

***Cornell University—Ithaca
Greenhouse Gas (GHG) Emissions Inventory
Fiscal Year 2008***

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Executive Summary

In June 2007, Cornell University President David Skorton signed the American College and University Presidents Climate Commitment. The Presidents Climate Commitment (PCC) is a pledge on the part of university presidents and chancellors to commit their institutions to prioritizing the transition to a climate neutral society. The common definition of climate neutrality is: no annual net emissions of global warming gases to the atmosphere from buildings, transportation, travel, land use, and processes under the entity's control.

A requirement of the PCC is the preparation of a Greenhouse Gas (GHG) inventory for the Ithaca campus associated with the following CO₂ emission sources:

- On-site combustion of fossil fuels;
- Purchased electricity consumption;
- Institution-funded air travel; and,
- Student, faculty, and staff commuting.

Based on the inventory, the fiscal year 2008 carbon footprint for the Ithaca Campus is estimated at **319,000 metric tons** CO₂-equivalent (CO₂-e) and includes carbon dioxide, nitrous oxide, and methane (the GHGs associated with fossil fuel consumption).

On-site combustion is the largest component at **176,000 metric tons** CO₂-e and represents approximately 55% of our total footprint. Ithaca still has cold winters! Cornell University also uses a significant amount of electricity. This electricity use is responsible for **87,000 metric tons** CO₂-e. At 9% and 8%, the respective footprints associated with commuting and air travel are comparable in magnitude. The results of the inventory are summarized in the following table:

Table: Ithaca Campus PCC GHG Inventory

Component	CO₂-e Emissions (metric tons)	% of Total
On-Site Combustion	176,000	55.1%
Purchased Electricity	87,000	27.3%
Commuting⁽¹⁾	29,000	9.1%
Air Travel⁽²⁾	27,000	8.5%
Totals	319,000	100%

Notes: (1) projected based on 2006 commuting survey, (2) projected based on FY 2007 data

This carbon footprint establishes the baseline for the key component of the PCC, called the Climate Action Plan (CAP) to be completed by September 2009.

Appendix A includes a summary of the study of the effects of the absorption of CO₂-e by the forests owned by Cornell University. Within 20 miles of campus, Cornell owns and manages over 5,600 hectares (14,000 acres), most of which is populated by forests. These lands are actively removing carbon dioxide from the atmosphere at a rate of 11,170 metric tons of CO₂-e each year, partially offsetting emissions from Cornell's operations.



Section 1: Introduction

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. The common definition of climate neutrality is that there are no annual net emissions of global warming gases to the atmosphere from buildings, transportation, travel, land use, and processes under the entity's control.

Specifically, the PCC calls for institutions to:

- Prepare a GHG inventory associated with on-site combustion of fossil fuels, purchased electricity, institution-funded air travel, and commuting;
- Within two years of signing, develop a plan with interim targets for actions that will lead to climate neutrality, and attain climate neutrality as soon as possible;
- Make climate neutrality and sustainability a part of the curriculum and educational experience, and expand research to achieve climate neutrality;
- Initiate two or more specific actions from a list of five initial steps to reduce greenhouse gases as quickly as possible; and
- Make the plan, inventory, and periodic progress reports publicly available.

As a PCC signatory, Cornell University is required to prepare a greenhouse gas (GHG) Inventory. This document serves to present the results of the inventory, including analysis and presentation of the status of any mitigation measures. In addition, this report compares previous GHG central utilities emissions calculated as part of Cornell University's commitment to the Kyoto Protocol.

Section 2: Inventory Planning

2.1 Inventory Boundary

Cornell University President David Skorton defined the initial efforts to focus on 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 (i.e., the P&C grocery store).



2.2 Inventory Components

As discussed in the PCC Implementation Guide, 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 21, 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 310. 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 ACUPCC Implementation Guide.

The Presidents Climate Commitment requires the GHG emissions associated with the following scopes:

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 but reported separately

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 PCC 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.



2.3 Inventory Protocols

Cornell University recently joined the Climate Registry (CR) as a “Founding Reporter.” The Climate Registry is a non-profit multinational organization whose goal is to support *voluntary/mandatory reporting and verification infrastructure* for Greenhouse Gases (GHG)s. The registry is a multistate-created organization largely based on the California Climate Registry. The CR is largely an attempt to centralize GHG reporting among corporations in anticipation of future emissions trading/regulations.

The Climate Registry has developed a protocol, *The Climate Registry, General Verification Protocol, Version 1.1, May 2008*, which focuses on Scopes 1 and 2. This protocol was used for the inventory effort.

In addition, the protocol/guidance developed by the World Resources Institute was used in developing the inventory for Scope 3 emissions. *Source: <http://www.wri.org/>*



Section 3: On-Site Combustion

3.1 Summary

CO₂-e emissions associated with on-site combustion of fossil fuels for the Ithaca Campus is calculated at **176,180 metric tons**. The primary fossil fuel is coal, which is used to generate steam that heats most of the Ithaca campus buildings. In FY 2008, the Ithaca campus burned over 65,000 tons of coal with an associated CO₂-e footprint of 154,000 metric tons. Natural gas consumption is the other significant fuel used, with a footprint of nearly 19,000 tons CO₂-e. Diesel/gasoline is used primarily by the State Fleet Garage facility, PDC Fuel Center, and Farm Services and Plantations. The footprint associated with on-site vehicular fuel is 3,500 metric tons CO₂-e.

A summary of on-site combustion is provided in Table 3.1

Table 3.1: On-Site Combustion Summary

Fuel Type	Quantity Consumed	CO₂-e Emitted (metric tons)	% of On-Site Combustion
Coal	65,420 tons	153,500	87%
Natural Gas	3,500,000 therms	19,000	11%
Gasoline—vehicles	296,000 gallons	2,600	1.5%
Diesel—vehicles	89,000 gallons	900	<1%
Misc. Oil/Propane	24,200 gallons	180	<<1%
Totals		176,180	100%
		<i>round to 176,000</i>	

The methodology and detailed results are provided in the sections below.

3.2 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. Consumption data sources were the following:

- Cornell central utilities provided consumption data for the coal, natural gas, and heating oil combusted at the central plant for steam and electric generation. In addition, the utilities data system (UDS) was used to obtain natural gas consumption for certain academic facilities that have a NYSEG gas meter.
- Cornell Real Estate provided consumption data for those facilities occupied by Cornell staff.



- Mobile fuel on-site consumption was provided by various Cornell Departments via coordination with the Environmental Compliance & Sustainability Office, which administers the University's New York State Title V Air Permit and reports this data on an annual basis. The GHG footprint is based the most recent calendar year (2007) data.
- Cornell Campus Life provided natural gas consumption for the gas meters paid through Campus Life.

Each fuel type has an associated emission factor with that fuel. The emission factors are from *The Climate Registry General Reporting Protocol, Version 1.1, May 2008*. The emission factor for coal is significantly higher when compared with natural gas or liquid fuels.

Table 3.2 provides the emission factors and associated energy content with each fuel.

Table 3.2: Emission Factors for On-Site Combustion

Fuel Type	CO₂ Emission Factor (kg CO₂ / MMBtu)	CH₄ Emission Factor (g CH₄ / MMBtu)	N₂O Emission Factor (g N₂O / MMBtu)
Coal	93.46	1.0	0.7
Natural Gas	53.06	5	0.1
Fuel Oil	73.15	11	0.6
Propane	63.07	5	0.1
Gasoline—mobile	70.88	N/A	N/A
Diesel—mobile	73.15	N/A	N/A

3.3 On-Site Combustion Energy and Emission Analysis

3.3.1 Energy Input and Emissions

As previously discussed in Section 3.1, the carbon footprint associated with on-site combustion is approximately 176,000 metric tons CO₂-e with a significant quantity associated with central utilities. For FY 2008, Cornell central utilities consumed 65,420 tons of coal and 1.21 million therms, equating to a combined energy input of 1,759,000 MMBtu (million Btu). Table 3.3 provides the energy input by major component (Central Utilities, Non-Central Utilities, Real Estate and Mobile Sources), along with the associated emissions for each.



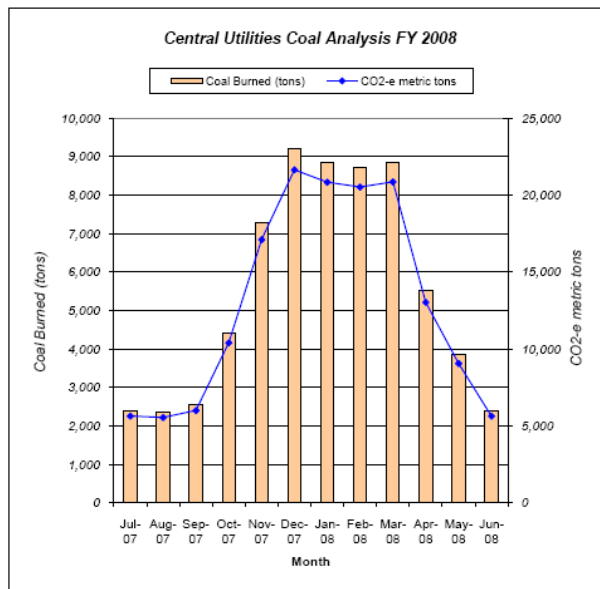
Table 3.3: On-Site Combustion Energy Input & Emissions

Ithaca Campus Component	Energy Input from On-Site Combustion (MMBtu)	% On-Site Energy Input	CO ₂ -e Emissions (metric tons)	% of Total On-Site Emissions
Cornell Central Utilities	1,759,000	88%	160,000	91%
Non-Central Utilities	150,000	8%	10,200	6%
Cornell Real Estate	43,000	2%	2,300	1%
Mobile Sources	49,000	2%	3,500	2%
Totals	2,001,000	100%	176,000	100%

The relative “cleanness” of each fuel is apparent; for example, Cornell Real Estate represents 2% of the energy input, yet only 1% of On-Site emissions. This is a direct result of burning natural gas, which is a much cleaner fuel from a GHG perspective than coal, but also significantly more expensive.

Coal is the primary fuel for central utilities and is used to produce steam for building heat and hot water sent via the steam distribution system. During the winter months, coal consumption is approximately 9,000 tons of coal per month with associated monthly emissions of 21,000 metric tons CO₂-e. During the summer, coal demand falls to approximately 2,500 tons per month, with associated monthly emissions exceeding 5,000 metric tons CO₂-e. Figure 3.1 presents monthly coal consumption and associated CO₂-e emissions.

Figure 3.1
Monthly Coal Consumption and Associated CO₂-e Emissions





3.3.2 Building Steam Consumption and Associated Emissions

During FY 2008, the Ithaca Campus used 1,008,000 kilo-pounds (klbs) of steam, with coal being the main fuel source (93% of energy input). Steam usage is metered for nearly 140 campus facility codes. From an individual facility perspective, 10 Cornell facilities account for approximately 32% of the campus steam consumption and associated CO₂-e footprint. In addition, the next top 10 steam users account for another 20% of total steam consumption. The end result is that only 20 campus facilities account for nearly 50% of our Scope 1 CO₂-e emissions.

The high steam users are primarily “research” intensive facilities; however, Mann Library, Statler Hall, and Balch Hall also make the top 20 list. Table 3.4 lists the top 10 steam users and their associated GHG footprint.

Table 3.4: Ithaca Campus Top 10 Steam Facilities

Facility Name	Steam Consumption (klbs)	Bldg Steam associated CO ₂ -e (metric tons)	% of Total Steam-related Emissions
VET MEDICAL CENTER	52,181	7,749	5.2%
ROBERT PURCELL CENTER ⁽¹⁾	37,513	5,571	3.7%
BRADFIELD HALL	37,045	5,501	3.7%
DUFFIELD HALL	32,681	4,853	3.2%
BAKER LABORATORY	31,445	4,670	3.1%
SCHURMAN HALL	27,888	4,141	2.8%
GUTERMAN BIOCLIMATIC LAB	26,870	3,990	2.7%
TOWER RD EAST GREEN HDS 1045G	26,271	3,901	2.6%
OLIN CHEMISTRY RESEARCH WING	26,023	3,864	2.6%
LIFE SCIENCES TECHNOLOGY BLDG	25,513	3,789	2.5%
Sub total	323,430	48,029	32.1%
Total Ithaca Campus	1,008,000	165,000	
% of Total	32.1%	32.1%	

Notes:

(1) Steam meter at Robert Purcell includes steam consumption with multiple Campus Life facilities



Section 4: Purchased Electricity

4.1 Purchased Electricity Summary

CO₂-e emissions associated with purchased electricity for the Ithaca Campus is calculated at 87,000 metric tons. Purchased electricity is classified as a Scope 2 emission. At 82,300 metric tons CO₂-e, Cornell central utilities grid-purchased electricity is the largest component (93%) of the Ithaca Campus footprint. A small percentage (5%) of Ithaca Campus facilities purchase their electricity direct from the NYSEG grid versus Cornell central utilities connected to the grid. These facilities are typically not connected to central utilities and include portions of Campus Life (i.e., Maplewood, Hasbrouck), Athletics (i.e., Reis Tennis Center, Cornell Golf Course), Baker Institute for Animal Health, and Cornell Real Estate facilities.

Table 4.1 provides a summary of the CO₂-e emissions associated with grid-purchased electricity.

Table 4.1: CO₂-e Associated with Grid-purchased Electricity

Ithaca Campus Component	Grid-purchased Electric (kWh)	CO₂-e Emissions (metric tons)	% of Total Purchased Electric Emissions
Cornell Central Utilities ⁽¹⁾	220,000,000	82,300	95%
Cornell Non-Central Utilities	6,500,000	2,400	3%
Cornell Real Estate	4,700,000	1,800	2%
Totals	231,200,000	86,500 <i>round to 87,000</i>	100%

(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.

The methodology, data sources, and detailed results are provided in the sections below.

4.2 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. For a limited number of Campus Life facilities, the records do not readily provide consumption data; however, the cost is provided. An estimate for unit cost was used to determine the consumption data for these cases.



4.3 Data Sources

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

Cornell Central Utilities

Facility specific electric consumption was provided via the Utilities Data System (UDS). The UDS is used for the billing of utilities connected to central utilities and includes electric consumption. In addition, some facilities not connected to central utilities also have their consumption data in UDS, such as the Baker Institute for Animal Health. The UDS data is for fiscal year 2008.

In addition, the “FY 08 Indicators Report” prepared by Cornell central utilities was used to obtain gross electric data (total electric purchases, total co-gen and hydro).

Cornell University Real Estate

Cornell University Real Estate provided calendar 2007 consumption data for those properties within Tompkins County. The real estate properties included within the Ithaca Campus include the East Hill Office Building, East Hill Plaza, 301 College Avenue, and 409 College Avenue.

Campus Life

Cornell University Campus Life operates the multiple student housing facilities for the Ithaca Campus. Some of these facilities have consumption data in UDS; however, many do not. Campus Life provided detailed fiscal year 2007 billing data for facilities not in UDS. Four of the twelve months included consumption data as well as costs. This data was used to develop an estimated electric cost of \$0.13 per kwh. This rate was used to estimate the electric consumption of the remaining months that contained only electric costs.

Athletics

Certain Cornell Athletics facilities are off-central utilities and are paid directly by the Athletic Department. These facilities are the Reis Tennis Center and the Cornell Golf Course. Calendar year 2007 electric bills were provided to ECOS by the Athletic Department and were tabulated to determine consumption.



4.4 Emission Factors

The applied emission factor for purchased electricity follows the protocols for GHG reporting per the Climate Registry. The grid electric emission factors are presented in Table 4.2. 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 4.2 Grid Electric Emission Factor

eGRID 2006 Subregion NPCC Upstate NY	(lbs CO ₂ / MWh)	(lbs CH ₄ / MWh)	(lbs N ₂ O / MWh)
Emission Rate	819.68	0.024	0.016
Global Warming Potential Factor (GWP)	1	21	310
CO ₂ -e Emission Factor	819.68	0.504	4.96

In addition, it should be noted that a time lag exists between the published emission factors for purchased electricity and the actual reporting year. The Environmental Protection Agency (EPA) eGRID emission factors (required factors for Climate Registry reporters) were most recently published in 2006 and are based on 2004 data.

4.5 Electricity and CO₂-e Emissions Analysis

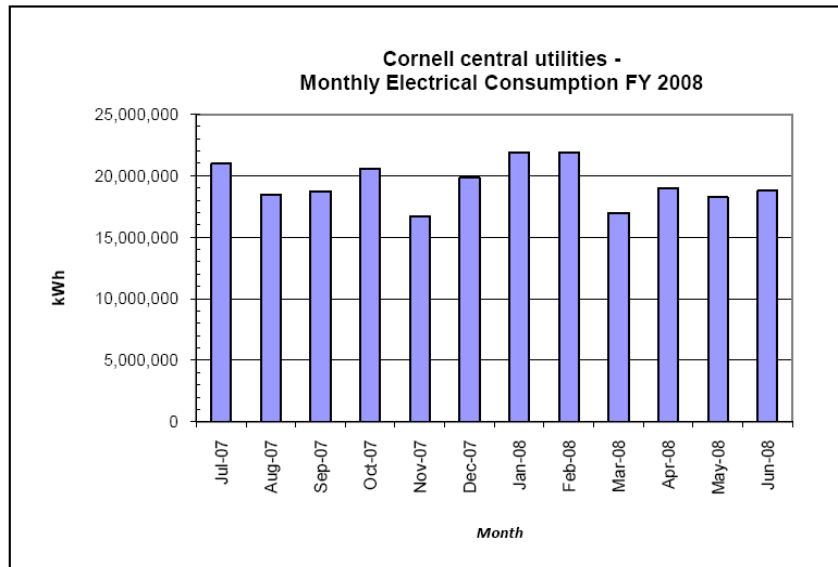
4.5.1 Electricity Consumption

The Ithaca Campus electricity consumption is 261,000,000 kwh, of which 231,000,000 is grid purchased. The remainder 30,000,000 kwh is produced on campus by Cornell central utilities from co-generation (using waste heat as an energy source) and hydroelectric (Beebe Dam). Emissions associated with on-site generated electricity are included in the On-Site Combustion section of this report.

Cornell central utilities facilities provides nearly 250,000,000 kwh, or 96% of the total Ithaca Campus consumption. Monthly electrical consumption for central utilities averaged 19.3 million kWh, with a low of 16.7 million kWh and a high of 21.9 million kWh. As shown in Figure 4.1, central utilities electricity consumption is fairly constant throughout the year and does not dip during the summer months. In fact, the lowest monthly electricity usage for FY 2008 was November (during fall semester). Research occurs year round, and numerous camps and summer programs keep the campus busy.



Figure 4.1: Cornell Central Utilities Monthly Electrical Consumption



4.5.2 Largest Electricity Consumers

Research is a significant part of Cornell University and, looking at our largest electricity consumers, this is clearly evident. Nearly one third of our total electricity consumption (purchased + on-site generated) is consumed by 10 facilities, with over 10% associated with one facility: Wilson Synchrotron. The College of Veterinary Medicine is also a complex that uses significant amounts of electricity, with 2 facilities in the top 10 (Vet Med Center and Vet Research Tower). Table 4.3 provides a list of the top 10 electricity consumers.

Table 4.3 Cornell Ithaca Campus Top 10 Electricity Consumers

Facility Name	Electricity (kWh)	% of Ithaca Campus Electric	CO ₂ -e (metric tons)
SYNCHROTRON	27,129,000	10.4%	8,916
VET MED CENTER	11,089,000	4.2%	3,644
RHODES HALL	9,863,000	3.8%	3,241
DUFFIELD	7,435,000	2.8%	2,443
BIOTECH	5,658,000	2.2%	1,860
CLARK HALL	5,061,000	1.9%	1,663
BTI	5,030,000	1.9%	1,653
VET RESR TOWER	4,404,000	1.7%	1,447
BIO SCI COMPLEX	4,349,000	1.7%	1,429
BAKER CHEMISTRY LAB	4,281,000	1.6%	1,407
Total Top 10 Facilities	84,298,000	32.3%	27,703
Ithaca Campus	261,000,000		86,500



Section 5: Commuting

Section 5.1 Summary

Ithaca Campus CO₂-e emissions associated with commuting is calculated at 28,800 metric tons (63.4 million pounds) and is approximately 8% of the total Ithaca Campus carbon footprint.

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 5.2 Methodology/Data Sources

The Cornell University transportation-Generic Environmental Impact Statement (t-GEIS), prepared by Martin/Alexiou/Bryson, 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 emission factors were updated to correspond to the Climate Registry General Reporting Protocol, Chapter 13: Mobile Combustion.

Section 5.3 Emission Factors

The emission factors are from the Climate Registry General Reporting Protocol, Chapter 13, Direct Emissions from Mobile Combustion. Gasoline produces 8.81 kg (19.4 lb) of CO₂ per gallon of gasoline burned and 10.15 kg (22.2 lb) per gallon of diesel fuel.

Section 5.4 Results

Cornell employees who travel by personal vehicle constitute the largest portion of the commuting GHG footprint, at 19,529 metric tons (approximately 68% of the commuting footprint). The total % attributable to employee commuting is 21,087 metric tons (73%) and includes the impact associated with buses.

Graduate students and undergraduates make up 16% and 11%, respectively, of the commuting carbon footprint.

The results are summarized in Table 5.1.



Table 5.1 Annualized CO₂-e Emissions Outputs (metric tons)

Travel Mode	Employees	Undergrads	Grad Students	Total
Auto	19,529	2,629	3,431	25,589
Bus	1,558	558	1,063	3,179
Total	21,087	3,187	4,494	28,768 round to 29,000

The predominance of employee commuting emissions can best be viewed in the context of “commuting distance,” summarized in Table 5.2 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 5.2 Commuting Distance Summary

	Population	<1/2 mi	1/2 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	10,141	2.4%	7.0%	14.1%	29.1%	19.3%	20.9%	7.2%
Undergraduates	13,510	59.3%	26.0%	6.6%	5.2%	1.4%	0.9%	0.6%
Grad & Prof'l	6,290	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 5.3 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 6: Air Travel

Section 6.1 Summary

CO₂-e emissions associated with university-sponsored air travel for the Ithaca Campus is estimated at **26,700 metric tons**, which is approximately 8% of the total Ithaca Campus carbon footprint.

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 6.2 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 data was obtained from the Division of Financial Affairs, Cornell University Travel Office, and AAA/Stone Travel (local travel agency). It is important to note that air travel is not centrally procured. Cornell University faculty/staff procure travel via the Cornell University travel office, the local travel agency, and online ticket services.

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.

The Presidents Climate Commitment Implementation Committee has forwarded a recommendation to enhance the existing travel reimbursement system to require origin/destination pairs for all flights, including connecting flights.



Section 6.3 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 6.4 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 source for the emission factor is 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 6.5 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 6.6 Air Travel GHG Emissions

Total CO₂-e emissions associated with Cornell University sponsored air travel is estimated at **26,700 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 below.

Table 6.1 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 27,000</i>

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



Section 7: Ithaca Campus Space Statistics

Section 7.1 Summary

To better understand the University's carbon footprint, it is important to know the type of space(s) that create this footprint. The total net area for the Ithaca Campus is approximately 12.2 million square feet. Using existing space inventory information maintained by Cornell's Facility Inventory Group, this space was grouped into twenty categories. The results are presented in Table 7.1.

The largest category, at 20% of the total space, (2.42 million square feet) is "General Circulation" (i.e., hallways, stairwells, lobbies, etc.). It is important to note that hallways and such located in residence halls are considered "General Circulation" space and are not in the "Housing" category. The building with the greatest amount of "General Circulation" space is the Vet Med Center at 82,000 square feet.

Office-type space is the second largest category at 15% (1.84 million square feet). Day Hall has the most "Office Space" (58,000 square feet) of any building on campus and is closely followed by Rhodes Hall.

The third largest space category is laboratory space (which is broadly defined) and includes wet labs, dry labs, classroom instruction labs (both group and individual). The laboratory category encompasses over 13% of the Ithaca Campus. Clark Hall has the greatest amount of "Lab" space (75,000 square feet) on campus. Baker Lab and the Biotechnology Building follow closely at 73,000 square feet and 69,000 square feet, respectively.

Housing is the fourth largest category, at 12% of the total area. At 196,000 square feet, the Hasbrouck complex has the most space in this category; the Maplewood complex is second at 109,000 square feet.

The category Classroom/Lecture space totals 3% of the total area and includes seminar rooms. Statler Hall has the greatest amount of "Classroom/Lecture" space at 26,000 square feet. Uris Hall is second with nearly 22,000 square feet.

We note that there are some spaces where classroom instruction occurs, though the space has a different category (e.g., Bailey Hall is primarily classified as Assembly/Exhibition space; however, the facility is also used as a lecture facility).



Table 7.1 Ithaca Campus Area by Room Category

Room Classification	Area	% of Total
GEN CIRC	2,422,901	19.9%
OFFICE	1,843,973	15.1%
LAB	1,620,288	13.3%
HOUSING	1,467,759	12.1%
MECH	965,364	7.9%
LIBRARY/STUDY	653,897	5.4%
ATHLETIC AREA	478,787	3.9%
MISC	434,443	3.6%
SHOP/STORAGE	409,381	3.4%
CLASS/LECTURE	360,847	3.0%
GARAGES	299,272	2.5%
ANIMAL QUARTERS	236,617	1.9%
DINING	202,240	1.7%
LOUNGE	173,719	1.4%
GREENHOUSE	172,567	1.4%
ASSB/EXHIBIT	168,715	1.4%
MEDICAL	113,865	0.9%
COMPUTERS	59,818	0.5%
MERCHANDISING	51,136	0.4%
RECREATION	39,174	0.3%
Ithaca Campus Net Area SF	12,177,266	100%



Appendix A

Absorption of CO₂ in the forests owned by Cornell: (prepared by the Department of Natural Resources)

A.1 Summary:

Within 20 miles of campus Cornell owns and manages over 5,600 hectares (14,000 acres), most of which is populated by forests. These lands are actively removing carbon dioxide from the atmosphere at a rate of 11,170 metric tons of CO₂ each year, partially offsetting emissions from Cornell's operations. By comparison, this current rate of annual accumulation offsets about 40% of the carbon dioxide emitted by faculty and staff commuting to work each year. The plants and soil contain a reservoir of almost 3 million metric tons of CO₂-equivalent carbon.

At least 2500 hectares of this land can be actively managed. These rates of carbon sequestration can be roughly doubled through a variety of management techniques. Further, carbon dioxide sequestration can be increased to an even greater degree by using Cornell agricultural fields to grow biomass crops. Fossil fuel use could be reduced by using plant material culled from these forests as biomass feedstocks for combustion, pyrolysis, or biodigestion processes.

	Area (hectares)	Accumulation rate (absorbed by forests) (metric tons CO ₂ /yr)	Current Stock (metric tons CO ₂)
Oak forest	1,246	3,747	967,604
Maple forest	1,029	2,268	662,243
Hemlock hardwoods and pine forest	830	3,257	607,235
Very young forest and shrubland	335	1,115	252,636
Wetland and floodplain forest	159	259	133,054
Other	252	524	217,821
Total	3,851	11,170	2,840,594

A summary of current carbon stock in forests and estimated carbon sequestration rate is provided in Table A.1. This analysis ignores soil pools which are assumed to be near steady state for this analysis.

A.2. Methodology

The methodology for calculating absorption of carbon dioxide by forests consisted of obtaining characteristic rates of carbon accumulation for each forest type and applying



these rates to each hectare on which that forest is found. In brief, data sources were the following:

- The characteristic rate of carbon accumulation for each forest type and age on each of Cornell's lands was calculated using the US Forest Service Northeast Decision Model to project forest growth. The accuracy of this model was carefully tested against known 50-year growth in a variety of characteristic forest types located in Arnot Forest.
- The distribution of forest types and their corresponding areas were delineated for the Cornell Plantations lands by the staff of the Natural Areas Program of Plantations. For each forest community type in the Plantations Natural Areas, we applied the carbon content and carbon accumulation rates found in the inventories of the managed Cornell forests, using rates from the same forest type, to estimate Plantations-wide carbon sequestration rates.
- The distribution of forest types and ages and their corresponding areas were delineated for the Arnot Forest and other non-Plantations managed forests owned by Cornell. Staff in the Department of Natural Resources were assisted by Cornell Agricultural Experimentation Station staff in developing these data bases.