Middlebury Institute of International Studies
Annual Greenhouse Gas Inventory
Fiscal Year 2019-2020

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Middlebury Institute *of*
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Summary Data

Comprehensive Summary: Fiscal Year 2019-2020

Sub-Scope	MTCDEs	Percent with Commute	Percent without Commute
S1S Natural Gas	0.0	0.0%	0.00%
S1M Gas	1.1	0.1%	0.08%
S2 Electricity	191.5	20.2%	14.62%
S3 Travel	706.2	74.7%	53.91%
S3 Landfill CH4	47.2	5.0%	3.60%
S3 Employee Commute	364.0		27.79%
Offsets	0.0		
Total	**946.0**	**100%**	
With Commute	**1,310.0**		
W/o travel or commute	**239.8**		

Sub-scope Total

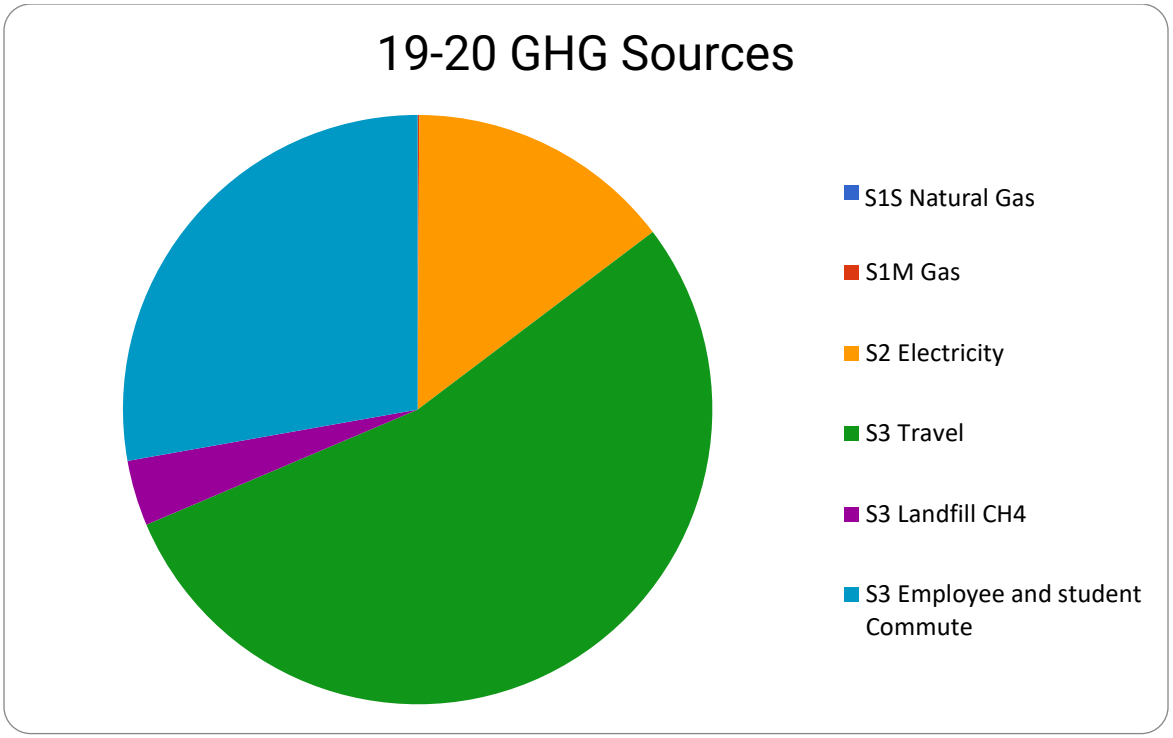
MTCDEs		Percent	
Scope 1: Stationary	0	S1S	0%
Scope 1: Mobile	1	S1M	0%
Scope 2: Electricity	192	S2	20%
Scope 3: Travel	706	S3 Trav	75%
Scope 3: Landfill CH4	47	S3 LF CH4	5%
Scope 3: Employee Commute	76	S3 Commute	8%
Total	**946.0**		**100%**

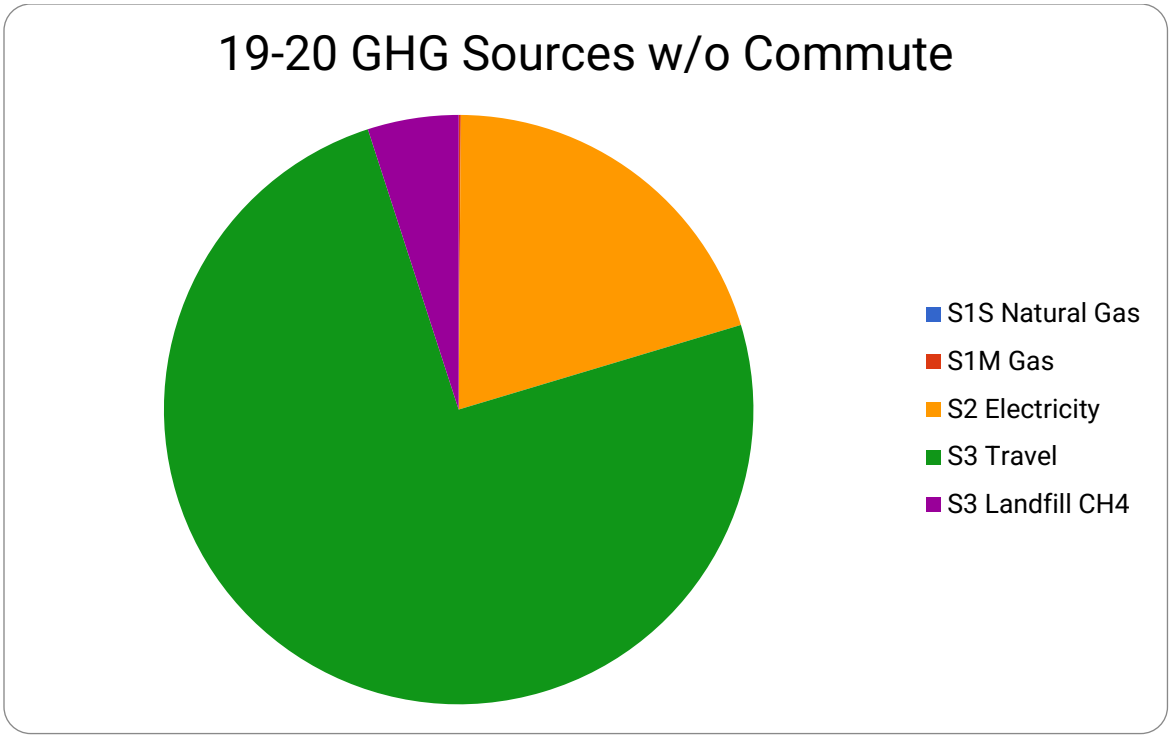
Scope Total

MTCDEs		Percent	
Scope 1	1	Scope 1	0%
Scope 2	192	Scope 2	15%
Scope 3	1,117	Scope 3	85%
Total	**1,310.0**		**100%**

MTCDEs by gas

GHG	MTCDE	Percent	
CO2	439.4	CO2	86.1%
CH4	48.9	CH4	9.6%
N2O	22.2	N2O	4.3%
Total	**510.5**	**Total**	**100.0%**


19-20 GHG Sources
S1S Natural Gas
S1M Gas
S2 Electricity
S3 Travel
S3 Landfill CH4
S3 Employee and student Commute


19-20 GHG Sources w/o Commute
S1S Natural Gas
S1M Gas
S2 Electricity
S3 Travel
S3 Landfill CH4

Symbols and Glossary

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

Symbols Indicating Data Provider

*	Collected annually by Sustainability Graduate Assistant from the PG&E bills. Access given by Barbara Burke. [HB12]
†	Collected annually from receipts of campus vehicle provided by accounting. Information received from Barbara Burke. [HB12]
‡	On campus solar
□	Collected annually by the Sustainability Graduate Student. Estimated from travel numbers provided by accounting. Information received from Barbara Burke. [HB11]
▲	Collected annually by Sustainability Graduate Assistant from Waste management bills. [HB12]
∞	Collected annually by Sustainability Graduate Assistant from Facilities. Information received from Barbara Burke [HB 12]
●	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

BBL	Barrels of liquid hydrocarbons
BTU (British Thermal Unit)	The amount of heat required to increase the temperature of a pint of water (which weighs exactly sixteen 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-year atmospheric life span of a CO2 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-CO2 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.
Intergovernmental Panel on Climate Change (IPCC)	Established in 1988 by WMO and UNEP to assess scientific, technical and socio-economic information relevant for the understanding of climate change, its potential impacts and options for adaptation and mitigation.
Therms	100,000 BTUs
ΣMTCDE (Metric Tons of Carbon Dioxide Equivalent)	Unit of measure that is used in this GHG audit

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 2019-2020

Sources	**MTCDEs**
Natural Gas	0
TOTAL	**0**

Value/EF	
Natural Gas (therms)	0
MMBTUs of fuel	0
Metric Tonnes CO2	0
Tonnes CH4	0
MTCDE from CH4	0
Tonnes N2O	0
MTCDE from N2O	0
ΣMTCDE from natural gas	**0**

Formulaic Numbers

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

#6 Fuel Oil

MMBTU/gal #6 EF	0.1497
Tonnes CO2/gal #6 EF	0.011669382
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 Malcolm Johnson from electronic PG&E bills. [‘13]
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 Malcolm Johnson from electronic PG&E bills. [‘13]
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 2019-2020

Sources	MTCDEs
Gas	1.1
TOTAL	**1.1**

Gasoline Fueled Vehicles

ΣScope 1Gas = campus gas + off campus gas

Factors determining off campus gas calculations:	
Car tank size (gal)	19.5
Car average miles/gal	20.0
15/11-pass. van tank size (gal)	0.0
15/11-pass. van average miles/gal	0.0
Mini-van tank size (gal)	0.0
Mini-van average miles/gal	0.0
Average Price of CA Gasoline	$2.55
Total Amount Spent on Gasoline	$300.00
Off Campus Gasoline (gal) †	117.6
Σ Scope 1 Gas (gal)	118
MMBTUs of fuel	14.7
Metric Tonnes CO2	1.0
Putative Vehicle mi/gal	15.0
Gas Vehicle Activity Miles	1,765
Tonnes CH4	0.0
MTCDE from CH4	0.01
Tonnes N2O	0.00
MTCDE from N2O	0.1
ΣMTCDE from Gasoline	**1.1**

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	0.01004
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 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 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]
CH4 GWP	Global Warming Potential (GWP) based on 100-year 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 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]
N2O GWP	Global Warming Potential (GWP) based on 100-year 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]
Barrels/gallon (1/42)	Unit Conversion
Tonne/kg (1/1,000)	Unit Conversion

Gasoline Fueled Vehicles

ΣScope 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. [HB 12]
Average Price of Gasoline	Monthly average for 2012-2013 Fiscal year calculated from: http://energyalmanac.ca.gov/gasoline/retail_gasoline_prices.html#2013
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 does not 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 2019-2020

Source	MTCDEs
ΣMTCDE from Natural Gas	180.74
ΣMTCDE from Coal	10.8
ΣMTCDE from Electricity Use	**191.542**

kWh Used by On-Campus Sources

Value/EF	
On-campus solar kWh ‡	1,953
Total kWh from PG&E *	868,133
Total kWh used w/in boundaries	**870,086**

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 Hydo	4.00**
% Wind	3.00
% Solar	1.00
% Other	1.00
Total	102***

MIIS Net kWh by Source

Solar	10,634
Biomass	34,725
Large Hydro	138,901
Nuclear	173,627
Natural Gas	408,023
Coal	17,363
Geothermal	34,725
Small Hydro	34,725
Wind	26,044
Other	8,681
Total kWh:	**887,449****

*% #1, 2, & 4 Fuel Oil

**% #5 & 6 Fuel Oil

***More than one hundred due to rounding conventions

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

MIIS Electricity Sources by Percent

Solar	1.2%
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%**

CO2 Emissions Calculations: Natural Gas

Value/EF	**Total**	**Units**	**Notes**
kWh from Natural Gas	408,023		
MMBTUs of electricity	1,392.2		
Metric Tonnes CO2	178.7		
Tonnes CH4	0.00132		
MTCDE from CH4	0.028		
Tonnes N2O	0.00013		
MTCDE from N2O	0.041		
ΣMTCDE from Natural Gas Excluding Losses	178.8		

Accounting for Losses (Natural Gas)

Value/EF	**Total**	**Units**	**Notes**
kWh consumed at MIIS from Natural Gas	408,023		
T&D loss factor	1.10%		from PG&E
kWh at generator	412,494		
Generation efficiency (heat rate)	8,250	Btu/kWh	PG&E avg
MBtu natural gas consumed at generator	3,403	MBtu	
Metric Tonnes CO2	180.57	tonnes	CO2
tonnes CH4	0.00323	tonnes	CH4
MTCDE from CH4	0.068	tonnes	CO2-eq
tonnes N2O	0.00032	tonnes	N2O
MTCDE from N2O	0.10022	tonnes	CO2-eq
ΣMTCDE from Natural Gas	180.74	tonnes	CO2-eq

CO2 Emissions Calculations: Coal

Value/EF	**Total**	**Units**	**Notes**
kWh from Coal	17,363		
MMBTUs of electricity	59.2		
Metric Tonnes CO2	19.1		
tonnes CH4	0.00006		
MTCDE from CH4	0.001		
tonnes N2O	0.00008		
MTCDE from N2O	0.0256928		

ΣMTCDE from Coal Excluding Losses	19.1		

Accounting for Losses (Coal)

Value/EF	Total	Units	Notes
kWh consumed at MIIS from Coal	17,363	kWh	
T&D loss factor	1.10%		from PG&E
kWh at generator	17,553	kWh	
Generation efficiency (heat rate)	11,500	Btu/kWh	PG&E avg
MBtu natural gas consumed at generator	202	MBtu	
Metric Tonnes CO2	10.71	tonnes	CO2
Tonnes CH4	0.00019	tonnes	CH4
MTCDE from CH4	0.004	tonnes	CO2-eq
Tonnes N2O	0.00028	tonnes	N2O
MTCDE from N2O	0.08761	tonnes	CO2-eq
ΣMTCDE from Coal	10.80	tonnes	CO2-eq
ΣMTCDE from Electricity Use	191.54	tonnes	CO2-eq

MTCDEs by Electricity Source

Solar	0
Biomass	0
Hydro	0
Nuclear	0
Natural Gas	181
Coal	11
Geothermal	0
Small Hydro	0
Wind	0
ΣMTCDE from electricity:	**192**

MTCDE Sources by Percent

Solar	0%
Biomass	0%
Hydro	0%
Nuclear	0%
Natural Gas	94%
Coal	6%
Geothermal	0%
Small Hydro	0%
Wind	0%
Should be 100%	100%

Formulaic Numbers

Standard Coefficients	
MWh/kWh (1/1000)	0.001
MMBTU/kWh	0.003412
Tonne/kg (1/1,000)	0.001
Tonne/gram (1/1x106)	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]
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MWh/kWh (1/1000)	Unit Conversion
MMBTU/kWh	Unit Conversion
Tonne/gram (1/1x106)	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 [HB12]
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 11/8/13: 27233 kWh since installation on 9/22/2001. Approximate FY11-12 kWh generated = kWh / year since installation = 27233 hWh / 12.125 years = 2246.0206 kWh [HB12].

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 2019-2020

Type of Expenditure Contributing to Emissions	% of Total	Amount ($)
Gasoline	40.03%	$131,875,25
Taxis	9.32%	$30,718.83
Bus	3.75%	$12,355.64
Airplanes	46.33%	$152,620.38
Trains	0.56%	$1,860.53
Total	**100.00%**	**$329,430.63**

Sources	MTCDEs	Percentage
Gasoline	309	43.8%
Taxis	3.9	0.6%
Bus	3	0.4%
Airplanes	389.2	55.1%
Trains	1.1	0.2%
TOTAL:	**706**	**100.0%**

Gasoline (Individual and Rental Cars)

Value/EF	
Total Reimbursement $ □	$131,875*
Annual avg cents/gal	403**
Total Reimbursement Gas (gal)	32,723
MMBTUs of fuel	4,092.8
Metric Tonnes CO2	287.1
Putative Vehicle mi/gal	20.0
Gas Vehicle Activity miles	654,468
tonnes CH4	0.075
MTCDE from CH4	1.57
tonnes N2O	0.066
MTCDE from N2O	20.3
ΣMTCDE from Mile Reimb.	**309.0**

*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 $	$30,719
Average $/person	$25
Average people/trip	1
Average $/trip	$25
Mode trip distance (mi)	5
Total Taxi Miles	6,144

Van mi/gal	15
Total Taxi Gas (gal)	410
MMBTUs of fuel	51.2
Metric Tonnes CO2	3.6
tonnes CH4	0.001
MTCDE from CH4	0.03
tonnes N2O	0.001
MTCDE from N2O	0.3
ΣMTCDE from Taxi Gasoline	**3.9**

Bus Emissions (Diesel)

Value/EF	
Total Bus $ □	$12,356
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)	298
MMBTUs of fuel	41.3
Metric Tonnes CO2	**3.0**
Gas Vehicle Activity miles	2,057
Tonnes CH4	0.000
MTCDE from CH4	**0.004**
tonnes N2O	0.000
MTCDE from N2O	**0.03**
ΣMTCDE from Bus Travel:	**3.0**

Air Travel Emissions

Value/EF	
Total Airline $ □	$152,620
% of $ spent on dom travel □	50%
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	220,000
International passenger mi	370,000
Total Passenger mi	590,000
Dom BTU jet fuel/pass. mi.	3,098
Int BTU jet fuel/pass. mi.	3,691
MMBTU/airfare $ EF	0.0134
Tonnes CO2/airfare $ EF	0.0009
MMBTUs of fuel	2,047.2
Metric Tonnes CO2	143.6
Radiative Forcing Index (RFI)	2.7
MTCDEs Adj. for RFI	387.7
Gallons of Jet Fuel Consumed	15,164
Tonnes CH4	0.004
MTCDE from CH4	0.08
tonnes N2O	0.005
MTCDE from N2O	1.4
ΣMTCDE from Air Travel:	**389.2**

Train Travel Emissions (Assume diesel fueled trains)

Value/EF	
Total Train $ □	$1,860.53
Salinas to San Franscisco RT price	$32
Salinas to San Francisco RT mileage	106.0
Salinas to San Francisco $/pass-mi	$0.302
Salinas to LA RT price	$96
Salinas to LA RT mileage	304.7
Salinas to LA $/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	7,331
Amtrak BTU/pass. mi.	2,100
MMBTU/airfare $ EF	0.008
Tonnes CO2/train $ EF	0.0005804
MMBTUs of fuel	15.4
Metric Tonnes CO2	1.1
Gallons of Diesel Fuel Consumed	111
MTCDE from CH4	0.002
Tonnes N2O	0.00003
MTCDE from N2O	0.003
ΣMTCDE from Train Travel:	**1.1**

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	0.0087747
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	0.0087747
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/bbll)	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 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 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]
CH4 GWP	Global Warming Potential (GWP) based on 100-year 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 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]
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]
N2O 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]
CH4 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 (1/1x106)	Unit Conversion
Bus Miles per Gal	Calculated from sourced data
Bus mi/gal	See Above
MMBTU/BTU (1/1 million)	Unit Conversion

Milage 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 CO2/gal gas EF	Calculated from sourced data
Putative Vehicle mi/gal	Mileage rate used by Middlebury 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 [NB08]
Average people/trip	Totally Estimated [NB08]
Average $/trip	Totally Estimated [NB08]
Mode trip distance (mi)	
Total Taxi Miles	Calculated from sourced data
Van mi/gal	N/A [NB08]
Tot Taxi Gas (gal)	Calculated from sourced data
MMBTU/gal gas EF	Calculated from sourced data
Tonnes CO2/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]
High Emissions / $ Scenario	
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 2019-2020

Source	MTCDEs
MTCDEs from Landfill CH4	**47.17**

Assessing the Split Between Landfills

Value/EF	
Total Solid Waste (lbs.) ▲	94,653
% 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	47.33
CH4 EF (tonnes gas/ton waste)	0.047
Tonnes MRWMD LF CH4	2.25

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	2.25
MTCDEs from Landfill CH4	**47.17**

Recycling	**57,651**

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)	
CH4 EF w/ Recovery (tonne gas/ton)	
CH4 EF w/ LFGE (tonne gas/ton)	
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 2019-2020

	MTCDEs by Year
Contributing Internal Offsets	0.00
Contributing External Offsets	0.00
TOTAL	**0.00**

Contributing Internal Offsets

Value/EF	MTCDEs by Year
Waste Composted (lbs.)	0
Tonnes CO2 sequestered	**0.00**

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

Group Categories	MTCDEs by Year
Athletics	
Academic Departments	
Administration	
Student Organizations	
Commons	
Total	**0.00**
Combined Reported Footprints	
Athletics	
Academic Departments	
Administration	
Student Organizations	
Commons	
Total	**0.00**

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

Group Categories	MTCDEs by Year
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	N/A
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