



**Community Greenhouse Gas
Emissions Inventory
Quality Management Plan**

**Years 2005 through 2010
and 2020 Forecast**

November, 2011

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I. Revision History

This section contains a history of **major** changes made to the City of Fort Collins Community greenhouse gas (GHG) inventory since 2005, the baseline year. A community inventory represents a useful tool for creating a quantitative understanding of emissions from the community and provides a best estimate based upon current understanding and data. That said - it is important to communicate to policymakers, staff, and community members that it does not represent a complete and unchanging picture of community emissions in the City of Fort Collins. Inventories will evolve because the science, models, and data infrastructure behind available data are continually evolving, and for this reason, available data and emissions factors are continually being refined and made more accurate. Changes documented in this section generally include changes in overall methodology or significant changes in emissions factors, conversion factors, sources of activity data, or recalculations due to discovery of errors. A summary of the revision history is presented in Table 1:

Table 1. Revision History					
Date	Revision No.	Where Published	Description of Changes	Impact on 2005 Baseline	Originator
2008	1	2008 Climate Action Plan (CAP) Status Report published July 2009	<p>In 2009 the City undertook a project to review and update community GHG accounting procedures. Evaluation of the Community Inventory Methodology by the Brendle Group resulted in the following recommendations that were adopted:</p> <ul style="list-style-type: none"> • Increased modeled average on-road fuel efficiency to better reflect current national averages • Included air travel by Fort Collins residents • Calculated landfill emissions using the Intergovernmental Panel on Climate Change and California Air Resources Board’s (CARB) First Order Decay model that accounts for “waste in place” at the landfill as well as annual additions • Added embodied energy from recyclable materials to align with CAP reduction strategies <p>Reported community inventory in metric tons (CO₂e) rather than short tons.</p>	<p>YES</p> <p>Revisions were made to reflect these changes in methodology.</p>	<p>Recommendations by the Brendle Group were adopted by the City.</p>

			Annual GHG emissions were reported both with and without the carbon benefits of renewable energy certificates (RECs), however progress on the GHG goal is evaluated without considering the benefit of RECs.		
2009	2	2009 CAP Status Report	<p>Three modifications were made to the emissions inventories to increase the consistency in reporting between the CAP, Fort Collins Energy Policy reporting, and the <i>Utilities for the 21st Century</i> Global Reporting Initiative (GRI) reporting. These changes affected the inventories from 2005 through 2008:</p> <ul style="list-style-type: none"> • Community electricity usage data was updated to include “transmission” losses (line losses across Platte River Power Authority’s (PRPA’s) lines from the generation source to the distribution lines) • The electricity emissions factors were modified to include “owned wind generation” (i.e., Fort Collins’ share of Medicine Bow and Silver Sage wind) in the factor • Community natural gas usage data was changed in all annual inventories to no longer weather-normalized 	<p>YES</p> <p>The baseline inventory and subsequent inventories were revised to reflect these changes.</p>	<p>Recommendations from the Brendle Group and the Natural Resources’ Environmental Services Division (ESD) staff in order to increase consistency in reporting between various carbon accounting systems.</p>
June 2010	3	2010 CAP Status Report	The vehicle miles traveled (VMT) distribution mix for the years 2008 and 2009 were updated to reflect new information from the Colorado Department of Public Health and Environment (CDPHE).	<p>NO</p> <p>No changes to baseline.</p>	ESD staff based on CDPHE updates.

Note: Fort Collins community emissions inventories reported prior to calendar year 2005 are not discussed in this QMP because the new community carbon reduction goal, established by City Council in 2008, sets 2005 as the baseline year. The prior community carbon goal sets 1990 as the baseline year.

II. Introduction

Fort Collins, Colorado is located in northern Colorado in the foothills of the Rocky Mountains. The 50-square mile city lies ~5000 feet above sea level. Residents enjoy a moderate, four season climate with an average of 300 days of sunshine and 14.5 inches of precipitation a year. Fort Collins is a regional center for employment, shopping, and healthcare, and provides a small town life style with some of the amenities of a larger city. Fort Collins has a population of 143,986 residents (2011 estimate) with a median age of 27.9 (based on 2009 US Census American Communities Survey). Major employment sectors include education, health care, and high tech industries. Fort Collins is a home rule city with a Council/Manager form of government with an operating budget of \$446 million (2011). Fort Collins operates its own a municipal electric and water utility.

This Quality Management Plan (QMP) was developed to provide a detailed reference document for the city-wide annual community greenhouse gas (GHG) emissions inventory and to provide complete transparency for the data sources, methods, and emissions and conversion factors used to prepare the inventory. The QMP also provides a record of major inventory revisions since the baseline year (2005) and establishes quality assurance and quality control procedures to ensure data integrity. This QMP should be viewed as a “living document” that will be revised as necessary as changes occur and as new and improved methods become available for carbon accounting.

Contact Information for the Quality Management Plan (QMP)

Name of Community: Fort Collins
Address: Environmental Services Division
Natural Resource Department, 215 N. Mason, PO Box 580, Fort
Collins, CO 50522-0580
Inventory Contact: Bonnie Pierce, Environmental Data Analyst
Phone: (970) 416-2648
Fax: (970) 224-6177
Email: bpierce@fcgov.com

In 2008 Fort Collins’ City Council renewed its commitment to climate protection by adopting Colorado’s statewide goals to reduce greenhouse gas (GHG) emissions by:

*20% below 2005 levels by 2020
80% below 2005 levels by 2050*

III. Baseline Year Selection

The year 2005 was selected as the Fort Collins community greenhouse gas (GHG) baseline year to measure future progress against. This aligns with Colorado's statewide goals.

Baseline Recalculation Policy

From 2005 until 2010, the City of Fort Collins decided that the baseline year emissions would be recalculated if there were changes in accepted calculation methodologies that would result in a 5% or greater change to the baseline year emissions. During this time frame, the emission factors and state-of-the-art of GHG accounting methodologies evolved substantially necessitating reassessment of the baseline recalculation policy. The following constitutes the revised baseline recalculation policy effective beginning 2011:

The following conditions will always trigger a base year recalculation:

- a) Major changes in calculation methodology (e.g., new emissions factors)

The following conditions will only trigger a base year recalculation if the annual total of the following conditions exceed the 2% significance threshold:

- a) Changes due to data accuracy and availability
 - b) Discovery of significant errors
-

IV. Boundary Conditions

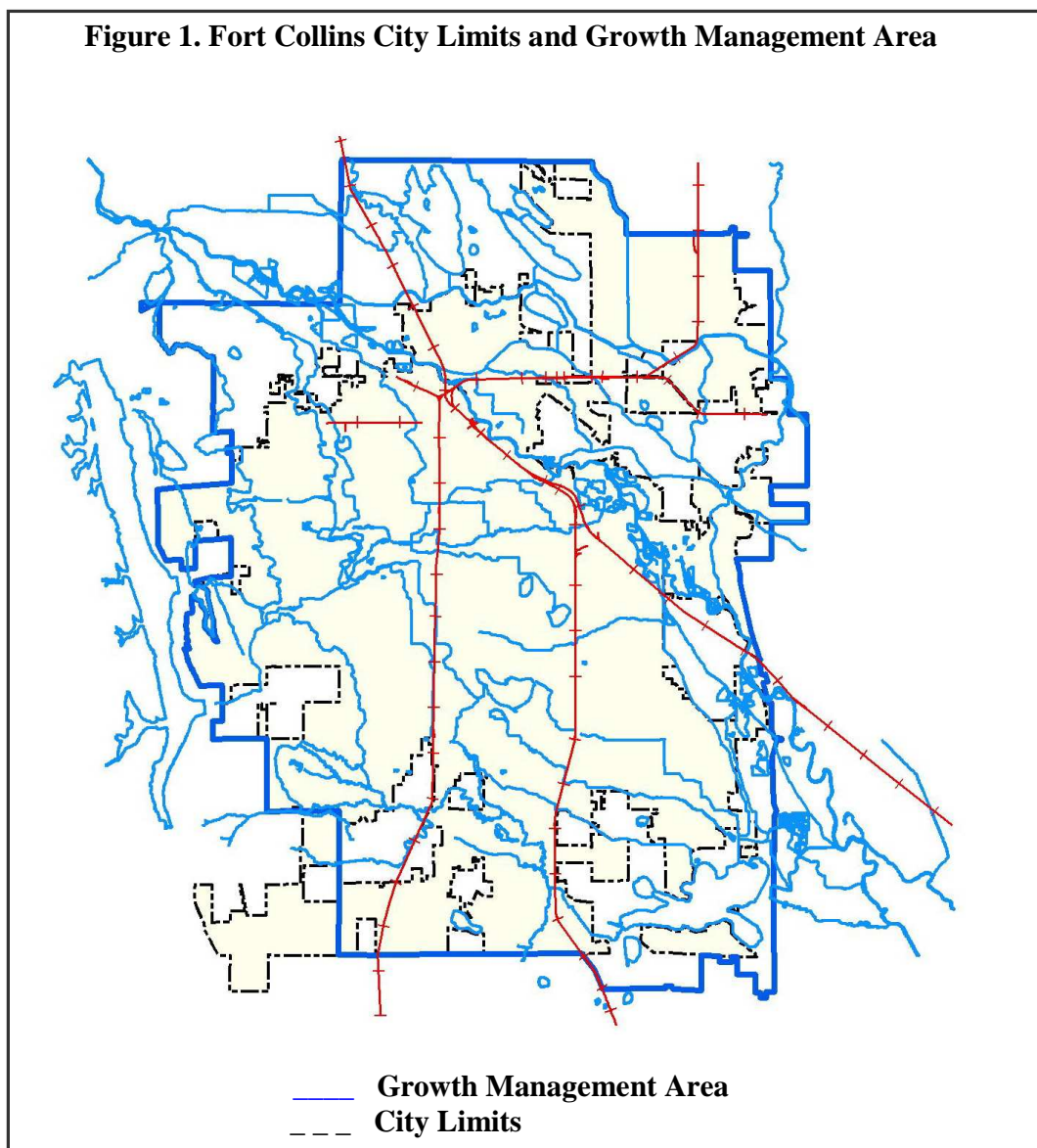
Community Boundaries

Figure 1 identifies the City limits and Growth Management Area (GMA) as of 2009. For the purposes of the Community GHG Emissions Inventory, the City limit provides the geopolitical boundary for electricity and natural gas usage, solid waste, and recyclables data, and the GMA provides the geopolitical boundary for transportation data. Emissions that result from activities taking place within the geopolitical boundary of the community are emissions that can be controlled or influenced by City of Fort Collins policies and programs. In cases where a local government cannot maintain direct control of an emissions source within its boundaries, it is still important to inventory these emissions as local government policies and programs can still have an indirect influence on these emissions.

Many community emissions inventories have difficulty completely accounting for all emissions from a given community within defined boundaries because of indistinct boundaries that occur over time. However, the more exact a community can be in its accounting for deviations from defined boundaries, the greater the accuracy of the community GHG inventory. The following boundary assumptions and exceptions are noted for the City of Fort Collins community GHG inventory:

- 99%+ of data from Fort Collins Utilities (FCU) are from within City limits. A small number of electricity accounts are outside of City limits, most of which are in the area of Link Lane, which are included in the community inventory.

- Electricity data does not include the Water Treatment Plant, which is located outside City limits.
- The vehicle miles traveled (VMT) modeling data that supports the calculation of GHG emissions from transportation activities covers the Fort Collins Metropolitan Attainment/Maintenance Area for Carbon Monoxide, as defined by the Colorado Department of Public Health and Environment (CDPHE). The maintenance area boundary is essentially the same as the City's GMA, with a very minor exception of a small parcel of land added to the southeast corner of the GMA that is not contained in the CO maintenance boundary.
- The method for calculating GHG emissions from air travel estimates the emissions from Fort Collins residents traveling out of both Denver International Airport (DIA) and the Fort Collins/Loveland Airport. It relies on zip coded enplanement data from DIA, to estimate travel from citizens in the Fort Collins area. The geographic coverage for Fort Collins' area zip codes is larger than the GMA.



Greenhouse Gas Emissions Types

The GHG emissions types included in the inventory are shown in Table 2:

GHG	City of Fort Collins Sources
Carbon dioxide (CO ₂)	Mobile and stationary combustion: purchased electricity and natural gas for heating buildings, fuel consumption for transportation, air travel, and solid waste management
Methane (CH ₄)	Natural gas, solid waste decomposition
Nitrous oxide (N ₂ O)	Natural gas
Hydrofluorocarbons (HFCs)	Not included in inventory
Perfluorocarbons (PFCs)	Not included in inventory
Sulfur hexafluoride (SF ₆)	Not included in inventory

GHG Emissions Categorized by Scope

Emissions sources can be categorized according to where they fall relative to the geopolitical boundary of the community. Using this method, emissions sources are categorized as direct or indirect emissions: **Scope 1** – Direct Emissions, **Scope 2** – Indirect Electricity Emissions, or **Scope 3** – Other Indirect Emissions. The City reports the community inventory using gross GHG emissions that exclude RECs and carbon offsets. The Natural Resources' ESD has determined which scopes to include in the inventory (Table 3) in consultation with the City's interdepartmental Energy Management Team.

Scope 1 - Direct Emissions are from sources located within the geopolitical boundary of the City limits for emissions from natural gas usage and sources within the GMA for mobile combustion sources (e.g., ground travel), excluding rail.

Scope 2 – Indirect Emissions are associated with indirect GHG emissions from consumption of purchased electricity, heat, or steam. Scope 2 emissions occur as a result of activities that take place within the defined geopolitical boundary of the local government, but occur at sources located outside of the government's jurisdiction (e.g., purchased electricity from Platte River Power Authority (PRPA) consumed by the City of Fort Collins).

Scope 3 – Other Indirect Emissions result from activities such as the extraction and production of purchased materials and fuels, transport-related activities (i.e., air travel) for city residents that occur outside the boundary, outsourced activities, and waste disposal.

Informational Category includes all other activities that affect net GHG emissions (e.g., benefit of RECs and known carbon offsets).

GHG emissions source scopes and data sources are detailed in Table 3:

Table 3. Greenhouse Emissions Scopes		
Emission Type	GHG Emissions Category	Data Source
Natural gas for residential, commercial, industrial, and transportation uses	Scope 1 - Direct	Xcel Energy
Ground travel	Scope 1 - Direct	City Transportation Planning and Northern Front Range Metropolitan Planning Organization (NFRMPO)
Electricity for “Total Fort Collins Operational Control”	Scope 2 - Indirect	Platte River Power Authority (PRPA)
Electricity for residential, commercial, and industrial use <i>Note: This scope is a different way of looking at the nearly identical data presented under electricity for “Total Fort Collins Operational Control” above. No double counting occurs.</i>	Scope 2 - Indirect	Fort Collins Utilities ¹
Electricity (50% for residential use and 50% for commercial use)	Scope 2 - Indirect	Xcel Energy
Community solid waste volumes	Scope 3 - Indirect	City of Fort Collins Natural Resources’ ESD, Waste Management, Inc.
Air travel	Scope 3 – Other Indirect	DIA and Fort Collins/Loveland Airport
Landfill gas	Scope 3 – Other Indirect	Larimer County
“Embodied Energy in Recyclable Materials”	Scope 3 – Other Indirect	City of Fort Collins Natural Resources’ ESD
Total carbon offsets purchased by Fort Collins residents or businesses	Informational	Colorado Carbon Fund and Trees, Water & People
Renewable energy credits (RECs)	Informational	PRPA

GHG Emissions Categorized by Sector

In addition to categorizing emissions by scope, communities can examine their emissions in the context of the sector that is responsible for those emissions. This sector-based approach can provide local governments with analyses more directly relevant to policy-making and project management, as it assists in formulating sector-specific reduction measures and climate action

¹ Fort Collins Utilities (FCU) is a municipally owned multi-service utility providing electric, water, wastewater, and stormwater services to the City of Fort Collins and surrounding areas. FCU receives electric generation and transmission services from PRPA, while FCU operates and maintains the electric distribution system facilities.

plan components. Table 4 describes the community sectors analyzed for the annual community inventory:

Community Sector	Description
Residential	Electricity and natural gas usage in homes
Commercial	Electricity and natural gas usage in commercial businesses
Industrial	Electricity and natural gas usage in industrial businesses
“Recyclable Materials Energy”	Emissions associated with recyclable materials disposed of at landfills rather than recycled ²
Landfill gas	Fugitive methane emissions at landfills
Air travel	Fuel consumption from air travel by community residents
Ground travel	Fuel consumption from on-road vehicles by community residents within the GMA
Other electricity	Fugitive emissions associated with electricity transmission and distribution losses

V. Emissions Quantification

Background

Greenhouse gas accounting protocols have evolved rapidly over the past few years. In 2009 the City undertook a project to review and update the community greenhouse gas accounting methodology to ensure we are using current best practices for community inventories. Past accounting methodologies were evaluated by the Brendle Group with an eye towards relevance (percent of emissions total and ability to impact), completeness, consistency, transparency, and accuracy. (See <http://www.fcgov.com/climateprotection/> for The Brendle Group report.)

Fort Collins joins many other communities in conducting periodic GHG inventory reviews and updates. As federal regulations are promulgated, protocols will continue to evolve, and additional updates to the methodology are anticipated.

Quantification Methods

A. Electricity

Electricity Method for the 2010 Inventory: The boundary for calculating GHG emissions from electricity is the City limits. Fort Collins Utilities (FCU) is the electricity provider for the Fort Collins community and serves accounts within City limits. An estimated 99%+ of the data reported by FCU is from within the City limits. When new areas are annexed by the City and served by FCU, they will be added to the community inventory. The community inventory does not include emissions from the Water Treatment Plant, located outside the City limits. These emissions are included in the local municipal government emissions reporting.

² GHG emissions associated with this sector are related to the energy and non-energy related CO₂ emissions in the manufacturing process, transportation, and waste management.

There are 3 differences in how FCU reports electricity GHG emissions and how Natural Resources' ESD reports them in the CAP for the Fort Collins community inventory:

- The first difference is that the Natural Resources' ESD community inventory also includes a few electricity accounts in Fort Collins served by Xcel Energy. Xcel's premise number includes a tax ID portion that identifies the entity to which Xcel will pay franchise fees for that premise. Using this tax ID, Xcel can identify the accounts it serves within City limits (per communications with Xcel Energy staff).
- A second difference in community GHG reporting is that the Natural Resources' ESD community inventory only reports under the operational control boundary and not by an ownership boundary. FCU's Global Reporting Initiative (GRI) report includes reporting under **both** an operational control boundary and an ownership boundary as defined by the Climate Registry's Electric Power Sector Protocol.
- Lastly, the Natural Resources' ESD community inventory does not include RECs in the inventory total, but only includes RECs for informational purposes, while the FCU GRI report includes the RECs in their operational control total.

The instructions in Table 5 are a guide for using the Inventory Spreadsheet (**Source:** H:/Environmental/Climate/2010CAP Status and GHG Inventory Files/2010-Inventory.xls) that was developed by Natural Resources' ESD staff to enter activity data and calculate GHG emissions from electricity for publication in the CAP Status Report.

Table 5. Instructions for Electricity Method for 2010 Inventory
Spreadsheet Instructions
General: Data is "entered" into yellow cells. When the term " <i>calculate</i> " is used, it indicates that the spreadsheet cell contains a formula that automatically calculates the value, so no data entry is required. Calculated values are displayed in white spreadsheet cells. Instructions for calculated cells are also italicized in Table 5. All information is either entered or displayed on the worksheet titled Sheet 1, unless otherwise specified. Note that the electricity emissions factor changes annually and is only for CO₂, not CO₂e.
1. Enter FCU Operational Control (MWh from PRPA) (cell B6)
2. Enter Total FCU Purchases (MWh from FCU) (cell B7)
3. Enter FCU Total Sales (MWh from FCU) (cell B10)
4. <i>Calculate Distribution losses (FCU Purchase minus FCU sales) (cell B8)</i>
5. <i>Calculate Transmission losses (Operational control minus FCU purchase) (cell B12)</i>
6. Enter Xcel kWh (F19 on electricity worksheet)
6. <i>Calculate Xcel residential = 0.5 x total Xcel kWh (cell B16 on electricity worksheet)</i>
7. <i>Calculate Xcel commercial = 0.5 x total Xcel kWh (cell B17 on electricity worksheet)</i>
8. Enter FCU Residential (MWh from FCU) (new column on electricity worksheet)
9. Enter FCU Commercial (MWh from FCU) (new column on electricity worksheet)
10. Enter FCU Industrial (MWh from FCU) (new column on electricity worksheet)
11. Enter FCU Streetlights (MWh from FCU) (new column on electricity worksheet)
12. Enter FCU Traffic Signals (MWh from FCU) (new column on electricity worksheet)
13. <i>Calculate total residential (FCU res + Xcel res) (cell B13)</i>
14. <i>Calculate total commercial (FCU comm + Xcel comm.) (cell B14)</i>

Table 5. Instructions for Electricity Method for 2010 Inventory (continued)
Spreadsheet Instructions
15. Calculate total “Other Electricity” short tons CO ₂ (streetlights + traffic signals + transmission losses + distribution losses)(cell G67)
16. Calculate total electricity MWh (Total Res + total Comm + ind + street lights + traffic signals + transmission losses + distribution losses)(cell B19)
17. Enter average electricity emission factor (# CO ₂ /MWh from PRPA) (cell B4)
18. Calculate various GHG emissions from electricity
19. Enter RECs (MWh from PRPA) (cell D5)
20. Enter REC emission factor (from PRPA) (cell D6)
21. Calculate tons CO _{2e} from RECs (cell B25)
22. Calculate revised Total metric tons CO ₂ from electricity (cell B26)

B. Natural Gas

Natural Gas Method for the 2010 Inventory: The boundary for calculating GHG emissions from natural gas is the City limits. Xcel Energy provides natural gas service to Fort Collins. Xcel’s premise number includes a tax ID portion that identifies the entity to which Xcel will pay franchise fees for that premise. Using this tax ID, Xcel can identify the accounts it serves within City limits (per communications with Xcel Energy staff). The activity data is taken from the annual summaries provided by Xcel Energy and entered into a spreadsheet to calculate community GHG emissions.

The instructions in Table 6 are a guide for using the Inventory Spreadsheet (**Source:** H:/Environmental/Climate/2010CAP Status and GHG Inventory Files/2010-Inventory.xls) that was developed by Natural Resources’ ESD staff to enter activity data and calculate GHG emissions from natural gas for the annual Community GHG Emissions Inventory contained in the CAP Status Report.

Table 6. Instructions for Natural Gas Method for 2010 Inventory
Spreadsheet Instructions
General: Data is “entered” into yellow cells. When the term “ <i>calculate</i> ” is used, it indicates that the spreadsheet cell contains a formula that automatically calculates the value, so no data entry is required. Calculated values are displayed in white spreadsheet cells. Instructions for calculated cells are also italicized in Table 6.
1. Enter actual DTH for Residential Usage (cell C17 in the “natgas” tab, which copies to cell E13)
2. Enter actual DTH for Commercial Usage (cell C19 in the “natgas” tab, which copies to cell E14)
3. Enter actual DTH for Industrial Usage (cell C17 in the “natgas” tab, which copies to cell E15)
4. Calculate Total DTH (cell E16)

C. Ground Transportation

Ground Transportation Method for the 2010 Inventory: The boundary for calculating GHG emissions from ground transportation for the Community GHG Inventory is the City’s growth management area (GMA). The vehicle miles traveled (VMT) modeling data that supports the

calculation of GHG emissions from transportation activities covers the Fort Collins Metropolitan Attainment/Maintenance Area for Carbon Monoxide, as defined by the Colorado Department of Public Health and Environment (CDPHE). The maintenance area boundary for Carbon Monoxide is essentially the same as the City's GMA (with a minor exception – see Section IV, Boundary Conditions). GHG emissions for each vehicle type are calculated as described in Table 7 below.

Source: H:/Environmental/Climate/2010CAP Status and GHG Inventory Files/2010-Inventory.xls that was developed by Natural Resources' ESD staff to enter activity data and calculate GHG emissions from ground transportation for the annual Community GHG Emissions Inventory contained in the CAP Status Report.

Table 7. Instructions for Ground Transportation Method for 2010 Inventory
Calculation Instructions
1. Multiply daily VMT by 330 to calculate Annual VMT (annual VMT for 2005 = 997,420,380) and enter annual VMT into cell B71.
2. Identify VMT percent – This apportions total VMT among the percentage of vehicle types in Fort Collins as estimated by the CDPHE for emissions modeling purposes. The most recent VMT percent was provided by the CDPHE in June 2011. (cells K75-K80)
3. Identify average MPG - Multiply the annual number of miles driven by average fuel economy (MPG) for that vehicle class to yield gallons consumed (see Table 8, below). (cells C77-C87)
4. Calculate gallons of fuel for each vehicle type. (cells D77-D87)
5. Identify emissions coefficients to convert from gallons of fuel to British Thermal Units (BTUs), to MMBTU, and then tons CO ₂ . (cells G77-G87)

The 5 values from Table 7, above, are then summed using the following equation:

$$\text{Tons CO}_2 \text{ (vehicle type)} = \text{daily VMT} * 330 * \% \text{VMT} * \text{MPG} * \text{MMBTU/gallons} * \text{Tons CO}_2/\text{MMBTU}$$

Table 8 provides fuel economy by vehicle type for input to the calculations in this section. The inventories apply the "revised MPG" that was updated to better reflect estimated on-road fleet fuel economy provided by FHWA, Bureau of Transportation Statistics and the Energy Information Administration.

Table 8. Fleet Fuel Economy (MPG) by Vehicle Type

Vehicle type	GVW	VMT percent	Original Inventory MPG	CACP2009 - (for 2005 vehicles) MPG	Revised MPG	Source
Gasoline car	<3750	0.5	19.7	18.61	22.1	DOE Transportation Data Book Table 4.1
Gasoline light truck	3750-8500	0.38	14.3	13.717	17.7	DOE Transportation Data Book Table 4.2
Gasoline heavy truck	8500<	0.036	8	4.843	13.9	DOE Transportation Data Book Table 4.3
Diesel car	<3750	0.001	30	19.378	19.378	CACP2009
Diesel light truck	3750-8500	0.002	17	16.859	16.859	CACP2009
Diesel heavy duty	8500<	0.081	5	5.634	5.634	CACP2009
Weighted Average			16.04	15.20	18.79	

Source: H:/Environmental/Climate/2010CAP Status and GHG Inventory Files/Seth-fuel economy comparison.xls that was developed by Natural Resources' ESD staff with input from The Brendle Group.

D. Air Travel

Air Travel Method for the 2010 Inventory: The boundary for calculating GHG emissions from air travel for the Community GHG Inventory is the City's GMA. The air travel methodology estimates the emissions from air travel by Fort Collins residents traveling out of Denver International Airport (DIA) and the Fort Collins/Loveland Airport. Since it relies on zip coded enplanement data from DIA, it probably best represents travel from citizens in the Fort Collins GMA.

Jet fuel consumption at DIA and the Fort Collins-Loveland airports are allocated to passengers originating trips in Fort Collins in the following manner. Total fuel consumption at DIA was reduced 45%, the percentage of connecting flights through DIA. According to a 2007 DIA passenger survey, 6% of DIA enplaned/deplaned passengers were from Larimer County. Of that 6%, 67% were from Fort Collins.

Fort Collins' emissions from the Fort Collins/Loveland Airport are estimated as a function of population, relative to data on population and jet fuel consumed by Allegiant Air. For example, in 2010 approximately 250,384 gallons of jet fuel were consumed at the Fort Collins-Loveland Airport. Airport personnel estimated that 85% of passengers are from the region, defined as a 35-mile radius around the airport. Therefore 61,288 gallons of fuel are attributed to regional passenger enplanements. Fort Collins population is 28.8% of the regional population and therefore, 28.8% of the jet fuel is attributed to Fort Collins passengers.

The steps in Table 9 apply to using the Inventory Spreadsheet (**Source:** H:/Environmental/Climate/2010CAP Status and GHG Inventory Files/2010-Inventory.xls) that was developed by Natural Resources' ESD staff to calculate the GHG inventory.

Table 9. Instructions for Air Travel Method for 2010 Inventory				
Step	Parameter	Number	Unit	Notes
<i>Already calculated in cell C108</i>	Total Fuel Consumption at DIA	409,974,874	gallons	DIA
Enter in cell C109	Percentage passengers connecting	45%	percent	DIA- Airport planner
Enter in cell C110	Percentage of enplaned/deplaned passenger from Larimer County	6.20%	percent	DIA Master Plan, Update Studies Passenger Surveys
Enter in cell C111	Fraction of Larimer County passengers from Fort Collins	0.67	none	Data provided by consultant who completed above plan, 60 of 89 County respondents from Fort Collins
<i>Automatically calculated in cell C112</i>	Fuel consumed by Fort Collins passengers	9,366,696	gallons	
<i>Automatically calculated in cell C113</i>	Total Fuel Consumption at Allegiant Air, Fort Collins/Loveland Airport	250,384	gallons	Fort Collins/Loveland Airport
<i>Automatically calculated in cell C114</i>	Percentage of enplaned from 35-mile region	85%	percent	Fort Collins/Loveland Airport
Enter in cell C115	Regional population	500,000	people	
Enter in cell C116	Approximate Fort Collins Population	143,986	people	City of Fort Collins Advance Planning
<i>Automatically calculated in cell C117</i>	Ratio of Fort Collins Population	0.287972	none	
<i>Automatically calculated in cell C118</i>	Fuel consumed by Fort Collins passengers	61,288	gallons	
<i>Automatically calculated in cell C119</i>	Total fuel consumed	9,427,984	gallons	
Enter in cell C120	Emissions factor	9.6	kg CO ₂ e	The Climate Registry
<i>Automatically calculated in cell C121</i>	Resulting emissions	90,226	mt CO ₂ e	
<i>Automatically calculated in cell C122</i>		99,457	short tons	

E. Solid Waste

Solid Waste Method for the 2010 Inventory: The boundary for calculating GHG emissions from solid waste disposal for the Community GHG Inventory is the City limits. Solid waste service in Fort Collins is provided by numerous private haulers. The City of Fort Collins collects data on hauling that is conducted within City limits (per conversations with City of Fort Collins Natural Resources' ESD staff). The following steps comprise the method for calculating GHG emissions from community solid waste.

Run the California Air Resources Board's (CARB) First Order Decay Model

The Climate Registry endorses an implementation of the IPCC's first-order-decay model such as the one made available by the California Air Resources Board (CARB). The spreadsheet is titled landfill_emissions_tool_v1_0_2009-03-26_larimer_county_May2011Update.xls. This model was applied to the Larimer County Landfill with the inputs shown in Table 10.

Table 10. CARB First Order Decay Model Inputs
CARB First Order Decay Model inputs on "Landfill Model Inputs" spreadsheet page
1. Landfill-specific percentage of anaerobically degradable carbon (ANDOC%) based on the Two-Season Waste Composition Study completed for Larimer County in May 2007. Resulting ANDOC% is 5.3. (This specific calculation is made on the "Landfill Specific ANDOC Values" spreadsheet page).
2. Historical waste input data from the LandGEM model provided by Larimer County.
3. Assumption that the daily cover materials of dirt and a slurry of recycled newspaper and tacky additive have very little degradable content and therefore do not contribute to ANDOC%.
4. K-value of 0.02 which corresponds to an annual average rainfall of <20 inches/year.
5. Extract metric tons CH ₄ (expressed at CO ₂ e) output from the "California Air Resources Board's Implementation of the IPCC's Mathematically Exact First-order Decay Model," released March 29, 2009. (The direct CO ₂ emissions from the landfill biomass degradation are not included in the inventory per standard GHG accounting protocols.)
6. Input total mass waste deposited in inventory year into "Landfill Model Inputs" tab; data supplied by Larimer County Solid Waste Division.

Table 11 displays the outputs from the CARB First Order Decay Model that were used in the Fort Collins Community GHG Inventories.

Table 11. CARB First Order Decay Model Outputs
Outputs of “CARBs Implementation of the IPCC’s Mathematically Exact First Order Decay Model” (on “Landfill Emissions Output” page)
Model Output: Methane and Carbon Dioxide Emissions
(metric tons of CO₂ equivalent)

from CARB's FOD
 Model, run May 19,
 2011

Year	CH ₄ MT CO ₂ e	CO ₂ (not included in inventory ³)
2000	34,077	5,442
2001	35,632	5,690
2002	37,026	5,913
2003	38,475	6,144
2004	39,844	6,363
2005	40,989	6,546
2006	42,037	6,713
2007	42,991	6,866
2008	43,937	7,017
2009	44,767	7,149
2010	45,494	7,265

The steps in Tables 12 and 13 apply to using the Inventory Spreadsheet (**Source:** H:/Environmental/Climate/2010CAP Status and GHG Inventory Files/2010-Inventory.xls) that was developed by Natural Resources’ ESD staff to enter activity data and calculate GHG emissions from solid waste for the annual Community GHG Emissions Inventory contained in the CAP Status Report.

Table 12. Set 1 Instructions for Solid Waste Method for 2010 Inventory	
Steps for Using the GHG Emissions Inventory Spreadsheet	
Step	Cell No.
1. Enter short tons deposited to Larimer County landfill	A129
2. Calculate short tons CO ₂ e (automatically done by spreadsheet) (1 MT x 1.1023 = 1 short ton)	A128
3. Calculate conversion factor (automatically done by spreadsheet) (short tons CO ₂ e/ tons waste to landfill)	A130
4. Enter short tons waste from entire community	A131
5. Calculate short tons CO ₂ e (Automatically done by spreadsheet) (Multiply short tons waste from community by conversion factor to calculate short tons CO ₂ e)	A132
6. Calculate metric tons CO ₂ e (Automatically done by spreadsheet) (Convert short tons CO ₂ e to metric tons (1 metric ton = 0.9072 short ton))	A133

³ CO₂ is not included in the inventory because it is a biogenic emissions source.

Not all of Fort Collins trash goes to the Larimer County Landfill. Some (approximately 35%) is taken to a private landfill in Ault, CO. The following formula is used to estimate total tons CO₂e from community-generated waste. It assumes the Ault landfill operates under the same conditions as the Larimer County (LC) Landfill.

$$\frac{\text{Tons waste in LC landfill}}{\text{Tons CO}_2\text{e emitted by LC Landfill}} \times \text{Tons waste from entire FC community} = \text{Total Tons CO}_2\text{e before landfill gas capture}$$

Table 13. Set 2 Instructions for Solid Waste Method for 2010 Inventory	
Steps for Using the GHG Emissions Inventory Spreadsheet (Continued)	
Step	Cell No.
7. Enter annual landfill gas collected and flared (data from Larimer County)	D128
8. Calculate tons CO ₂ e (Spreadsheet automatically converts to ton CO ₂ e by multiplying by 21) Assumes complete combustion of CH₄ and that no fugitive CH₄ escaped to atmosphere.	D130
9. Calculate Fort Collins' portion of "credit" for landfill gas collection and flaring, based on Fort Collins population proportion to the entire Larimer County population. (Automatically calculated by spreadsheet) Fort Collins population in 2010 = 143,986 Larimer County population in 2010 = 300,804 (prior to 2010 Census update) Fort Collins proportion = 47.9%	D131
10. Calculate Fort Collins' proportional benefit from gas collection and flaring in metric tons CO ₂ e. (Automatically calculated by spreadsheet as 18,659 MT CO ₂ e * 47.9% = 8,931 MT CO ₂ e for 2010).	D132
11. Calculate Net metric tons CO ₂ e emissions from landfill (Automatically calculated by spreadsheet by subtracting this from the total CO ₂ e before landfill gas capture)	D133

Table 14 illustrates all 12 steps for calculating GHG emissions from Solid Waste for the community during 2010.

Table 14. Summary Instructions for Solid Waste Method for 2010 Inventory		
Steps Used to calculate Fort Collins 2010 emissions from solid waste		
Step #	Data	Description
1.	45,494	LC landfill MTCO ₂ e from CARB FOD Model
2.	50,148	short tons CO ₂ e
3.	132,224	short tons waste disposed at landfill
4.	0.379265763	short tons CO ₂ e/ton landfill waste
5.	129,867	short tons waste disposed by community
6.	49,254	short tons CO ₂ e from all FC waste before gas collection subtracted
7.	44,683	MT CO ₂ e before gas collection subtracted
8.	888.5	Metric tons CH ₄ recovered by system and flared
	21	Global Warming Potential (GWP)/CH ₄
9.	18,659	Metric tons CO ₂ e recovered & flared
10.	0.479758232	Fort Collins population proportion of CH ₄ flair benefit
11.	8,952	FC share metric tons CO ₂ e recovered & flared
12.	35,752	MT CO₂e from community solid waste

F. Embodied Energy in Recyclable Materials

Embodied Energy in Recyclable Materials Method for the 2010 Inventory: The Brendle Group prepared a report, dated March 2009, *City of Fort Collins Community Greenhouse Gas Accounting Protocols*, which recommended inclusion of the upstream impact of key materials that were included in the CAP as quantified emissions reductions. The recommended methodology is a unique method based on the Demand-Centered, Hybrid Life Cycle protocol that has also been adapted for use by the City of Denver for “key urban materials.” This approach provides a protocol for including some transportation, upstream, and downstream material emissions contained in recyclable materials that occur outside of the community inventory boundary, based on activity data collected from private haulers within the community boundary of the City limits.

In order to demonstrate the impact of solid waste diversion activities on the total community GHG emissions, it was first necessary to include the energy associated with the materials (e.g., recyclables) in the total community inventory. This unique approach facilitates the inclusion of reduction measures (e.g., recycling and composting) that address these impacts in the community CAP. For Fort Collins, these “key” materials are of subset of recyclable materials (e.g., cardboard, wood, paper, aluminum, organics, and others (refer to Table 24), and the energy associated with them is referred to as “embodied energy in recyclable materials.” The life-cycle GHG emissions associated with these materials can be broken down into five components:

Upstream:

1. (+) CO₂ from energy and non-energy related emissions from extraction and transportation of raw materials.
2. (+) CO₂ from energy and non-energy related emissions from manufacturing and transportation of the product.
3. (+) CO₂ from reduced carbon sequestration (for paper/wood-based materials)

4. Downstream:
5. (+) CH₄ emissions from decay of organic materials in the landfill
6. (-) CO₂ from long-term carbon sequestration of organic materials placed in the landfill.

The boundary for calculating GHG emissions for embodied energy in recyclable materials is the City limits. Solid waste service is provided by numerous private haulers, and the City of Fort Collins collects data on hauling that is conducted within City limits (per conversations with City of Fort Collins staff).

By applying the most recent (2007) waste characterization at the Larimer County Landfill, it is estimated that over 30% of total incoming waste at the landfill, by weight, represents material types that could feasibly be recycled using diversion measures (e.g., recycling) described in the CAP. The Environmental Protection Agency's (EPA's) Waste Reduction Model (WARM), provides source reduction factors that combine the three upstream emissions sources for the recyclable materials being landfilled. The WARM model is one of the sources for the emissions factors in ICLEI's CACP and the source of recycling factors applied in the CAP.

The steps in Table 15 apply to using the Inventory Spreadsheet (**Source:** H:/Environmental/Climate/2010CAP Status and GHG Inventory Files/2010-Inventory.xls) that was developed by Natural Resources' ESD staff to enter activity data and calculate GHG emissions from embodied energy in recyclable materials in the annual Community GHG Emissions Inventory contained in the CAP Status Report.

Table 15. Instructions for Recyclable Materials Methods for 2010 Inventory	
Steps for Using the GHG Emissions Inventory Spreadsheet	
Step	Cell No.
1. Enter total short tons of Fort Collins' MSW (municipal solid waste). See Table 12 for method to calculate this number in cell A131.	B136
2. Spreadsheet automatically calculates the annual weight of "recyclable materials going into the landfill" by applying the percent of recyclable material to the total waste generated in Fort Collins.	F138 through F151
3. Spreadsheet automatically calculates the "upstream" emissions, or "source reduction" emissions, for each type of material then sums the data (cell H152) using the "Source Reduction factor in cells D138 to D151.	H138 through H151

Table 16 presents the outputs from the GHG Emissions Inventory Spreadsheet for the baseline year 2005.

Table 16. 2005 Recyclable Materials Emissions						
Source of Table: The Brendle Group, March 2009						
Material	Source Reduction Emissions Factor* (MTCE/t)	Source Reduction Emissions Factor-Calculated in Short Tons (tCO₂e/t)	Percentage from Waste Characterization**	Weight in 2005 (tons)***	Upstream Emissions (tCO₂e)	Upstream Emissions (MTCO₂e)
Cardboard	1.52	6.13	7.80%	18,544	113,689	103,138
Glass	0.16	0.65	2.00%	4,755	3,069	2,784
Aluminum	2.24	9.03	0.90%	2,140	19,332	17,538
Steel	0.87	3.51	0.90%	2,140	7,508	6,812
Plastic	0.5	2.02	1.40%	3,328	6,712	6,089
Newsprint	1.33	5.36	4.30%	10,223	54,840	49,751
Mixed Office Paper	2.18	8.79	6.30%	14,978	131,697	119,476
Magazines	2.36	9.52	1.50%	3,566	33,946	30,795
Wood	0.55	2.22	6.70%	15,929	35,336	32,057
		Total	32%	75,604	406,128	368,440

* Source reduction factor from EPA's WARM model

** Percentages from Larimer County Two Season Waste Composition Study, May 2007 (See <http://www.larimer.org/solidwaste/Publications/WasteSort.pdf>, page 39)

*** Fort Collins' total short tons waste in 2010 = 129,876 tons

Table 17 provides a summary of emissions from Recyclable Materials from 2005 to present.

Table 17. Summary of Fort Collins' GHG Emissions from Recyclable Materials Now Being Disposed of in the Landfill		
Year	Short Tons MSW	Metric Tonnes CO₂e from Recyclables
2005	237,747	368,440
2006	224,700	348,221
2007	227,842	353,090
2008	187,510	290,090
2009	159,708	247,502
2010	129,867	201,253

G. Emissions Not Reported

The Brendle Group's report evaluating Fort Collins' community-wide GHG accounting practices recommends performing a simplified estimation with readily available data sources to estimate the magnitude of emissions sources that are anticipated to be negligible or small (deMinimus emissions). These potential emissions and emissions sources are not currently included in the community inventory.

- CO₂ from beer production
- HFCs, PFCs, and SF₆ emissions
- Composting
- Biomass combustion

- Fertilizer application
- Livestock
- Non-road and off-road vehicles and equipment
- Propane
- Refrigeration equipment
- Commuting beyond inventory boundary
- Refrigeration equipment
- Wastewater treatment
- Land use change
- Railroad system

Emissions Factors and Other Constants

A. Electricity

Current Electricity Emissions Factors

Table 18 below summarizes the various emissions factors for electricity used in the community GHG inventory.

Table 18. Summary of Greenhouse Gas Electricity Emissions Factors (lbs CO₂/MWh)							
Description	2005	2006	2007	2008	2009	2010	Notes
Electricity inventory emission factor	1827	1829	1741	1669	1777	1610	Based on PRPA resource mix with owned renewables but w/out RECs
REC renewable energy factor	1218	1270	1307	1543	1536	1351	Based on Green-E method using weighted regional factors

Fort Collins' electricity related emissions inventory is estimated using a conversion factor based on PRPA's resource mix with owned renewable energy and without RECs included. Table 19 shows the data used to calculate the 2010 electricity emissions factors.

Table 19. Calculation of Localized 2010 Electricity Emissions Factors

2010 Operational Boundary Fort Collins GHG Emissions (Emissions Levels at Source)			
Resource	Energy @ Generator (MWh)	Actual Emissions @ Generator (MT)	Emission Rate (lbs/MWh)
WAPA	289,839		
Purchased Power	29,365	25,081	1,883
Renewable Owned Generation (Wind)	42,579		0
Fossil Generation	1,138,157	1,070,505	2,074
Total Fort Collins Operational Control	1,499,940	1,095,587	1,610
RECs	53,421	-32,737	-1,351
Total Net Utilities Operational Emissions	1,499,940	1,062,850	0

Source: PRPA, 2011, archived at H:/Environmental/Climate/2010CAP Status and GHG Inventory Files/PaulDavis-FortCollinsRequest for 2010 data.xls, tab “GHG FC Accounting Method”.)

The electricity emissions factor of 1,610 lbs CO₂/MWh is lower in 2010 than the 2009 factor because the amount of owned wind energy went up by over 200%, from 13.6 MWh in 2009 to 42.6 MWh in 2010, and the amount of fossil fuel generation went down by 2%.

Previous Emissions Factors for Community Electricity Use

Tables 47, 50, 53, 56, and 59 contain previous emissions factors used in 2005 through 2009 in Appendices C through G of this QMP.

Emissions Factor for Renewable Energy Certificates (RECs)

RECs are reported in electricity units of megawatt-hours. Carbon emissions reductions are estimated and reported here *for information purposes only*. The calculation uses a method prescribed by Green-e for estimating GHG emissions reductions due to REC purchases. The marginal emission rate is based on the 2007 eGRID non-baseloads factors for each North American Electric Reliability Corporation (NERC) region from which PRPA purchased RECs, weighted according to the amount purchased from each region. The RECs emissions factors for each year are summarized in Table 18, Summary of Greenhouse Gas Electricity Emissions Factors, presented earlier in this section.

Current Electricity Conversion Factors

Tons CO₂e are calculated as follows: (MWh purchased x emissions factor)/2000 = tons CO₂e

B. Natural Gas

Current Emissions Factors for Natural Gas

Decatherms are multiplied by the sector-specific emissions factor for CO₂, CH₄, and N₂O, to calculate total CO₂e emissions. Sector-specific factors are given in Table 20 below, and conform to factors used in IPCC and The Climate Registry. **Note the natural gas factor is for CO₂e.**

Emission Factor Source	CO₂ (ton/MMBtu)	CH₄ (lb/MMBtu)	N₂O (lb/MMBtu)	Combined Factor CO₂e (tons/MMBtu)
The Climate Registry (ICR)				
Assuming heat content of 975-1,000 Btu/Standard Cubic Foot				
Residential	0.0595	0.011	0.0002	0.0597
Commercial	0.0595	0.011	0.0002	0.0597
Industrial	0.0595	0.011	0.0002	0.0596

Source: The Brendle Group report, dated March 2009, *City of Fort Collins Community Greenhouse Gas Accounting Protocols*

Current Natural Gas Conversion Factor
1 Decatherm (DTH) = 1 MMBtu

C. Ground Transportation

Current Transportation Emissions Factors

Table 21 presents the vehicle emissions factors used in the 2010 inventory.

Vehicle type	Emissions factors
Gasoline car	0.0824 tons CO ₂ /MMBtu
Gasoline light truck	0.0824 tons CO ₂ /MMBtu
Gasoline heavy truck	0.0824 tons CO ₂ /MMBtu
Diesel car	0.086 tons CO ₂ /MMBtu
Diesel light truck	0.086 tons CO ₂ /MMBtu
Diesel heavy duty	0.086 tons CO ₂ /MMBtu

Current Transportation Conversion Factors

Table 22 presents the vehicle conversion factors used in the 2010 inventory.

Vehicle type	Conversion factors
Gasoline car	0.125 MMBtu/gallon
Gasoline light truck	0.125 MMBtu/gallon
Gasoline heavy truck	0.125 MMBtu/gallon
Diesel car	0.122 MMBtu/gallon
Diesel light truck	0.122 MMBtu/gallon
Diesel heavy duty	0.122 MMBtu/gallon

C. Air Travel

Current Air Travel Emissions Factor

The current air travel emissions factor is 9.57 kg CO₂/gallon fuel (**Source:** The Climate Registry).

D. Solid Waste

Current Solid Waste Emissions Factor

The emissions factor is calculated by spreadsheet (H:/Environmental/Climate/2010CAP Status and GHG Inventory Files/2010-Inventory.xls) based on the inputs from the CARB model. The value calculated for 2010 is 0.379265763 short tons CO₂e/ton landfill waste.

Current Solid Waste Conversion Factors

Table 23 presents the solid waste conversion factors used in the 2010 inventory.

Category of Waste	Conversion Factors
Loose solid waste	200 lbs/CY
Compacted solid waste	750 lbs/CY
Tree limbs	300 lbs/CY
Whole tires	25 lbs/tire (average)
Shredded tires	600 lbs/CY

Source: Larimer County, archived in H:/Environmental/Climate/2010CAP Status and GHG Inventory Files/2010-Inventory.xls, see tab “Landfill”.)

E. Embodied Energy in Recyclable Materials

Current Embodied Energy in Recyclable Materials Emissions Factors

Table 24 presents the emissions factors for embodied energy in recyclable materials used in the 2010 inventory.

Recyclable Material	Source Reduction Emissions Factor (metric tons C_e/ton)⁴
Cardboard	1.52
Glass	0.16
Aluminum	2.24
Steel	0.87
Plastic	0.5
Newsprint	1.33
Mixed Office Paper	2.18
Magazines	2.36
Wood	0.55

VI. Data Management

Activity Data

A. Electricity

Electricity data provided by PRPA

Source: PRPA

PRPA provides data for “Total Fort Collins Operational Control” MWh and total RECs (MWh) purchased by Fort Collins. An example of the annual report is shown below in Table 25.

Table 25. 2010 Operational Boundary for Platte River Power Authority Electricity

Resource	Energy @ Generator (MWh)	Actual Emissions @ Generator (MT)	Emission Rate (lbs/MWh)
WAPA	289,839		
Purchased Power	29,365	25,081	1,883
Renewable Owned Generation (Wind)	42,579		0
Fossil Generation	1,138,157	1,070,505	2,074
Total Fort Collins Operational Control	1,499,940	1,095,587	1,610
RECs	53,421	-32,737	-1,351
Total Net Utilities Operational Emissions	1,499,940	1,062,850	0

Source: PRPA, 2011, archived at H:/Environmental/Climate/2010CAP Status and GHG Inventory Files/PaulDavis-Fort CollinsRequest for 2010 data.xls, tab “GHG FC Accounting Method”.)

The City of Fort Collins Utilities 2009 Sustainability Report indicates that its GHG inventory reporting methodology reflects an ownership and operational control boundary for reporting as

⁴ Note that these units are in **carbon equivalents** not carbon dioxide equivalents.

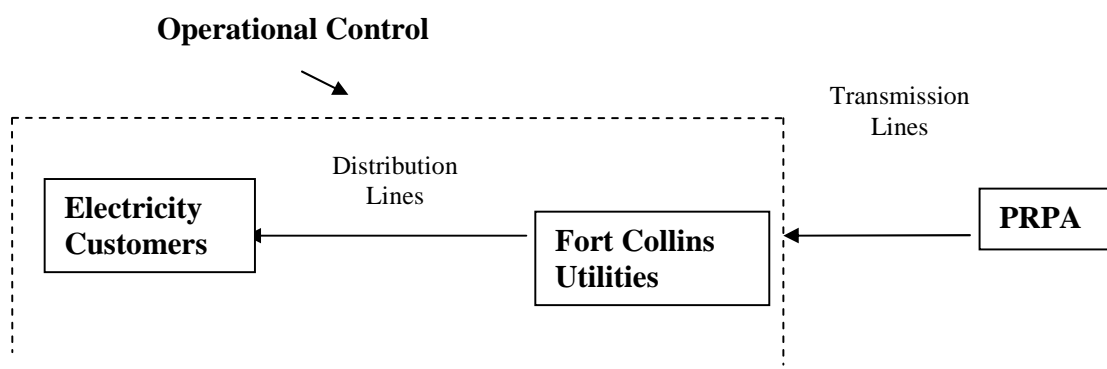
defined by the Climate Registry's Electric Power Sector Protocol. Ownership-boundary results report an ownership allocation of all PRPA's direct generation emissions, including off-system electric sales. Operational-boundary reporting results in the emissions directly related to Utilities' purchased energy on behalf of all electric customers. The City's ownership of PRPA was calculated in 2009 at 48%.

Table 5.1 of the Climate Registry's Electric Power Sector Protocol recommends reporting GHG emissions from the following indirect sources for local distribution companies:

- Scope 2 Indirect Emissions from:
 - Local transmission and distribution losses
 - Purchased and consumed electricity
- Scope 3 Indirect Emissions from
 - Specified purchases
 - Other purchases
 - Direct access
 - Power exchanges

Figure 2 visually depicts the definition of "operational control" for purposes of GHG accounting of emissions from electricity for the community of Fort Collins.

Figure 2. Operational Control Boundary for Greenhouse Gas Emissions for Electricity



Electricity data provided by Fort Collins Utilities

Source: Fort Collins Utilities

The electricity data provided in the Table 26 below are not weather normalized. These data do not include the Water Treatment Plant, which is served by Xcel Energy and is outside City limits.

Table 26. Summary of Electricity Data from Fort Collins Utilities**Source of Table:** Fort Collins Utilities Department, 2011

	2005 kWh	2006 kWh	2007 kWh	2008 kWh	2009 kWh	2010 kWh
Residential	453,821,891	467,812,034.00	484,963,794.00	472,383,132.00	465,543,155	494,037,969
Commercial	473,927,646	481,341,081.00	492,908,700.00	499,601,183.00	492,275,230	499,986,645
Industrial	464,277,920	454,720,330.00	464,359,890.00	457,192,996.00	446,089,800	448,106,550
Traffic	907,818	910,631.00	628,640.00	620,223.00	621,057	610,067
Street Lighting (Provided)	8,123,199	8,235,645.00	8,421,683.00	8,546,092.00	8,534,299	8,526,559
Total	1,401,058,474	1,413,019,721.00	1,451,282,707.00	1,438,343,626.00	1,413,063,541	1,451,267,790
Distribution Losses	31,507,064	29,872,500.00	33,673,950.00	33,524,826.00	38,495,582	21,672,785
Purchases from PRPA	1,432,565,538	1,442,892,221.00	1,484,956,657.00	1,471,868,452.00	1,451,559,123	1,472,940,575

*Note: 2 customers moved from Industrial to Commercial in 2008 because their average peak demands fell below 750 kW.

** Transmission losses were calculated based on Total Operational Control data.

Source: City of Fort Collins Utilities, archived at H:/Environmental/Climate/2010CAP Status and GHG Inventory Files/EllenSwitzer-Community-2005-2010 kWh by Class.xls)

Electricity data provided by Xcel Energy

Source: Xcel Energy

Table 27 shows the total electric sales values for the purchase of electricity from Xcel Energy.

Table 27. Fort Collins Total Electric Sales by Xcel Energy**Source of Table:** Xcel Energy, 2011

Year	kWh		Notes
2005	497,001	**	This number may be lower than the actual because of the switch from the CIS to CRS accounting system.
2006	693,826		
2007	821,718		
2008	975,824		
2009	1,372,325		
2010	1,433,541		

Source: Data archived at H:/Environmental/Climate/2010CAP Status and GHG Inventory Files/GlennMonroe-FtCollins2010GasSales.xls, see tab "Electricity"

The Xcel electricity data was apportioned by Natural Resources ESD staff as 50% to the residential category and 50% to the commercial category.

Carbon Offsets

Sources: Colorado Carbon Fund; Trees, Water, and People

The Colorado Carbon Fund provides total carbon offsets purchased by Fort Collins residents or businesses for each calendar year (in metric tons CO₂e). Thus far, these data only represent a small fraction of offsets purchased through the Colorado Carbon Fund and the non-profit organization Trees, Water, and People. It does not represent the large acquisitions that are made by CSU, PSD, New Belgium and other organizations.

B. Natural Gas

Natural Gas from Buildings

Source: Xcel Energy

The “Actual Sales” data are used in the inventory. Transport gas, provided by other gas vendors but delivered through Xcel lines, is included in the inventory.

Current Natural Gas Activity Data

Table 28 displays natural gas use from Xcel Energy for Fort Collins.

Table 28. 2010 Fort Collins Natural Gas Use from Xcel Energy

									WEATHER	
2010									ADJ	
	ACTUAL		NORMAL	ACTUAL	NORMAL	BASE	HEATING	HEATING	HEATING	NORMAL
	SALES	CUSTOMER	HDD	HDD	FACTOR	LOAD	LOAD	LOAD	LOAD	SALES
RESIDENTIAL	3,543,627	46,700	6238	5714	1.0917	921,343	2,622,284	2,862,747		3,784,090
COMMERCIAL	1,302,271	4,126				429,749	872,522	952,532		1,382,281
IND & TRANSPORT	2,946,521	182								2,946,521
TOTAL	7,792,419	51,008								8,112,892

Source: Data archived at H:/Environmental/Climate/2010CAP Status and GHG Inventory Files/GlennMonroe-FtCollins2010GasSales.xls, see tab “Gas”

Previous Natural Gas Activity Data

Tables 48, 51, 54, 57, and 60 contain previous natural gas use from Xcel Energy used in 2005 through 2009 in Appendices C through G of this QMP.

C. Ground Transportation

Source: City Transportation Planning

GHG emissions from the Fort Collins community from ground-based transportation are based on modeled estimates of vehicle miles traveled (VMT) in Fort Collins. Two slightly different datasets exist for Fort Collins’ VMT estimates. One is a dataset used by the Metropolitan Planning Organization (MPO) for determining conformity of transportation plans. The other was developed by the City of Fort Collins for the Mason Corridor project. The City dataset used the same model but relies on socioeconomic assumptions provided by the City’s Advance Planning Department, which modifies the allocation of growth, compared to the assumptions used in the MPO model. MPO uses assumptions consistent with the State Demographer control totals for the Northern Front Range (NFR).

Both datasets are generated using the TransCAD model. The TransCAD model is periodically calibrated against ground count data. 2005 was a calibration year. Both the Mason Corridor and the MPO data sets used **3,022,486 as a daily VMT for Fort Collins**, and this is the VMT data used for the 2005 community inventory baseline. The 2009 calibration year analyses were not

complete at the time of GHG reporting, so the inventory continues with the same (conservative) assumptions that VMT is growing by 1.23 %/year. Current data indicate that VMT may actually be decreasing.

Table 29. Fort Collins Vehicle Miles of Travel Estimates

Source of Table: Transportation Planning Department, 2005

Year	Daily VMT	X 330 =annual
2000	2,531,071	835,253,430
2001	2,629,354	867,686,820
2002	2,727,637	900,120,210
2003	2,825,920	932,553,600
2004	2,924,203	964,986,990
2005	3,022,486	997,420,380

(In...\Audit\2005-2006\VMT-Projections.xls (2/23/08))

Forecasted transportation data (daily estimated VMT) were provided by the City of Fort Collins Transportation planning staff and LSA Associates. It uses the 2010, 2015, and 2020 projections and a linear interpolation for the interim years between each modeled data point (shown in bold below in Table 30).

Table 30. Estimated Future Vehicle Miles of Travel in Fort Collins			
Source of Table: Transportation Planning Department, 2008			
Prepared 3/6/08			
Year	Estimated Daily VMT	Annual VMT	Annual percent change
2005	3,022,489	997,421,370	
2006	3,059,563	1,009,655,708	1.23%
2007	3,097,091	1,022,040,113	1.23%
2008	3,135,080	1,034,576,424	1.23%
2009	3,173,535	1,047,266,505	1.23%
2010	3,212,461	1,060,112,242	1.23%
2011	3,251,865	1,073,115,545	1.23%
2012	3,291,753	1,086,278,345	1.23%
2013	3,332,129	1,099,602,600	1.23%
2014	3,373,001	1,113,090,290	1.23%
2015	3,414,374	1,126,743,420	1.23%
2016	3,448,441	1,137,985,655	1.00%
2017	3,482,849	1,149,340,061	1.00%
2018	3,517,599	1,160,807,757	1.00%
2019	3,552,697	1,172,389,874	1.00%
2020	3,588,144	1,184,087,553	1.00%

Source: H:/Environmental/Climate/2010CAP Status and GHG Inventory Files/VMT Interpolation march2008.xls that was developed by Natural Resources' ESD using data from the 2035 RTP and from city of Fort Collins Transportation Planning staff.

For the 2011 Community Inventory, the City anticipates developing a new system of VMT estimation, possibly involving Highway Performance Management System (HPMS) data. The following table shows the VMT distribution in the community GHG inventory.

Table 31. Fort Collins Vehicle Miles Traveled Distribution

	2008+	2004-2007
LDGV	50.19%	0.5
LDGT	45.21%	0.38
HDGV	0.92%	0.036
LDDV	0.08%	0.0012
LDDT	0.18%	0.0016
HDDV	3.42%	0.081

Source: Transportation Planning Department, 2008

The 2004 VMT mix was obtained from the NFRMPO. It recalculates the mix by folding motorcycles (1%) into the other categories. The 2008 data was obtained from CPDHE in June 2011. It was first completed in late 2009. The VMT mix for each category is weighted total VMT on “unrestricted” (75%) and freeway travel (25%).

Table 32. Raw 2008 Vehicle Miles Traveled Mix Data
Source of Table: Transportation Planning Department, 2008

COUNTY	Urban	Rtype	M5VehClass	fraction
Larimer	U	unrestricted	HDDV	0.016192
Larimer	U	unrestricted	HDGV	0.008839
Larimer	U	unrestricted	LDDT	0.001812
Larimer	U	unrestricted	LDDV	0.000833
Larimer	U	unrestricted	LDGT1	0.347614
Larimer	U	unrestricted	LDGT2	0.112926
Larimer	U	unrestricted	LDGV	0.509741
Larimer	U	unrestricted	MC	0.002043
Larimer	U	freeway	HDDV	0.088155
Larimer	U	freeway	HDGV	0.010379
Larimer	U	freeway	LDDT	0.001694
Larimer	U	freeway	LDDV	0.000767
Larimer	U	freeway	LDGT1	0.321114
Larimer	U	freeway	LDGT2	0.10579
Larimer	U	freeway	LDGV	0.469015
Larimer	U	freeway	MC	0.003086

Table 33 contains the vehicle miles traveled (VMT) from the Colorado Department of Public Health and Environment (CDPHE).

Table 33. Northern Front Range Vehicle Miles Traveled						
Source of Table: CDPHE						
REGION	COUNTY	FIPS	FIPSCOUNTY	Road type	VMT	Percent
NORTHERN FR	Larimer	69	69	Freeway	1,709,823.00	0.250194
NORTHERN FR	Larimer	69	69	Unrestricted	5,124,170.00	0.749806

D. Air Travel

Source: DIA and Fort Collins/Loveland Airport

Data are input to the spreadsheet (H:/Environmental/Climate/2010CAP Status and GHG Inventory Files/2010-Inventory.xls, see “JetFuel” tab) that was developed by Natural Resources’ ESD staff to calculate GHG emissions from air travel for the Fort Collins community. Table 33 contains the fuel consumption data for DIA from 2005 to present.

Table 34. Fuel Consumption at Denver International Airport							
Source of Table: DIA, 2011							
Denver Fuel Facility		2005	2006	2007	2008	2009	2010
Jet Fuel	gallons	393,749,978	401,950,955	423,115,977	417,075,677	373,910,521	409,974,874
Gasoline	gallons	547,430	546,670	569,960	510,427	7,623	
Diesel	gallons	395,762	447,607	610,521	665,223	521,850	
Av Gas	gallons	22,526	19,912	12,297	9,479	667,609	

E. Solid Waste

Two activity data sets are used.

Fort Collins community trash disposed at landfills (excluding recycling)

Natural Resources’ ESD attempts to quantify, as accurately as possible, the community-wide waste diversion rate based on data collected from the following sources:

Source: City of Fort Collins Natural Resources’ ESD – S. Gordon and C. Mitchell

- Trash hauler reports (2x / yr); hauler reports per ordinance for commercial and residentially generated trash, regardless of which landfill is used for disposal
- CSU (annual); CSU Facilities Department
- Percent Larimer County Landfill citizen self-haul (annual); Larimer County Solid Waste Department

The following approach was used to calculate community trash levels for 2006, 2008, and 2009: Community trash data for 2005 and 2007 were derived from a model developed by Skumatz Economic Research Associates (SERA) in 2006 to support Natural Resources ESD's solid waste reduction planning efforts. This approach used data originally quantified in 2004 by SERA to develop estimates of community solid waste tonnages. A summary of weights for community solid waste are presented in Table 35.

Year	Short Tons Solid Waste
2005	237,747
2006	224,700
2007	227,842
2008	187,510
2009	159,708
2010	129,867

Landfills around the country saw a drop in solid waste tonnages in 2008 and 2009.

Total tons waste deposited in the Larimer County landfill, as input to the LandGEM model.

Source: Larimer County

Category	Unit	Note	Totals	Conversion Factors
Minimum Load	each			cy / load (avg)
	cu.yd.			
Loose Waste	cu.yd.		146386	
Loose C&D Debris	cu.yd.			
Non-Fri Asbestos	cu.yd.	[1]	4410	
Dirt & RipRap	cu.yd.	[1]	19686	
Commercial Loose			240702	0.75
CFC Appliance	each	[2]	1,035	
Total Loose MSW	cu.yd.	[1]	387,088	
Compact Waste	cu.yd.	[3]	180405	
Rubble			39048	
Sludge			3828	
Sludge Discount			-3714	
Compact C&D	cu.yd.	[3]		
Tree Limbs	cu.yd.		10931	
Recycle Discount	cu.yd.	[4]	-6,179	
Whole Tires	each		3,842	
Tires Recycled	each	[5]	-3,842	
Shredded Tires	cu.yd.		2	

Table 36. 2010 Larimer County Landfill Data (continued)				
Category	Category	Category	Category	Category
Total Loose MSW	Lbs.	[6]	77,417,600	200
Total Compact MSW	Lbs.	[7]	135,303,750	750
Total Rubble	Lbs.		49,981,440	1,280
WWTP Sludge			323,760	2,840
Whole Tires	Lbs.	[9]		25
Shredded Tires	Lbs.	[9]	1,200	600
Total Degradable solid waste Landfilled	tons		132,224	

Notes [1] Non-friable asbestos, dirt, and riprap (concrete) are nondegradable and are not included in the calculation of "Total Loose MSW."
 [2] After CFCs are removed by a certified contractor, appliances are recycled by a scrap metal dealer.
 [3] Waste hauled in packer truck or compactor type roll-off.
 [4] Includes construction & demolition debris and other bulky wastes.
 [5] "Sludge" includes wastes from water and wastewater treatment plants.
 [6] WTP sludge is nondegradable and is not counted in the total tonnage.
 [7] Accounts for Christmas trees and tree limbs that were ground up and recycled (i.e. not landfilled).
 [8] Accounts for tires that were shipped to a recycling facility.
 [9] Assumes an average density of 200 pounds per cubic yard.

Source: Larimer County, archived in H:/Environmental/Climate/2010CAP Status and GHG Inventory Files/2010-Inventory.xls, see "Landfill" tab

Total Biogas captured at Larimer County landfill

Source: Larimer County Solid Waste Department

In October 2009, a partial landfill gas collection system began operating at the Larimer County Landfill. Gas volumes, reported as metric tons CH₄ are reported by the landfill operators. In 2010, 888.5 metric tons CH₄ were captured at the landfill and flared. (See H:/Environmental/Climate/2010CAP Status and GHG Inventory Files/2010-Inventory.xls, see "Landfill-Gas" tab)

F. Embodied Energy in Recyclable Materials

Source: City of Fort Collins Natural Resources' ESD

Tons of trash generated by the Fort Collins community are estimated based on the reported trash hauler tonnages (required per the City of Fort Collins "Pay as You Throw" ordinance) plus "unaccounted tonnage". These unaccounted tons were revealed by a 2004 solid waste survey completed by SERA in 2005. Unaccounted tons include commercial tons not collected by licensed trash haulers (e.g., Colorado State University (CSU) maintains its own trash trucks and hauls materials directly to the Larimer County Landfill) and "self-hauled" trash to the Larimer County Landfill. Community trash tons were calculated using this methodology for 2006 and 2008.

Community trash data for 2005 and 2007 were derived from a model developed by SERA in 2006 to support the Natural Resources' ESD solid waste reduction strategic planning efforts. This approach used the original 2004 SERA data to develop estimates of community trash tonnages.

The Larimer County Landfill data for 2010, "2010 Larimer County Landfill Data" in Section VI, E. Solid Waste, above, were used to calculate GHG emissions from embodied energy in recyclable materials for the Fort Collins Community Inventory.

Normalization Factors

No data used in the preparation of the Community GHG Emissions Inventory are weather normalized.

Quality Assurance

Beginning in 2011, the data collection process will be reviewed annually by Natural Resources' ESD Environmental Data Analyst during the annual inventory reporting process. ESD recognizes that there are potential sources for errors that are inherent to an annual inventory that encompasses a community the size of Fort Collins. For example, errors could occur when transferring data sources, converting from volumes to weights or metric units, or when calculating GHG emissions. To ensure that the data collected for the City of Fort Collins Community Inventory is accurate, the following measures will be taken at a minimum annually:

- The ESD Environmental Data Analyst will contact the City of Fort Collins Advanced Planning Office (T. Wilder) to identify whether there have been changes to the boundaries of the City Limit or the GMA.
- Inquiries to the Energy Management Team will be made to identify new emissions sources within the boundaries of the community inventory.
- The Natural Resources ESD's Environmental Data Analyst will review all annual activity summaries used in the annual GHG Community Inventory from:
 - Xcel Energy
 - PRPA
 - Fort Collins Utilities
 - Colorado Carbon Fund and Trees, Water & People
 - City Transportation Planning
 - Environmental Programs at DIA
 - Fort Collins/Loveland Airport
 - Natural Resources' ESD Waste Reduction and Recycling Program
 - Larimer County Solid Waste Department for landfill data
- The ESD Environmental Data Analyst will review all emissions factors used as part of the annual inventory.
- ESD will request, to the extent possible, that data used to calculate GHG be provided in a form that allows an "actual" calculation, versus an estimate.
- At its discretion, ESD will conduct periodic reviews of the GHG Inventory and identify any areas that appear to be in error.
- ESD will seek an external, informal review of the 2011 Community GHG emissions inventory, as has been done for the 2009 and 2010 community inventory data.

Data Security

Beginning 2011, information compiled for the purposes of conducting the community annual inventories, including activity data, emissions factors, conversion factors, normalization factors, the QMP, and any changes to the current quantification methods will be maintained both in electronic and printed form in secure locations by the ESD Environmental Data Analyst.

Community Reporting Frequency

Current data reporting is conducted on an annual basis in time for an annual inventory (July).

Document Retention and Control Policy

Effective in 2011, records used to calculate and document the GHG Inventory from 2006 through the end of the goal period will be maintained by ESD for a minimum of three years beyond the inventory reporting period, with the exception of data for the 2005 baseline inventory. Baseline inventory data will be maintained through the end of the goal period. After the three-year period following the end of the reporting period, ESD will dispose of supporting documents and only the final reports will be kept.

VII. Summary of Inventory Results

Appendices B through G provide details of the results of calculations to determine GHG emissions in metric tons CO₂e by source for the annual inventories from 2005 through 2010. Table 37 is an overall summary of GHG Emissions for the City of Fort Collins as revised during 2011:

Current GHG Inventory Results:

Table 37. Summary of Gross Community Greenhouse Gas Emissions	
Year	GHG (metric tons CO₂e)
2005	2,691,839
2006	2,690,160
2007	2,704,675
2008	2,543,043
2009	2,543,375
2010	2,392,800

VIII. 2020 Community Forecast

The community-wide Fort Collins GHG Emissions forecast for CO₂e was updated in 2010 to reflect any forecast changes that occurred since 2008/2009 reporting. It holds all the CO₂ emissions factors constant at the 2009 level. Updates were made to the 2020 emissions forecast to reflect current growth predictions and are shown in Table 38. All the forecast calculations referenced below are archived at H:/Environmental/Climate/2009CAP Status and GHG Inventory Files/1990-2020Forecast-July2010.xls.

Emissions Source	Previous Growth Assumptions	Current Growth Assumptions
Electricity (from Fort Collins Utilities)	Estimates 23% growth in MWh purchased from 2009 through 2020.	1.5% drop from 2009 to 2010 1.77% drop from 2010 to 2011 0.43% growth from 2011-2012 0.42% growth from 2013-2018 0.41% growth from 2019-2020
Natural Gas (from Xcel Energy)	Estimates 0.1% annual growth with the benefits of their demand side management programs factored in.	Flat (no growth or decline)
Population	Estimates 1.5% annual growth	Apply DOLA annual growth projections for Larimer County, which show a net population growth of 21.8% from 2009 to 2020, or an average annual growth of 1.8%.
Solid Waste	Based on population growth estimates of 1.5%/year	16% drop from 2009 to 2010 (the average drop in Fort Collins solid waste in 2008 and 2009, reflecting the low economy) Increase 2.5% annually from 2011 to 2020, based on CDPHE projections for waste to landfills in Colorado.
Air Travel	Based on population growth estimates	Based on population growth estimates
Energy in Recyclable Materials	Based on population growth estimates	Based on population growth estimates

The forecast will be updated biennially along with preparation of the Climate Action Plan's biennial status report.

A. Electricity

Table 39 provides the electricity forecast through 2020. It is based largely on the April 2010 projection by Fort Collins Utilities but includes the small additional electricity provided by Xcel Energy.

Table 39. Fort Collins Electricity Projection

Source of Table: Fort Collins Utilities, 2010

YEAR	MWh	Notes	
2005	1,459,322	updated 7/1/10, includes Xcel	Actual Data
2006	1,470,034	updated 7/1/10, includes Xcel	Actual Data
2007	1,513,028	updated 7/1/10, includes Xcel	Actual Data
2008	1,499,824	updated 7/1/10, includes Xcel	Actual Data
2009	1,479,538	updated 7/1/10, includes Xcel	Actual Data
2010	1,505,743	1.77%	Projections
2011	1,512,197	0.43%	Projections
2012	1,518,652	0.43%	Projections
2013	1,525,106	0.42%	Projections
2014	1,531,560	0.42%	Projections
2015	1,538,014	0.42%	Projections
2016	1,544,468	0.42%	Projections
2017	1,550,922	0.42%	Projections
2018	1,557,376	0.42%	Projections
2019	1,563,830	0.41%	Projections
2020	1,570,285	0.41%	Projections

The GHG emissions for the forecast were calculated conservatively, using the 2009 PRPA average emissions factor, including renewables. This factor is 1,777 lbs CO₂/MWh. The electricity forecast will be updated annually by Fort Collins Utilities. Overall, the trend is likely to be downward as the carbon intensity of electricity used in Fort Collins decreases.

B. Natural Gas

This forecast growth rate was provided by Xcel Energy during early 2010. The projection was flat (no growth), with Demand Side Management programs accounted for. The factor used to convert DTH to tons CO₂e is 0.597 tons CO₂e/DTH/ (residential and commercial factor), instead of the 0.596 commercial factor. This is a stable, nationally recognized factor, and this factor is not likely to change significantly in the future.

C. Ground Transportation

Transportation forecast data (daily estimated VMT) were provided by the City of Fort Collins Transportation planning staff and LSA Associates. It uses the 2010, 2015, and 2020 projections and a linear interpolation for the interim years between each modeled data point (shown in bold below in Table 40).

Year	Estimated Daily VMT	Annual VMT	Annual percent change
2005	3,022,489	997,421,370	
2006	3,059,563	1,009,655,708	1.23%
2007	3,097,091	1,022,040,113	1.23%
2008	3,135,080	1,034,576,424	1.23%
2009	3,173,535	1,047,266,505	1.23%
2010	3,212,461	1,060,112,242	1.23%
2011	3,251,865	1,073,115,545	1.23%
2012	3,291,753	1,086,278,345	1.23%
2013	3,332,129	1,099,602,600	1.23%
2014	3,373,001	1,113,090,290	1.23%
2015	3,414,374	1,126,743,420	1.23%
2016	3,448,441	1,137,985,655	1.00%
2017	3,482,849	1,149,340,061	1.00%
2018	3,517,599	1,160,807,757	1.00%
2019	3,552,697	1,172,389,874	1.00%
2020	3,588,144	1,184,087,553	1.00%

(See .../AUDIT/Forecast/VMT interpolationMARCH2008.xls)

Table 41 identifies the assumptions used in the transportation modeling.

Annual VMT Growth (Air Quality Boundary)		Annual Household Growth (MPO Fort Collins Subarea)		
Year	Model VMT	Annual Growth Rate	Households	Annual Growth Rate
2005	3,022,489	n/a	63,764	n/a
2015	3,414,374	1.2%	71,767	1.2%
2025	3,770,758	1.0%	80,914	1.2%
2035	4,103,400	0.8%	87,703	0.8%

In order to calculate the emissions from VMT, the conversion factors in Table 42 were applied to the VMT estimate. The “VMT percent” is based on VMT distribution provided by the MPO from 2004. The average fuel efficiencies for gasoline vehicles are from the Department of Energy (DOE) Transportation Data Book, Table 4.1, 4.2, and 4.3. The fuel economy factors for

diesel vehicles are taken from the International Council on Local Environmental Initiatives (ICLEI) Clean Air Climate Program (CACP) Software, June 2009 version. No adjustments were made for the new fuel efficiency requirements of the 2007 Energy Independence and Security Act that requires new cars, light trucks, and SUVs sold in the United States to achieve a fleet wide average of at least 35 miles per gallon by 2020.

Vehicle type	VMT percent	Avg MPG	Conversion factor	Conversion factor
Gasoline car	50.0	22.1	0.125 MMBtu/gallon	0.0824 tons CO ₂ /MMBtu
Gasoline light truck	38.0	17.7	0.125 MMBtu/gallon	0.0824 tons CO ₂ /MMBtu
Gasoline heavy truck	3.6	13.9	0.125 MMBtu/gallon	0.0824 tons CO ₂ /MMBtu
Diesel car	0.1	19.378	0.122 MMBtu/gallon	0.086 tons CO ₂ /MMBtu
Diesel light truck	0.2	16.859	0.122 MMBtu/gallon	0.086 tons CO ₂ /MMBtu
Diesel heavy duty	8.1	5.634	0.122 MMBtu/gallon	0.086 tons CO ₂ /MMBtu

Based on 2009 data, a conversion factor was calculated as follows:

$$\frac{601,835 \text{ Metric Tons CO}_2\text{e}}{1,047,266,505 \text{ Miles}} = 0.000574672 \text{ Metric Tons CO}_2\text{e/mile.}$$

This proportional factor was applied to all future VMT estimates from 2009 through 2020.

D. Air Travel

Based on 2009 data, a conversion factor was calculated as follows:

$$\frac{82,538 \text{ Metric Tons CO}_2\text{e}}{137,200 \text{ Population}} = 0.594521145 \text{ TonsCO}_2 / \text{Person}$$

Fort Collins population growth is estimated at an average of 1.8 %/year, based on 2010 projections from the CO Department of Local Affairs (DOLA). See below for more information on the population growth projection. Future emissions from air travel are not likely to change significantly unless an improved methodology or data emerges. The future trend is likely to be slightly downward with increasing fuel economy of airlines.

E. Landfill Gas from Solid Waste

Based on 2009 data, a conversion factor was calculated as follows:

$$\frac{52,026 \text{ Metric Tons CO}_2\text{e}}{159,708 \text{ Tons Trash from Fort Collins}} = 0.325757007 \text{ Metric TonsCO}_2\text{e} / \text{Tons Trash}$$

Fort Collins population growth is estimated at an average of 1.8 %/year, based on 2010 projections from DOLA. The tons CO₂e for future years were calculated by applying the factor above to the estimated tons trash. The resultant community solid waste projections are listed in Table 43.

Table 43. Fort Collins Community Solid Waste Projections				
Year	Short Tons Fort Collins Municipal Solid Waste	Metric tons CO₂e	Percent change MSW	Notes
2005	237,747	62,731	22.79%	Measured
2006	224,700	64,202	-5.49%	measured
2007	227,842	64,707	1.40%	measured
2008	187,510	58,367	-	measured
2009	159,708	52,026	14.83%	measured
2010	185,261	60,350	-	Average of 2008 and 2008 change
2011	189,893	61,859	2.50%	Estimated by CPDHE for Colorado
2012	194,640	63,405	2.50%	" "
2013	199,506	64,991	2.50%	" "
2014	204,494	66,615	2.50%	" "
2015	209,606	68,281	2.50%	" "
2016	214,846	69,988	2.50%	" "
2017	220,217	71,737	2.50%	" "
2018	225,723	73,531	2.50%	" "
2019	231,366	75,369	2.50%	" "
2020	237,150	77,253	2.50%	" "

Note: Even if the waste input rate were to be held constant, the landfill gas from solid waste will increase over time, due to the cumulative impact of ongoing decomposition of solid waste deposited in previous years.

F. Energy in Recyclable Materials

Based on 2009 data, a conversion factor was calculated as follows:

$$\frac{247,498 \text{ Metric Tons CO}_2\text{e}}{137,200 \text{ Population}} = 1.782727888 \text{ Metric TonsCO}_2 / \text{Person}$$

Fort Collins population growth is estimated at an average of 1.8%/year, based on 2010 projections from DOLA. See below for more information on the population growth projection. The tons CO₂e for future years were calculated by applying the factor above to the estimated energy from recyclable materials in 2009.

G. Population Growth Projections

The Fort Collins population growth projections were based on the Colorado Department of Local Affairs “Preliminary Population Forecasts for Colorado Counties: 2000-2035” for Larimer County. (Obtained from <http://dola.colorado.gov/dlg/demog/population/forecasts/counties1yr.xls> .)

**Table 44. Fort Collins Population Growth Projections used in 2020
Greenhouse Gas Forecast**

Source of Table: Spreadsheet derived from Advance Planning Department data

Year	Population	Projected Growth Rate	Notes
2005	127,686		From City of Fort Collins Advance Planning Dept.
2006	129,511		" "
2007	132,101		" "
2008	134,743		" "
2009	137,200		" "
2010	138,831	1.19%	DOLA Projected Growth rate for Larimer County
2011	140,675	1.33%	" "
2012	142,854	1.55%	" "
2013	145,353	1.75%	" "
2014	148,075	1.87%	" "
2015	151,033	2.00%	" "
2016	154,221	2.11%	" "
2017	157,412	2.07%	" "
2018	160,614	2.03%	" "
2019	163,811	1.99%	" "
2020	167,137	2.03%	" "
Average		1.81%	

Table 45 summarizes the activity data projects used to generate future Fort Collins GHG emissions forecasts.

Table 45. Activity Data Projections Used to Generate Future Fort Collins Emissions Forecast

Year	Electricity (MWh)	Nat Gas (DTH)	Ground Travel (VMT)	Air Travel (Metric Tonnes CO ₂)	Short Tons Solid Waste	Energy in Recyclables (Metric Tons CO ₂ e)	Population
2005	1,459,322	7,228,151	997,421,370	86,933	237,747	368,433	127,686
2006	1,470,034	7,191,536	1,009,655,708	88,742	224,700	348,215	129,511
2007	1,513,028	7,601,955	1,022,040,113	93,405	227,842	353,084	132,101
2008	1,499,824	7,987,500	1,034,576,424	92,082	187,510	290,582	134,743
2009	1,479,538	7,909,579	1,047,266,505	82,538	159,708	247,498	137,200
2010	1,505,743	7,909,579	1,060,112,242	82,538	185,261	247,498	138,831
2011	1,512,197	7,909,579	1,073,115,545	83,634	189,893	250,785	140,675
2012	1,518,652	7,909,579	1,086,278,345	84,930	194,640	254,669	142,854
2013	1,525,106	7,909,579	1,099,602,600	86,416	199,506	259,126	145,353
2014	1,531,560	7,909,579	1,113,090,290	88,034	204,494	263,977	148,075
2015	1,538,014	7,909,579	1,126,743,420	89,792	209,606	269,251	151,033
2016	1,544,468	7,909,579	1,137,985,655	91,688	214,846	274,935	154,221
2017	1,550,922	7,909,579	1,149,340,061	93,585	220,217	280,623	157,412
2018	1,557,376	7,909,579	1,160,807,757	95,488	225,723	286,331	160,614
2019	1,563,830	7,909,579	1,172,389,874	97,389	231,366	292,030	163,811
2020	1,570,285	7,909,579	1,184,087,553	99,366	237,150	297,960	167,137

Source: /.../1990-2020Forecast-July2010.xls

Appendix A

Perspectives on Renewable Energy Credits

1. Perspectives Opposed to Quantifying RECs as GHG Reduction

A. The Offset Quality Initiative (June 2009)

The OQI published a paper in June 2009 recommending that RECs should not be treated as equivalent to GHG offsets and purchasers of RECs should not make GHG reduction claims associated with RECs retired primarily for two reasons.

- 1) Double-Counting and Ownership - The OQI paper states that it is difficult to establish clear ownership of indirect reductions from grid-tied renewable energy projects, and that clearly documenting transfer of ownership is difficult when the reduction itself is not clearly defined. They state that in the USA, “it is not currently possible for a renewable energy generator selling RECs to assure that emissions reductions are being conveyed with RECs and that the emissions reductions are not being counted or claimed by other-grid-connected entities.”
- 2) Additionality – If the purchasers of offsets use them in lieu of making their own emissions reductions, it is highly important that offsets represent emissions reductions that would not have otherwise occurred. The OQI paper claims that if the additionality of an a REC cannot be determined, it is inappropriate to use it as an offset.

The paper therefore recommends that RECs should not be treated as equivalent to GHG offsets and that purchasers of RECS should not make GHG emissions reduction claims associated with the retirement of RECs.

B. ICLEI’s “Local Government Operations Protocol” (September 2008)

ICLEI has prepared a draft GHG protocol for local government operations (as opposed to community-wide emissions). Version 1.0 (See

http://www.iclei.org/fileadmin/user_upload/documents/Global/Programs/CCP/Standards/LGOP_USA_2008.pdf, page 43) states that purchases of RECs ...

“are encouraged and should be reported as supplemental information in your local Government Operations Standards Protocol Report. However these purchases may not be deducted from your Scope 2 emissions. Scope 2 emissions result from the power you consume directly, either from a dedicated plant or from the grid, and represent your actual emissions. The partner organizations strongly support the development of renewable energy resources and recognize its importance in the fight against climate change. We recognize the need to develop a specific accounting framework for green power purchases in order to encourage and incentivize emissions reduction efforts. There is not yet consensus on how to accurately and credibly track green power purchases.... The Climate Registry plans to devote significant time to this issue in the development of their Electric Generation Protocol, which should be completed in spring 2009. We will plan to review the outcome of this process and update this section appropriately.”

2. Perspectives that Provide Guidance on Quantifying RECs as GHG Reductions

A. The Climate Registry's Electric Power Sector Protocol (finalized June 2009)

(See http://www.theclimateregistry.org/downloads/2009/05/Electric-Power-Sector-Protocol_v1.0.pdf)

On July 14, 2009, The Climate Registry announced the release of newly adopted protocols for GHG reporting by the electric power sector (EPS). Chapter EPS-3, page 107, states that “because of the size of the REC market and the value The Registry sees in promoting low emitting power sources of power, this protocol provides a method for appropriately recognizing purchases of RECs and special power certificates by EPS members.” It goes on to say, “When an LSE [Fort Collins Utility is a load serving utility] purchases an unbundled special power certificate, the EPS protocol allows it to account for the effect the transactions have on the GHG intensity of the electricity mix that the LSE delivers to its customers.” The protocol lists several eligibility requirements for RECs to be included. Step 4 on pages 109 and 110 outlines the process used to adjust the metrics to account for special power certificate purchases such as RECs.

B. EPA Climate Leaders Guidance (November 2008)

(See http://www.epa.gov/stateply/documents/greenpower_guidance.pdf)

The *Climate Leaders Greenhouse Gas Inventory Protocol Optional Modules Methodology for Green Power and Renewable Energy Certificates (RECS)*, Version 2.1, states that partners in the Climate Leaders Program may use external reductions, such as purchases of green power, to achieve their reduction goals as long as the green power generation has not been mandated for the generating facility. The guidance addresses the eligibility of green power purchases from both contracts with a utility and through RECs. A renewable source is considered to be ‘additional’ if it was constructed on or after January 1, 1997. A green power purchase is considered to be additional if it is not paid for in utility standard rates. For REC purchases, it stipulates that once a REC is unbundled from electricity, the electricity must not be marketed or sold in any way as ‘renewable’ or “green power’ on the wholesale market, including as part of a state or regional public disclosure law. Other eligibility criteria are listed on page 10 of the guidance document. The guidance goes on to provide a method for calculating emissions inventory adjustments as a result of green power purchases.

C. Green-E's Method for Calculating Carbon Equivalencies

(See http://www.green-e.org/getcert_re_stan.shtml#coccdr)

Section VII (B) of Green-E Energy Code of Conduct and Customer Disclosure Requirements addresses *Communicating the Emissions Avoidance Value of a Green-e Energy Certified Product*. This section states that Green-E Energy Certified renewable energy products must be denominated in megawatt-hours (MWh) or kilowatt-hours (kWh) and that offsetting emissions from other sources must be made with GHG reductions held to a different set of additionality criteria. This can be accomplished with products certified by Green-E Climate. However, the policy allows Green-E Energy participants to make environmental equivalency claims associated with the renewable energy products that they sell. The policy goes on to provide a methodology to convert to tons of CO₂ emissions avoided. [Note: This is the method used to calculate emissions reductions associated with RECs as reported in the community-wide greenhouse gas inventory.]

D. Community-wide GHG Reporting

Many communities including Denver, Boulder, Boulder County and Portland, OR. all include RECs and carbon offsets when calculating their net community greenhouse gas inventories.

Appendix B. – 2005 Base Year Inventory Results

Table 46 below identifies the community baseline GHG emissions, as broken into scopes.

Table 46. Fort Collins Community-wide 2005 GHG Emissions
 Source of Table: 2005 CAP Status Report

Source	MT CO ₂ e	Type
Electricity	1,209,359	Indirect (Scope 2)
Natural Gas	391,192	Direct (Scope 1)
Ground Transport	573,190	Direct (Scope 1)
Air Travel	86,933	Indirect (Scope 3)
Landfill Gas	62,731	Indirect (Scope 3)
Recyclable Materials Energy	368,433	Indirect (Scope 3)
Total	2,691,839	
Benefit of RECs	-11,050	
Benefit of Known Offsets	0	
Revised Total	2,680,789	

Figures 3 and 4 below show the net community emissions by source and end user, respectively, in 2005.

Figure 3. Fort Collins 2005 GHG Emissions by Source
 Source of Table: 2005 CAP Status Report

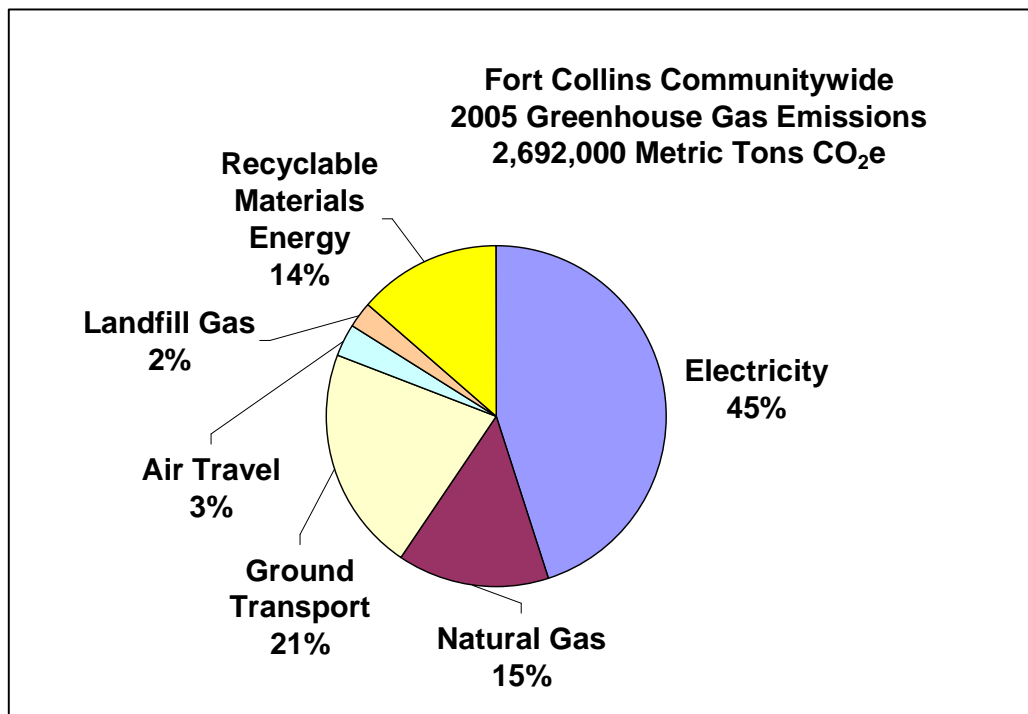


Figure 4. Fort Collins 2005 GHG Emissions by End User

Source of Table: 2005 CAP Status Report

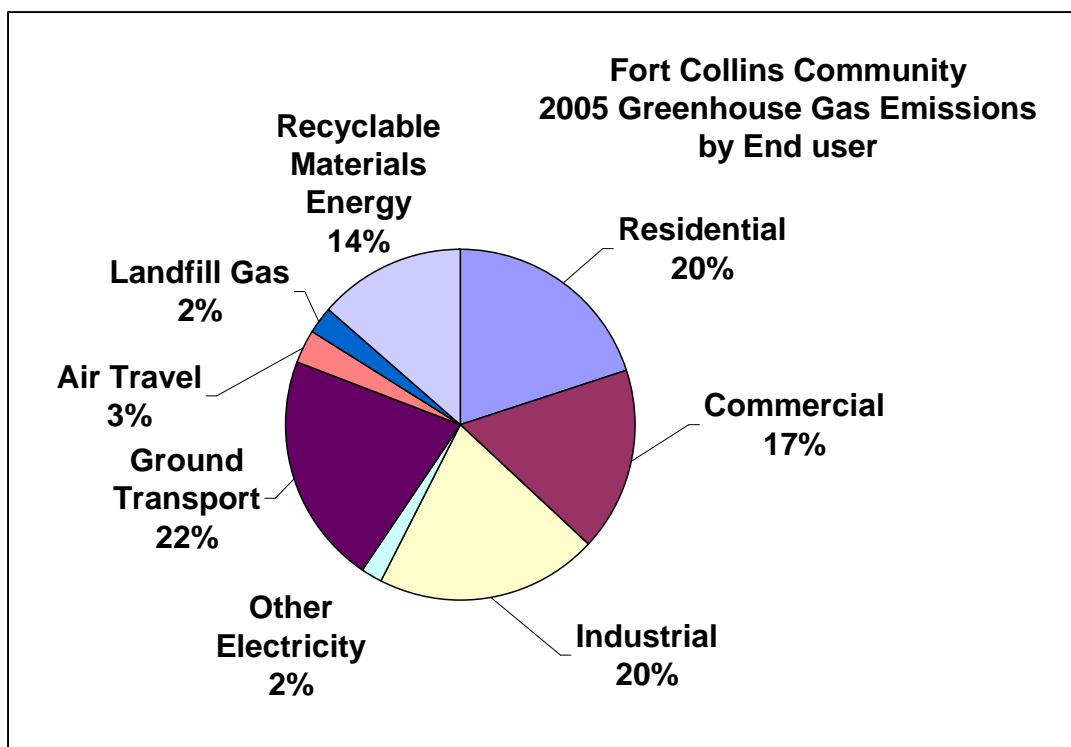


Table 47 details the calculation of localized 2005 Electricity Emissions Factors by PRPA:

Table 47. Calculation of Localized 2005 Electricity Emissions Factor

Source of Table: PRPA, 2006

2005 Operational Boundary Fort Collins GHG Emissions (Emissions Levels at Source)			
Resource	2005 Energy @ Generator (MWh)	Actual Emissions @ Generator (MT)	Emission Rate (lbs/MWh)
WAPA	319,594	-	-
Purchased Power	64,016	54,373	1,873
Renewable Owned Generation (Wind)	11,499	-	-
Fossil Generation	1,063,716	1,154,763	2,393
Total Fort Collins Operational Control	1,458,825	1,209,136	1,827
RECs	20,000	(11,053)	(1,218)
Total Net Utilities Operational Emissions	1,458,825	1,198,083	1,811

Table 48 summarizes natural gas use during 2005:

Table 48. 2005 Fort Collins Natural Gas Use from Xcel Energy

Source of Table: Xcel Energy, 2006

								WEATHER	
2005					WEATHER			ADJ	
		ACTUAL	NORMAL	ACTUAL	NORMAL	BASE	HEATING	HEATING	NORMAL
		SALES	HDD	HDD	FACTOR	LOAD	LOAD	LOAD	SALES
RESIDENTIAL		2,968,669	6238	5519	1.13028	771,854	2,196,815	2,483,016	3,254,870
COMMERCIAL		1,207,770				398,564	809,206	914,629	1,313,193
IND & TRANSPORT		3,051,712							3,051,712
TOTAL		7,228,151							7,619,775

Appendix C. – 2006 Emissions

Table 49. Fort Collins Community-wide 2006 GHG Emissions

Source of Table: 2006 CAP Status Report

Source	MT CO ₂ e	Type
Electricity	1,219,570	Indirect (Scope 2)
Natural Gas	389,209	Direct (Scope 1)
Ground Transport	580,221	Direct (Scope 1)
Air Travel	88,742	Indirect (Scope 3)
Landfill Gas	64,202	Indirect (Scope 3)
Recyclable Materials Energy	348,215	Indirect (Scope 3)
Total	2,690,160	
Benefit of Metered Wind	0	
Total	2,690,160	
Benefit of RECs	-16,833	
Benefit of Known Offsets	0	
Revised Total	2,673,327	

Table 50 below details the calculation of localized 2006 Electricity Emissions Factors by PRPA:

Table 50. Calculation of Localized 2006 Electricity Emissions Factor

Source of Table: PRPA, 2007

2006 Operational Boundary Fort Collins GHG Emissions (Emissions Levels at Source)			
Resource	2006 Energy @ Generator (MWh)	Actual Emissions @ Generator (MT)	Emission Rate (lbs/MWh)
WAPA	276,825	0	0
Purchased Power	60,697	51,554	1,873
Renewable Owned Generation (Wind)	16,379	0	0
Fossil Generation	1,115,439	1,167,519	2,308
Total Fort Collins Operational Control	1,469,340	1,219,072	1,829
RECs	29,220	-16,833	-1,270
Total Net Utilities			
Operational Emissions	1,469,340	1,202,240	1,804

Table 51 summarizes natural gas use during 2006:

Table 51. 2006 Fort Collins Natural Gas Use from Xcel Energy

Source of Table: Xcel Energy, 2007

								WEATHER	
2006					WEATHER			ADJ	
	ACTUAL	NORMAL	ACTUAL	NORMAL	BASE	HEATING	HEATING	HEATING	NORMAL
	SALES	HDD	HDD	FACTOR	LOAD	LOAD	LOAD	LOAD	SALES
RESIDENTIAL	2,922,660	6238	5550	1.12396	759,892	2,162,768	2,430,865		3,190,757
COMMERCIAL	1,221,100				402,963	818,137	919,553		1,322,516
IND & TRANSPORT	3,047,776								3,047,776
TOTAL	7,191,536								7,561,049

Appendix D. – 2007 Emissions**Table 52. Fort Collins Community-wide 2007 GHG Emissions**

Source of Table: 2007 CAP Status Report

Source	MT CO2e	Type
Electricity	1,194,703	Indirect (Scope 2)
Natural Gas	411,439	Direct (Scope 1)
Ground Transport	587,338	Direct (Scope 1)
Air Travel	93,405	Indirect (Scope 3)
Landfill Gas	64,707	Indirect (Scope 3)
Recyclable Materials Energy	353,084	Indirect (Scope 3)
Total	2,704,675	
Total	2,704,675	
Benefit of RECs	-48,590	
Benefit of known Offsets	0	
Revised Total	2,753,265	

Table 53 details the calculation of localized 2007 Electricity Emissions Factors by PRPA:

Table 53. Calculation of Localized 2007 Electricity Emissions Factors

Source of Table: PRPA, 2008

2007 Operational Boundary Fort Collins GHG Emissions (Emissions Levels at Source)			
Resource	2007 Energy @ Generator (MWh)	Actual Emissions @ Generator (MT)	Emission Rate (lbs/MWh)
WAPA	281,198	-	-
Purchased Power	32,391	29,911	2,036
Renewable Owned Generation (Wind)	11,039	-	-
Fossil Generation	1,187,578	1,164,155	2,161
Total Fort Collins Operational Control	1,512,207	1,194,067	1,741
RECs	81,961	(48,591)	(1,307)
Total Net Utilities			
Operational Emissions	1,512,207	1,145,476	1,670

Table 54 summarizes natural gas use during 2007:

Table 54. 2007 Fort Collins Natural Gas Use from Xcel Energy
Source of Table: Xcel Energy, 2008

								WEATHER	
2007					WEATHER			ADJ	
	ACTUAL		NORMAL	ACTUAL	NORMAL	BASE	HEATING	HEATING	NORMAL
	SALES	CUSTOMERS	HDD	HDD	FACTOR	LOAD	LOAD	LOAD	SALES
RESIDENTIAL	3,259,015	42,425	6238	5610	1.11194	847,344	2,411,671	2,681,633	3,528,977
									per
COMMERCIAL	1,312,612	3,872				433,162	879,450	977,896	1,411,058
IND & TRANSPORT	3,030,328	139							3,030,328
TOTAL	7,601,955	46,436							7,970,363

Appendix E. – 2008 Emissions

Table 55. Fort Collins Community-wide 2008 GHG Emissions

Source of Table: 2008 CAP Status Report

Source	MT CO ₂ e	Type
Electricity	1,135,603	Indirect (Scope 2)
Natural Gas	432,310	Direct (Scope 1)
Ground Travel	534,099	Direct (Scope 1)
Air Travel	92,082	Indirect (Scope 3)
Landfill Gas	58,367	Indirect (Scope 3)
Recyclable Materials Energy	290,582	Indirect (Scope 3)
Total	2,543,043	
Benefit of RECs and Known Offsets	-53,488	
Revised Total	2,596,531	

Table 56 details the calculation of localized 2008 Electricity Emissions Factors by PRPA:

Table 56. Calculation of Localized 2008 Electricity Emissions Factors

Source of Table: PRPA, 2009

2008 Operational Boundary Fort Collins GHG Emissions (Emissions Levels at Source)			
Resource	Energy @ Generator (MWh)	Actual Emissions @ Generator (MT)	Emission Rate (lbs/MWh)
WAPA	299,437	-	-
Purchased Power	58,728	50,161	1,883
Renewable Owned Generation (Wind)	16,247	-	-
Fossil Generation	1,124,435	1,084,715	2,127
Total Fort Collins Operational Control	1,498,848	1,134,876	1,669
RECs	76,753	(53,719)	(1,543)
Total Net Utilities Operational Emissions	1,498,848	1,081,157	1,590

Table 57 summarizes natural gas use during 2007:

Table 57. 2008 Fort Collins Natural Gas Use from Xcel Energy
Source of Table: Xcel Energy, 2009

2008	ACTUAL		NORMAL	ACTUAL	WEATHER			ADJ	
	SALES	CUSTOMERS	HDD	HDD	FACTOR	BASE	HEATING	HEATING	NORMAL
						LOAD	LOAD	LOAD	SALES
RESIDENTIAL	3,499,162	43,643	6238	5981	1.04297	909,782	2,589,380	2,700,646	3,610,428
COMMERCIAL	1,357,919	3,910				448,113	909,806	948,900	1,397,013
IND & TRANSPORT	3,130,419	150							3,130,419
TOTAL	7,987,500	47,703							8,137,860

Appendix F. – 2009 Emissions**Table 58. Fort Collins Community-wide 2009 GHG Emissions**

Source: 2009 CAP Status Report

Source	MT CO ₂ e	Type
Electricity	1,192,558	Indirect (Scope 2)
Natural Gas	428,105	Direct (Scope 1)
Ground Travel	540,650	Direct (Scope 1)
Air Travel	82,538	Indirect (Scope 3)
Landfill Gas	52,026	Indirect (Scope 3)
Recyclable Materials Energy	247,498	Indirect (Scope 3)
Total	2,543,375	
Benefit of RECs and Known Offsets	-56,769	
Revised Total	2,486,606	

Table 59 details the calculation of localized 2009 Electricity Emissions Factors by PRPA:

Table 59. Calculation of Localized 2009 Electricity Emissions Factors

Source of Table: PRPA, 2010

2009 Operational Boundary Fort Collins GHG Emissions (Emissions Levels at Source)			
Resource	Energy @ Generator (MWh)	Actual Emissions @ Generator (MT)	Emission Rate (lbs/MWh)
WAPA	291,999	-	-
Purchased Power	8,427	7,198	1,883
Renewable Owned Generation (Wind)	13,643	-	-
Fossil Generation	1,164,097	1,184,348	2,243
Total Fort Collins Operational Control	1,478,166	1,191,546	1,777
RECs	81,358	(56,684)	(1,536)
Total Net Utilities Operational Emissions	1,478,166	1,134,862	1,693

Table 60 summarizes natural gas use during 2009:

Table 60. 2009 Fort Collins Natural Gas Use from Xcel Energy
Source of Table: Xcel Energy, 2010

									WEATHER	
2009						WEATHER			ADJ	
	ACTUAL		NORMAL	ACTUAL	NORMAL	BASE	HEATING	HEATING	HEATING	NORMAL
	SALES	CUSTOMERS	HDD	HDD	FACTOR	LOAD	LOAD	LOAD	LOAD	SALES
RESIDENTIAL	3,582,743	46,087	6238	5919	1.05389	931,513	2,651,230	2,794,105		3,725,618
COMMERCIAL	1,352,791	4,070				446,421	906,370	955,214		1,401,635
IND & TRANSPORT	2,974,045	167								2,974,045
TOTAL	7,909,579	50,324								8,101,298

Appendix G. – 2010 Emissions**Table 61. Fort Collins Community-wide 2010 GHG Emissions**

Source: 2010 CAP Status Report

Source	MT CO₂e	Type
Electricity	1,096,499	Indirect (Scope 2)
Natural Gas	421,762	Direct (Scope 1)
Ground Travel	547,282	Direct (Scope 1)
Air Travel	90,226	Indirect (Scope 3)
Landfill Gas	35,757	Indirect (Scope 3)
Recyclable Materials Energy	201,274	Indirect (Scope 3)
Total	2,392,800	
Benefit of RECs	-32,737	
Benefit of Known Offsets	-332	
Revised Total	2,359,731	