

**Cornell University—Ithaca
Greenhouse Gas (GHG) Emissions Inventory**

***Supporting Documentation for the
Association for the Advancement of Sustainability in Higher Education -
Sustainability Tracking Assessment & Rating System***

Base Year 2005 and Performance Year 2010

***Credits:
Operations-4 Greenhouse Gas Emissions Inventory
Operations-5 Greenhouse Gas Emissions Reductions***

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Executive Summary

Cornell University has registered to participate in the Sustainability Tracking, Assessment & Rating System (STARs®) developed by the Association for the Advancement of Sustainability in Higher Education. STARs® is intended to be a transparent, self-reporting framework for colleges and universities to measure their sustainability performance. STARs® measures sustainability in three main categories with multiple sub-categories using a credit system:

- Category 1: Education & Research (ER);**
- Category 2: Operations (OP); and,**
- Category 3: Planning, Administration & Engagement (PAE).**

Included under OP is the Climate subcategory. Two credits are available for this subcategory; (1) OP-4: Greenhouse Gas Emissions Inventory; and, (2) OP-5: Greenhouse Gas Emissions Reduction. Credit OP-4 requires a greenhouse gas emission inventory for the performance year. Credit OP-5 requires baseline 2005 emissions along with performance year emissions. This report documents the results of the GHG inventory for the base year and performance year.

The calendar year 2010 carbon footprint for the Ithaca Campus is estimated at **180,000 metric tons** CO₂-equivalent (CO₂-e) for Scope 1 (On-Site Combustion) and Scope 2 (Purchased Energy). This value is 27% lower than the baseline (CY 2005) carbon footprint of **246,000 metric tons** CO₂-e. This significant reduction is largely the result of (i) start-up of the new combined heat and power plant and (ii) Cornell's Beyond Coal initiative. The results of the inventory are summarized in the following table:

Table: Ithaca Campus GHG Inventory Comparison Scope 1 & 2

Component	2005 CO ₂ -e Emissions (metric tons)	2010 CO ₂ -e Emissions (metric tons)	Change CO ₂ -e Emissions (metric tons)
Scope 1: On-Site Combustion	172,000	157,000	(15,000)
Scope 2: Purchased Electricity	74,000	23,000	(51,000)
Totals	246,000	180,000	(66,000) (decrease)

Table: Ithaca Campus GHG Inventory Comparison Scope 3

Component	2005 CO ₂ -e Emissions (metric tons)	2010 CO ₂ -e Emissions (metric tons)	Change CO ₂ -e Emissions (metric tons)
Scope 3: Commuting	28,000	27,000	(1,000)
Scope 3: Air Travel	27,000	27,000	No Change
Totals	55,000	54,000	(1,000) (decrease)



Section 1: Introduction

Cornell University has registered to participate in the Sustainability Tracking, Assessment & Rating System (STARs®) developed by the Association for the Advancement of Sustainability in Higher Education. STARs® is intended to be a transparent, self-reporting framework for colleges and universities to measure their sustainability performance. STARs® measures sustainability in three main categories with multiple sub-categories using a credit system:

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Included under OP is the Climate subcategory. Two credits are available for this subcategory; (1) OP-4: Greenhouse Gas Emissions Inventory; and, (2) OP-5: Greenhouse Gas Emissions Reduction. Credit OP-4 requires a greenhouse gas emission inventory for the performance year. Credit OP-5 requires baseline 2005 emissions along with performance year emissions. This report documents the results of the GHG inventory for the base year and performance year.

In addition, in 2007 Cornell joined the American College and University Presidents Climate Commitment. The American College and University Presidents Climate Commitment is a pledge on the part of presidents and chancellors to commit their institutions to prioritizing the transition to a climate neutral society.

Section 2: Institutional Boundary

The institutional boundary is the "Ithaca Campus". The boundary for what constitutes the "Ithaca Campus" is defined by the Cornell University Campus Planning Office and is the same boundary used during development of the Cornell University Master Plan. GHG emissions are calculated for facilities within this boundary that are occupied/operated by Cornell University. The inventory includes Cornell Real Estate facilities that are occupied by Cornell University employees, for example, part of East Hill Plaza. Facilities owned by Cornell University Real Estate not occupied/operated by Cornell University employees are excluded.

Section 3: Inventory Components

The main focus of the inventory is on combustion-related greenhouse gases, which currently constitute the largest component of a college/university carbon footprint. The three greenhouse gases associated with fossil fuel combustion are carbon dioxide (CO₂), nitrous oxide (N₂O), and methane (CH₄). The emissions of these gases are converted to an equivalent amount of CO₂ (referred to as CO₂-e), using the appropriate global warming potential (GWP) of the gas. For example, methane (CH₄) has a global warming potential



of 25, which means that the emissions of 1 metric ton of methane is equivalent to emitting 21 metric tons of CO₂. The global warming potential of nitrous oxide is 298.

Although the GWP for methane and nitrous oxide are significantly greater than carbon dioxide, the campus emits only a very small quantity of these gases. Small emissions can be excluded from the inventory as *de minimis*, provided that the emissions sources collectively comprise less than 5% of the total GHG emissions. A rough, upper-bound estimate is used to show that emissions contribute less than 5% of the total emissions in accordance with the Greenhouse Gas Protocol materiality criteria.

This inventory addresses the following components:

Scope 1: On-site combustion of fossil fuels—stationary and mobile: Scope 1 emissions are direct GHG emissions that occur from sources that are owned or controlled by an organization; for example, emissions from combustion in owned or controlled boilers, furnaces, vehicles, etc. Direct CO₂-e emissions from the combustion of biomass (if any) are not included in scope 1.

Scope 2: Purchased electricity indirect GHG emissions: Scope 2 emissions are associated with the generation of **purchased** electricity. The Ithaca campus is located in eGRID subregion 4, NPCC Upstate New York. Please note that emissions associated with electricity generated by Cornell central utilities are considered Scope 1 emissions.

Scope 3: Student, faculty, and staff commuting and institution-funded air travel: The Presidents Climate Commitment requires the reporting of commuting and institution-funded air travel. Both of these emission types are considered Scope 3 (“all other indirect emissions”). Scope 3 emissions are a consequence of the activities of the company, but occur from sources not owned or controlled by the company. Other examples of Scope 3 activities (which are not part of this inventory effort) are extraction and production of purchased materials; transportation of purchased fuels; and use of sold products and services.

Section 4: Inventory Protocols

The Greenhouse Gas Protocol developed by the World Resources Institute and the World Business Council for Sustainable Development was used in developing this inventory. The inventory was developed based primarily on calendar year data.

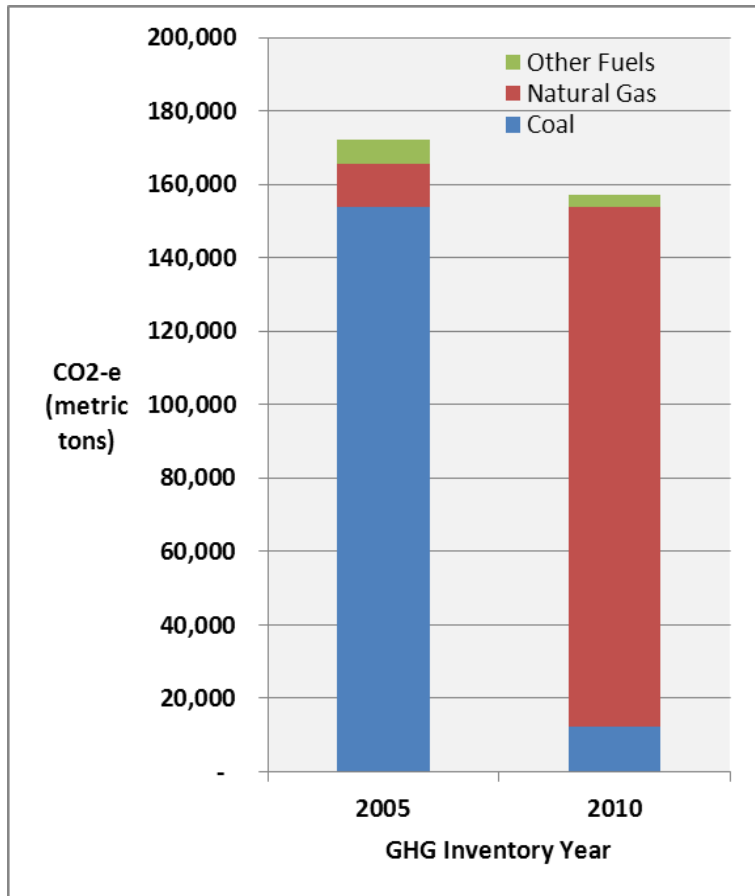


Section 5: Scope 1: On-Site Combustion

5.1 Summary

CO₂-e emissions associated with on-site combustion of fossil fuels for the Ithaca Campus is calculated at **157,000 metric tons for 2010**, which is a **15,000 metric ton** reduction from the 2005 value of **172,000 metric tons**.

**Figure 5.1 On-Site Combustion
CO₂ emissions comparison FY 2005 vs. FY 2010**



The reduction is primarily the result of our new combined heat & power plant and our “Beyond Coal” initiative. The campus central energy plant burned significantly less coal in 2010 compared with 2005 (5,000 tons versus 65,000 tons). Natural gas displaced the use of coal, with consumption increasing from 0.9 million therms to nearly 24.6 million therms).

CO₂-e. emissions associated with vehicles, fuel oil and propane are an insignificant amount of our footprint. A summary of on-site combustion is provided in Table 5.1.



Table 5.1: On-Site Combustion Summary CY 2010

Fuel Type	Quantity Consumed	CO ₂ -e Emitted (metric tons)	% of On-Site Combustion
Coal - Central Energy Plant	5,100 tons	12,200	8%
Natural Gas - Central Energy Plant	24,600,000 therms	130,200	83%
Fuel Oil - Central Energy Plant	112,000 gallons	1,100	<1%
Total Central Energy Plant		143,500	
Natural Gas – Non-Central Plant	2,200,000 therms	11,500	7%
Gasoline/Diesel—vehicles	248,000 gallons	2,200	1%
Propane	4,800 gallons	26	<<1%
Fuel Oil	2,900 gallons	30	<<1%
Total Non Central Energy Plant		13,756	
Totals On-Site Combustion		157,256	100%
		<i>round to 157,000</i>	

Table 5.2: On-Site Combustion Summary CY 2005

Fuel Type	Quantity Consumed	CO ₂ -e Emitted (metric tons)	% of On-Site Combustion
Coal - Central Energy Plant	65,000 tons	154,000	89%
Natural Gas - Central Energy Plant	900,000 therms	4,800	3%
Fuel Oil - Central Energy Plant	372,000 gallons	4,300	2%
Total Central Energy Plant		163,100	
Natural Gas – Non Central Plant	1,400,000 therms	7,200	4%
Gasoline/Diesel—vehicles	207,000 gallons	1,900	1%
Misc. Fuel Oil / Propane	6,000 gallons	60	<<1%
Total Non Central Energy Plant		9,160	
Totals On-Site Combustion		172,260	100%
		<i>round to 172,000</i>	



5.2 Methodology

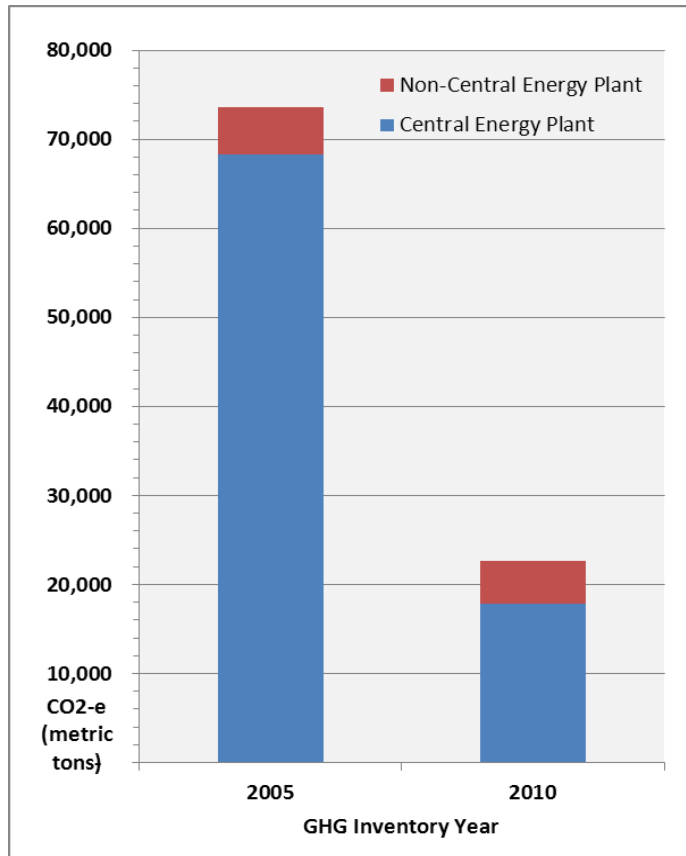
The methodology for calculating emissions associated with on-site combustion consists of obtaining fuel consumption data and applying a unit emission factor for that fuel. Scope 1 (On-site combustion) data was provided by Cornell's Environmental Health & Safety group, which administers the University's New York State Title V Air Permit and reports this data on an annual basis. Emissions factors were obtained from the Clean Air Cool Planet Calculator.

Section 6: Scope 2 Emissions - Purchased Electricity

6.1 Purchased Electricity Summary

Purchased electricity is classified as a Scope 2 emission. 2010 CO₂-e emissions associated with purchased electricity for the Ithaca Campus is calculated at **23,000 metric tons**. A reduction of **41,000 metric tons** compared to the **2005 inventory value of 74,000 metric tons**.

Figure 6.1: Purchased Electricity Emissions Summary





This reduction is primarily associated with lower electricity purchases due to increased on-site generation from the new combined heat and power plant. In addition, the applied emission factor for grid purchased electricity decreased for the New York eGRID region from 2005 to 2010 (i.e. cleaner grid mix).

Please note that 2005 electric consumption for non-central energy plant facilities is not available; thus, it is assumed that 2005 electric consumption is equivalent to 2010 electric consumption for non-central energy plant facilities.

Tables 6.1 and 6.2 provide a summary of the CO₂-e emissions associated with grid-purchased electricity for 2010 and 2005.

Table 6.1: CO₂-e Associated with Grid-purchased Electricity 2010

Ithaca Campus Component	Grid-purchased Electric (kWh)	CO ₂ -e Emissions (metric tons)	% of Total Purchased Electric Emissions
Cornell Central Utilities ^{(1),(2)}	57,300,000	17,790	78%
Cornell Non-Central Utilities	15,800,000	4,900	22%
Totals	134,200,000	22,690	100%
		<i>round to 23,000</i>	

Notes:

(1) Includes purchased electricity used by Cornell's Lake Source Cooling Heat Exchange Facility—which provides chilled water—and is located outside the "Ithaca Campus" boundary.

(2) Net of Grid Purchases less Exported Electric

Table 6.2: CO₂-e Associated with Grid-purchased Electricity 2005

Ithaca Campus Component	Grid-purchased Electric (kWh)	CO ₂ -e Emissions (metric tons)	% of Total Purchased Electric Emissions
Cornell Central Utilities ⁽¹⁾	207,900,000	68,300	93%
Cornell Non-Central Utilities	15,800,000	5,200	7%
Totals	231,200,000	73,500	100%
		<i>round to 74,000</i>	

Notes:

(1) Includes purchased electricity used by Cornell's Lake Source Cooling Heat Exchange Facility—which provides chilled water—and is located outside the "Ithaca Campus" boundary.



6.2 Ithaca Campus Electricity Consumption

As previously mentioned in Section 6.1, the core Ithaca Campus (i.e. connected to the central energy plant) purchased (net) approximately 57,300 MWh for FY 2010. The remainder of core campus electric consumption was generated on site. Table 6.3 provides a summary of campus electric consumption for 2005 and 2010.

Table 6.3: Electric Consumption – Ithaca Campus

Ithaca Campus Component	2005 kwh	2010 kwh
CEP Grid Purchased Electric ⁽¹⁾	207,900,000	57,300,000 ⁽²⁾
Cornell On-Site: Central Energy Plant	31,300,000	179,600,000
Cornell On-Site: Small Scale Hydro	4,600,000	3,000,000
Core-Campus Totals	243,800,000	239,900,000
Non-Core Campus	15,800,000	15,800,000
Grand Total Ithaca Campus	259,600,000	255,700,000

Notes:

(1) Includes purchased electricity used by Cornell's Lake Source Cooling Heat Exchange Facility—which provides chilled water—and is located outside the "Ithaca Campus" boundary.

(2) Net of Grid Purchases less Exported Electric

6.3 Methodology

The methodology for calculating emissions associated with purchased electricity consists of obtaining electricity consumption data (kwh) and applying emission factors for the electricity consumed.

6.4 Data Sources

A variety of data sources were used to obtain purchased electricity. These sources are:

- **Cornell Central Utilities:** Cornell's Energy & Sustainability Department provided electric consumption for core campus. This electric is provided via the Central Energy Plant and includes grid purchased electric and on-site generation.
- **NYSEG Billing Records:** Billing records were obtained from NYSEG for Cornell facilities which are not part of the UDS. Most of these records were for Campus Life facilities not connected to the central energy plant.

6.5 Emission Factors

The applied emission factor is from the eGRID subregion and GHG emissions finder tool developed by the U.S. Environmental Protection Agency.

Available at <http://www.epa.gov/cleanenergy/energy-resources/egrid/index.html>



In addition, it should be noted that a time lag exists between the published emission factors for purchased electricity and the current reporting year. The current Environmental Protection Agency (EPA) emission factors are from eGRID2010 based on 2007 data. The grid electric emission factors are presented in Table 6.2.

As a component of the grid electric emission factor, the greenhouse gases methane and nitrous oxide are relatively insignificant (about ½ percent of the total emission factor) despite the higher global warming potential.

Table 6.4 Grid Electric Emission Factor

eGRID Subregion NPCC Upstate NY	(lbs CO ₂ / MWh)	(lbs CH ₄ / MWh)	(lbs N ₂ O / MWh)	Total
2010 Factors	680.5	0.0174	0.0099	
2005 Factors	720.8	0.0248	0.0112	
Global Warming Potential Factor (GWP)	1	25	298	
2010 CO₂-e Emission Factor	680.50	0.435	2.95	683.9
2005 CO₂-e Emission Factor	720.80	0.62	3.33	724.75

The 2010 emission factor for purchased electric is approximately 6% lower than the 2005 grid electric emission factor and is due to a “cleaner” electric mix.

Section 7: Commuting

Section 7.1 Summary

Ithaca Campus CO₂-e emissions associated with commuting is calculated at 27,000 metric tons for CY 2010 and represents a decrease of approximately 1,000 metric tons from the CY 2005 baseline of 28,000 metric tons. This decrease is due to changes in population, particularly a decrease in employees by over 1,100 people. Student population increase over the same time frame; however, the footprint for students is much less than employees.

Commuting is considered a Scope 3 emission. Scope 3 emissions are a consequence of the activities of the University, but occur from sources not owned or controlled by the University. The methodology, data sources, and detailed results are provided in the sections below.



Section 7.2 Methodology/Data Sources

The Cornell University transportation-Generic Environmental Impact Statement (t-GEIS), prepared by Martin/Alexiou/Bryson in 2008, included an extensive survey of commuting habits. The data from this survey was further utilized to develop a baseline for commuter transportation emissions in the report, “Cornell University, Fiscal Year 2008 Commuter Transportation Emissions Estimate—Baseline Measurement.”

Accompanying the report was an emission worksheet with multiple inputs. The worksheet allows for updating the commuting GHG footprint to accommodate changes in population, distance travelled, mode of travel (including public transportation), vehicle used, emission factors, etc. The population inputs were updated with 2010 and 2005 values to determine commuting emissions for these two time periods.

Noticeable population change occurred between the baseline year (2005) and the performance year (2010). These changes, summarized in Table 7.1, result in an overall increase of approximately 300 people, with a significant decrease in employees (over 1,100).

Table 7.1 Population Changes

Year	CY 2005	CY 2010	Increase / (Decrease)
Employees	10,141	9,004	(1,137)
Undergraduates	13,223	13,931	708
Grad/Professional	5,938	6,702	764
Total	29,302	29,637	335

Section 7.3 Emission Factors

Heat Content and Default Emission factors are from the EPA Final Mandatory Reporting of Greenhouse Gases Rule Table C-1. Gasoline produces 8.78 kg (19.4 lb) of CO₂ per gallon of gasoline burned and 10.21 kg (22.2 lb) per gallon of diesel fuel.

Section 7.4 Results

Cornell employees who travel by personal vehicle constitute the largest portion of the commuting GHG footprint, at 16,969 metric tons (approximately 64% of the commuting footprint). The total % attributable to employee commuting is 18,352 metric tons (69%) and includes the impact associated with buses. Graduate students and undergraduates make up 18% and 12%, respectively, of the commuting carbon footprint.

The 2010 results are summarized in Table 7.2 and the 2005 numbers are presented in Table 7.3 for comparison.



Table 7.2 CY 2010 Annualized CO₂-e Emissions Outputs (metric tons)

Travel Mode	Employees	Undergrads	Grad Students	Total
Auto	16,969	2,708	3,695	23,371
Bus	1,383	575	1,147	3,105
Total 2010	18,352	3,283	4,841	26,476 round to 27,000

Table 7.3 CY 2005 Annualized CO₂-e Emissions Outputs (metric tons)

Travel Mode	Employees	Undergrads	Grad Students	Total
Auto	19,111	2,570	3,197	24,878
Bus	1,558	546	992	3,096
Total 2008	20,669	3,116	4,189	27,974 round to 28,000

The predominance of employee commuting emissions can best be viewed in the context of “commuting distance,” summarized in Table 5.4 below. Nearly 77% of employees live more than 2 miles from core campus, with almost 30% living greater than 10 miles. Undergraduates live much closer, with 85% living within only one mile from core campus.

Table 7.4 Commuting Distance Summary

	Population	<½ mi	½ mi to < 1 mi	1 mi to < 2 mi	2 mi to < 5 mi	5 mi to < 10 mi	10 mi to < 25 mi	>25 mi
Employees	9,004	2.4%	7.0%	14.1%	29.1%	19.3%	20.9%	7.2%
Undergraduates	13,931	59.3%	26.0%	6.6%	5.2%	1.4%	0.9%	0.6%
Grad & Prof'l	6,702	15.3%	20.7%	21.5%	27.0%	9.8%	4.2%	1.4%

As a result of the combination of commuting distance, local terrain, and personal obligations pre and post work (i.e., children responsibilities, etc.) employees choose personal vehicle (either by themselves or carpool) as the mode of travel 73% of the time. The emission free mode (bike/walk) largely correlates to a commuting distance of less than one mile.

Table 7.5 Mode of Travel

	Drive Alone	Carpool & Drop Off	Vanpool	Bus	Private Shuttle	Bike	Walk	Other
Employees	56%	17%	0%	14%	0%	3%	9%	1%
Undergraduates	5%	3%	0%	15%	5%	1%	71%	0%
Grad & Prof'l	19%	6%	0%	38%	2%	4%	31%	1%



Section 8: Air Travel

Section 8.1 Summary

CO₂-e emissions associated with university-sponsored air travel are estimated at 27,000 metric tons for both 2010 and 2005. The estimate is based on the 2008 inventory performed in support of the President's Climate Commitment. Air travel is considered a Scope 3 emission. Scope 3 emissions are a consequence of the activities of the University, but occur from sources not owned or controlled by the University. The methodology, data sources, and detailed results are provided in the sections below.

Section 8.2 Methodology/Data Sources

The methodology of estimating GHG emissions associated with Cornell University sponsored air travel is:

- Determine total flight mileage from air travel data
- Apply emission factor for CO₂ associated with mileage
- Apply emission factor for Climate Forcing

Air travel is centrally reimbursed via the Cornell University Division of Financial Affairs (DFA); however, the existing DFA travel dataset does not collect trip pairs (origin/destination) or mileage. Information from the DFA dataset fields was utilized to determine the origin/destination pairs for most trips; however, in some cases it was necessary to assume a trip origin of Ithaca. The determination of market pairs was performed manually for the air travel dataset. Mileage for the market pairs was determined using the website: <http://www.webflyer.com/>

Segregating the Ithaca Campus air travel from this dataset is not possible. The dataset includes Cornell University air travel, except for Weill Medical School. A conservative approach was used, which assumes that all travel in the DFA dataset is associated with the Ithaca Campus.

Section 8.3 Air Travel Adjustment Factors

The "raw" air travel mileage derived from the DFA dataset was adjusted to account for data incompleteness, landing/takeoff fuel consumption, and multi-passenger trips. Each adjustment factor is described below.

Connecting Trip Factor

The air travel data allows for determination of the Origin/Destination Pairs; however, the intermediate flights are not provided. For example, a flight from Ithaca to San Francisco would include intermediate flights of Ithaca to Philadelphia and Philadelphia to San Francisco. A mileage factor of 15% was applied to account for the additional mileage attributable to the intermediate flights. This factor is based on comparing the Origin/Destination mileage with the "true" mileage for a sample of flights.



LTO (Landing/Takeoff) Factor

A factor of 10% is applied to account for fuel burned during takeoff and landing. Approximately 10% of the CO₂-e emissions occur during these phases. *Source: 2006 IPCC Guidelines for National Greenhouse Gas Inventories, Section 3.6 Civil Aviation.*

Multi-Passenger Factor

A factor of 5% was applied to the calculated air mileage. This factor accounts for multiple passengers under the same trip ID. In general, a trip ID is for one passenger; however, it is clear from the data that there are instances where a single trip ID includes multiple individuals (i.e., the basketball team travelling to France). This factor of 5% is based on our review of the travel dataset.

Origin of Ithaca/Return Trip

Flights were assumed to originate from Ithaca if no data was provided. A return trip was assumed unless a one-way flight was specifically mentioned in the dataset.

Section 8.4 Emission Factor

The CO₂-e emission factor applied for air travel mileage is 0.15 kg CO₂ per passenger kilometer (0.24 kg CO₂ per passenger mile). The emission factor is derived from the protocol developed by the World Resources Institute for calculating GHG emissions associated with business travel (Version 2.0 June 2006).

Available at <http://www.ghgprotocol.org/calculation-tools/service-sector>

Section 8.5 Climate Forcing Factor

The Intergovernmental Panel on Climate Change (IPCC) recommends that a radiative forcing factor of 2.7 be applied against all air travel. This factor accounts for the fact that airplane emissions occur in the upper atmosphere, compared to lower atmosphere emissions. Upper atmosphere GHG emissions, along with contrails from the plane (which contain water vapor—a GHG in itself), have a large positive radiative factor, that inhibits infrared radiation and heat from leaving the Earth's atmosphere.

Source: <http://www.ipcc.ch/ipccreports/sres/aviation/064.htm>.

Section 8.6 Air Travel GHG Emissions

Total CO₂-e emissions associated with Cornell University sponsored air travel is estimated at **27,000 metric tons** and is fairly split between domestic and international flights. The ratio of the number of domestic flight pairs to international flight pairs is 3.4 to 1; however, the mileage associated with international trips slightly exceeds domestic trips. The emission estimate includes both the CO₂-e associated with the flight mileage and the equivalent CO₂-e associated with climate forcing. The results are summarized in Table 6.1.

**Table 8.1 University Sponsored Air Travel GHG Emissions**

Flight Mode	Domestic	International	Total
# of Origin/Destination Pairs (round-trip) ⁽¹⁾	6,318	1,850	8,168
Mileage ⁽²⁾	19,643,000	21,494,000	41,137,000
CO ₂ -e associated w/ Mileage ⁽³⁾	4,714	5,158	9,873
Total CO ₂ equivalent w/ Climate Forcing (metric tons) ⁽⁴⁾	12,728	13,928	26,657 <i>Round to</i> 27,000

Notes:

- (1) Assumes all origin/destination pairs are round-trips
- (2) Mileage includes 15% connecting trip factor, 10% landing/takeoff factor, and 5% multiple trip factor
- (3) Per WRI protocol for business travel
- (4) Forcing factor of 2.7 multiplied by emissions applied per IPCC guidelines