



Calculations Explained for The Climate Trust's "Business and Organization Carbon Calculator"

Introduction

Calculating a business or organization's impact on the climate is not an exact science. The calculations below, therefore, try to incorporate the most up-to-date references and data available. The most prudent assumptions have been made, and objective sources of information have been used for citation purposes. Where they are applicable, conservative estimates have been made.

The total amount of metric tons that appears on the second page of the calculator is arrived at by adding together the total emissions calculated in the *Infrastructure*, *Transportation*, and *Shipping* sections.

Infrastructure

The calculator determines the carbon footprint of the indirect emissions from the electricity and natural gas usage attributable to the organization using common conversion factors, if energy usage is known. If the amount of annual energy usage is not known, the carbon footprint is calculated one of two ways based on: 1) data specific to the building or complex hosting the event; or 2) regional data based on national energy surveys. In either case, the energy intensity of the building or complex hosting the organization is calculated.

Electricity

Option 1) If site specific data is available, the total kilowatt hours consumed annually by the building/complex needs to be divided by the total amount of square feet of the building/complex. For example, if a building uses six million kWhs in a year and the square footage of the building is 600,000 ft², then the electricity energy intensity of the building is 10 kWhs consumed per square foot per year.

Option 2) If site specific data is not available, regional data is used and energy intensity is calculated based on the region where the building is located and its range of

square footage. For example, if the building hosting an event is located in the Midwest and falls within the range of 10,001 and 100,000 ft², the energy intensity of the building is 11.4 kWhs consumed per square foot per year. These figures are taken from the U.S. Energy Information Administration's *2003 Consumer Buildings Energy Consumption Survey*.ⁱ (Note the figures in the table have been discounted by 10% for calculation purposes to account for more energy intensive activities that fall within the "commercial" category.)

The calculator then multiplies the energy intensity figure (calculated above) by the total amount of square feet used for the organization's operations. The result is the estimated annual amount of electricity (kWhs) that will be consumed by the square footage dedicated to the organization.

To calculate carbon dioxide emissions associated with electricity consumption, the amount of electricity used (either known from utility bills, or calculated using one of the options above) is multiplied by the emissions factor of the electricity grid of the state where the organization is located. Electricity grid emissions intensity is calculated by determining the amount of pounds of carbon dioxide that is emitted as a result of generating one kilowatt hour of electricity; this figure varies considerably by state and region depending on the types of resources, e.g. coal, natural gas, wind, hydro, etc. that are used to generate the electricity consumed in the region where the state is located. A state, for example, located in a region that relies more on electricity that is generated from hydro power will have a lower intensity than a state located in a region that relies heavily on coal for power generation. For the purposes of this calculator, each state has been assigned a particular emissions rate (intensity) based on the US Environmental Protection Agency's *Emissions & Generation Resource Integrated Database (eGRID)*.ⁱⁱ These emission rates are located in Appendix A of this document.

Total electricity consumed (kWhs) multiplied by the emissions factor determines the amount of pounds of carbon dioxide that are attributable to the organization as a result of electricity consumption.

Natural Gas

If annual energy usage for natural gas is not known, calculating the building's energy intensity for natural gas consumption must be determined, as above.

Option 1) If site specific data is available, the average total therms consumed annually by the building that hosts the organization needs to be divided by the total amount of square feet of the building. For example, if a building uses 200,000 therms annually and the square footage of the building is one million ft², then the natural gas energy intensity of the building is 0.2 therms consumed per square foot per year. To determine the estimated amount of natural gas used, the calculator then multiplies the energy intensity for natural gas by the amount of square footage used by the organization.

Option 2) If site specific data is not available, regional data is used and energy intensity is calculated based on the region where the building is located and its range of square footage. For example, if the building hosting the organization is located in the Midwest and falls within the range of 10,001 and 100,000 ft², the energy intensity of the building is 49.9 cubic feet of natural gas consumed per square foot per year. (These figures are taken from the U.S. Energy Information Administration's *2003 Consumer Buildings Energy Consumption Survey*.ⁱⁱⁱ) This figure is then multiplied by the total square footage used by the organization's operations to arrive at the total number of cubic feet of natural gas that is consumed. This figure is converted into therms by dividing by 100 (100 cubic feet = one therm).

To calculate the amount of pounds of carbon dioxide from natural gas consumption attributable to the organization, the calculator multiplies the number of therms used annually by 12.0593,^{iv} the amount of pounds of CO₂ that is emitted from burning one therm of natural gas.

Total for Infrastructure

To calculate the total CO₂ emissions in metric tons, the calculator adds the total number of pounds of CO₂ that are attributable to the organization's electricity and natural gas usage, and then divides that total by 2,205, the amount of pounds in a metric ton.

Transportation

Automobile

To calculate CO₂ emissions associated with the organization's annual automobile travel, the calculator divides the total amount of miles entered by the average fuel efficiency of the vehicles used to determine the amount of gallons used annually. The amount of gallons is then multiplied by 19.36,^v the amount of pounds of CO₂ that is emitted from burning one gallon of gasoline. To calculate the total CO₂ emissions from automobile travel in metric tons, the calculator divides the total number of pounds by 2,205, the amount of pounds in a metric ton.

Air Travel

If the estimated number of *hours* flown by the organization's employees is entered, the calculator multiplies this figure by 414.65,^{vi} the average number of miles flown per hour of air travel. The product is multiplied by 1.3068,^{vii} which is the total climate impact of one air-passenger mile, expressed in pounds of carbon dioxide. The result is then divided by 2,205, the number of pounds in a metric ton.

If the estimated number of *miles* flown by the organization's employees is entered, the calculator multiplies this figure by 1.3068, which is the total climate impact of one air-

passenger mile, expressed in pounds of carbon dioxide. The result is then divided by 2,205, the number of pounds in a metric ton.

Total for Transportation

To calculate the total amount of metric tons associated with transportation, the calculator adds together the total tons from automobile and air travel.

Shipping

Air Shipping

To determine the amount of CO₂ emitted as a result of air shipping, the calculator multiplies the amount shipped (metric tons) by the number of miles it was shipped. It then multiplies the product by the emissions factor for air shipping, 0.0009 metric tons CO₂ per metric ton-mile¹ transported. This emissions factor was calculated as follows: According to the U.S. Department of Transportation's Federal Highway Administration, the amount of CO₂ emitted in 2003 as a result of air shipping was 12.4 teragrams of CO₂, or 12,400,000 metric tons of CO₂.^{viii} According to the U.S. Department of Transportation's Bureau of Transportation Statistics, that amount was transported by air shipping a total of 15.1 billion short ton-miles in 2003.^{ix} To convert this figure into metric ton-miles, multiply it by 0.907 (1 short ton = 0.907 metric tons), which equals 13.7 billion metric ton-miles. Finally, to determine the emissions factor perform the following calculation:

$12,400,000 \text{ metric tons CO}_2 / 13,700,000,000 \text{ metric ton-miles} = 0.0009 \text{ metric tons of CO}_2 \text{ per metric ton-mile.}$

Maritime Shipping

To determine the amount of CO₂ emitted as a result of maritime shipping, the calculator multiplies the amount shipped (metric tons) by the number of miles it was shipped. It then multiplies the product by the emissions factor for maritime shipping, 0.000088 metric tons CO₂ per metric ton-mile transported. This emissions factor was calculated as follows:

According to the U.S. Environmental Protection Agency, the amount of CO₂ emitted in 2005 as a result of maritime shipping was 49.9 teragrams of CO₂, or 49,900,000 metric tons of CO₂.^x According to the U.S. Department of Transportation's Bureau of Transportation Statistics, that amount was transported by maritime shipping a total of 591.3 billion short ton-miles in 2005.^{xi} To convert this figure into metric ton-miles, multiply it by 0.907 (1 short ton = 0.907 metric tons), which equals 536.3 billion metric ton-miles. Finally, to determine the emissions factor perform the following calculation:

¹ A ton-mile is defined as one ton of freight shipped one mile and, therefore, reflects both the volume shipped (tons) and the distance shipped (miles).

$49,900,000 \text{ metric tons CO}_2 / 563,300,000,000 \text{ metric ton-miles} = 0.000088 \text{ metric tons of CO}_2 \text{ per metric ton-mile.}^2$

Heavy-duty Truck

To determine the amount of CO₂ emitted as a result of shipping by heavy-duty truck, the calculator multiplies the amount shipped (metric tons) by the number of miles it was shipped. It then multiplies the product by the emissions factor for heavy-duty truck shipping, 0.00033 metric tons CO₂ per metric ton-mile transported. This emissions factor was calculated as follows:

According to the U.S. EPA, the amount of CO₂ emitted in 2005 as a result of heavy-duty trucking was 385.8 teragrams of CO₂, or 385,800,000 metric tons of CO₂.^{xii} According to the U.S. Department of Transportation's Bureau of Transportation Statistics, that amount was transported by heavy-duty truck a total of 1,293.3 billion short ton-miles in 2005.^{xiii} To convert this figure into metric ton-miles, multiply it by 0.907 (1 short ton = 0.907 metric tons), which equals 1,173.02 billion metric ton-miles. Finally, to determine the emissions factor perform the following calculation:

$385,800,000 \text{ metric tons CO}_2 / 1,173,020,000,000 \text{ metric ton-miles} = 0.00033 \text{ metric tons of CO}_2 \text{ per metric ton-mile.}$

Total for Shipping

To calculate the total amount of metric tons associated with shipping, the calculator adds together the total tons from air, maritime and heavy-duty truck shipping.

² Note that this calculation is based only on U.S. domestic freight data, not international. If international maritime shipping data were also considered, this emissions factor would likely be less due to large tankers being able to transport a significant amount of freight with comparably less fossil fuel input.

ⁱ US Department of Energy, Energy Information Administration, *2003 Commercial Buildings Energy Consumption Survey: Consumption and Expenditures Tables*, Table C21, “Electricity Consumption and Conditional Energy Intensity by Building Size for Non-Mall Buildings, 2003,” http://www.eia.doe.gov/emeu/cbecs/cbecs2003/detailed_tables_2003/2003set10/2003pdf/c21.pdf.

ⁱⁱ See U.S. Environmental Protection Agency, “eGRID2006 Version 2.1: Year 2004 Summary Tables,” April 2007, p.3, http://www.epa.gov/cleanenergy/egrid/pdfs/eGRID2006V2_1_Summary_Tables.pdf. Each state has been assigned to one of the 26 eGRID subregions, illustrated in the document, and therefore to that subregion’s corresponding emissions rate. For any state that lies completely within the boundaries of a subregion, that subregion was assigned to the state. For a state that lies within the boundaries of multiple subregions, it was assigned to the subregion with the lowest emissions rate (lbs. CO₂/kWh), unless it is obvious that most of the population of the state lives in the more emissions intensive subregion, e.g. Alaska. (A Census Bureau Population Density Map based on counties was used to determine this, see <http://www.census.gov/popest/gallery/maps/popdens06.html>.) Interestingly, the emissions rates of these adjoining regions within a state do not vary by much, and the more densely populated areas of almost all of the states correspond to the less intensive subregion.

ⁱⁱⁱ US Department of Energy, Energy Information Administration, *2003 Commercial Buildings Energy Consumption Survey: Consumption and Expenditures Tables*, Table C31, “Natural Gas Consumption and Conditional Energy Intensity by Building Size for Non-Mall Buildings, 2003,” http://www.eia.doe.gov/emeu/cbecs/cbecs2003/detailed_tables_2003/2003set16/2003pdf/c31a.pdf.

^{iv} US Department of Energy, Energy Information Administration, *Voluntary Reporting of Greenhouse Gases Program (Emission Coefficients)*, “Fuel and Energy Source Codes and Emission Coefficients,” <http://www.eia.doe.gov/oiaf/1605/factors.html>.

^v US Department of Energy, Office of Policy and International Affairs, “Technical Guidelines: Voluntary Reporting of Greenhouse Gases (1605(b)) Program,” March 2006, Table 1.D.1, p. 64, http://www.eia.doe.gov/oiaf/1605/TechnicalGuidelines_March2006.pdf.

^{vi} U.S. Department of Transportation, Bureau of Transportation Statistics, “U.S. Air Carrier Traffic Statistics,” http://www.bts.gov/xml/air_traffic/src/datadisp.xml; table generated on 8/18/2006, figure was calculated by dividing the total number of scheduled System Revenue Aircraft Miles Flown in 2005, 7,915,129,000 miles, by the total number of scheduled System Revenue Aircraft Hours (Airborne) in 2005, 19,088,831 hours.

^{vii} In 2005, total Revenue Passenger Miles flown (scheduled flights only for domestic and international flights of US certificated airlines) was 779,004,706,880 miles (source: U.S. Department of Transportation, Bureau of Transportation Statistics; TranStats, *Air Carrier Summary: Schedule T-1*, http://www.transtats.bts.gov/Fields.asp?Table_ID=264; table generated 8/18/2006). Total jet fuel consumed (scheduled flights only for domestic and international flights) in 2005 was 18,062,449,227 gallons (source: U.S. Department of Transportation, Bureau of Transportation Statistics, “Airline Fuel Cost and Consumption – 2005,” <http://www.bts.gov/xml/fuel/report/src/monthrep.xml?styyyy=2005>; table accessed 8/18/2006). Divide these two numbers to get 43.13 Revenue Passenger Miles per gallon of jet fuel burned. This figure is then divided into 20.88, the amount of pounds of carbon dioxide that is emitted when one gallon of jet fuel is burned (see US DOE “Technical Guidelines: above), to get 0.484 lbs. of CO₂ per Revenue Passenger Mile. A conservative RFI (radiative forcing index) of 2.7 was then applied to account for the more accurate global warming impact of air travel, which includes the impact of greenhouse gases in addition to CO₂, such as nitrous oxide, and contrails; see <http://www.grida.no/climate/ipcc/aviation/064.htm>. Thus, 2.7 multiplied by 0.484 equals 1.3068 lbs of CO₂ equivalent emitted for each Revenue Passenger mile traveled.

^{viii} U.S. Department of Transportation, Federal Highway Administration, “Assessing the Effects of Freight Movement on Air Quality at the National and Regional Level,” April 2005, Table 2-12, <http://www.fhwa.dot.gov/environment/freightaq/chapter2.htm>.

^{ix} U.S. Department of Transportation, Bureau of Transportation Statistics, *BTS Special Reports*, “A Decade of Growth in Domestic Freight - July 2007,” Table 1, http://www.bts.gov/publications/bts_special_report/2007_07_27/html/table_01.html.

^x U.S. Environmental Protection Agency, *Inventory of U.S. Greenhouse Gas Emissions and Sinks: 1990 – 2005*, April 2007, Table A-111, page A-129,
<http://www.epa.gov/climatechange/emissions/usinventoryreport.html>.

^{xi} U.S. Department of Transportation, Bureau of Transportation Statistics, *BTS Special Reports*, “A Decade of Growth in Domestic Freight - July 2007,” Table 1,
http://www.bts.gov/publications/bts_special_report/2007_07_27/html/table_01.html.

^{xii} U.S. Environmental Protection Agency, *Inventory of U.S. Greenhouse Gas Emissions and Sinks: 1990 – 2005*, April 2007, Table A-111, page A-129,
<http://www.epa.gov/climatechange/emissions/usinventoryreport.html>.

^{xiii} U.S. Department of Transportation, Bureau of Transportation Statistics, *BTS Special Reports*, “A Decade of Growth in Domestic Freight - July 2007,” Table 1,
http://www.bts.gov/publications/bts_special_report/2007_07_27/html/table_01.html.

Appendix A

State Electricity Grid Emission Factors

State	Output Emission Rate	
	(lb/MWh)	lbs CO2/kWh
Alabama	1490.37	1.49037
Alaska	1257.188	1.257188
Arizona	1254.018	1.254018
Arkansas	1135.463	1.135463
California	878.707	0.878707
Colorado	2035.813	2.035813
Connecticut	908.902	0.908902
Delaware	908.902	0.908902
Florida	1327.661	1.327661
Georgia	1490.37	1.49037
Hawaii	1728.121	1.728121
Idaho	921.104	0.921104
Illinois	1844.344	1.844344
Indiana	1556.388	1.556388
Iowa	1813.81	1.81381
Kansas	1971.417	1.971417
Kentucky	1494.886	1.494886
Louisiana	1135.463	1.135463
Maine	908.902	0.908902
Maryland	1095.533	1.095533
Massachusetts	908.902	0.908902
Michigan	1641.412	1.641412
Minnesota	1813.81	1.81381
Mississippi	1135.463	1.135463
Missouri	1844.344	1.844344
Montana	921.104	0.921104
Nebraska	1813.81	1.81381
Nevada	1254.018	1.254018
New Hampshire	908.902	0.908902
New Jersey	1095.533	1.095533
New Mexico	1254.018	1.254018
New York	819.684	0.819684
North Carolina	1146.386	1.146386
North Dakota	1813.81	1.81381
Ohio	1556.388	1.556388
Oklahoma	1761.14	1.76114
Oregon	921.104	0.921104
Pennsylvania	1095.533	1.095533
Rhode Island	908.902	0.908902
South Carolina	1146.386	1.146386
South Dakota	1556.388	1.556388

Tennessee	1494.886	1.494886
Texas	1420.559	1.420559
Utah	921.104	0.921104
Vermont	908.902	0.908902
Virginia	1146.386	1.146386
Washington	921.104	0.921104
Washington, D.C.	1095.533	1.095533
West Virginia	1556.388	1.556388
Wisconsin	1858.719	1.858719
Wyoming	921.104	0.921104