

# **Lawrence Livermore National Laboratory**

## **FY10 Greenhouse Gas Inventory - Quarters 1 thru 3**

**September 28, 2010**

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## Note to reader:

This report only represents LLNL's GHG emissions for the first three quarters of FY10 as agreed upon by Karin King, Livermore Site Office, to be followed by a full report for FY10 by the end of November. This report represents calculations based on the best data available at this time and will be revised as necessary to accommodate either changes in guidance or data quality.

In the final report an Executive Summary will be included and a brief discussion as to the relationship of LLNL's FY10 Greenhouse Gas (GHG) emissions to the baseline FY08 prepared by DOE with input data from LLNL. In addition LLNL will calculate an FY08 baseline based on all the components of the FY10 data assuming equivalent data is available for all the scope requirements.

LLNL is in the process of developing a Site Sustainability Plan (SSP) which will include plans and considerations of actions to assist DOE in meeting the goals of a 28% reduction of Scope 1 and 2 GHG emissions (FY08 baseline) and a 13% reduction of Scope 3.

### Q1-Q3 FY10 Emissions Summary

	Sources		CO <sub>2</sub> e Tonnes
Scope 1	Reduction Goal 28%		
	Combustion		
		Stationary Combustion	21,604.8 <sup>+</sup>
		Mobile Combustion (Gasoline/Diesel)	983.10
		E85	394.97
	Common Fugitive Emissions	SF6	108.34
		PFC	84.10
		HFC	38.33
	Other Gases	CO <sub>2</sub>	
		CH <sub>4</sub>	
	Other	Sewage Lagoon	1.551
		Controlled Burns	2946 <sup>**</sup>
Scope 2	Reduction Goal 28%		
	Electricity	Building Electricity	97,708.33
	REC		To be included in final report
Scope 3	Reduction Goal 13%		
	Travel	Air	7,214.93
		Commuting	31,505.73
	Transmission & Distribution		6,436.00
	Wastewater Treatment (LWRP)		176.386
	Municipal Waste Disposal		25.48
Total GHG			169,228.51

<sup>+</sup>Based on Calculations from the GHG Protocol due to an error in the GSA Tool

<sup>\*\*</sup> GH calculated based on "Smoke Emissions from Prescribed Burning of Southern California Chaparral. Feb 1996."

## **Introduction**

Lawrence Livermore National Laboratory (LLNL) is a premier national security research laboratory that is part of the National Nuclear Security Administration (NNSA) within the U.S. Department of Energy (DOE).

As a national security laboratory, LLNL is responsible for advancing and applying science and technology to ensure that the nation's nuclear weapons remain safe, secure, and reliable. The Laboratory also meets other pressing national security needs, including countering the proliferation of weapons of mass destruction and strengthening homeland security; conducts major research in atmospheric, earth, and energy sciences; bioscience and biotechnology; and engineering, basic science, and advanced technology. The Laboratory, with a staff of approximately 6400, serves as a scientific resource to the U.S. government and a partner to industry and academia.

The Laboratory is committed to providing a safe, clean environment for its employees and neighboring communities. LLNL programs comply with the National Environmental Policy Act, DOE Orders, and related federal and state requirements. LLNL operations release a variety of constituents into the environment via atmospheric, surface water, and groundwater pathways. All releases are highly regulated and carefully monitored. Safe, secure, and efficient operations that provide a safe, clean environment for employees and neighboring communities are a necessary part of the Laboratory's research and development programs and underpin their success. Experts in Environment, Safety and Health (ES&H) support all Laboratory activities. LLNL's radiological control program ensures that radiological exposures and releases are reduced to as low as reasonably achievable to protect the health and safety of its employees, contractors, the public, and the environment.

LLNL is committed to enhancing its environmental stewardship and reducing any impacts its operations may have on the environment. The Laboratory encourages the public to participate in matters related to the Laboratory's environmental impact on the community by soliciting citizens' input on matters of significant public interest and through various communications. The Laboratory also provides public access to information on its ES&H activities.

This report represents data from the first three quarters of FY10. The report will be updated in November to represent the entire fiscal year.

## **Partner Information**

LLNL is managed and operated by Lawrence Livermore National Security, LLC (LLNS); the management team includes Bechtel National, University of California, Babcock and Wilcox, Washington Division of URS Corporation, and Battelle. NNSA awarded Contract Number DEAC52-07NA27344 to LLNS to manage and operate LLNL.

Facility Address: 7000 East Avenue  
Livermore, CA 94550

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Other relevant Information: Reporting Period	FY10
Number of Employees	5914
Building Square Feet (Sites 200 and 300)	7,029,899

## Organizational Boundaries

For setting organizational boundaries for the reporting of LLNL's GHG emissions LLNL will utilize the Operations Control Approach. This will ensure that LLNL is accounting for 100% of the GHG emissions from the operations that it controls. The inventory does not include Scope 2 and 3 emissions related to the activities of DOE staff that reside at LLNL. For this purpose Operational Control means:

- Facilities that LLNL has the full authority to introduce and implement its operating policies, and
- Leased facilities that LLNL has the ability to track energy use and/or emissions from the leased property.

LLNL consists of two sites—an urban site in Livermore, California, referred to as the “Livermore site,” which occupies 1.3 square miles; and a rural Experimental Test Site, referred to as “Site 300,” near Tracy, California, which occupies 10.9 square miles. All the structures, activities and lands within these two sites are within the control of LLNL.

Livermore Site: 7000 East Avenue  
Livermore, CA 94550  
DOE Owned – LLNS Operated

Site 300: Corral Hollow Road (in rural foothills approximately six miles southwest of downtown Tracy and 15 miles southeast of Livermore)  
DOE Owned – LLNS Operated

**Table 1.  
Leased Assets**

<b>Description</b>	<b>Location</b>	<b>Sq. Feet</b>	<b>Lease Dates</b>	<b>Electric/Gas</b>
Office Space Warehouse	2368 Research Drive, Livermore	3,570	05/07/2010 to 11/06/2013	Yes/Yes
Office Space (2 suites)	Graham Court, Livermore	14,288	xxxx - 08/2010	Yes/Yes
NIF Warehouse	6818 Patterson Pass, Livermore	51,936	02/25/1998 to 09/13/2010	We pay electric as "Additional Rent"
Office Space	2300 First Street, Livermore	3,647	03/01/2008 to 02/28/2014	Yes/Yes
Office Space	L'Enfant Plaza, Washington, DC	5,274	03/06/1998 to 09/30/2012	No/No
Laboratory	Holland Laboratory, Rockford, MD	5,682	11/20/2007 to 04/30/2011	No/No

**Other Properties**

<b>Description</b>	<b>Location</b>	<b>Sq. Feet</b>	<b>Lease Date</b>	<b>Electric/Gas</b>
Pump Station	Arroyo Mocho	NA	NA	Yes/No
Environmenta l Restoration off-site treatment	Miscellaneous	NA	NA	Yes/No
Leased sites for continuous air monitors	Varies	NA	Varies	No/No

## Operational Boundaries: Scopes

The Operational Boundaries are defined by the three major scopes of Green House Gas emissions. These are depicted below with a drawing from the World Resources Institute and are described below.

### Scope 1

LLNL must report all direct GHG emissions from sources that we own or control. While EO 13514 allows for some exclusion of certain sources for the GHG reduction targets they are not excluded from the inventory. LLNL's Scope 1 emissions result primarily from the following types of activities:

- Fuel combustion for the generation of electricity, heat, cooling, or steam (e.g., boilers, furnaces, and emergency generators).
- Mobile source agency controlled emissions that result from the combustion of fuels in mobile combustion sources including LLNL's GSA-leased vehicles, commercially leased, and agency-owned vehicles and the emissions from biofuel combustion.
- Fugitive emissions from intentional or unintentional releases of GHGs from within LLNL's organizational boundary:
  - equipment leaks from joints, seals, packing, and gaskets;
  - landfills (domestic) and wastewater (municipal) treatment, LLNL currently only operates the sewage lagoon at Site 300 which would qualify under this activity;

- Pure gases such as CO<sub>2</sub> and Methane;
- HFC/PFC emissions from the use of refrigeration and air conditioning equipment; methane leaks from gas transport; and
- SF<sub>6</sub> emissions from leaking electrical equipment/accelerators.

## **Scope 2**

LLNL must account for and report indirect emissions associated with:

- Consumption of purchased or acquired electricity, steam, heating, or cooling.
- Emissions related to the electricity purchased for Federal fleet electric vehicles, including low speed electric vehicles (LSEVs). LLNL currently does not have any fleet electric vehicles. LLNL does have LSEVs, but there is no metered data for the recharging of these vehicles, therefore it is included within the consumption of purchased electricity.
- Agencies that purchase electricity must report indirect emissions associated with transmission and distribution (T&D) losses in Scope 2 only for the T&D operations they control. Emissions associated with T&D losses from purchased steam and chilled water are categorized as Scope 2 emissions. LLNL does not purchase steam or chilled water. Indirect T&D electricity losses (i.e. those associated with electricity purchased from a utility or provider not under the operational control of the agency) are required in Scope 3 reporting.

## **Scope 3**

Scope 3 includes all other indirect emissions not included in Scope 2. Scope 3 emissions are the consequence of LLNL's activities but are released from sources outside our organizational boundary. Based on draft guidance, Scope 3 is an evolving area of GHG accounting, recent and accepted methods for calculating emissions are evolving. As new methodologies and procedures are developed they will be included in the requirements for the inventory process. Examples of these areas include operations associated with leased space, vendors, contractors and supply chain.

The current requirements for Scope 3 include the following:

- Federal employee business air travel;
- Federal employee business ground travel (this will be added for the final report);
- Federal employee commuting;
- Contracted solid waste disposal, i.e. municipal solid waste that is sent to a landfill not owned or operated by the agency;
- Wastewater treatment, i.e. municipal wastewater that is sent to a wastewater treatment plant not owned or operated by LLNL; and
- T&D losses associated with purchased electricity.

LLNL's specific classes of emission sources are presented in Table 2.



**Table 2. Emission Sources**

X = Total emissions from an activity

x = Specific activities that contribute to the total emissions

\*Activities required to be reported to DOE annually (FY)

	CO <sub>2</sub>	CH <sub>4</sub>	N <sub>2</sub> O	SF <sub>6</sub>	HFCs	PCFs
<b>Scope 1: Direct Emissions:</b>						
<b>Natural Gas/Propane Total*</b>	<b>X</b>	<b>X</b>	<b>X</b>			
Stationary Boilers	x	x	x			
Water Heaters	x	x	x			
Miscellaneous Laboratory Equipment	x	x	x			
<b>Unleaded Gasoline - Total*</b>	<b>X</b>	<b>X</b>	<b>X</b>			
Construction Equipment	x	x	x			
Equipment	x	x	x			
Forklifts	x	x	x			
GSA Vehicles	x	x	x			
NNSA Vehicles	x	x	x			
Portable Equipment	x	x	x			
<b>Diesel Total*</b>	<b>X</b>	<b>X</b>	<b>X</b>			
Construction Equipment	x	x	x			
Equipment	x	x	x			
Forklifts	x	x	x			
GSA Vehicles	x	x	x			
NNSA Vehicles	x	x	x			
Portable Equipment	x	x	x			
<b>Propane Total *</b>	<b>X</b>	<b>X</b>	<b>X</b>			
Equipment	x	x	x			
Forklifts	x	x	x			
<b>E85*</b>	<b>X</b>	<b>X</b>	<b>X</b>			
GSA Vehicles	x	x	x			
NNSA Vehicles	x	x	x			
<b>Refrigerants Emissions*</b>						
PFC-318/PFC-c318						X
HFC-43-10mee					X	
<b>Wasterwater Treatment – Sewage Lagoon*</b>	<b>X</b>	<b>X</b>				
<b>Fugitive Emissions SF<sub>6</sub>*</b>				<b>X</b>		
Accelerators				x		
Electrical Equipment				x		
<b>Other Gases*</b>						
CO <sub>2</sub>	X					
Methane		X				

	CO <sub>2</sub>	CH <sub>4</sub>	N <sub>2</sub> O	SF <sub>6</sub>	HFCs	PCFs
<b>Other</b>						
Open Burning	CO	X				
<b>Scope 2 Indirect Emissions:</b>						
<b><i>Purchased Electricity*</i></b>	X	X	X			
HVAC Systems	x	x	x			
Lighting	x	x	x			
Water Heaters	x	x	x			
R&D/Equipment Support	x	x	x			
<b><i>REC Reductions*</i></b>						
<b>Scope 3 Indirect Miscellaneous Emissions</b>						
<b><i>Transmission &amp; Distribution Losses*</i></b>	X	X	X			
<b><i>Employee Commuting*</i></b>	X					
<b><i>Employee Travel*</i></b>						
Employee Travel short Haul <300 miles	X	X	X			
Employee Travel Medium Haul 300- <700 miles	X	X	X			
Employee Travel Long Haul >700 miles	X	X	X			
Ground Travel-Rental Cars and POVs	X	X	X			
<b><i>Solid Waste Disposal*</i></b>	X	X				
<b><i>Wastewater Treatment – Domestic Sewage (LWRP)*</i></b>	X	X				

Table 3 describes the original data resource utilized to quantify data as the input data to the GSA Carbon Footprint and Green Procurement Tool for the specific type of activity. The GSA Carbon Footprint and Green Procurement Tool utilizes accepted values from the World Resource Institute (WRI, 2006) ([www.ghgprotocol.org](http://www.ghgprotocol.org)). The calculations generated by the GSA Tool are in accordance with the ISO 14064-1 “Specification with Guidance at the organization level for quantification and reporting of greenhouse gas emissions and removals.”

For example under indirect emissions generated as a result of electric energy utilization, the purchased electrical energy will be input to the GSA Tool and the emission factors associated with the electric grid sub-region will be identified by the eGrid.

**Table 3. Data Sources for Determining GHG Emissions**

\*Activities required to be reported to DOE annually (FY)

<b>Scope 1: Direct Emissions:</b>	<b>Documentation type for determining GHG Emissions</b>
<b><i>Natural Gas/Propane Total*</i></b>	As reported to FEMP and is based on the PG&E billing
Stationary Boilers	LLNL has 4 permitted and metered boilers. Though this is a subset of total natural gas it is presented to add some detail.
Water Heaters	Included in total above
Miscellaneous Laboratory Equipment	Balance of unaccounted utilization of purchased fuel included in the total
<b><i>Unleaded Gasoline*</i></b>	
Construction Equipment	Records of dispensed fuel
Equipment	Records of dispensed fuel
Forklifts	Records of dispensed fuel
GSA Vehicles	Records of dispensed fuel
NNSA Vehicles	Records of dispensed fuel
Portable Equipment	Records of dispensed fuel
<b><i>Diesel*</i></b>	
Construction Equipment	Records of dispensed fuel
Equipment	Records of dispensed fuel
Forklifts	Records of dispensed fuel
GSA Vehicles	Records of dispensed fuel
NNSA Vehicles	Records of dispensed fuel
Portable Equipment	Records of dispensed fuel
<b><i>Propane*</i></b>	
Equip.	Records of dispensed fuel
Forklifts	Records of dispensed fuel
<b><i>E85*</i></b>	
GSA Vehicles	Records of dispensed fuel
NNSA Vehicles	Records of dispensed fuel
<b><i>Refrigerants Emissions*</i></b>	Delta of purchased and in stock
<b><i>Wasterwater Treatment – Sewage Lagoon*</i></b>	Information received from the Site 300 Managers Office
<b><i>Fugitive Emissions SF<sub>6</sub>*</i></b>	Combined purchasing of SF <sub>6</sub> minus returned empty containers
<b><i>Other Gases*</i></b>	Combined purchasing of the specific gas minus returned empty containers
<b><i>Other</i></b>	
Open Burning	Actual acreage burned

<b>Scope 2 Indirect Emissions:</b>	
<b><i>Purchased Electricity*</i></b>	Total purchase based on metering/billing
<b>Scope 3 Indirect Miscellaneous Emissions</b>	
<b><i>Employee Commuting*</i></b>	Estimation based on HR data on number of employees, average commute miles based on ZIP codes, number of employees on alternative work week 9/80 and 4/10s
<b><i>Employee Travel*</i></b>	Travel data is provided by the LLNL travel agency. The data represents the tickets sold and miles per ticket. It does not include those who buy tickets outside the travel agency such as interviewees, other guests, contractors etc.
<b>Solid Waste Disposal – Off-site*</b>	(Does not include concrete, soil or non-friable asbestos)
Routine	Invoices
Non-routine	Invoices
<b><i>Wastewater Treatment – Domestic Sewage (LWRP)*</i></b>	Calculations are based on number of employees

The majority of data originates from either measured by metering or purchasing data (invoices).

## Inventory Results

**Table 4. Q1-Q3 FY10 and DOE's FY08 Emissions Summary**

Emissions Summary			1-3Q FY10	DOE FY08
		Source Total	CO <sub>2</sub> e Tonnes	CO <sub>2</sub> e Tonnes
Scope 1				
	Combustion			
		Stationary combustion	21604.8 <sup>+</sup>	25,884.97
		Mobile Combustion (Gasoline/Diesel)	983.10	2,010.08
		E85	394.97	70.01
	Common Fugitive Emissions	SF6	108.34	33,227.23
		PFC	84.10	
		HFC	38.33	
	Other Gases	CO <sub>2</sub>		
		CH <sub>4</sub>		
	Other	Sewage Lagoon	1.551	
		Controlled Burning (Site 300)	2964 <sup>**</sup>	
Scope 2				
	Electricity	Building Electricity	97,708.33	130,928.31
		RECs	To be included in final report	
Scope 3				
	Travel	Air	7,214.93	9,686.94
		Commuting	31,505.73	775.36
	Transmission & Distribution		6,436.00	16,723.95
	Other	Wastewater Treatment (LWRP)	176.386	
		Municipal Waste Disposal	25.48	
Total GHG			169,228.047	219,307.70

<sup>+</sup>Based on Calculations from the GHG Protocol due to an error in the GSA Tool

<sup>\*\*</sup> GH calculated based on "Smoke Emissions from Prescribed Burning of Southern California Chaparral. Feb 1996,"

In the final report, which will include the complete FY10 GHG inventory, a discussion and comparison with the FY08 data will be presented. Currently if the fourth quarter is consistent with the first three, it would appear LLNL's GHG inventory has increased, due to the fact that the FY08 GHG inventory does not include all the elements of the

FY10 and there appears to be an error in the DOE commuting calculation. Where data is available, LLNL will develop a more complete inventory for more accurate comparisons.

In addition the Renewable Energy Credits (RECs) have not been incorporated into the inventory, but will be incorporated into the final report. The GSA tool and the GHG protocol tools do not have REC calculations.

## Future Planning

LLNL is in the process of developing a Site Sustainability Plan (SSP) which will include plans and considerations of actions to assist DOE in meeting the goals of a 28% reduction in GHG emissions (FY08 baseline) of Scope 1 and 2 and a 13% reduction of Scope 3 GHG emissions. The SSP will be incorporating existing planning from the DOE 430.2B Executable Plan Update and Annual Report on Energy Management, with new proposed efforts to continue LLNL's implementation of sustainability.

Current items in the Executable Plan that can have an effect on GHGs are presented in the summary below:

<b>Goals from the Current DOE 430.2B Order</b>	<b>Contributing efforts and proposals presented in the December 31, 2009 report</b>
28% Scope 1 & 2 GHG reduction by FY20 from a FY08 baseline - related goals from the executable plan:	
30% energy intensity reduction by FY15 from a FY03 baseline	Data Centers Efficiency Measures: <ul style="list-style-type: none"> <li>• server consolidation</li> <li>• server virtualization</li> </ul> Best Management Practices: <ul style="list-style-type: none"> <li>• Software applications are being</li> <li>• Added: WEBCTRL for the HVAC controls, and EEM Data Management and Analysis for the advanced metering system.</li> <li>• Implementing the American Society of Heating, Refrigerating and Air-Conditioning Engineers (ASHRAE) TC 9.9 Data Center cooling best practices</li> </ul> Energy Conservation Measures in the Terasacle Simulation Facility "Energy Star" Rated Appliances and energy efficient Equipment: <ul style="list-style-type: none"> <li>• Replace B111 old boilers with three condensing boilers, a new hot water boiler and gas meters.</li> <li>• Replace boilers at B381 with a condensing boiler and install advanced gas meter.</li> </ul>
7.5% of a site's annual electricity consumption from renewable sources by FY10 (2x credit if the energy is produced on-site)	LLNL continues to promote the purchase of a renewable power generating facility through the Northern California Power Agency and via the purchase of Renewable Energy Credits (RECs).

<b>Goals from the Current DOE 430.2B Order</b>	<b>Contributing efforts and proposals presented in the December 31, 2009 report</b>
Every site to have at least one on-site renewable energy generating system by FY10	To date low cost of electricity at LLNL makes renewable energy projects life-cycle cost-ineffective though LLNL: <ul style="list-style-type: none"> <li>• Is evaluating the possibility of installing a fuel cell generating station on-site.</li> <li>• LLNL continues to promote the installation of PVs to replace standard external lighting for parking areas and exterior building lighting.</li> </ul>
10% annual increase in fleet alternative fuel consumption by FY15 relative to a FY05 baseline	In all three of these areas we continue to develop initiatives to reduce petroleum consumption, to name a few:
2% annual reduction in fleet petroleum consumption by FY15 relative to a FY05 baseline	<ul style="list-style-type: none"> <li>• Right-size the government vehicle fleet,</li> <li>• On-site mass transportation,</li> <li>• Restructuring the fleet vehicle type,</li> <li>• Restructuring the alternative fuel vehicle fleet,</li> <li>• Introduction of new types of alternative fuel vehicles into the fleet, and</li> <li>• Restructuring the bicycle fleet.</li> </ul>
75% of light duty vehicle purchases must consist of alternative fuel vehicles (AFV) by FY15	<ul style="list-style-type: none"> <li>• Restructuring the bicycle fleet.</li> </ul>
To the maximum extent practicable: advanced metering for electricity (by October 2012), steam, and natural gas (by October 2016); standard meters for water	<ul style="list-style-type: none"> <li>• Approximately 70 of the 87 advanced meters were scheduled to be online by the end of FY10.</li> <li>• LLNL is developing a plan to provide for remote data collection from meters and installation of new meters at facilities consuming natural gas.</li> </ul>
Cool roofs, unless uneconomical, for roof replacements unless project already has CD-2 approval. New roofs must have thermal resistance of at least R-30.	These will be new to the SSP and are in development.
Training and outreach. DOE facility energy managers to be Certified Energy Managers by September 2012.	These will be new to the SSP and are in development.
Sulfur hexafluoride (SF6) capture program by September 2012.	These will be new to the SSP and are in development.
13% Scope 3 GHG reduction by FY20 from a FY08 baseline	As with many goals this one will be a challenge. The development of the SSP will incorporate studies for effectiveness of reducing GHG while complementing the operation and mission of the Laboratory. Such initiatives could include: <ul style="list-style-type: none"> <li>• Mandatory AWS work schedule with a specified day off resulting in a three day weekend every other week</li> <li>• Telecommuting</li> <li>• Incentives for car/van pooling</li> </ul> Potential policy development for travel: <ul style="list-style-type: none"> <li>• Eliminating rentals when there is adequate public transportation</li> <li>• No car rental when staying in the host hotel of a conference</li> <li>• Increasing the use of electronic media (webinars, video conference/meeting and conference calls)</li> </ul>

There are four existing Environmental Management Plans that will contribute to the continued reduction of GHGs:

- Energy Conservation, EMP-LLNL-2010-004
- Fossil Fuel Consumption, EMP-LLNL-2010-006
- GHG Emissions Reduction, EMP-LLNL-2010-003
- Municipal Waste Reduction, EMP-LLNL-2010-002

As new proposals develop and become funded they will be incorporated into the EMS process as appropriate.



## **Attachment 1**

### **GSA Carbon Footprint and Green Procurement Tool**



## *Carbon Footprint and Green Procurement Tool*

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### **GHG Report**

## **Annual Demo Agency - Tool Preview Emissions FY2010**

**Site: CA**

**Generated on: September 28, 2010, 8:09 pm**

### **Agency**

**Reporting Agency:** Demo Agency - Tool Preview

**Agency Description:**

**Agency Website:** <http://www.carbonfootprint.gsa.gov>

**Report Preparer:** John Consolati

**Reporting Period:** The base year for this report is FY2010.

**Organizational Boundaries:**

**Operational Boundaries:**

## CO<sub>2</sub> Emissions Summary

<b>Emissions Summary:</b>	<b>Electricity</b>	<b>Fuel Consumption</b>	<b>Business Travel</b>	<b>Commuting</b>	<b>Total</b>
	97,708.334	1,612.705	13,852.925	31,505.733	144,679.697

All values are in metric tons of CO<sub>2</sub> equivalents.

<b>Other Gases:</b>	<b>N<sub>2</sub>O</b>	<b>CH<sub>4</sub></b>	<b>HFC</b>	<b>PFC</b>	<b>SF<sub>6</sub></b>	<b>Total</b>
	0.000	0.000	38.329	84.096	108.409	230.833

All values are in metric tons of CO<sub>2</sub> equivalents.

## Formulas Calculated in the GHG Inventory

### Scope 1: Direct Emissions

(Required; direct GHG emissions) – Emissions from sources that the company owns or controls. Includes direct emissions such as direct fuel consumption.

#### Mobile Combustion

Fossil Fuels
<b>Mobile Combustion - Fossil Fuel CO<sub>2</sub></b>
= Annual CO <sub>2</sub> Fossil Fuels
$= ( ( 74326.6 \text{ gallons} * 0.125 \text{ MMBtu / Gallon of Gasoline} * 70.22 \text{ Kg CO}_2 / \text{MMBtu of Gasoline} ) + ( 31523.7 \text{ gallons} * 0.138 \text{ MMBtu / Gallon of Diesel} * 73.96 \text{ Kg CO}_2 / \text{MMBtu of Diesel} ) + ( 0 \text{ gallons} * 0.120 \text{ MMBtu / Gallon of Aviation Gas} * 69.25 \text{ Kg CO}_2 / \text{MMBtu of Aviation Gas} ) + ( 0 \text{ gallons} * 0.135 \text{ MMBtu / Gallon of Jet Fuel} * 72.22 \text{ Kg CO}_2 / \text{MMBtu of Jet Fuel} ) + ( 0 \text{ gallons} * 0.135 \text{ MMBtu / Gallon of LPG} * 72.22 \text{ Kg CO}_2 / \text{MMBtu of LPG} ) ) * 2.20462$
= 2,147,625.602 Lbs CO <sub>2</sub>
<b>Mobile Combustion - Fossil Fuel N<sub>2</sub>O</b>
= Annual CO <sub>2</sub> e Fossil Fuels N <sub>2</sub> O
$= ( ( 74326.6 \text{ gallons} * 17.2 \text{ miles per gallon} * 0.0157 \text{ g N}_2\text{O} / \text{mile} ) + ( 31523.7 \text{ gallons} * 17.2 \text{ miles per gallon} * 0.0157 \text{ g N}_2\text{O} / \text{mile} ) + ( 0 \text{ gallons} * 0.11 \text{ g N}_2\text{O} / \text{gallon} ) + ( 0 \text{ gallons} * 0.31 \text{ g N}_2\text{O} / \text{gallon} ) + ( 0 \text{ gallons} * 0.067 \text{ g N}_2\text{O} / \text{gallon} ) ) / 1000.0 * 2.20462$
= 63.016 Lbs CH <sub>4</sub>
<b>Mobile Combustion - Fossil Fuel CH<sub>4</sub></b>
= Annual CO <sub>2</sub> e Fossil Fuels CH <sub>4</sub>
$= ( ( 74326.6 \text{ gallons} * 17.2 \text{ miles per gallon} * 0.0148 \text{ g CH}_4 / \text{mile} ) + ( 31523.7 \text{ gallons} * 17.2 \text{ miles per gallon} * 0.0148 \text{ g CH}_4 / \text{mile} ) + ( 0 \text{ gallons} * 7.04 \text{ g CH}_4 / \text{gallon} ) + ( 0 \text{ gallons} * 0.27 \text{ g CH}_4 / \text{gallon} ) + ( 0 \text{ gallons} * 0.037 \text{ g CH}_4 / \text{gallon} ) ) / 1000.0 * 2.20462$
= 59.404 Lbs N <sub>2</sub> O
<b>Total CO<sub>2</sub>e emissions</b>
= 2,147,625.602 lbs CO <sub>2</sub> + 63.016 lbs CH <sub>4</sub> * 21 + 59.404 lbs N <sub>2</sub> O * 310
= 2,167,364.200 Lbs CO <sub>2</sub> e
= 983.100 MT CO <sub>2</sub> e

#### BioFuels

<b>Mobile Combustion - BioFuel CO<sub>2</sub></b>
= Annual CO <sub>2</sub> BioFuels
$= ( ( 63356.2 \text{ gallons} * 0.084 \text{ MMBtu / Gallon of Ethanol} * 68.44 \text{ Kg CO}_2 / \text{MMBtu of Ethanol} * 0.85 ) + ( 63356.2 \text{ gallons} * 0.125 \text{ MMBtu / Gallon of Gasoline} * 70.22 \text{ Kg CO}_2 / \text{MMBtu of Gasoline} * 0.15 ) + ( 0 \text{ gallons} * 0.128 \text{ MMBtu / Gallon of BioDiesel} * 73.84 \text{ Kg} )$

$$\text{CO}_2 / \text{MMBtu of BioDiesel} * 0.20) + (0 \text{ gallons} * 0.138 \text{ MMBtu} / \text{Gallon of Diesel} * 73.96 \text{ Kg CO}_2 / \text{MMBtu of Diesel} * 0.80) + (0 \text{ gallons} * 0.128 \text{ MMBtu} / \text{Gallon of BioDiesel} * 73.84 \text{ Kg CO}_2 / \text{MMBtu of BioDiesel})) * 2.20462$$

$$= 866,446.034 \text{ Lbs CO}_2$$

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**Mobile Combustion - BioFuel N<sub>2</sub>O**


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$$= \text{Annual CO}_2\text{e BioFuel N}_2\text{O}$$

$$= ((63356.2 \text{ gallons} * 0.084 \text{ MMBtu} / \text{Gallon of Ethanol} * 0.85) + (63356.2 \text{ gallons} * 0.125 \text{ MMBtu} / \text{Gallon of Gasoline} * 0.15) + (0 \text{ gallons} * 0.128 \text{ MMBtu} / \text{Gallon of BioDiesel} * 0.20) + (0 \text{ gallons} * 0.138 \text{ MMBtu} / \text{Gallon of Diesel} * 0.80) + (0 \text{ gallons} * 0.128 \text{ MMBtu} / \text{Gallon of BioDiesel})) * 0.00011 \text{ Kg CO}_2\text{e} / \text{MMBtu of BioFuel for N}_2\text{O} * 2.20462$$

$$= 1.385 \text{ Lbs CH}_4$$

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**Mobile Combustion - BioFuel CH<sub>4</sub>**


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$$= \text{Annual CO}_2\text{e BioFuel CH}_4$$

$$= ((63356.2 \text{ gallons} * 0.084 \text{ MMBtu} / \text{Gallon of Ethanol} * 0.85) + (63356.2 \text{ gallons} * 0.125 \text{ MMBtu} / \text{Gallon of Gasoline} * 0.15) + (0 \text{ gallons} * 0.128 \text{ MMBtu} / \text{Gallon of BioDiesel} * 0.20) + (0 \text{ gallons} * 0.138 \text{ MMBtu} / \text{Gallon of Diesel} * 0.80) + (0 \text{ gallons} * 0.128 \text{ MMBtu} / \text{Gallon of BioDiesel})) * 0.0011 \text{ Kg CO}_2\text{e} / \text{MMBtu of BioFuel for CH}_4 * 2.20462$$

$$= 13.851 \text{ Lbs N}_2\text{O}$$

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**Total CO<sub>2</sub>e emissions**


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$$= 866,446.034 \text{ lbs CO}_2 + 1.385 \text{ lbs CH}_4 * 21 + 13.851 \text{ lbs N}_2\text{O} * 310$$

$$= 870,768.933 \text{ Lbs CO}_2\text{e}$$

$$= 394.974 \text{ MT CO}_2\text{e}$$


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## Common Fugitive Emissions

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### Hydrofluorocarbons

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**Fugitive Gas - Hydrofluorocarbons**


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$$= \text{HFC-23} * \text{gwp of HFC-23} + \text{HFC-32} * \text{gwp of HFC-32} + \text{HFC-125} * \text{gwp of HFC-125} + \text{HFC-134a} * \text{gwp of HFC-134a} + \text{HFC-143a} * \text{gwp of HFC-143a} + \text{HFC-152a} * \text{gwp of HFC-152a} + \text{HFC-227ea} * \text{gwp of HFC-227ea} + \text{HFC-236fa} * \text{gwp of HFC-236fa} + \text{HFC-245fa} * \text{gwp of HFC-245fa} + \text{HFC-43-10mee} * \text{gwp of HFC-43-10mee} + \text{HFC-365mfc} * \text{gwp of HFC-365mfc}$$

$$= 0 \text{ lbs} * 11700 + 0 \text{ lbs} * 650 + 0 \text{ lbs} * 2800 + 0 \text{ lbs} * 1300 + 0 \text{ lbs} * 3800 + 0 \text{ lbs} * 140 + 0 \text{ lbs} * 2900 + 0 \text{ lbs} * 6300 + 0 \text{ lbs} * 1030 + 65 \text{ lbs} * 1300 + 0 \text{ lbs} * 794$$

$$= 84,500.000 \text{ Lbs CO}_2$$

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**Total CO<sub>2</sub>e emissions**


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$$= 84,500.000 \text{ lbs CO}_2$$

$$= 84,500.000 \text{ Lbs CO}_2\text{e}$$


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$$= 38.329 \text{ MT CO}_2\text{e}$$

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### Perfluorocarbons

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#### Fugitive Gas - Perfluorocarbons

$$= \text{PFC-14} * \text{gwp of PFC-14} + \text{PFC-116} * \text{gwp of PFC-116} + \text{PFC-218} * \text{gwp of PFC-218} + \text{PFC-318} * \text{gwp of PFC-318} + \text{PFC-3-1-10} * \text{gwp of PFC-3-1-10} + \text{PFC-4-1-12} * \text{gwp of PFC-4-1-12} + \text{PFC-5-1-14} * \text{gwp of PFC-5-1-14} + \text{PFC-9-1-18} * \text{gwp of PFC-9-1-18}$$

$$= 0 \text{ lbs} * 6500 + 0 \text{ lbs} * 9200 + 0 \text{ lbs} * 7000 + 18 \text{ lbs} * 10300 + 0 \text{ lbs} * 7000 + 0 \text{ lbs} * 7500 + 0 \text{ lbs} * 7400 + 0 \text{ lbs} * 7500$$

$$= 185,400.000 \text{ Lbs CO}_2$$

#### Total CO<sub>2</sub>e emissions

$$= 185,400.000 \text{ lbs CO}_2$$

$$= 185,400.000 \text{ Lbs CO}_2\text{e}$$

$$= 84.096 \text{ MT CO}_2\text{e}$$


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### Sulfur Hexafluoride

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#### Fugitive Gas - Sulfur Hexafluoride

$$= \text{Sulfur Hexafluoride} * \text{gwp of Sulfur Hexafluoride}$$

$$= 10 \text{ lbs} * 23900$$

$$= 239,000.000 \text{ Lbs CO}_2$$

#### Total CO<sub>2</sub>e emissions

$$= 239,000.000 \text{ lbs CO}_2$$

$$= 239,000.000 \text{ Lbs CO}_2\text{e}$$

$$= 108.409 \text{ MT CO}_2\text{e}$$


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## Wastewater Treatment

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### Treatment lagoons

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#### Wastewater - Treatment lagoons

$$= (\text{Population served} * \text{Workdays per year} * \text{Fraction of time allocated to facility}) * \text{Amount of BOD}_5 \text{ produced per day} * \text{Fraction of BOD}_5 \text{ removed in primary treatment} * \text{Maximum Methane producing capacity for domestic wastewater} * \text{Methane correction factor for anaerobic systems} * \text{Fraction of lagoon BOD}_5 \text{ removal performance} * \text{Convert to pounds}$$

$$= (52 \text{ people} * 230.0 * 0.5) * 0.090 * (1 - 0.3) * 0.6 * 0.8 * 1.0 * 2.20462$$

$$= 398.673 \text{ Lbs CH}_4$$

#### Total CO<sub>2</sub>e emissions

$$= 398.673 \text{ lbs CH}_4 * 21$$


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$$= 8,372.131 \text{ Lbs CO}_2\text{e}$$

$$= 3.798 \text{ MT CO}_2\text{e}$$

**Scope 2: Indirect Emissions**

(Required; indirect GHG emission from purchased electricity, steam, or heat) – Emissions associated with the generation of electricity, steam, or heat purchased and consumed by facilities or equipment that the company owns or controls.

**Building Electricity**

Monthly kWh Consumption
<b>Electricity CO2</b>
= monthly kWh electric * electricity emission factor
= (0 kWh + 0 kWh + 96531000 kWh + 0 kWh + 0 kWh + 99220000 kWh + 0 kWh + 0 kWh + 0 kWh + 0 kWh + 0 kWh + 100443000 kWh ) * 0.72412 lbs CO2/kWh
= 214,479,999.280 Lbs CO <sub>2</sub>
<b>Electricity CH4</b>
= monthly kWh electric * electricity emission factor
= (0 kWh + 0 kWh + 96531000 kWh + 0 kWh + 0 kWh + 99220000 kWh + 0 kWh + 0 kWh + 0 kWh + 0 kWh + 0 kWh + 100443000 kWh ) * 0.00003024 lbs CH4/kWh
= 8,956.907 Lbs CH <sub>4</sub>
<b>Electricity N2O</b>
= monthly kWh electric * electricity emission factor
= (0 kWh + 0 kWh + 96531000 kWh + 0 kWh + 0 kWh + 99220000 kWh + 0 kWh + 0 kWh + 0 kWh + 0 kWh + 0 kWh + 100443000 kWh ) * 0.00000808 lbs N2O/kWh
= 2,393.248 Lbs N <sub>2</sub> O
<b>Total CO<sub>2</sub>e emissions</b>
= 214,479,999.280 lbs CO <sub>2</sub> + 8,956.907 lbs CH <sub>4</sub> * 21 + 2,393.248 lbs N <sub>2</sub> O * 310
= 215,410,001.049 Lbs CO <sub>2</sub> e
= 97,708.334 MT CO <sub>2</sub> e

**Scope 3: Other Indirect Emissions**

(Optional; other indirect GHG emissions) – Emissions from other sources the company does not own or control. This may include waste disposal, leased/outsourced activities, or emissions such as those related to business travel and employee commuting.

**Air Travel**

Travel Estimate Details
<b>Air Estimate</b>

= total number of trips \* average distance per trip \* emission factor for medium length flights

= 10864 trips \* 3486 miles per trip \* 0.42 lbs per passenger mile

= 15,906,199.680 Lbs CO<sub>2</sub>

**Total CO<sub>2</sub>e emissions**

= 15,906,199.680 lbs CO<sub>2</sub>

= 15,906,199.680 Lbs CO<sub>2</sub>e

= 7,214.931 MT CO<sub>2</sub>e

**Car Commuting****Commute Estimate Details****Commute Estimate**

= (total number of employees \* average round trip \* number of days the employees commute \* number of working weeks in a year \* motor gasoline emission factor) / EPA avg mpg large car in city

= (5891 employees \* 45.2 miles \* 5 days per week \* 48 \* 19.564 lbs CO<sub>2</sub> / U.S. gallons fuel used) / 18.0

= 69,458,251.797 Lbs CO<sub>2</sub>

**Total CO<sub>2</sub>e emissions**

= 69,458,251.797 lbs CO<sub>2</sub>

= 69,458,251.797 Lbs CO<sub>2</sub>e

= 31,505.733 MT CO<sub>2</sub>e

**Transmission and Distribution Losses for Electricity****Electricity T&D Losses****Electricity Transmission & Distribution Losses CO<sub>2</sub>**

= Monthly kWh electric \* T&D adjustment factor \* Electricity emission factor

= 296194000 kWh \* ( 0.0618 / ( 1 - 0.0618 ) ) \* 0.72412 lbs CO<sub>2</sub>/kWh

= 14,127,972.666 Lbs CO<sub>2</sub>

**Electricity Transmission & Distribution Losses CH<sub>4</sub>**

= Monthly kWh electric \* T&D adjustment factor \* Electricity emission factor

= 296194000 kWh \* ( 0.0618 / ( 1 - 0.0618 ) ) \* 0.00003024 lbs CH<sub>4</sub>/kWh

= 589.999 Lbs CH<sub>4</sub>

**Electricity Transmission & Distribution Losses N<sub>2</sub>O**

= Monthly kWh electric \* T&D adjustment factor \* Electricity emission factor



$$= 296194000 \text{ kWh} * ( 0.0618 / ( 1 - 0.0618 ) ) * 0.00000808 \text{ lbs N}_2\text{O/kWh}$$

$$= 157.645 \text{ Lbs N}_2\text{O}$$

---

**Total CO<sub>2</sub>e emissions**

$$= 14,127,972.666 \text{ lbs CO}_2 + 589.999 \text{ lbs CH}_4 * 21 + 157.645 \text{ lbs N}_2\text{O} * 310$$

$$= 14,189,232.642 \text{ Lbs CO}_2\text{e}$$

$$= 6,436.128 \text{ MT CO}_2\text{e}$$


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## Contracted Wastewater Treatment

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### Digester gas

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**Contracted Wastewater - Incomplete combustion of digester gas**

= ( Population served (federal employees only) \* Convert workdays to year \* Fraction of time allocated to facility (12 hrs) ) \* Digester Gas \* Fraction of Methane in biogas \* Density of Methane at standard conditions \* Convert to pounds

$$= ( 5914 \text{ people} * 230.0 * 0.5 ) * 1.0 * 0.65 * 0.019 * 2.20462$$

$$= 18,517.394 \text{ Lbs CH}_4$$

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**Total CO<sub>2</sub>e emissions**

$$= 18,517.394 \text{ lbs CH}_4 * 21$$

$$= 388,865.268 \text{ Lbs CO}_2\text{e}$$

$$= 176.386 \text{ MT CO}_2\text{e}$$


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## Contracted Waste Disposal

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### Contracted Waste Disposal

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**Contracted Waste Disposal - CO2**

= Aggregate of municipal solid waste disposed of in landfill \* Convert to metric tons \* Degradable organic carbon \* Degradable organic carbon digestible under the anaerobic conditions in the landfill \* Methane correction factor/uncontrolled release of CO<sub>2</sub> \* Fraction of methane by volume in generated landfill gas \* Molecular weight ratio of Methane/Carbon \* Convert to kilograms \* Convert to pounds

$$= ( 0 \text{ short tons} + 0 \text{ short tons} + 0 \text{ short tons} + 0 \text{ short tons} + 0 \text{ short tons} + 1747.69252 \text{ short tons} + 0 \text{ short tons} + 0 \text{ short tons} + 0 \text{ short tons} + 0 \text{ short tons} + 0 \text{ short tons} + 0 \text{ short tons} ) * 0.90718 * 0.203 * 0.5 * 0.01 * 0.5 * 44/12 * 1000 * 2.20462$$

$$= 6,504.287 \text{ Lbs CO}_2$$

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**Contracted Waste Disposal - CH4**

= Aggregate of municipal solid waste disposed of in landfill \* Convert to metric tons \* Degradable organic carbon \* Degradable organic carbon digestible under the anaerobic conditions in the landfill \* Methane correction factor/uncontrolled release of CO<sub>2</sub> \* Fraction of methane by volume in generated landfill gas \* Molecular weight ratio of Methane/Carbon \* Convert to kilograms \* Convert to pounds

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$$= ( 0 \text{ short tons} + 0 \text{ short tons} + 0 \text{ short tons} + 0 \text{ short tons} + 0 \text{ short tons} + 1747.69252 \text{ short tons} + 0 \text{ short tons} + 0 \text{ short tons} + 0 \text{ short tons} + 0 \text{ short tons} + 0 \text{ short tons} + 0 \text{ short tons} + 0 \text{ short tons} ) * 0.90718 * 0.203 * 0.5 * 0.01 * 0.5 * 16/12 * 1000 * 2.20462$$

$$= 2,365.195 \text{ Lbs CH}_4$$

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**Total CO<sub>2</sub>e emissions**


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$$= 6,504.287 \text{ lbs CO}_2 + 2,365.195 \text{ lbs CH}_4 * 21$$

$$= 56,173.390 \text{ Lbs CO}_2\text{e}$$

$$= 25.480 \text{ MT CO}_2\text{e}$$


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**Water: Water Consumption**

No formulas computed for this scope.

**Total Carbon Emissions**

<b>Scope 1</b>	1,612.705
<b>Scope 2</b>	97,708.334
<b>Scope 3</b>	45,358.658
<b>Water</b>	0.000
<b>Total</b>	144,679.697 metric tons CO <sub>2</sub> e

## Additional Information

<b>Quantification Methodologies:</b>	Refer to "Formulas Calculated in the GHG Inventory" to view scenario-specific quantification methodologies.
<b>GHG Emission or Offset Factors:</b>	<p>Refer to "Formulas Calculated in the GHG Inventory" to view scenario-specific emission factors.</p> <p>These emission factors are the accepted values from the World Resources Institute (WRI, 2006) (<a href="http://www.ghgprotocol.org">www.ghgprotocol.org</a>)</p>
<b>GHG Offsets Quantified in CO<sub>2</sub>e</b>	The following removals have been quantified in CO <sub>2</sub> e: 0
<b>Impact of Uncertainties:</b>	<p>There are specific inherent uncertainties recognized and accepted by most GHG registry programs. These inherent uncertainties are associated with the inexact nature of collecting data and calculating GHG emissions (i.e. metering equipment calibration, emission factors, significant digits, rounding errors, etc.). Inherent uncertainties also derive from the inexact nature of using registry-permitted simplified estimation methods. Specific GHG programs require that no more than 5 percent of the total emissions can be based on non-registry-approved simplified estimation methods. Given that inherent uncertainties are generally accepted, the impact on the accuracy of the GHG assertion for such uncertainties is negligible.</p> <p>There are two forms of estimations used in the GHG Analyzer - 1) Calculation estimation methods that are derived from WRI-published calculation methods, and 2) Data estimations provided by Noblis' engineers and the Reporter. Certain accepted WRI estimation methods can be used to calculate emissions from a facility's electric consumption using building square footage as the source of activity data. They are also used for calculating emissions from business travel and commuting using mileage as the source of activity data. Given that WRI's calculation estimation methods are internationally accepted best practices, it is unlikely there will be an impact on the accuracy of the GHG assertion.</p> <p>Data estimations provided by Noblis are taken from energy surveys provided by the Department of Energy (DOE) and the Environmental Protection Agency (EPA). Information provided by DOE uses building square footage ranges to determine electricity consumption. Information provided by EPA uses data center specifications to determine electricity consumption. Once the electricity consumption data is estimated, the WRI protocol for calculating emissions is used. Because some of these ranges are broad, there may be a large percent discrepancy between the estimated results and the actual values. The Reporter should be aware that using such estimations instead of actual data can result in low levels of assurance.</p> <p>Data estimations provided by the Reporter would have a limited level of assurance given that there may be no source of information to support their assumption. In such cases where the Reporter is asked to estimate data, the Reporter provides the data that are then used in WRI calculation methods. Using this alternative instead of providing actual data can result in low levels of assurance without proper explanation from the Reporter regarding the "degree of error" associated with the estimated data.</p>
<b>Changes to Quantification Methodologies Previously Used:</b>	
<b>Changes to Historical GHG Data (Including the Base Year):</b>	
<b>GHG Source, Facility, or Sink Exclusion:</b>	
<b>Combustion of Biomass:</b>	

**GHG Sequestration:**

**Offsets:**

**Reductions at Sources  
Sold/Transferred as  
Offsets:**

**Emissions Sold or  
Transferred:**

**Emissions Purchased for  
Re-Sale:**

**GHGs Not Covered By the  
Kyoto Protocol:**

**GHG Reduction Program:**

**Internal and External  
Benchmark Performance:**

**Inventory Quality  
Program:**

**Ratio Performance  
Indicators:**

**Contractual Provisions:**

**Verification Steps/Level of  
Assurance:**

**ISO 14064-1 Compliance:** This report has been generated in accordance with ISO 14064-1 "Specification with guidance at the organization level for quantification and reporting of greenhouse gas emissions and removals" and World Resources Institute calculation and reporting methods.

**Base Year and Reporting  
Year:**

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