



**Middlebury Institute of International Studies
Annual Greenhouse Gas Inventory
Fiscal Year 2009-2010**

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**Middlebury Institute of
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Table of Contents

[Summary Data](#)

[Symbols and Glossary](#)

[Scope 1, Part A: Direct Emissions from Stationary Combustion](#)

[Sources for Scope 1, Part A Data](#)

[Scope 1, Part B: Direct Emissions from Mobile Combustion](#)

[Sources for Scope 1, Part B Data](#)

[Scope 2: Indirect Emissions from Electricity Purchases](#)

[Sources for Scope 2 Data](#)

[Scope 3, Part A: Indirect Emissions from Outsourced Travel](#)

[Sources for Scope 3, Part A Data](#)

[Scope 3, Part B: Indirect Emissions from Landfill Waste](#)

[Sources for Scope 3, Part B Data](#)

[Direct Sequestration, Renewable Energy Certificates, and Offsets](#)

[Sources for Offsets](#)

[Normalization Factors](#)

Summary Data

Color Code

| |
|--|
| Annual Dependent Variable I: Factor susceptible to change that must be updated from primary sources with each inventory. |
| Annual Dependent Variable II: Factor susceptible to change that must be updated each fiscal year, regardless of inventory completion date. |
| A MIIS-specific number that will need to be updated, but not necessarily annually. |
| National statistical data that should be updated or checked each year. |
| Totals |
| Dynamic factors and coefficients used |

Comprehensive Summary: Fiscal Year 2009-2010

| Sub-Scope | MTCDEs | | |
|---------------------|----------------|------------------------------|----------------|
| S1S Natural Gas | 235.4 | W/o travel or commute | 565.5 |
| S1M Gas | 2.2 | | |
| S2 Electricity | 281.0 | | |
| S3 Travel | 1432.6 | | |
| S3 Landfill CH4 | 46.9 | | |
| S3 Employee Commute | 458.0 | | |
| Offsets | 0.0 | | |
| Total | 1,998.1 | With Commute | 2,456.1 |

Percent

| | | | |
|---------------------|-------------|--|--------|
| S1S Natural Gas | 11.8% | | 9.58% |
| S1M Gas | 0.1% | | 0.09% |
| S2 Electricity | 14.1% | | 11.44% |
| S3 Travel | 71.7% | | 58.33% |
| S3 Landfill CH4 | 2.3% | | 1.91% |
| S3 Employee Commute | | | 18.65% |
| Offsets | - | | |
| Total | 100% | | |

Sub-scope Total

| | |
|---------------------------|----------------|
| MTCDEs | |
| Scope 1: Stationary | 235 |
| Scope 1: Mobile | 2 |
| Scope 2: Electricity | 281 |
| Scope 3: Travel | 1,433 |
| Scope 3: Landfill CH4 | 47 |
| Scope 3: Employee Commute | 0 |
| Total | 1,998.1 |

Percent

| | |
|-----|-----|
| S1S | 12% |
|-----|-----|

| | |
|--------------|-------------|
| S1M | 0% |
| S2 | 14% |
| S3 Trav | 72% |
| S3 LF CH4 | 2% |
| S3 Commute | 0% |
| Total | 100% |

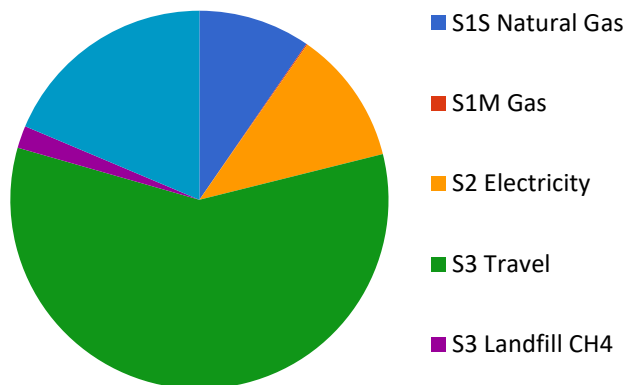
Scope Total

| | |
|----------------|----------------|
| MTCDEs | |
| Scope 1 | 238 |
| Scope 2 | 281 |
| Scope 3 | 1,938 |
| Total | 2,456.1 |
| Percent | |
| Scope 1 | 10% |
| Scope 2 | 11% |
| Scope 3 | 79% |
| Total | 100% |

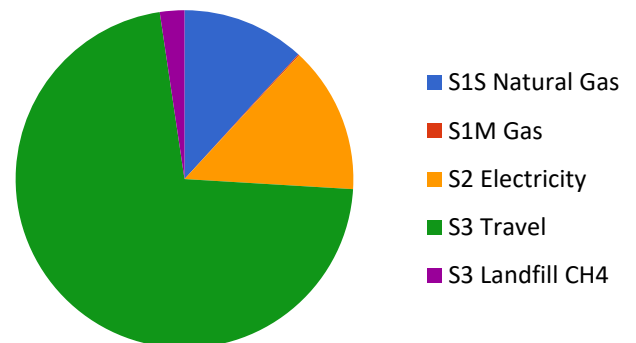
MTCDEs by Gas

| GHG | MTCDE |
|----------------|---------------|
| CO2 | 1093.1 |
| CH4 | 47.7 |
| N2O | 9.7 |
| Total | 1150.4 |
| Percent | |
| CO2 | 95.0% |
| CH4 | 4.1% |
| N2O | 0.8% |
| Total | 100.0% |

09-10 GHG sources



09-10 GHG sources w/o commute



Symbols and Glossary

Symbols Indicating Data Provider

| | |
|---|---|
| * | Collected annually by Sustainability Graduate Assistant from the PG&E bills. Access given by Barbara Burke. [RB & CS 09] |
| † | Collected annually from receipts of campus vehicle provided by accounting. Information received from Barbara Burke. [CS & RB 09] |
| ‡ | On campus solar |
| □ | Collected annually by the Sustainability Graduate Student. Estimated from travel numbers provided by accounting. Information received from Barbara Burke. [NB 08] (We are currently developing a new system of data collection for this.) |
| ▲ | Collected annually by Sustainability Graduate Assistant from Waste management bills. [NB 08] |
| ∞ | Collected annually by Sustainability Graduate Assistant from Facilities. Information received from Barbara Burke. [NB 08] |
| ● | Calculated from employee zip codes, percentage of full-time and part-time employees, number of working days, and average number of vacation days. Information provided by Barbara Burke. [NL 10] |

Glossary

| | |
|--|---|
| BTU (British Thermal Unit) | The amount of heat required to increase the temperature of a pint of water (which weighs exactly 16 ounces) by one degree Fahrenheit. For example, 3412.14 BTUs = 1 kWh, and 1 BTU = 1,055.06 joules. One Million BTU's can be expressed as MBTU or MMBTU. Middlebury College facilities publications typically use MMBTU to express this quantity. |
| CCC (Carbon Content Coefficient) | The mass to energy ratio of a fuel source. i.e., the mass of carbon atoms per million BTU's (MMBTU or MBTU). |
| EF (Emissions Factor) | General name for conversion factors that are calculated experimentally and can change over time. These need to be updated regularly for the monitoring and reporting system to retain its accuracy. |
| GWP (Global Warming Potential) | Value based on the amount that a given GHG contributes to Global Warming. All GWP's are typically based on a 100-year time horizon, which is somewhat putative, given the 5-200 yr atmospheric life span of a CO ₂ molecule (IPCC, 2001, "Observed Changes in Globally Well-Mixed Greenhouse Gas Concentrations and Radiative Forcing." http://www.grida.no/climate/ipcc_tar/wg1/016.htm). For examples of GWP's see: US EPA. 2006. "Non-CO ₂ Gasses Economic Analysis and Inventory: Global Warming Potentials and Atmospheric Lifetimes." http://www.epa.gov/nonco2/econ-inv/table.html . |
| GHG (Greenhouse Gas) | Greenhouse gases are gases in an atmosphere that absorb and emit radiation within the thermal infrared range. This process is the fundamental cause of the greenhouse effect. |
| HC (Heat Content) | The amount of energy (in this case heat) contained in a given mass or volume. E.g. MMBTU/bbl of #6 Fuel oil = 6.287 MMBTU/bbl. |
| ΣMTCDE (Metric Tons of Carbon Dioxide Equivalent) | Unit of measure that is used in this GHG audit |

Source: [IPCC — Intergovernmental Panel on Climate Change](#)

Scope 1, Part A: Direct Emissions from Stationary Combustion

This section includes emissions from all stationary combustion of fossil fuels purchased by the institution and combusted within the geographic and control boundaries established in the introduction.

Summary Data: Fiscal Year 2009-2010

| Sources | MTCDEs |
|---------------|--------------|
| Natural Gas | 235.4 |
| TOTAL: | 235.4 |

| Value/EF | |
|--------------------------------|--------------|
| Natural Gas (therms) | 38,530 |
| MMBTUs of fuel | 3,960.0 |
| Metric Tonnes CO2 | 235.2 |
| tonnes CH4 | 0.004 |
| MTCDE from CH4 | 0.08 |
| tonnes N2O | 0.00038 |
| MTCDE from N2O | 0.12 |
| ΣMTCDE from natural gas | 235.4 |

Formulaic Numbers

| Standard Coefficients | |
|--|------------|
| <i>Barrels/gallon (1/42)</i> | 0.02381 |
| <i>Tonne/gram (1/1x10⁶)</i> | 0.000001 |
| <i>Tonne/kg (1/1,000)</i> | 0.001 |
| CH4 GWP | 21 |
| N2O GWP | 310 |

#6 Fuel Oil

| | |
|------------------------|-------------|
| MMBTU/gal #6 EF | 0.1497 |
| Tonnes CO2/gal #6 EF | 0.011669381 |
| HC (MMBTU/bbl) | 6.287 |
| CCC (kg C/ MMBTU) | 21.49 |
| Fraction Oxidized | 0.99000 |
| MW ratio (kg CO2/kg C) | 3.664 |
| CH4 EF (g gas/MMBTU) | 2.00 |
| N2O EF (g gas/MMBTU) | 0.601 |

Natural Gas

| | |
|---------------------------------|----------|
| MMBTU/therm natural gas EF | 0.1027 |
| Tonnes CO2/therm natural gas EF | 0.006105 |
| HC (MMBTU/therm) | 0.1027 |
| CCC (kg C/ MMBTU) | 14.47 |
| Fraction Oxidized | 0.995 |
| CH4 EF (g gas/MMBTU) | 0.95 |
| N2O EF (g gas/MMBTU) | 0.095 |

Sources for Scope 1, Part A Data

This section includes emissions from all stationary combustion of fossil fuels purchased by the institution and combusted within the geographic and control boundaries established in the introduction.

Formulaic Numbers

| | |
|------------------------|---|
| HC (MMBTU/bbl) | Higher heating values (HHV) are used. FY01/02-FY05/06: EPA Climate Leaders. 2004. "Core Module Guidance: Direct Emissions from Stationary Combustion Sources." pp 22. < http://www.epa.gov/climateleaders/docs/stationarycombustionguidance.pdf > [BB 07] |
| CCC (kg C/ MMBTU) | EPA Climate Leaders. 2004. "Core Module Guidance: Direct Emissions from Stationary Combustion Sources." pp 22. < http://www.epa.gov/climateleaders/docs/stationarycombustionguidance.pdf > [BB 07] |
| Fraction Oxidized | EPA Climate Leaders. 2004. "Core Module Guidance: Direct Emissions from Stationary Combustion Sources." pp 22. < http://www.epa.gov/climateleaders/docs/stationarycombustionguidance.pdf > [BB 07] |
| MW ratio (kg CO2/kg C) | Molecular Weights are accepted as chemical standards. Value = $((12.011+2*16.000)/12.011)$ [BB 07] |
| CH4 EF (g gas/MMBTU) | Based on HHV and residential/commercial efficiency. EPA Climate Leaders. 2004. "Core Module Guidance: Direct Emissions from Stationary Combustion Sources." pp 20. < http://www.epa.gov/climateleaders/docs/stationarycombustionguidance.pdf > [BB 07] |
| CH4 GWP | Global Warming Potential (GWP) based on 100 yr time horizon: US EPA. 2006. "Non-CO2 Gasses Economic Analysis and Inventory: Global Warming Potentials and Atmospheric Lifetimes." < http://www.epa.gov/nonco2/econ-inv/table.html > [BB 07] |
| N2O EF (g gas/MMBTU) | Based on HHV and industrial efficiency. EPA Climate Leaders. 2004. "Core Module Guidance: Direct Emissions from Stationary Combustion Sources." pp 20. < http://www.epa.gov/climateleaders/docs/stationarycombustionguidance.pdf > [BB 07] |
| CH4 EF (g gas/MMBTU) | Based on HHV and industrial efficiency. EPA Climate Leaders. 2004. "Core Module Guidance: Direct Emissions from Stationary Combustion Sources." pp 20. < http://www.epa.gov/climateleaders/docs/stationarycombustionguidance.pdf > [BB 07] |
| N2O GWP | Global Warming Potential (GWP) based on 100 yr time horizon: US EPA. 2006. "Non-CO2 Gasses Economic Analysis and Inventory: Global Warming Potentials and Atmospheric Lifetimes." < http://www.epa.gov/nonco2/econ-inv/table.html > [BB 07] |
| Tonne/kg (1/1,000) | Unit Conversion |
| Barrels/gallon (1/42) | Unit Conversion |

#6 Fuel Oil

| | |
|----------------------|--|
| #6 Fuel Oil (gal) | Collected by Noah Lichtenstein and Lisa Johnston from the PG&E bills |
| MMBTU/gal #6 EF | Calculated from sourced data |
| Tonnes CO2/gal #6 EF | Calculated from sourced data |

#2 Fuel Oil / Off Road Diesel

| | |
|-------------------------------|--|
| Straight #2 Fuel Oil (gal) | Collected by Noah Lichtenstein and Lisa Johnston from the PG&E bills |
| B-5 Bioheat (gal) | N/A |
| B-20 Bioheat (gal) | N/A |
| Off-Road Diesel (inc. blends) | N/A |
| MMBTU/gal #2 EF | Calculated from sourced data |
| Tonnes CO2/gal #2 EF | Calculated from sourced data |

Propane

| | |
|---------------------------|------------------------------|
| Propane (gal) | N/A |
| MMBTU/gal propane EF | Calculated from sourced data |
| Tonnes CO2/gal propane EF | Calculated from sourced data |

Notes on Source Reproduction

For #6, #2, and Diesel:

HC values were originally published in U.S. Department of Energy, Energy Information Administration. 2003. "Annual Energy Review 2002," DOE/EIA 0384(2002), Washington, DC, October 2003.

Carbon Content Coefficients and Fractions Oxidized were found in US EPA. 2004. "Inventory of U.S. Greenhouse Gas Emissions and Sinks:" 1990-2002, EPA430-R-04-003, U.S. EPA, Washington, DC, April 2004.

For Propane:

HC and Carbon Content Coefficients values were originally published in Guthrie, V.B. (ed.). 1960 Characteristics of Compounds, Petroleum Products Handbook. New York, NY: McGraw Hill. pp 3.

Carbon Content Coefficient values and Fractions Oxidized were calculated based on the findings of US EPA. 2004. "Inventory of U.S. Greenhouse Gas Emissions and Sinks:" 1990-2002, EPA430-R-04-003, U.S. EPA, Washington, DC, April 2004.

Scope 1, Part B: Direct Emissions from Mobile Combustion

This section includes emissions from all mobile combustion of fossil fuels purchased by the institution combusted within all vehicles owned and controlled by the institution as established in the introduction.

Summary Data: Fiscal Year 2009-2010

| Sources | MTCDEs |
|--------------|-------------|
| Gas | 2.2 |
| TOTAL | 2.20 |

Gasoline Fueled Vehicles

Σ Scope 1 Gas = campus gas + off campus gas

| | |
|---|-------------|
| Factors determining off campus gas calculations: | |
| Car tank size (gal) | 19.5 |
| Car ave miles/gal | 20.0 |
| 15/11-pass. van tank size (gal) | 0.0 |
| 15/11-pass. van ave miles/gal | 0.0 |
| Mini-van tank size (gal) | 0.0 |
| Mini-van ave miles/gal | 0.0 |
| Average price of CA gasoline | \$3.00 |
| Total Amount Spent on Gasoline | \$689.86 |
| Off Campus Gasoline (gal) † | 230.0 |
| Σ Scope 1 Gas (gal) | 230 |
| MMBTUs of fuel | 28.8 |
| Metric Tonnes CO2 | 2.0 |
| Putative Vehicle mi/gal | 15.0 |
| Gas Vehicle Activity miles | 3,449 |
| tonnes CH4 | 0.001 |
| MTCDE from CH4 | 0.01 |
| tonnes N2O | 0.001 |
| MTCDE from N2O | 0.2 |
| ΣMTCDE from Gasoline | 2.2 |

Formulaic Numbers

| | |
|-----------------------|----------|
| Standard Coefficients | |
| Barrels/gallon (1/42) | 0.02381 |
| Tonne/kg (1/1,000) | 0.001 |
| Tonne/gram (1/1x106) | 0.000001 |
| CH4 GWP | 21 |
| N2O GWP | 310 |

Gasoline Fueled Vehicles

| | |
|-----------------------|--------|
| MMBTU/gal gas EF | 0.1251 |
| Tonnes CO2/gal gas EF | 0.009 |
| CH4 EF (g gas/mile) | 0.1984 |
| N2O EF (g gas/mile) | 0.1517 |

| | |
|------------------------|-------|
| HC (MMBTU/bbl) | 5.253 |
| CCC (kg C/ MMBTU) | 19.34 |
| Fraction Oxidized | 0.99 |
| MW ratio (kg CO2/kg C) | 3.664 |

Diesel Fueled Vehicles

| | |
|--------------------------|-----------|
| MMBTU/gal diesel EF | 0.1387 |
| Tonnes CO2/gal diesel EF | 0.0100371 |
| CH4 EF (g gas/mile) | 0.0966 |
| N2O EF (g gas/mile) | 0.0483 |
| HC (MMBTU/bbl) | 5.825 |
| CCC (kg C/ MMBTU) | 19.95 |
| Fraction Oxidized | 0.99 |
| MW ratio (kg CO2/kg C) | 3.664 |

Sources for Scope 1, Part B Data

This section includes emissions from all mobile combustion of fossil fuels purchased by the institution combusted within all vehicles owned and controlled by the institution as established in the introduction.

Formulaic Numbers

| | |
|-------------------------------------|--|
| HC (MMBTU/bbl) | Higher heating values (HHV) are used. EPA Climate Leaders. 2004. "Core Module Guidance: Direct Emissions from Mobile Combustion Sources." pp 26. < http://www.epa.gov/climateleaders/docs/mobilesourceguidance.pdf > [BB 07] |
| CCC (kg C/ MMBTU) | EPA Climate Leaders. 2004. "Core Module Guidance: Direct Emissions from Mobile Combustion Sources." pp 26. < http://www.epa.gov/climateleaders/docs/mobilesourceguidance.pdf > [BB 07] |
| Fraction Oxidized | EPA Climate Leaders. 2004. "Core Module Guidance: Direct Emissions from Mobile Combustion Sources." pp 26. < http://www.epa.gov/climateleaders/docs/mobilesourceguidance.pdf > [BB 07] |
| MW ratio (kg CO ₂ /kg C) | Molecular Weights are accepted as chemical standards. Value = ((12.011+2*16.000)/12.011) [zbb 07] |
| CH ₄ EF (g gas/MMBTU) | Based on 1985-1986 EFs for heavy duty vehicles (most conservative values). EPA Climate Leaders. 2004. "Core Module Guidance: Direct Emissions from Mobile Combustion Sources." pp 9. < http://www.epa.gov/climateleaders/docs/mobilesourceguidance.pdf > [BB 07] |
| CH ₄ GWP | Global Warming Potential (GWP) based on 100 yr time horizon: US EPA. 2006. "Non-CO ₂ Gasses Economic Analysis and Inventory: Global Warming Potentials and Atmospheric Lifetimes." < http://www.epa.gov/nonco2/econ-inv/table.html > [BB 07] |
| N ₂ O EF (g gas/MMBTU) | Based on 1996 EFs for heavy duty vehicles (most conservative values). EPA Climate Leaders. 2004. "Core Module Guidance: Direct Emissions from Mobile Combustion Sources." pp 9. < http://www.epa.gov/climateleaders/docs/mobilesourceguidance.pdf > [BB 07] |
| N ₂ O GWP | Global Warming Potential (GWP) based on 100 yr time horizon: US EPA. 2006. "Non-CO ₂ Gasses Economic Analysis and Inventory: Global Warming Potentials and Atmospheric Lifetimes." < http://www.epa.gov/nonco2/econ-inv/table.html > [BB 07] |
| Barrels/gallon (1/42) | Unit Conversion |
| Tonne/kg (1/1,000) | Unit Conversion |

Gasoline Fueled Vehicles

Σ Scope 1Gas = campus gas + off campus gas

| | |
|---|---|
| Factors determining off campus gas calculations: | |
| Truck tank size (gal) | 2005-2007 Toyota Camrys used as case studies (6 cyl 3 L): < http://www.fueleconomy.gov/feg/noframes/20932.shtml > Estimated by the number given by Middlebury [NB 08] |
| Truck avg miles/gal | Given to us from Facilities [NB 08] |
| 15/11-pass. van tank size (gal) | N/A |
| 15/11-pass. van ave miles/gal | N/A |
| Mini-van tank size (gal) | N/A |
| Mini-van ave miles/gal | N/A |
| Total Spent on Gasoline | Calculated from amount spent on the Union 76 card given by Barbara Burke and average price CA gasoline [NL and LJ 10] |
| Average Price of Gasoline | Monthly average for 2009-2010 Fiscal year on http://www.californiagasprices.com/retail_price_chart.aspx |
| On- Campus Gasoline (gal) | N/A |

| | |
|----------------------------|---|
| MMBTU/gal gas EF | Calculated from sourced data |
| Tonnes CO2/gal gas EF | Calculated from sourced data |
| Putative Vehicle mi/gal | 2005-07 Toyota Camrys used as case studies (6 cyl 3 L): < http://www.fueleconomy.gov/feg/noframes/20932.shtml > Estimated from the Middlebury numbers [NB 08] |
| Gas Vehicle Activity miles | Calculated from sourced data |

Diesel Fueled Vehicles

| | |
|-------------------------------|---|
| Straight on-road diesel (gal) | I removed this from the calculation because MIIS doesn't own a diesel fueled vehicle [NB08] |
| B-5 Biodiesel (gal) | N/A |
| B-20 Biodiesel (gal) | N/A |
| MMBTU/gal diesel EF | Calculated from sourced data |
| Tonnes CO2/gal diesel EF | Calculated from sourced data |
| Putative Vehicle mi/gal | N/A |
| Gas Vehicle Activity miles | Calculated from sourced data |

Notes on Source Reproduction

Methane and Nitrous oxide EFs are based on highway vehicle EFs taken directly from US EPA. 2004. "Inventory of U.S. Greenhouse Gas Emissions and Sinks:" 1990-2002, EPA430-R-04-003, U.S. EPA, Washington, DC, April 2004, as are CCC's and FO factors. FO values of .99 are also recommended by IPCC guidelines.

For #6, #2, and Diesel:

HC values were originally published in U.S. Department of Energy, Energy Information Administration. 2003. "Annual Energy Review 2002," DOE/EIA 0384(2002), , Washington, DC, October 2003.

Carbon Content Coefficients and Fractions Oxidized were found in US EPA. 2004. "Inventory of U.S. Greenhouse Gas Emissions and Sinks:" 1990-2002, EPA430-R-04-003, U.S. EPA, Washington, DC, April 2004.

For Propane:

HC and Carbon Content Coefficients values were originally published in Guthrie, V.B. (ed.). 1960 Characteristics of Compounds, Petroleum Products Handbook. New York, NY: McGraw Hill. pp 3.

Carbon Content Coefficient values and Fractions Oxidized were calculated based on the findings of US EPA. 2004. "Inventory of U.S. Greenhouse Gas Emissions and Sinks:" 1990-2002, EPA430-R-04-003, U.S. EPA, Washington, DC, April 2004.

Scope 2: Indirect Emissions from Electricity Purchases

This section includes emissions from all stationary combustion of fossil fuels done in direct proportion to an energy source purchased by the institution, i.e., purchased electricity and steam generated outside the geographic/control boundaries set in the introduction, yet consumed within them.

Summary Data: Fiscal Year 2009-2010

| Source | MTCDEs |
|------------------------------------|---------------|
| ΣMTCDE from Natural Gas | 265.12 |
| ΣMTCDE from Coal | 15.85 |
| ΣMTCDE from Electricity Use | 280.97 |

kWh Used by On-Campus Sources

| Value/EF | |
|---------------------------------------|------------------|
| On-campus solar kWh ‡ | 1,983 |
| Total kWh from PG&E * | 1,273,442 |
| Total kWh used w/in boundaries | 1,275,425 |

PG&E Sources as Percents

| | |
|---------------|---------------|
| % Biomass | 4.00 |
| % Large Hydro | 16.00 |
| % Nuclear | 20.00 |
| % Natural Gas | 47.00 |
| % Coal | 2.00 |
| % Geothermal | 4.00* |
| % Small Hydro | 4.00** |
| % Wind | 3.00 |
| % Solar | 1.00 |
| % Other | 1.00 |
| Total | 102*** |

MIIS Net kWh by Source

| | |
|-------------------|----------------------|
| Solar | 14,718 |
| Biomass | 50,938 |
| Large Hydro | 203,751 |
| Nuclear | 254,688 |
| Natural Gas | 598,518 |
| Coal | 25,469 |
| Geothermal | 50,938 |
| Small Hydro | 50,938 |
| Wind | 38,203 |
| Other | 12,734 |
| Total kWh: | 1,300,894**** |

MIIS Electricity Sources by Percent

| | |
|-------|------|
| Solar | 1.1% |
|-------|------|

| | |
|---------------|---------------|
| Biomass | 3.9% |
| Hydro | 15.7% |
| Nuclear | 19.6% |
| Natural Gas | 46.0% |
| Coal | 2.0% |
| Geothermal | 3.9% |
| Small Hydro | 3.9% |
| Wind | 2.9% |
| Other | 1.0% |
| Total: | 100.0% |

*% #1, 2, & 4 Fuel Oil

**% #5 & 6 Fuel Oil

***More than 100 due to rounding conventions

**** Larger than in-boundary kWh b/c of PG&E rounding conventions

CO2 Emissions Calculations: Natural Gas

| Value/EF | Total | Units | Notes |
|---|--------------|-------|-------|
| kWh from Natural Gas | 598,518 | | |
| MMBTUs of electricity | 2,042.2 | | |
| Metric Tonnes CO2 | 262.2 | | |
| Tonnes CH4 | 0.00194 | | |
| MTCDE from CH4 | 0.041 | | |
| Tonnes N2O | 0.00019 | | |
| MTCDE from N2O | 0.060 | | |
| ΣMTCDE from Natural Gas Excluding Losses | 262.3 | | |

Accounting for Losses (Natural Gas)

| Value/EF | Total | Units | Notes |
|--|---------------|---------------|---------------|
| kWh consumed at MIIS from Natural Gas | 598,518 | | |
| T&D loss factor | 1.10% | | from PG&E |
| kWh at generator | 605,077 | | |
| Generation efficiency (heat rate) | 8250 | Btu/kWh | PG&E avg |
| MBtu natural gas consumed at generator | 4992 | MBtu | |
| Metric Tonnes CO2 | 264.88 | tonnes | CO2 |
| tonnes CH4 | 0.00474 | tonnes | CH4 |
| MTCDE from CH4 | 0.100 | tonnes | CO2-eq |
| tonnes N2O | 0.00047 | tonnes | N2O |
| MTCDE from N2O | 0.14701 | tonnes | CO2-eq |
| ΣMTCDE from Natural Gas | 265.12 | tonnes | CO2-eq |

CO2 Emissions Calculations: Coal

| Value/EF | Total | Units | Notes |
|-----------------------|---------|-------|-------|
| kWh from Coal | 25,469 | | |
| MMBTUs of electricity | 86.9 | | |
| Metric Tonnes CO2 | 28.0 | | |
| tonnes CH4 | 0.00009 | | |
| MTCDE from CH4 | 0.002 | | |

| | | | |
|-----------------------------------|-----------|--|--|
| Tonnes N2O | 0.00012 | | |
| MTCDE from N2O | 0.0377146 | | |
| ΣMTCDE from Coal Excluding Losses | 28.0 | | |

Accounting for Losses (Coal)

| Value/EF | Total | Units | Notes |
|--|---------------|---------------|---------------|
| kWh consumed at MIIS from Coal | 25,469 | kWh | |
| T&D loss factor | 1.10% | | from PG&E |
| kWh at generator | 25,748 | kWh | |
| Generation efficiency (heat rate) | 11,500 | Btu/kWh | PG&E avg |
| MBtu natural gas consumed at generator | 296 | MBtu | |
| Metric Tonnes CO2 | 15.71 | tonnes | CO2 |
| Tonnes CH4 | 0.00028 | tonnes | CH4 |
| MTCDE from CH4 | 0.006 | tonnes | CO2-eq |
| Tonnes N2O | 0.00041 | tonnes | N2O |
| MTCDE from N2O | 0.12851 | tonnes | CO2-eq |
| ΣMTCDE from Coal | 15.85 | tonnes | CO2-eq |
| ΣMTCDE from Electricity Use | 280.97 | tonnes | CO2-eq |

MTCDEs by Electricity Source

| | |
|---------------------------------|------------|
| Solar | 0 |
| Biomass | 0 |
| Hydro | 0 |
| Nuclear | 0 |
| Natural Gas | 265 |
| Coal | 16 |
| Geothermal | 0 |
| Small Hydro | 0 |
| Wind | 0 |
| ΣMTCDE from electricity: | 281 |

MTCDE Sources by Percent

| | |
|--------------|-------------|
| Solar | 0% |
| Biomass | 0% |
| Hydro | 0% |
| Nuclear | 0% |
| Natural Gas | 94% |
| Coal | 6% |
| Geothermal | 0% |
| Small Hydro | 0% |
| Wind | 0% |
| Total | 100% |

Formulaic Numbers

| | |
|------------------------|----------|
| Standard coefficients: | |
| MWh/kWh (1/1000) | 0.001 |
| MMBTU/kWh | 0.003412 |

| | |
|-----------------------------------|----------|
| Tonne/kg (1/1,000) | 0.001 |
| tonne/gram (1/1x10 ⁶) | 0.000001 |
| Tonne/lb (1/2,204.6) | 0.000454 |
| CH4 GWP | 21 |
| N2O GWP | 310 |

Natural Gas

| | |
|------------------------|----------|
| Tonnes CO2/kWh NG EF | 0.000438 |
| lbs CO2/MMBtu | 117 |
| CH4 EF (g gas/MMBTU) | 0.95 |
| N2O EF (g gas/MMBTU) | 0.095 |
| CCC (kg C/ MMBTU) | 14.47 |
| Fraction Oxidized | 0.995 |
| MW ratio (kg CO2/kg C) | 3.664 |

Coal

| | |
|------------------------|----------|
| Tonnes CO2/kWh Coal EF | 0.001100 |
| lbs CO2/MMBtu | 210 |
| CH4 EF (g gas/MMBTU) | 1.00 |
| N2O EF (g gas/MMBTU) | 1.40 |
| CCC (kg C/ MMBTU) | 25.49 |
| Fraction Oxidized | 0.99 |
| MW ratio (kg CO2/kg C) | 3.664 |

Sources for Scope 2 Data

This section includes emissions from all stationary combustion of fossil fuels done in direct proportion to an energy source purchased by the institution, i.e., purchased electricity and steam generated outside the geographic/control boundaries set in the introduction, yet consumed within them.

Formulaic Numbers

| | |
|-----------------------------------|---|
| CCC (kg C/ MMBTU) | EPA Climate Leaders. 2004. "Core Module Guidance: Direct Emissions from Stationary Combustion Sources." pp 22. < http://www.epa.gov/climateleaders/docs/stationarycombustionguidance.pdf > [JK 06] |
| Fraction Oxidized | EPA Climate Leaders. 2004. "Core Module Guidance: Direct Emissions from Stationary Combustion Sources." pp 22. < http://www.epa.gov/climateleaders/docs/stationarycombustionguidance.pdf > [JK 06] |
| MW ratio (kg CO2/kg C) | Molecular Weights are accepted as chemical standards. Value = $((12.011+2*16.000)/12.011)$ [JK 06] |
| CH4 EF (g gas/MMBTU) | Based on HHV and residential/commercial efficiency. EPA Climate Leaders. 2004. "Core Module Guidance: Direct Emissions from Stationary Combustion Sources." pp 20. < http://www.epa.gov/climateleaders/docs/stationarycombustionguidance.pdf > [JK 06] |
| CH4 GWP | Global Warming Potential (GWP) based on 100 yr time horizon: US EPA. 2006. "Non-CO2 Gasses Economic Analysis and Inventory: Global Warming Potentials and Atmospheric Lifetimes." < http://www.epa.gov/nonco2/econ-inv/table.html > [BB 07] |
| N2O EF (g gas/MMBTU) | Based on HHV and industrial efficiency. EPA Climate Leaders. 2004. "Core Module Guidance: Direct Emissions from Stationary Combustion Sources." pp 20. < http://www.epa.gov/climateleaders/docs/stationarycombustionguidance.pdf > [JK 06] |
| N2O GWP | Global Warming Potential (GWP) based on 100 yr time horizon: US EPA. 2006. "Non-CO2 Gasses Economic Analysis and Inventory: Global Warming Potentials and Atmospheric Lifetimes." < http://www.epa.gov/nonco2/econ-inv/table.html > [BB 07] |
| MWh/kWh (1/1000) | Unit Conversion |
| MMBTU/kWh | Unit Conversion |
| Tonne/gram (1/1x10 ⁶) | Unit Conversion |
| Tonne/lb (1/2,204.6) | Unit Conversion |
| Tonne/kg (1/1,000) | Unit Conversion |

Calculating kWh of Carbon Emitting Electricity Sources

| | |
|------------------------|---|
| Total kWh from PG&E | Collected Annually from PG&E bills [NB 08] |
| PG&E kWh from CH4 dig. | N/A [NB 08] |
| On-campus co-gen kWh | N/A [NB 08] |
| On-campus wind kWh | N/A [RB 09] |
| On-campus solar kWh | Solar converter reading on 1/23/2011: 20426 kWh since installation on 9/22/2001. Approximate FY09-10 kWh generated = kWh / year since installation = 20426 kWh / 10.3 yrs = 1983.107 kWh [LJ 11] |

PG&E Sources as Percents

| | |
|---------------|--|
| % Coal | http://www.pge.com/myhome/myaccount/explanationofbill/billinserts/previous/2009/feb.shtml [RB 09] *Spoke to PG&E rep, this info is most recent as of 7/21/09 |
| % Large Hydro | Same as above |
| % Natural Gas | Same as above |
| % Nuclear | Same as above |
| % Biomass | Same as above |

| | |
|---------------|---------------|
| % Geothermal | Same as above |
| % Small Hydro | Same as above |
| % Solar | Same as above |
| % Wind | Same as above |
| % Other | Same as above |

| | | |
|--------------------------------|---------------------------|------------------------------|
| Natural Gas | Tonnes CO2/kWh NG EF | Calculated from sourced data |
| Coal | Tonnes CO2/kWh Coal EF | Calculated from sourced data |
| #1, 2, & 4 Fuel Oil | Tonnes CO2/kWh Dis Oil EF | Calculated from sourced data |
| #5 & 6 Fuel Oil | Tonnes CO2/kWh Res Oil EF | Calculated from sourced data |

Notes on Source Reproduction

For Natural Gas #6, #2, and Diesel:

HC values were originally published in U.S. Department of Energy, Energy Information Administration. 2003. "Annual Energy Review 2002," DOE/EIA 0384(2002), , Washington, DC, October 2003.

Carbon Content Coefficients and Fractions Oxidized were found in US EPA. 2004. "Inventory of U.S. Greenhouse Gas Emissions and Sinks:" 1990-2002, EPA430-R-04-003, U.S. EPA, Washington, DC, April 2004.

For Coal:

Carbon Content Coefficients and HC were found in DOE/EIA. 2002. "Documentation for Emissions of Greenhouse Gasses in the United States 2002," DOE/EIA-0638(2002), Energy Information Administration, Office of Integrated Analysis and Forecasting, U.S. Department of Energy, January 2004.

Fractions Oxidized were found in U.S. Department of Energy, Energy Information Administration. 2003. "Annual Energy Review 2002," DOE/EIA 0384(2002), , Washington, DC, October 2003.

** Jim Williams strongly recommended that we add conversion efficiency and transmission losses to our calculations for the electricity. Instead of replacing the original formula from Middlebury, Professor William's calculations are found on the previous sheet. The numbers calculated from his formulas are tied to our final GHG number [NB 08]

Scope 3, Part A: Indirect Emissions from Outsourced Travel

This section includes emissions from all mobile combustion of fossil fuels used in vehicles not owned by the institution, but whose services are directly solicited by the institution.

Summary Data: Fiscal Year 2009-2010

| Total Amount Spent on Travel | | |
|------------------------------|----------------|-------------------|
| Type of Expenditure | % of total | Amount (\$) |
| Gasoline | 3.18% | 16,487.65 |
| Taxis | 9.39% | 48,714.81 |
| Bus | 0.77% | 3,995.28 |
| Airplanes | 86.47% | 448,632.75 |
| Trains | 0.20% | 1,015.04 |
| Total | 100.00% | 518,845.53 |

| Sources | MTCDEs | Percentage |
|--------------|--------------|---------------|
| Rental Cars | 0 | 0% |
| Gasoline | 58.3 | 4.1% |
| Taxis | 6.2 | 0.4% |
| Bus | 1 | 0.1% |
| Airplanes | 1,366.5 | 95.4% |
| Trains | 0.6 | 0.0% |
| Total | 1,433 | 100.0% |

Gasoline and Rental Cars

| Value/EF | |
|--------------------------------|-------------|
| Total Reimbursement \$ | \$16,488* |
| Annual avg cents/gal | 267.1** |
| Total Reimbursement Gas (gal) | 6,173 |
| MMBTUs of fuel | 772.0 |
| Metric Tonnes CO2 | 54.2 |
| Putative Vehicle mi/gal | 20.0 |
| Gas Vehicle Activity miles | 123,457 |
| tonnes CH4 | 0.014 |
| MTCDE from CH4 | 0.30 |
| tonnes N2O | 0.012 |
| MTCDE from N2O | 3.8 |
| ΣMTCDE from Mile Reimb. | 58.3 |

*15% of Total Travel for Gasoline Reimbursement + 10% of Travel for Car Rental

**316.85 - Number Used by Billy Borden and in previous audits

Taxi Emissions (Gasoline)

| Value/EF | |
|---------------------|----------|
| Total Taxi \$ □ | \$48,715 |
| Average \$/person | \$25.00 |
| Average people/trip | 1 |
| Average \$/trip | \$25 |

| | |
|----------------------------------|------------|
| Mode trip distance (mi) | 5 |
| Total Taxi Miles | 9,743 |
| Van mi/gal | 15 |
| Total Taxi Gas (gal) | 650 |
| MMBTUs of fuel | 81.2 |
| Metric Tonnes CO2 | 5.7 |
| Tonnes CH4 | 0.002 |
| MTCDE from CH4 | 0.04 |
| Tonnes N2O | 0.001 |
| MTCDE from N2O | 0.5 |
| ΣMTCDE from Taxi Gasoline | 6.2 |

Bus Emissions (Diesel)

| | |
|--|--------------|
| Value/EF | |
| Total Bus \$ □ | \$3,995 |
| Mode Bus Size (by capacity) | \$55 |
| Base hourly fee (\$/hr) | \$101 |
| Live Mile charge/mile (\$/mi) | \$3.55 |
| Dead Mile charge/mile (\$/mi) | \$3.55 |
| High Emissions/\$ Scenario: Midd=>Colby for a 4 Hour Event | |
| Live Speed | 56.18 |
| Dead Speed | 40.43 |
| Total Cost | \$4,129 |
| Total Gal Diesel Combusted | 99.6 |
| Gal/\$ Given the High Em. Scenario | 0.0241 |
| Total diesel (gal) | 96 |
| MMBTUs of fuel | 13.4 |
| Metric Tonnes CO2 | 1.0 |
| Gas Vehicle Activity miles | 665 |
| tonnes CH4 | 0.000 |
| MTCDE from CH4 | 0.001 |
| tonnes N2O | 0.000 |
| MTCDE from N2O | 0.01 |
| ΣMTCDE from Bus Travel: | 1.0 |

Air Travel Emissions

| | |
|--------------------------------|---------|
| Value/EF | |
| Total Airline \$ □ | 448,633 |
| % of \$ spent on dom travel □ | 20% |
| San Jose to LAX RT price | \$220 |
| San Jose to LAX RT miles | 388 |
| San Jose to LAX \$/pass-mile | \$0.567 |
| SFO to Burlington RT price | \$388 |
| SFO to Burlington RT miles | 3,043 |
| SFO to Burlington \$/pass-mile | \$0.127 |
| SFO to Tokyo price | \$1,075 |
| SFO to Tokyo miles | 5,180 |

| | |
|--------------------------------|----------------|
| SFO to Tokyo \$/pass-mile | \$0.208 |
| Domestic \$/passenger mi | \$0.347 |
| International \$/passenger mi | \$0.208 |
| Domestic passenger mi | 260,000 |
| International passenger mi | 1,730,000 |
| Total Passenger mi | 1,990,000 |
| Dom BTU jet fuel/pass. mi. | 3,098 |
| Int BTU jet fuel/pass. mi. | 3,691 |
| MMBTU/airfare \$ EF | 0.0160 |
| Tonnes CO2/airfare \$ EF | 0.0011 |
| MMBTUs of fuel | 7,190.9 |
| Metric Tonnes CO2 | 504.2 |
| Radiative Forcing Index (RFI) | 2.7 |
| MTCDEs Adj. for RFI | 1,361.3 |
| Gallons of Jet Fuel Consumed | 53,266 |
| tonnes CH4 | 0.014 |
| MTCDE from CH4 | 0.23 |
| tonnes N2O | 0.016 |
| MTCDE from N2O | 5.0 |
| ΣMTCDE from Air Travel: | 1,366.5 |

Train Travel Emissions (Assume diesel fueled trains)

| Value/EF | |
|-------------------------------------|-------------|
| Total Train \$ □ | \$1,015 |
| Salinas to San Francisco RT price | \$32 |
| Salinas to San Francisco RT mileage | 106.0 |
| Burlington to St. Albans \$/pass-mi | \$0.302 |
| Salinas. to LA RT price | \$96 |
| Salinas. to LA RT mileage | 304.7 |
| Burl. to NYC \$/pass-mi | \$0.315 |
| Burl. to DC RT price | \$152 |
| Burl. to DC RT mileage | 1,052.0 |
| Burl. to Washington DC \$/pass-mi | \$0.144 |
| Average \$/passenger-mile | \$0.254 |
| Total train passenger -miles | 3,999 |
| Amtrak BTU/pass. mi. | 2,100 |
| MMBTU/airfare \$ EF | 0.008 |
| Tonnes CO2/train \$ EF | 0.000580291 |
| MMBTUs of fuel | 8.4 |
| Metric Tonnes CO2 | 0.6 |
| Gallons of Diesel Fuel Consumed | 61 |
| MTCDE from CH4 | 0.001 |
| Tonnes N2O | 0.00002 |
| MTCDE from N2O | 0.002 |
| ΣMTCDE from Train Travel: | 0.6 |

Formulaic Numbers

| | |
|-------------------------|----------|
| Standard Coefficients | |
| MMBTU/BTU (1/1 million) | 0.000001 |
| Barrels/gallon (1/42) | 0.02381 |
| Tonne/kg (1/1,000) | 0.0 |
| Tonne/gram (1/1x106) | 0.000001 |
| US Dollars/cent (1/100) | 0.01 |
| Kg/tonne (1,000/1) | 1,000 |
| CH4 GWP | 21 |
| N2O GWP | 310 |

Mileage Reimbursement for use of Personal and Rental Cars (Gasoline)

| | |
|------------------------|-------------|
| MMBTU/gal gas EF | 0.1251 |
| Tonnes CO2/gal gas EF | 0.008774691 |
| CH4 EF (g gas/mile) | 0.1143 |
| N2O EF (g gas/mile) | 0.1003 |
| HC (MMBTU/bbl) | 5.253 |
| CCC (kg C/ MMBTU) | 19.34 |
| Fraction Oxidized | 0.99 |
| MW ratio (kg CO2/kg C) | 3.664 |

Taxi Emissions (Gasoline)

| | |
|------------------------|-------------|
| MMBTU/gal gas EF | 0.1251 |
| Tonnes CO2/gal gas EF | 0.008774691 |
| CH4 EF (g gas/mile) | 0.1984 |
| N2O EF (g gas/mile) | 0.1517 |
| HC (MMBTU/bbl) | 5.253 |
| CCC (kg C/ MMBTU) | 19.34 |
| Fraction Oxidized | 0.99 |
| MW ratio (kg CO2/kg C) | 3.664 |

Bus Emissions (Diesel)

| | |
|---------------------------|---------|
| MMBTU/gal diesel EF | 0.1387 |
| Tonnes CO2/gal diesel EF | 0.01004 |
| CH4 EF (g gas/mile) | 0.0966 |
| N2O EF (g gas/mile) | 0.0483 |
| HC (MMBTU/bbl) | 5.8 |
| CCC (kg C/ MMBTU) | 19.95 |
| Fraction Oxidized | 0.99 |
| MW ratio (kg CO2/kg C) | 3.664 |
| Live RT Distance (mi) | 618 |
| Dead RT Distance (mi) | 69 |
| Live Time (hr) | 11.00 |
| Dead Time (hr) | 1.72 |
| Stationary Time (hr) | 4.00 |
| Gallons per Mile (diesel) | 0.1449 |

| | |
|-------------------|------|
| Bus Miles per Gal | 6.90 |
|-------------------|------|

Air Travel Emissions

| | |
|------------------------------|-------|
| CH4 EF (g gas/kg fuel) | 0.087 |
| N2O EF (g gas/kg fuel) | 0.10 |
| HC (MMBTU/bbl) | 5.670 |
| CCC (kg C/ MMBTU) | 19.33 |
| Fraction Oxidized | 0.99 |
| MW ratio (kg CO2/kg C) | 3.664 |
| Jet Fuel Density (tonne/bbl) | 0.126 |

Train Travel Emissions (Assume diesel fueled trains)

| | |
|------------------------|-------|
| Fuel Density (kg/gal) | 3.19 |
| CH4 EF (g gas/kg fuel) | 0.25 |
| N2O EF (g gas/kg fuel) | 0.08 |
| HC (MMBTU/bbl) | 5.825 |
| CCC (kg C/ MMBTU) | 19.33 |
| Fraction Oxidized | 1 |
| MW ratio (kg CO2/kg C) | 3.664 |

Sources for Scope 3, Part A Data

This section includes emissions from all mobile combustion of fossil fuels used in vehicles not owned by the institution, but whose services are directly solicited by the institution.

Formulaic Numbers

| | |
|-------------------------------------|--|
| HC (MMBTU/bbl) | Higher heating values (HHV) are used. FY01/02-FY05/06: EPA Climate Leaders. 2004. "Core Module Guidance: Direct Emissions from Stationary Combustion Sources." pp 22. < http://www.epa.gov/climateleaders/docs/stationarycombustionguidance.pdf > [JK 06] |
| CCC (kg C/ MMBTU) | Higher heating values (HHV) are used. EPA Climate Leaders. 2004. "Core Module Guidance: Direct Emissions from Mobile Combustion Sources." pp 26. < http://www.epa.gov/climateleaders/docs/mobilesourceguidance.pdf > [JK 06] |
| Fraction Oxidized | EPA Climate Leaders. 2004. "Core Module Guidance: Direct Emissions from Mobile Combustion Sources." pp 26. < http://www.epa.gov/climateleaders/docs/mobilesourceguidance.pdf > [BB 07] |
| MW ratio (kg CO ₂ /kg C) | Molecular Weights are accepted as chemical standards. Value = $((12.011+2*16.000)/12.011)$ [BB 07] |
| CH ₄ EF (g gas/MMBTU) | Based on 1987-1993 EFs for vans, pickups, and SUVs (most conservative light-duty values), 1985-1986 EFs for heavy duty vehicles (most conservative values), 1966-1982 EFs for heavy duty vehicles (most conservative values), values for locomotive diesel fuel. EPA Climate Leaders. 2004. "Core Module Guidance: Direct Emissions from Mobile Combustion Sources." p 9 and 25. http://www.epa.gov/climateleaders/docs/mobilesourceguid , and Jet Fuel Specific EFs. Inventory of U.S. Greenhouse Gas Emissions and Sinks: 1990-2001 (April 2003) EPA 430-R-03-004; Annex E [JK 06] |
| CH ₄ GWP | Global Warming Potential (GWP) based on 100-year time horizon: US EPA. 2006. "Non-CO ₂ Gasses Economic Analysis and Inventory: Global Warming Potentials and Atmospheric Lifetimes." < http://www.epa.gov/nonco2/econ-inv/table.html > [BB 07] |
| N ₂ O EF (g gas/MMBTU) | Based on 1987-1993 EFs for vans, pickups, and SUVs (most conservative light-duty values), 1985-1986 EFs for heavy duty vehicles (most conservative values), 1966-1982 EFs for heavy duty vehicles (most conservative values), values for locomotive diesel fuel. EPA Climate Leaders. 2004. "Core Module Guidance: Direct Emissions from Mobile Combustion Sources." p 9 and 25. http://www.epa.gov/climateleaders/docs/mobilesourceguid , and Jet Fuel Specific EFs. Inventory of U.S. Greenhouse Gas Emissions and Sinks: 1990-2001 (April 2003) EPA 430-R-03-004; Annex E [JK 06] |
| N ₂ O GWP | Global Warming Potential (GWP) based on 100 yr time horizon: US EPA. 2006. "Non-CO ₂ Gasses Economic Analysis and Inventory: Global Warming Potentials and Atmospheric Lifetimes." < http://www.epa.gov/nonco2/econ-inv/table.html > [BB 07] |
| N ₂ O EF (g gas/mile) | Based on 1987-1993 EFs for vans, pickups, and SUVs (most conservative light-duty values), 1985-1986 EFs for heavy duty vehicles (most conservative values), 1966-1982 EFs for heavy duty vehicles (most conservative values), values for locomotive diesel fuel. EPA Climate Leaders. 2004. "Core Module Guidance: Direct Emissions from Mobile Combustion Sources." p 9 and 25. http://www.epa.gov/climateleaders/docs/mobilesourceguid , and Jet Fuel Specific EFs. Inventory of U.S. Greenhouse Gas Emissions and Sinks: 1990-2001 (April 2003) EPA 430-R-03-004; Annex E [JK 06] |
| CH ₄ EF (g gas/mile) | Based on 1987-1993 EFs for vans, pickups, and SUVs (most conservative light-duty values). EPA Climate Leaders. 2004. "Core Module Guidance: Direct Emissions from Mobile Combustion Sources." p 9. http://www.epa.gov/climateleaders/docs/mobilesourceguid [JK 06] |

| | |
|-----------------------------------|------------------------------|
| Barrels/gallon (1/42) | Unit Conversion |
| US Dollars/cent (1/100) | Unit Conversion |
| Tonne/kg (1/1,000) | Unit Conversion |
| Tonne/gram (1/1x10 ⁶) | Unit Conversion |
| Bus Miles per Gal | Calculated from sourced data |
| Bus mi/gal | See Above |
| MMBTU/BTU (1/1 million) | Unit Conversion |

Mileage Reimbursement for use of Personal and Rental Cars (Gasoline)

| Value/EF | Sources |
|------------------------------------|--|
| Total Reimbursement \$ | Total travel expenditure given by Barbara Burke [NL 10] |
| Annual average cents/gal | U.S. Department of Energy, Energy Information Administration. "WHAT WE PAY FOR IN A GALLON OF REGULAR GASOLINE", http://www.eia.gov/oog/info/gdu/gaspump.html , site last updated 04/10/10. [NL 10] |
| Total Reimbursement Gas (gal) | Calculated from sourced data |
| MMBTU/gal gas EF | Calculated from sourced data |
| Tonnes CO ₂ /gal gas EF | Calculated from sourced data |
| Putative Vehicle mi/gal | Mileage rate used by Monterey Institute of International Studies in determining \$ reimbursements. Taken From Middlebury College CCAL Gas Mileage Chart by Charlotte Chase. [JK 06] |
| Gas Vehicle Activity miles | Calculated from sourced data |

Taxi Emissions (Gasoline)

| Value/EF | Sources |
|------------------------------------|--|
| Total Taxi \$ | Estimated as 5% of Total travel, from Barbara Burke (CS & RB 09) |
| Average \$/person | Totally Estimated [NB 2008] |
| Average people/trip | Totally Estimated [NB 2008] |
| Average \$/trip | Totally Estimated [NB 2008] |
| Mode trip distance (mi) | |
| Total Taxi Miles | Calculated from sourced data |
| Van mi/gal | N/A [NB 08] |
| Tot Taxi Gas (gal) | Calculated from sourced data |
| MMBTU/gal gas EF | Calculated from sourced data |
| Tonnes CO ₂ /gal gas EF | Calculated from sourced data |

Bus Emissions (Diesel)

| Value/EF | Sources |
|-------------------------------|--|
| Total Bus \$ | Estimated as 0% of Total travel, from Barbara Burke (CS & RB 09) |
| Mode Bus Size (by capacity) | N/A [NB 08] |
| Base hourly fee (\$/hr) | N/A [NB 08] |
| Live Mile charge/mile (\$/mi) | N/A [NB 08] |
| Dead Mile charge/mile (\$/mi) | N/A [NB 08] |
| Gallons per Mile (diesel) | EPA Climate Leaders. 2004. "Core Module Guidance: Direct Emissions from Mobile Combustion Sources." pp 12. < http://www.epa.gov/climateleaders/docs/mobilesourceguidance.pdf > [BB 07] |
| Live RT Distance (mi) | MapQuest Queries End point: 460 Pierce Street, Monterey, CA 93940: < http://www.mapquest.com/directions/main.adp?bCTsettings=1 > |

| | |
|------------------------------------|--|
| Dead RT Distance (mi) | MapQuest Queries End point:460 Pierce Street, Monterey, CA 93940: < http://www.mapquest.com/directions/main.adp?bCTsettings=1 > |
| Live Time (hour) | MapQuest Queries End point: 460 Pierce Street, Monterey, CA 93940: < http://www.mapquest.com/directions/main.adp?bCTsettings=1 > |
| Dead Time (hr) | MapQuest Queries by End point: 460 Pierce Street, Monterey, CA 93940: < http://www.mapquest.com/directions/main.adp?bCTsettings=1 > |
| Stationary Time (hr) | Putatively small in order to remain conservative |
| Live Speed | Calculated from sourced data |
| Dead Speed | Calculated from sourced data |
| Total Cost | Calculated from sourced data |
| Total Gal Diesel Combusted | Calculated from sourced data |
| Gal/\$ Given the High Em. Scenario | Calculated from sourced data |
| MMBTU/gal diesel EF | Calculated from sourced data |
| Tonnes CO2/gal diesel EF | Calculated from sourced data |
| Gas Vehicle Activity miles | Calculated from sourced data |

Air Travel Emissions

| Value/EF | Sources |
|-------------------------------|--|
| Total Airline \$ | Estimated as 30% of Total travel, from Barbara Burke (CS & RB 09) |
| % of \$ spent on dom travel | Estimated by Natalie Berland confirmed by Jim Williams [NB 08] |
| San Jose to LAX RT price | Average price of non-weekend travel and weekend travel two months from booking date < www.kayak.com > [NL] |
| San Jose to LAX RT milage | Mileage data collected via MapQuest < http://www.mapquest.com > [NB 08] |
| SFO to Burlington RT price | Average price of non-weekend travel and weekend travel two months from booking date < www.kayak.com > [NL] |
| SFO to Burlington RT milage | Mileage data collected via MapQuest < http://www.mapquest.com > [NB 08] |
| SFO to Tokyo RT price | Average price of non-weekend travel and weekend travel two months from booking date < www.kayak.com > [NL] |
| SFO to Tokyo RT milage | Mileage data collected via MapQuest < http://www.mapcrow.info/ > [NB 08] |
| Dom BTU jet fuel/pass. mi. | Energy Intensity of Passenger Modes (BTU per passenger miles), Bureau of Transportation Statistics, National Transportation Statistics 2007, (Table 4-20), pp 286: < http://www.bts.gov/publications/national_transportation_statistics/pdf/entire.pdf > [BB 07] |
| Int BTU jet fuel/pass. mi. | Energy Intensity of Passenger Modes (BTU per passenger miles), Bureau of Transportation Statistics, National Transportation Statistics 2007, (Table 4-20), pp 286: http://www.bts.gov/publications/national_transportation_statistics/pdf/entire.pdf [BB 07] |
| MMBTU/airfare \$ EF | Calculated from sourced data (given the % domestic travel given) |
| Tonnes CO2/airfare \$ EF | Calculated from sourced data (given the % domestic travel given) |
| Radiative Forcing Index (RFI) | 1992 Global RFI as set by the IPCC. This is one of the more concrete RFI numbers in circulation and is higher than that used by Native Energy and the Carbon Exchange. < http://www.grida.no/climate/ipcc/aviation/064.htm > [BB 07] |
| | "In 1992, the RFI for aircraft is 2.7; it evolves to 2.6 in 2050 for the Fa1 scenario." |

Train Travel Emissions (Assume diesel fueled trains)

| Value/EF | Sources |
|------------------|--|
| Total Train \$ | Estimated as 0% of Total travel, from Barbara Burke (CS & RB 09) |
| Short Haul Price | Price of non-weekend travel 2 months from booking date < http://www.orbitz.com > |

| | |
|--------------------------|--|
| Short Haul Mileage | Mileage data collected via MapQuest < http://www.mapquest.com > |
| Medium Haul Price | Price of non-weekend travel 2 months from booking date < http://www.orbitz.com > |
| Medium Haul Mileage | Mileage data collected via MapQuest < http://www.mapquest.com > |
| Long Haul Price | Price of non-weekend travel 2 months from booking date < http://www.orbitz.com > |
| Long Haul Mileage | Mileage data collected via MapQuest < http://www.mapquest.com > |
| Amtrack BTU/pass. mi. | Energy Intensity of Passenger Modes (BTU per passenger miles), Bureau of Transportation Statistics, National Transportation Statistics 2007, (Table 4-20), pp 286: < http://www.bts.gov/publications/national_transportation_statistics/pdf/entire.pdf > [BB 07] |
| MMBTU/airfare \$ EF | Calculated from sourced data (given the % domestic travel given) |
| Tonnes CO2/airfare \$ EF | Calculated from sourced data (given the % domestic travel given) |

Notes on Source Reproduction

Methane and Nitrous oxide EFs are based on highway vehicle EFs that were taken directly from US EPA. 2004. "Inventory of U.S. Greenhouse Gas Emissions and Sinks:" 1990-2002, EPA430-R-04-003, U.S. EPA, Washington, DC, April 2004, as were CCC's and FO factors. FO values of .99 are also recommended by IPCC guidelines.

Scope 3, Part B: Indirect Emissions from Landfill Waste

This section includes emissions from methane produced by the institutional waste stream.

Primary Assumption: That the institution is responsible for the lifetime effect of the methane emitted during the reporting period during that reporting period only.

Summary Data: Fiscal Year 2009-2010

| Source | MTCDEs |
|--------------------------|--------|
| MTCDEs from Landfill CH4 | 46.92 |

Assessing the Split Between Landfills

| Value/EF | |
|------------------------------------|--------|
| Total Solid Waste (lbs) ▲ | 94,146 |
| % Taken to MRWMD | 100% |
| MRWMD Landfill Emissions | |
| Straight Landfill | 0.0% |
| CH4 Recovery/Flaring w/o LFGE? (%) | 0.0% |
| Electricity Generation (%) | 100.0% |
| Short Tons Solid Waste | 47.07 |
| CH4 EF (tonnes gas/ton waste) | 0.047 |
| Tonnes MRWMD LF CH4 | 2.23 |

Net Methane + Emissions Factor Calculations

| Value/EF | |
|----------------------------------|-------|
| CH4 EF w/out Recovery (MTCE/ton) | 0.52 |
| CH4 EF w/ Recovery (MTCE/ton) | 0.40 |
| CH4 EF w/ LFGE (MTCE/ton) | 0.27 |
| Tonnes CH4 | 2.23 |
| MTCDEs from Landfill CH4 | 46.92 |

Formulaic Numbers

| Standard Coefficients | |
|--------------------------------|--------|
| Short tons/lb (1/2000) | 0.0005 |
| CH4 GWP | 21 |
| MTCDE/MTCE (tonne CO2/tonne C) | 3.664 |

Landfill Emissions

| | |
|---------------------------------------|-------|
| CH4 EF w/out Recovery (tonne gas/ton) | 0.091 |
| CH4 EF w/ Recovery (tonne gas/ton) | 0.070 |
| CH4 EF w/ LFGE (tonne gas/ton) | 0.047 |

Sources for Scope 3, Part B Data

This section includes emissions from methane produced by the institutional waste stream.

Directly proportional to: Total amounts of waste, Diversion rates, Methane processing technology

Primary Assumption: That the institution is responsible for the lifetime effect of the methane emitted during the reporting period during that reporting period only.

Formulaic Numbers

| | |
|---------------------------------------|--|
| Short tons/lb (1/2000) | Unit Conversion |
| CH4 EF w/out Recovery (tonne gas/ton) | *** (see note below) |
| CH4 EF w/ Recovery (tonne gas/ton) | *** (see note below) |
| CH4 EF w/ LFGE (tonne gas/ton) | *** (see note below) |
| MTCDE/MTCE (tonne CO2/tonne C) | Molecular Weights are accepted as chemical standards. Value = $((12.011+2*16.000)/12.011)$ |
| CH4 GWP | Global Warming Potential (GWP) based on 100 yr time horizon: US EPA. 2006. "Non-CO2 Gasses Economic Analysis and Inventory: Global Warming Potentials and Atmospheric Lifetimes." < http://www.epa.gov/nonco2/econ-inv/table.html > |

Assessing the Split Between Landfills

| | |
|------------------------------------|--|
| Value/EF | Sources: |
| Total Solid Waste (lbs) | Waste Audit Document [NL 10] |
| MRWMD Landfill Emissions | |
| Straight LF | Determined by calling Monterey Regional Waste Disposal Management District [NL&LJ '10] |
| CH4 Recovery/Flaring w/o LFGE? (%) | |
| Electricity Generation? (%) | |

Direct Sequestration, Renewable Energy Certificates, and Offsets

This section catalogues all carbon sinks, and verifiable third-party investments in renewable energy.

Summary Data: Fiscal Year 2009-2010

| | MTCDEs by year (FY09/10) |
|-------------------------------|--------------------------|
| Contributing Internal Offsets | 0.00 |
| Contributing External Offsets | 0.00 |
| Total | 0.00 |

Contributing Internal Offsets

| Value/EF | |
|-------------------------------|-------------|
| Waste Composted (lbs) | 0 |
| Tonnes CO2 sequestered | 0.00 |

Contributing External Offsets: All values in metric tonnes.

| Group Categories | MTCDEs by year (FY09/10) |
|-------------------------------------|--------------------------|
| Athletics | |
| Academic Departments | |
| Administration | |
| Student Organizations | 0* |
| Commons | |
| Total | 0.00 |
| Combined Reported Footprints | |
| Athletics | |
| Academic Departments | |
| Administration | |
| Student Organizations | |
| Commons | |
| Total | 0 |

*ETF Happy Hour

Non-Contributing External Offsets: All values are to be entered in metric tonnes.

| Group Categories | MTCDEs by Year (FY09/10) |
|-----------------------|--------------------------|
| Athletics | |
| Academic Departments | |
| Administration | |
| Student Organizations | |
| Commons | |
| Total | 0.0 |

Formulaic Numbers

| | |
|-------------------------|--------|
| MTCDE seq/ton composted | 0.03 |
| Short tons/lb (1/2000.) | 0.0005 |

Sources for Direct Sequestration, Renewable Energy Certificates, and Offsets

This section catalogues all carbon sinks, and verifiable third-party reductions directly produced by the institution in hopes of reducing its environmental impact on a global scale.

Formulaic Numbers

| | |
|-------------------------|-----------------|
| Short tons/lb. (1/2000) | Unit Conversion |
|-------------------------|-----------------|

Contributing Internal Offsets

| Value/EF | Sources |
|------------------------|---------|
| Waste Composted (lbs.) | n/a |

Contributing External Offsets

| | |
|-----------------------|------|
| Administration | n/a |
| Student Organizations | ETF? |
| Commons | n/a |

Non-Contributing External Offsets

| | |
|-----------------------|--|
| Student Organizations | ETF Purchased carbon offsets for the Carbon Neutral happy hour. However, we do not know if these credits were calculated to offset the electricity used during the event. We believe that the offsets were used to offset the food and alcohol, and the transportation of the people to come to happy hour. Therefore, it is debatable whether or not these credits are applicable to the GHG audit. In addition, we are not sure as to the location of the certificate for the offsets (therefore the number of offsets purchased), or whether they were bought in MIIS' name. This is something that needs to be addressed when ETF purchases offsets in the future. |
| Academic Departments | n/a |
| Administration | n/a |
| Commons | n/a |

Normalization Factors

This section includes information that relates to institutional growth between reporting periods. By Normalizing emissions data, emissions can be displayed in the context of organic growth.

| | |
|------------------------|-----|
| Total Students | 722 |
| Total Employees | 199 |

This information is from the campus community census report to the City of Monterey Planning Department (June 25, 2007). Represents total MIIS community members for fall 2006 and spring 2007 [NB 08]