities (including energy consumption in street/traffic lights and treatment facility operations)</b>								
I.2.i	Direct Emissions	1A4a	Scope1	In-Boundary				
I.2.ii	Energy Indirect Emissions	-	Scope2	In-Boundary				
<b>I.3 Energy Generation (includes generation of electricity, heating and/or cooling)</b>								
I.3.i	Direct Emissions	1A1a	Scope1	In-Boundary				
I.3.ii	Energy Indirect Emissions	-	Scope2	In-Boundary				
<b>I.4 Energy Use in Industrial Activities</b>								
I.4.i	Direct Emissions	1A1b-c + 1A2 + 1A5 + 1A4c	Scope1	In-Boundary				
I.4.ii	Energy Indirect Emissions	-	Scope2	In-Boundary				
<b>II Mobile Units</b>								
<b>II.1 On-Road Transportation (Cars, LDV, HDV/Buses, others)</b>								
II.1.i	Direct Emissions	1A3b	Scope1	In-Boundary				
II.1.ii	Energy Indirect Emissions	-	Scope2	In-Boundary				
<b>II.2 Railways (including urban metro/rail transport systems)</b>								
II.2.i	Direct Emissions	1A3c	Scope1	In-Boundary and Proportional Responsibility				
II.2.ii	Energy Indirect Emissions	-	Scope2	In-Boundary and Proportional Responsibility				
<b>II.3 Water-Borne Navigation</b>								
II.3.i	Direct Emissions	1A3di	Scope1	In-Boundary				
II.3.ii	Energy Indirect Emissions	-	Scope2	In-Boundary				
II.3.iii	Indirect Emissions from Inter-City Domestic Marine Trips	1A3di	Scope3	Origination				
II.3.iv	Indirect Emissions from International Marine Trips	1A3di	Scope3	Origination				
<b>II.4 Aviation</b>								
II.4.i	Direct Emissions	1A3aii	Scope1	In-Boundary				
II.4.ii	Energy Indirect Emissions	-	Scope2	In-Boundary				
II.4.iii	Indirect Emissions from Inter-City Domestic Flights (LTO and Cruise)	1A3aii	Scope3	Origination				
II.4.iv	Indirect Emissions from Inter-City International Flights (LTO and Cruise)	1A3ai	Scope3	Origination				
<b>II.5 Off-Road</b>								
II.5.i	Direct Emissions	1A3eii	Scope1	In-Boundary				
II.5.ii	Energy Indirect Emissions	-	Scope2	In-Boundary				
<b>III Waste</b>								
<b>III.1 Solid Waste Disposal</b>								
III.1.i	Future Indirect Emissions from Community Generated Waste Landfilled in the Community in the Analysis-Year	4A	Scope3	Proportional Responsibility				
III.1.ii	Future Indirect Emissions from Other Communities' Waste Landfilled in the Community in the Analysis-Year	4A	Scope3	Proportional Responsibility				
III.1.iii	Future Indirect Emissions from Community Generated Waste Landfilled outside the Community in the Analysis-Year	-	Scope3	Proportional Responsibility				
<b>III.2 Biological Treatment of Waste</b>								
III.2.i	Direct Emissions from Community Generated Waste	4B	Scope1	Proportional Responsibility				
III.2.ii	Direct Emissions from Other Communities' Waste Treatment	4B	Scope1	Proportional Responsibility				
III.2.iii	Emissions from Community Generated Waste Treated Outside the Community	-	Scope3	Proportional Responsibility				
<b>III.3 Incineration and open burning</b>								
III.3.i	Direct Emissions from Community Generated Waste Incineration	4C	Scope1	Proportional Responsibility				
III.3.ii	Direct Emissions from Other Communities' Waste Incineration	4C	Scope1	Proportional Responsibility				
III.3.iii	Emissions from Community Generated Waste Incinerated Outside the Community	-	Scope3	Proportional Responsibility				
<b>III.4 Wastewater Treatment and discharge</b>								
III.4.i	Direct Emissions from Community Generated Wastewater Treatment	4D	Scope1	Proportional Responsibility				
III.4.ii	Direct Emissions from Other Communities' Wastewater Treatment	4D	Scope1	Proportional Responsibility				
III.4.iii	Emissions from Community Generated Wastewater Treated Outside the Community	-	Scope3	Proportional Responsibility				
<b>IV IPPU</b>								
<b>IV.1 Industrial Processes and Product Uses</b>								
IV.1.i	Direct Emissions from Industrial Processes	2A+2B+2C+2E	Scope1	In-Boundary				
IV.1.ii	Direct Emissions from Product Use	2D+2F+2G+2H	Scope1	In-Boundary				

The GPC encourages communities to use notation keys to assist in transitioning existing inventories to the new Standard and provide for better-informed comparison between communities, by allowing for interpretation where adjustments had to be made for conformance with the Standard. These keys are defined in the GPC as follows:

- **IE – Included Elsewhere:** Emissions for this activity are estimated and included in the inventory but not presented separately in the category. The category where these emissions are included should be noted in explanation.
- **NA – Not Applicable:** The activity exists but relevant emissions are considered never to occur. Explanation should be provided as to why the category activity occurs, but emissions do not.
- **NO – Not Occurring:** An activity or process does not exist within the community.
- **NE– Not Estimated:** Emissions occur but have not been estimated or reported. Emissions sources not estimated should note justification for exclusion.

**Table 1** below has been annotated using these keys as they apply to this CY2010 Community-wide inventory:

TABLE 1: Summary of Operational Boundary					
GPC No.	GHG Emission Sources	IPCC Code	Scope	Accounting Approach	Monroe County
<b>I</b>	<b>Stationary Units</b>				
<b>I.1</b>	<b>Residential Buildings</b>				
I.1.i	Direct Emissions	1A4b	Scope 1	In-Boundary	NE (sources unknown)
I.1.ii	Energy Indirect Emissions	-	Scope 2	In-Boundary	Estimated
<b>I.2</b>	<b>Commercial/Institutional Facilities</b> (including energy consumption in street/traffic lights and treatment facility operations)				
I.2.i	Direct Emissions	1A4a	Scope 1	In-Boundary	NE (sources unknown)
I.2.ii	Energy Indirect Emissions	-	Scope 2	In-Boundary	Estimated
<b>I.3</b>	<b>Energy Generation</b> (includes generation of electricity, heating and/or cooling)				
I.3.i	Direct Emissions	1A1a	Scope 1	In-Boundary	NO
I.3.ii	Energy Indirect Emissions	-	Scope 2	In-Boundary	NO
<b>I.4</b>	<b>Industrial Facilities</b>				
I.4.i	Direct Emissions	1A1b-c + 1A2 + 1A5 + 1A4c	Scope 1	In-Boundary	NE (sources unknown)
I.4.ii	Energy Indirect Emissions	-	Scope 2	In-Boundary	Estimated

## II Mobile Units

### II.1 On-Road Transportation (Cars, LDV, HDV/Buses, others)

II.1.i	Direct Emissions	1A3b	Scope 1	In-Boundary	Estimated
II.1.ii	Energy Indirect Emissions	-	Scope 2	In-Boundary	IE (1.1, 1.2 or 1.4)

### II.2 Railways (including urban metro/rail transport systems)

II.2.i	Direct Emissions	1A3c	Scope 1	In-Boundary and Proportional Responsibility	NO
II.2.ii	Energy Indirect Emissions	-	Scope 2	In-Boundary and Proportional Responsibility	NO

### II.3 Water-Borne Navigation

II.3.i	Direct Emissions	1A3dii	Scope 1	In-Boundary	IE (II.1)
II.3.ii	Energy Indirect Emissions	-	Scope 2	In-Boundary	IE (I.2)
II.3.iii	Indirect Emissions from Inter-Community Domestic Marine Trips	1A3dii	Scope 3	Origination	IE (I.2)
II.3.iv	Indirect Emissions from International Marine Trips	1A3di	Scope 3	Origination	IE (I.2)

### II.4 Aviation

II.4.i	Direct Emissions	1A3aii	Scope 1	In-Boundary	NE
II.4.ii	Energy Indirect Emissions	-	Scope 2	In-Boundary	IE (I.2)
II.4.iii	Indirect Emissions from Inter-City Domestic Flights (LTO and Cruise)	1A3aii	Scope 3	Origination	NE
II.4.iv	Indirect Emissions from Inter-City International Flights (LTO and Cruise)	1A3ai	Scope 3	Origination	NE

### II.5 Off-Road

II.5.i	Direct Emissions	1A3eii	Scope 1	In-Boundary	IE (II.1.i)
II.5.ii	Energy Indirect Emissions	-	Scope 2	In-Boundary	IE (I.1, 1.2 or 1.4)

## III Waste

### III.1 Solid Waste Disposal

III.1.i	Future Indirect Emissions from Community Generated Waste Land-filled in the Community in the Analysis-Year	4A	Scope 3	Proportional Responsibility	NO
III.1.ii	Future Indirect Emissions from Other Communities' Waste Land-filled in the Community in the Analysis-Year	4A	Scope 3	Proportional Responsibility	NO
III.1.iii	Future Indirect Emissions from Community Generated Waste Land-filled outside the Community in the Analysis-Year	-	Scope 3	Proportional Responsibility	Estimated

### III.2 Biological Treatment of Waste

III.2.i	Direct Emissions from Community Generated Waste	4B	Scope 1	Proportional Responsibility	NO
III.2.ii	Direct Emissions from Other Communities' Waste Treatment	4B	Scope 1	Proportional Responsibility	NO
III.2.iii	Emissions from Community Generated Waste Treated Outside the Community	-	Scope 3	Proportional Responsibility	NO

### III.3 Incineration and Open Burning

III.3.i	Direct Emissions from Community Generated Waste Incineration	4C	Scope 1	Proportional Responsibility	NO
III.3.ii	Direct Emissions from Other Communities' Waste Incineration	4C	Scope 1	Proportional Responsibility	NO
III.3.iii	Emissions from Community Generated Waste Incinerated Outside the Community	-	Scope 3	Proportional Responsibility	Estimated

### III.4 Wastewater Treatment and discharge

III.4.i	Direct Emissions from Community Generated Wastewater Treatment	4D	Scope1	Proportional Responsibility	NE
III.4.ii	Direct Emissions from Other Communities' Wastewater Treatment	4D	Scope1	Proportional Responsibility	NO
III.4.iii	Emissions from Community Generated Wastewater Treated Outside the Community	-	Scope3	Proportional Responsibility	NO

## IV IPPU

### IV.1 Industrial Processes and Product Uses

IV.1.i	Direct Emissions from Industrial Processes	2A+2B+2C+2E	Scope1	In-Boundary	NE (sources unknown)
IV.1.ii	Direct Emissions from Product Use	2D+2F+2G+2H	Scope1	In-Boundary	NE

It is important to note that the geopolitical boundary for this Inventory is large and multi-jurisdictional, and therefore no direct survey of all sources and fuel types has been undertaken. The operational boundary for this Inventory was delineated using knowledge from Monroe County personnel and publicly available information. Notes regarding the sources where emissions were not estimated are as follows:

- Red diesel used in marine vessels - this fuel is not taxed at the federal or state levels and therefore the amounts purchased within Monroe County are not easily identified and aggregated.
- Propane can be used in water heaters, stoves, grills, clothes dryers, generators, forklifts, tractors and in other equipment. In Monroe County there are 16 commercial locations where propane may be purchased.<sup>9</sup> Purchased amounts of propane in CY2010 from these locations was not readily available.

<sup>9</sup> <http://bit.ly/LBCd3q>

- Aviation fuel purchased at both the Marathon and Key West airports, as well as the data on the types of flights emanating from those airports (i.e., in-community, domestic, international) were not readily available.
- Data on wastewater treatment and discharge were not readily available.
- Data on product use in the community were not readily available.
- Information on the existence of boilers, burners or other types of stationary equipment that use fuel oils was not available. As the existence of such sources could not be ruled out, the residential, commercial and industrial stationary source categories are denoted as "NE" instead of "NO". The same holds for the category of industrial processes.

Finally, GPC categories identified as "Additional" were excluded from the boundaries of this Inventory due to budget constraints.

### 3.0 METHODOLOGY

#### 3.1 Community-Wide Data Collection

All data collection, quality assurance/quality control was conducted by Monroe County personnel. Activity data provided to Cameron-Cole are as follows, grouped by Scope:

##### Scope 1

- Fuel Use in Mobile Sources – total gallons of motor fuel (gasoline) and diesel fuel sold in Monroe County for fiscal year 2009 – 2010 (July 1, 2009 to June 30, 2010) were provided by the Florida Department of Revenue, based on taxable fuel sales.<sup>10</sup> Data for sales from July 1, 2010 to December 31, 2010 were not provided. Therefore, fiscal year 2009 – 2010 data has been used as a proxy for calendar year 2010. Also –
  - Gallons of gasoline purchased were provided as an aggregated sales figure for this time period. More granular information on purchases made for use in on-road vehicles and small marine vessels was not available. As there is no basis for allocating gallons of gasoline between these categories, the total amount of

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<sup>10</sup> Excel® file: "Copy of certgallons10", Florida Department of Revenue, Certificate of Taxable Gallons, 2009-2010 fiscal year.

50,161,815.96 gallons was assigned to the Mobile Source category for On-Road Vehicles (GPC II.1.i).

- Gallons of diesel purchased were provided as an aggregated sales figure for this time period. More granular information on purchases made for use in on-road vehicles, off-road vehicles and stationary sources (boilers, backup generators, etc.) was not available. As there is no basis for allocating gallons of diesel among these categories, the total amount of 3,936,695.83 gallons was assigned to the Mobile Source category for On-Road Vehicles (GPC II.1.i).

No other activity data for Scope 1 was provided.

## Scope 2

- Electricity Consumption - total kWh for residential, commercial/institutional and industrial (denoted as "large commercial") accounts from Keys Energy Services (Keys Energy).<sup>11</sup> Data provided were from "FY2010", which according to public documents covers the period of October 1, 2009 to September 30, 2010. Data from October 1, 2010 to December 31, 2010 were not provided. Therefore, FY2010 data has been used as a proxy for CY2010 consumption. Totals provided are:
  - Residential - 332,705,132 kWh (332,705.13 MWh)
  - Commercial – 289741836 kWh (289,741.84 MWh)
  - Industrial – 21234670 kWh (21,234.67 MWh)
- Electricity Consumption – total kWh for calendar year 2010 for the residential, commercial and industrial accounts, provided by the Florida Keys Energy Cooperative (FKEC).<sup>12</sup> Totals provided are:
  - Residential – 366,482,178 kWh (= 366,482.18 MWh)
  - Commercial – 99,343,847 kWh (= 99,343.85 MWh)
  - Industrial – 174,002,729 kWh (= 174,002.73 MWh)

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<sup>11</sup> .pdf file: "#42 kWh Sales by Type\_keys energy".

<sup>12</sup> Excel® file: "Copy of TJ Annual Report 2012".

These two sets of activity data constitute the total electricity consumption within the geopolitical boundary of this Inventory.

### **Scope 3**

- Municipal Solid Waste (MSW) – all MSW is collected and then disposed of outside the boundary of Monroe County. Total tons of waste recycled, landfilled and combusted in CY2010 were provided as part of the Solid Waste Management Report from the Florida DEP.<sup>13</sup> In CY2010, 156,465 tons were collected, and of that total, 33,071 tons were recycled (21%), 33,395 were landfilled (21%) and 89,999 tons were incinerated (58%).

It is important to note that the general composition of MSW in Monroe County (for 2009, used as a proxy for 2010) was provided to use in this Inventory. The composition of the MSW allows for methane calculations to be conducted for waste that is landfilled. Incineration calculations, however, require additional information that was not made available: dry matter content for each MSW waste stream; fraction of carbon in dry matter for each waste stream; fraction of fossil carbon in dry matter for each waste stream; and oxidation fraction or factor. Instead of using national or international default values for some of these parameters, a decision was made to postpone these calculations until more accurate information can be made available.

For other types of GHG-emitting activities outside the geopolitical boundary of this Inventory (Scope 3), no other activity data was provided.

### **3.2 Quantification Methodologies**

The GHG inventory calculations were conducted in Microsoft Excel<sup>®</sup>. An emissions calculations tab was inserted into the data collection spreadsheet.

### **Scope 1**

As noted previously, granular activity data for gasoline and diesel fuel purchases among on-road vehicles (by vehicle type), off-road vehicles (by vehicle type) and marine vessels (gas-powered) was not available, as well as any information on red diesel used in larger recreational and commercial marine vessels.

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<sup>13</sup> [http://www.dep.state.fl.us/waste/categories/recycling/SWreportdata/10\\_data.htm](http://www.dep.state.fl.us/waste/categories/recycling/SWreportdata/10_data.htm)

The GPC expects that emissions from mobile sources be segregated and calculated separately for (at a minimum) all in-boundary travel, and recommends that vehicle miles traveled ("VMT" - on-road, off-road, nautical miles) within the geopolitical boundary be modeled. In-boundary trips are classified as Scope 1 (direct) emissions while those that transcend the geopolitical boundary are classified as Scope 3 (indirect). Those Scope 3 emissions from cross-boundary travel may be determined using an origin-destination model.

However, modeling using VMT by vehicle type, as well as applying the origin-destination model for cross-boundary travel is beyond the scope of this effort. Therefore, all emissions from combusting fuel purchased in Monroe County was allocated to Scope 1, and classified as on-road transportation.

Equation B.1b from the GPC was used to calculate emissions from on-road travel:

Equation B.1b		On-Road Vehicle Fuel Consumption Direct Emissions	
$CO_2 \text{ Emissions} = \sum_{a,b} Fuel_{a,b} \times CO_2EmissionsFactor_{a,b} \div 1000$ $N_2O \text{ Emissions} = \sum_{a,b} Fuel_{a,b} \times N_2OEmissionsFactor_{a,b} \div 1000$ $CH_4 \text{ Emissions} = \sum_{a,b} Fuel_{a,b} \times CH_4EmissionsFactor_{a,b} \div 1000$			
Description			Value
$CO_2 \text{ Emissions}$	=	CO <sub>2</sub> emissions in metric tonnes	Computed
$N_2O \text{ Emissions}$	=	N <sub>2</sub> O emissions in metric tonnes	Computed
$CH_4 \text{ Emissions}$	=	CH <sub>4</sub> emissions in metric tonnes	Computed
$Fuel_{a,b}$	=	Total fuel consumed (volume) by on-road vehicles, by fuel type for each vehicle class	User Input (see Activity Data)
$a$	=	Fuel type (e.g. gasoline, diesel, compressed natural gas, etc.)	User Input
$b$	=	Vehicle class, where possible to obtain (e.g. passenger car, truck, etc.)	User Input
$CO_2EmissionsFactor_{a,b}$	=	CO <sub>2</sub> per volume unit of fuel combusted (e.g. kg CO <sub>2</sub> /L), by fuel type for each vehicle class	User Input (see Emissions Factor)
$N_2OEmissionsFactor_{a,b}$	=	N <sub>2</sub> O per volume unit of fuel combusted (e.g. kg N <sub>2</sub> O/L), by fuel type for each vehicle class	User Input (see Emissions Factor)
$CH_4EmissionsFactor_{a,b}$	=	CH <sub>4</sub> per volume unit of fuel combusted (e.g. kg CH <sub>4</sub> /L), by fuel type for each vehicle class	User Input (see Emissions Factor)

The following emission factors from The Climate Registry (TCR) were used for gasoline and diesel, respectively: 8.78 kg CO<sub>2</sub>/gallon and 10.21 kg CO<sub>2</sub>/gallon. Also from TCR, the following

emission factors were used for both fuel types<sup>14</sup>, CH<sub>4</sub> = 0.0000623 % of CO<sub>2</sub>, N<sub>2</sub>O<sup>1</sup> = 0.0000697 % of CO<sub>2</sub>.

## Scope 2

Indirect emissions from electricity purchases for residential, commercial and industrial consumption were calculated using the following equation from the GPC:

**Step 3: Insert emissions factors and energy consumption data and calculate GHG emissions, by gas.**

Equation A.2b	Stationary Units: Indirect Emissions from Grid-Supplied Energy Consumption	
$CO_2e \text{ Emissions} = a,b [Energy_{a,b} * CO_2eEmissionsFactor_{a,b}]$		
Description		Value
<i>Emissions</i>	= Total CO <sub>2</sub> e emissions from utility-delivered electricity, heating and/or cooling	Computed
<i>Energy<sub>a,b</sub></i>	= Electricity, heating and/or cooling consumed by units of energy (e.g. KWh, GJ, or MMBTU, etc.)	User input (see Activity Data)
<i>CO<sub>2</sub>eEmissionsFactor<sub>a,b</sub></i>	= CO <sub>2</sub> e per unit of energy	User input (see Emissions Factor)
<i>a</i>	= Energy type (e.g. electricity, heating, or cooling)	User Input
<i>b</i>	= Building type (e.g. residential, commercial, etc.)	User Input

The emissions factors used are from 2010 U.S. EPA eGRID<sup>15</sup> Subregion FRCC: 1220.11 lbs CO<sub>2</sub>/megawatt hour (MWh), 41.19 CH<sub>4</sub>/gigawatt hour (GWh) and 15.25 lbs N<sub>2</sub>O/GWh. The geopolitical boundary for this community falls within the FRCC<sup>16</sup> Subregion.

The CH<sub>4</sub> and N<sub>2</sub>O emissions were then converted to CO<sub>2</sub> equivalent (CO<sub>2</sub>e) using global warming potential (GWP) factors from the Intergovernmental Panel on Climate Change Second Assessment Report published in 1995 (ICLEI, 2010), in line with best practice. The GWPs for CH<sub>4</sub> and N<sub>2</sub>O are 21 and 310, respectively.

Although a portion of the activity data from Keys Energy were not available (July 1 – December 31, 2010), the adjustments for cooling degree days (CDD) and heating degree days (HDD) were not made due to budget constraints.<sup>17</sup>

<sup>14</sup> Since mileage data was not available, CH<sub>4</sub> and N<sub>2</sub>O were based on CO<sub>2</sub> emissions using guidance issued by The Climate Registry (TCR, 2009).

<sup>15</sup> 2010 eGRID factor were used to provide the most accurate emissions estimates possible.

<sup>16</sup> The FRCC Subregion encompasses most of Florida.

<sup>17</sup> GPC Version 0.9, March 2012, page 28, lines 14-22.

### Scope 3

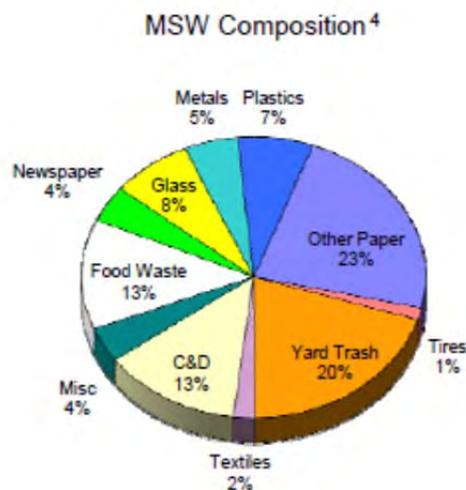
The GPC states that emissions must be accounted and reported for all MSW generated and disposed by the community. In cases where MSW is landfilled, communities should quantify methane emissions, regardless of whether the landfill is located within the geopolitical boundary of the community or outside it. The notion is that the future downstream commitment of emissions from the waste generated by the community in the analysis year should be accounted for within the inventory.

The GPC also states that where MSW is incinerated, communities should report the methane, nitrous oxide and non-biogenic carbon dioxide emissions associated with MSW combustion based upon the amount of community generated waste incinerated in the analysis year. This should be done regardless of whether the incineration facility is located within the geopolitical boundary of the community (Scope 1) or outside it (Scope 3).

All MSW generated from within the geopolitical boundary of this Inventory is disposed of in other communities, and therefore all the resulting emissions are categorized as Scope 3.

### ***MSW to Landfill***

First, the composition of the MSW generated within the Inventory boundary was determined using the 2009 Solid Waste Report from the Florida DEP for Monroe County (most recent available):



4 Some materials have been combined: Metals include Aluminum Cans, Steel Cans, Ferrous and Non-ferrous metals, and White Goods; Other Paper includes Corrugated, Office and Other Paper; and Plastics include Plastic Bottles and Other Plastics.

Composition of the MSW was then used to calculate the degradable organic carbon (DOC) using Equation C.1a from the GPC:

Equation C.1a	Degradable organic carbon (DOC)
$\text{DOC} = (0.15 \times A) + (0.2 \times B) + (0.4 \times C) + (0.43 \times D) + (0.24 \times E) + (0.15 \times F)$	
Where:	
A	= Fraction of MSW that is food
B	= Fraction of MSW that is garden waste and other plant debris
C	= Fraction of MSW that is paper
D	= Fraction of MSW that is wood
E	= Fraction of MSW that is textiles
F	= Fraction of MSW that is industrial waste
Source : Equation adapted from <i>IPCC Good Practice Guidance and Uncertainty Management in National Greenhouse Gas Inventories</i> (2000). Default carbon content values sourced from IPCC Waste Model spreadsheet, available at: <a href="http://www.ipcc-nggip.iges.or.jp/public/2006gl/vol5.html">http://www.ipcc-nggip.iges.or.jp/public/2006gl/vol5.html</a>	

For the methane commitment for MSW that is sent to landfill, Equation C.1b of the GPC was used:

Equation C.1b	Methane commitment for MSW sent to landfill
$\text{CH}_4 \text{ Emissions} = M_{\text{waste}} \times L_0 \times (1 - f_{\text{rec}}) \times (1 - OX)$	
<i>Description</i>	<i>Value</i>
$\text{CH}_4 \text{ Emissions}$ =	Total CH <sub>4</sub> emissions in metric tonnes Computed
$M_{\text{waste}}$ =	Mass of MSW sent to landfill in inventory year, measured in metric tonnes User input
$L_0$ =	Methane generation potential, see below. User input

$f_{rec}$	=	Fraction of methane recovered at the landfill (flared or energy recovery)	User input
$OX$	=	Oxidation factor	0.1 for well-managed landfills; 0 for unmanaged landfills

Source : Toronto and Region Conservation *Getting to Carbon Neutral: A Guide for Canadian Municipalities*. Adapted from Revised 1996 IPCC Guidelines for National Greenhouse Gas Inventories.

Methane generation potential was calculated using Equation C.1b from the GPC:

Equation C.1b		Methane generation potential, $L_0$	
$L_0 = MCF \times DOC \times DOC_f \times F \times 16/12$			
Description		Value	
$MCF$	=	Methane correction factor based on type of landfill site (managed, unmanaged, etc.)	Managed = 1.0 Unmanaged ( $\geq 5$ m deep) = 0.8 Unmanaged (<5 m deep) = 0.4 Uncategorized = 0.6
$DOC$	=	Degradable organic carbon	User input; see Equation C.1a
$DOC_f$	=	Fraction of DOC that is ultimately degraded (reflects the fact that some organic carbon does not degrade)	Assumed equal to 0.6
$F$	=	Fraction of methane in landfill gas	Default range 0.4-0.6 (usually taken to be 0.5)
$16/12$	=	Stoichiometric ratio between methane and carbon	

Source : IPCC Good Practice Guidance and Uncertainty Management in National Greenhouse Gas Inventories (2000).

### MSW to Incineration

As noted previously, MSW generated within the geopolitical boundary is sent to other communities for incineration. In order to calculate GHG emissions from this activity, more information must be collected. Once the information is made available, the following equation (Equation C.2a of the GPC) may be used to calculate emissions associated with incinerating the

community's MSW:

Equation C.2a		CO <sub>2</sub> Emissions from the incineration of waste	
$CO_2 \text{ Emissions} = m \times \sum_i WF_i \times dm_i \times CF_i \times FCF_i \times OF_i \times (44/12)$			
Description			Value
<i>CO<sub>2</sub> Emissions</i>	=	Total CO <sub>2</sub> emissions from incineration of MSW in metric tonnes	Computed
<i>m</i>	=	Mass of waste incinerated	User input
<i>WF<sub>i</sub></i>	=	Fraction of waste of consisting of type <i>I</i> matter	User input (see waste composition)
<i>dm<sub>i</sub></i>	=	Dry matter content in the type <i>I</i> matter	User input (see waste composition)
<i>CF<sub>i</sub></i>	=	Fraction of carbon in the dry matter of type <i>I</i> matter	User input (see waste composition)
<i>FCF<sub>i</sub></i>	=	Fraction of fossil carbon in the total carbon component of type <i>I</i> matter	User input (see waste composition)
<i>OF<sub>i</sub></i>	=	Oxidation fraction or factor	User input
<i>I</i>	=	Matter type of the MSW incinerated such as paper/cardboard, textile, food waste, etc.	See waste composition
<b>NOTE:</b>		$\sum_i WF_i = 1$	
Source : 2006 IPCC Guidelines for National Greenhouse Gas Inventories			

## 4.0 RESULTS AND ANALYSIS

### 4.1 Results - CY2010 Community-Wide Emissions

Based on the information provided to Cameron-Cole and the methodology employed from the GPC, the total amount of GHG emissions from the community is 1,853,703 Tonnes of CO<sub>2</sub>e. The results of the Community-wide GHG Emissions Inventory for CY2010 are presented in Table 2 on the following page:

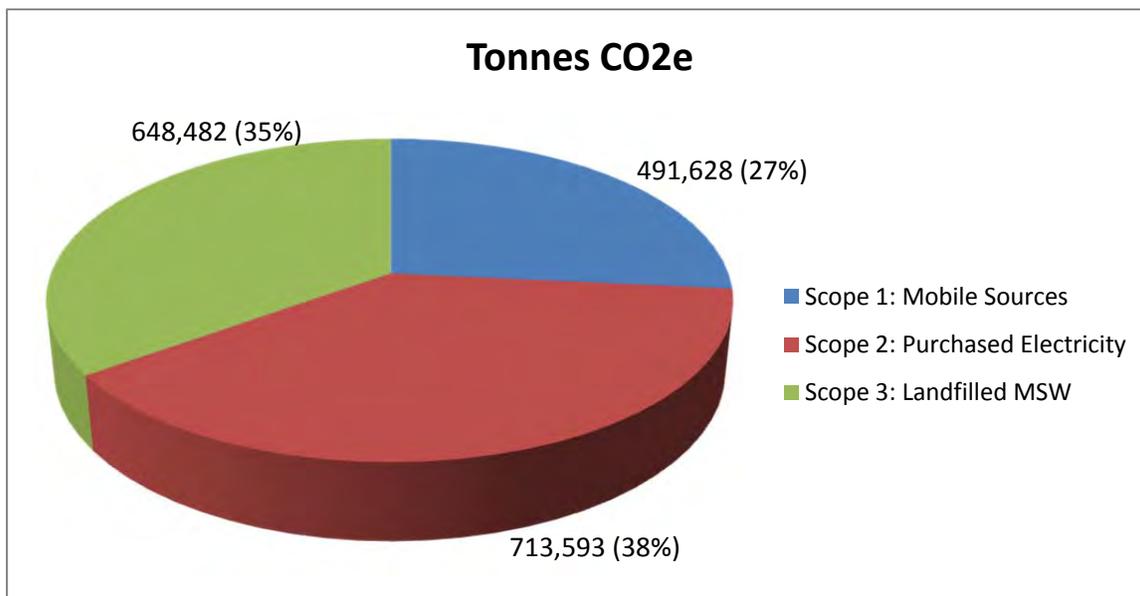
**Table 2: Results of the Community-wide GHG Inventory – CY2010**

Emissions Category	Activity Data (Quantity)	Units	Emissions (Tonnes)			
			CO <sub>2</sub>	CH <sub>4</sub>	N <sub>2</sub> O	CO <sub>2</sub> e
<b>Scope 1</b>						
<i>Mobile Sources</i>						
Diesel - On-Road Vehicles	3,936,696	gal	40194	3	3	41115
Gasoline - On-Road Vehicles	50,161,816	gal	44421	27	31	450513
<b>TOTAL SCOPE 1 EMISSIONS</b>						<b>491,628</b>
<b>Scope 2</b>						
	Quantity	Units	Emissions (Tonnes)			
			CO <sub>2</sub>	CH <sub>4</sub>	N <sub>2</sub> O	CO <sub>2</sub> e
Purchased Electricity - Residential	699,187	MWh	386954	13	5	388727
Purchased Electricity - Commercial	389,086	MWh	215333	7	3	216320
Purchased Electricity - Industrial	195,237	MWh	108051	4	1	108546
<b>TOTAL SCOPE 2 EMISSIONS</b>						<b>713,593</b>
<b>Scope 3</b>						
	Quantity	Units	Emissions (Tonnes)			
			CH <sub>4</sub>	CO <sub>2</sub> e		
Landfilled MSW	30296	Tonnes	2092	648482		
<b>TOTAL SCOPE 3 EMISSIONS</b>						<b>648,482</b>
<b>TOTAL COMMUNITY-WIDE EMISSIONS (ALL SCOPES):</b>						<b>1,853,703</b>

#### 4.2 Analysis

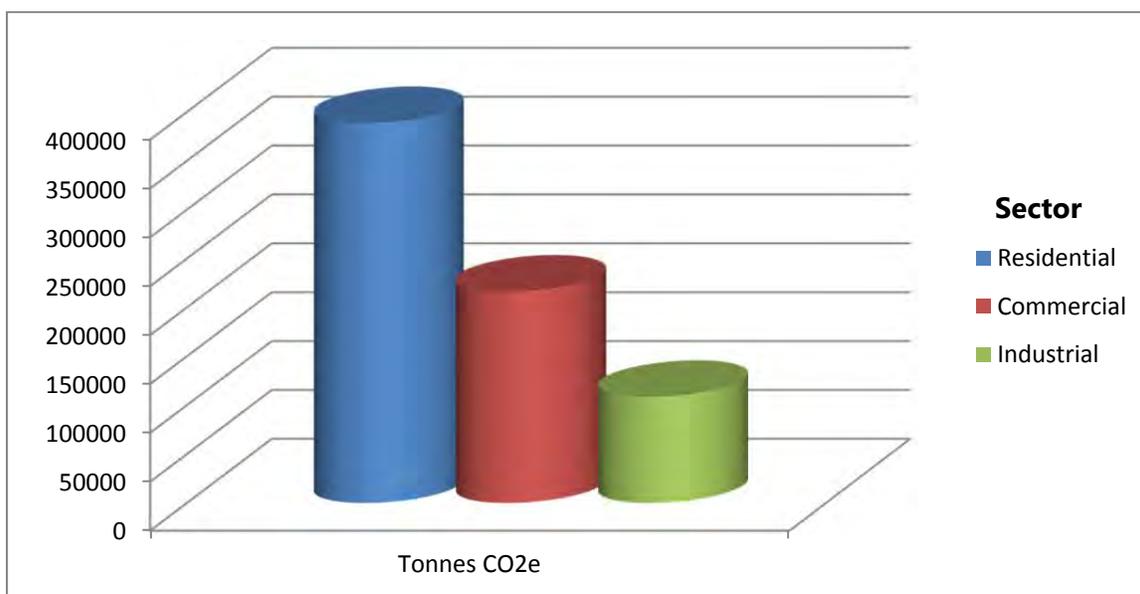
An illustration of all community-wide GHG emissions for CY2010 is provided in Figure 1 on the following page:

**Figure 1: Community-Wide GHG Emissions**



An illustration of community-wide GHG emissions from electricity purchased (by sector) is provided in Figure 2:

**Figure 2: Community-Wide GHG Emissions from Electricity Consumption**



It is important to note that the results of this Inventory are incomplete, as several major

categories of emissions were not available at the time the Inventory was compiled. Therefore, the results should not be cited as a complete accounting of the community's greenhouse gas footprint.

## **5.0 RECOMMENDATIONS**

CY2010 was Monroe County's first Community-wide Inventory following the methodology in the GPC. A great deal of work is still needed to improve upon the results presented in this report. The following recommendations are provided to assist Monroe County personnel in improving the accuracy and completeness of future Community-wide Inventories:

1. Some of the activity data provided to compile this inventory was not from calendar year 2010. Although it is reasonable to use data from previous years as a proxy for inventory-year data, additional effort should be put forth to obtain the missing CY2010 data.
2. Since incineration of MSW outside the geopolitical boundary of this inventory (Scope 3) is a significant source of GHG emissions, analysis of this waste for key parameters – namely dry matter content for each MSW waste stream; fraction of carbon in dry matter for each waste stream; fraction of fossil carbon in dry matter for each waste stream; and oxidation fraction or factor. If MSW waste stream analysis is not possible, then best approximations (using other local or state analyses rather than national or international default values) should be obtained and used.
3. There are two airports within the geopolitical boundary for this Inventory – one in Key West and one in Marathon. Data on fuel use and flight distance (in-boundary/local; domestic; international) should be gathered in order to calculate emissions from these mobile sources.
4. To calculate emissions directly associated with marine vessels (recreational and commercial), a request should be made to local fuel vendors for annual marine fuel purchases and use the purchased quantities as the basis for emissions estimates.
5. Surveys or analysis of stationary sources within the geopolitical boundary of the Inventory, as well as the types and amounts of liquid and gaseous fuels purchased and combusted in these sources should be made in order to conduct emissions calculations for these sources.

6. Data gathering for wastewater treatment systems operating inside the geopolitical boundary of the Inventory should be conducted in order to calculate emissions from these sources.
7. As data sets are gathered, gaps are filled and emissions are calculated per the recommendations above, the GPC table ("2012 Accounting Standard", pg. 7 of this document) should be filled in to allow for a community-to-community comparison of emissions in categories and subcategories.
8. Data collection templates should be developed for use in future inventory efforts. These templates assist with memorializing data sources over time and ensuring consistency year-to-year.