The Climate Trust

Calculations Explained for The Climate Trust's "Carbon Calculator for Events"

Introduction

Calculating an event'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 *Lodging* sections.

Infrastructure

The calculator determines the carbon footprint of the indirect emissions from the electricity and natural gas usage attributable to the event in 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 event is calculated.

Electricity

Option 1) 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 ft^2, 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, such as Food Sales and Food Service, at the buildings hosting the event.)

Option 2) If site specific data is available to the event planner, 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 ft^2, then the electricity energy intensity of the building is 10 kWhs consumed per square foot per year.

The calculator then divides the energy intensity figure (calculated above) by 365 to arrive at the amount of kWhs consumed per square foot per day. This is then multiplied by the total amount of square feet of the *event area* and then multiplied by the number of days of the event. The result is the estimated amount of electricity (kWhs) that will be consumed by the square footage dedicated to the event for the duration of the event.

To calculate carbon dioxide emissions associated with electricity consumption, the estimated amount of electricity usage is multiplied by the emissions intensity of the electricity grid of the state where the event will be held. 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 (lbs. CO_2/kWh) determines the amount of pounds of carbon dioxide that will be attributable to the event as a result of electricity consumption.

Natural Gas

Calculating energy intensity for natural gas consumption is done similarly.

Option 1) 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 ft^2, 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 divided by 365 to calculate the daily energy intensity. This figure is then multiplied by the total square footage of the event area, and then multiplied again by the number of days of the event to arrive at the total number of cubic feet of natural gas that will be consumed by the designated *event area*. This figure is converted into therms by dividing by 100 (100 cubic feet = one therm).

Option 2) If site specific data is available to the event planner, the average total therms consumed annually needs to be divided by the total amount of square feet of the building/complex. For example, if a building uses 200,000 therms annually and the square footage of the building is one million ft^2, then the natural gas energy intensity of the building is 0.2 therms consumed per square foot per year. This figure is then divided by 365 to calculate the daily energy intensity. This figure is then multiplied by the total square footage of the event area, and then multiplied again by the number of days of the event to arrive at the total number of therms that will be consumed by the designated *event area*.

To calculate the amount of pounds of carbon dioxide from natural gas consumption attributable to the event, the calculator multiplies the number of therms (calculated above) by 12.0593,[iv] the amount of pounds of CO_2 that is emitted from burning one therm of natural gas.

Total for Infrastructure

To calculate the total CO_2 emissions in metric tons, the calculator adds the total number of pounds of CO_2 that are attributable to the event'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 CO_2 emissions associated with event participants driving to and from the event, the calculator divides the estimated total amount of miles that will be driven (i.e. the average round-trip distance multiplied by the number of participants driving) by 21,[v] the national fleet fuel efficiency average (miles-per-gallon), to arrive at the number of gallons of gasoline that will be burned as a result of participants' vehicle travel. This figure is then multiplied by 19.36,[vi] the amount of pounds of CO_2 that is emitted from burning one gallon of gasoline.

To calculate CO_2 emissions associated with event participants driving during event days, the calculator divides the estimated total number of miles to be driven during event days by 21, and then multiplies the result by 19.36.

To calculate the total CO_2 emissions from automobile travel in metric tons, the calculator adds together the amount of pounds corresponding to driving to and from the event and during the event and divides this number by 2,205, the amount of pounds in a metric ton.

Air Travel

If the estimated number of *hours* that will be flown by event participants is known, the calculator multiplies the average number of round-trip hours by the estimated number of participants flying. It then multiplies that figure by 414.65,[vii] the average number of miles flown per hour of air travel. The product is multiplied by 1.3068, [viii] 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 total *miles* that will flown by all event participants is known, the calculator multiplies the number of round-trip miles 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 to and from and during the event, the calculator adds together the total tons from automobile and air travel.

Lodging

To calculate the amount of CO_2 emissions associated with event participants staying in hotels, the calculator adds together the amount of emissions attributable to the rooms' electricity and natural gas consumption.

Electricity

The Climate Trust has estimated that the average square footage of a hotel room is 400 ft^2, so the calculator multiplies the number of participants staying in hotels by 400 to arrive at the total square footage used. It then multiplies this figure by 13.5,[ix] the national average of kWhs consumed per square foot per year for buildings whose principal activity is lodging. This figure is divided by 365 and then multiplied by the number of nights the participants will be staying in hotels to arrive at the total kWhs to be consumed as a result of occupying the rooms. This product, as above in the electricity section for *Infrastructure*, is multiplied by the emissions factor of the state where the event will be held and then divided by 2,205 to calculate metric tons of CO_2.

Natural Gas

If the hotel uses natural gas, the calculator multiplies 400 ft^2, from above, by the number of participants staying in hotels. It then multiplies this figure by 0.1340, the amount of cubic feet consumed per square foot per day by buildings whose principal activity is lodging; 0.1340 is arrived at by dividing 48.9,[x] the yearly national consumption average of natural gas for buildings whose principal activity is lodging, by 365. The product is then multiplied by the number of nights entered. This figure is then divided by 100 to convert the total amount of cubic feet estimated to be consumed into therms (100 cubic feet = one therm). This figure is then multiplied by 12.0593, the amount of pounds of CO_2 emitted from burning one therm of natural gas, and then divided by 2,205 to arrive at total metric tons.

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[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] Heavenrich, Robert M., US EPA, Office of Transportation and Air Quality, "Light-Duty Automotive Technology and Fuel Economy Trends: 1975 Through 2005," July 2005, Table 14, pg. 50, http://www.epa.gov/otaq/cert/mpg/fetrends/420r05001.pdf. The average adjusted fuel economy for all model year 2005 vehicles was 21.0 mpg.

[vi] 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.

[vii] 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.

[viii] 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 CO_2 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 CO_2, 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 CO_2 equivalent emitted for each Revenue Passenger mile traveled.

[ix] US Department of Energy, Energy Information Administration, *2003 Commercial Buildings Energy Consumption Survey: Consumption and Expenditures Tables*, Table C14, "Electricity Consumption and Expenditure Intensities for Non-Mall Buildings, 2003," http://www.eia.doe.gov/emeu/cbecs/cbecs2003/detailed_tables_2003/2003set10/2003pdf/c14.pdf.

[x] US Department of Energy, Energy Information Administration, *2003 Commercial Buildings Energy Consumption Survey: Consumption and Expenditures Tables*, Table C24, "Natural Gas Consumption and Expenditure Intensities for Non-Mall Buildings, 2003," http://www.eia.doe.gov/emeu/cbecs/cbecs2003/detailed_tables_2003/2003set11/2003pdf/c24.pdf.

Appendix A

State Electricity Grid Emission Factors

State	Output Emission Rate (lb/MWh)	lbs CO_2/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