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Stevens Forward! - Carbon Footprint Calculator

Center for Small Towns (University of Minnesota, Morris)

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Outline for County Carbon Footprint Calculator

County Travel –Sheet 6

Cell contents and factors will be described according to cell locations.

Cells A5-A12 include the types of vehicles

Cells B5-B12 include the number of vehicle in each category

Cells C5-C12 include the gallons of fuel per vehicle per year consumed

Cells D5-D12 include the metric tons of CO2 emitted per year calculated by dividing the total pounds of CO2 produced in G5-G12 by 2204.62 pounds CO2 per metric ton.

Cells G5-G12 include the pounds of CO2 emitted per year for all the vehicles in a particular class

The Data for the number of passenger vehicles, pickup trucks, buses, other trucks, motorcycles recreational vehicles, mopeds and tax exempt vehicles can be found for all Minnesota counties at https://dps.mn.gov/divisions/dvs/forms-documents/Documents/MotorVehicle-CountyReport-2009.pdf. The 2010 data for Stevens County can be found on page 75.

Data for the number of gallons used per vehicle for passenger vehicles, pickup trucks and other trucks can be found on page 35 of http://www.cleanenergyresourceteams.org/files/westcentralplan.pdf.

Data for the number of gallons used by busses can be found at http://www.americanschoolbuscouncil.org/issues/environmental-benefits.

Data for the number of gallons used per year by a motorcycle can be found under the heading “Total fuel consumption” at http://www.ridetowork.org/transportation-fact-sheet

Data for the number of gallons of fuel used by mopeds in a year can be found by taking the average number of miles traveled and the average miles per gallon for mopeds found at http://www.denverpost.com/recommended/ci_4113101

The constants for converting burned gasoline and diesel fuel into CO_2 can be found at http://www.eia.gov/tools/faqs/faq.cfm?id=307&t=11. The conversion for gasoline is in the first paragraph 19.64 pounds of CO_2 per gallon of gasoline without ethanol or 17.68 pounds of

CO_2 per gallon of gasoline with 10% ethanol, this is the standard for gasoline used in automobiles, and the conversion for diesel fuel is in the second paragraph at 22.38 pounds of CO_2 per gallon of diesel fuel.

The county totals are summed in cells B14-G14. The total amounts of CO_2 released are reformatted in cells C16 as metric tons of CO_2 per year and in cell C17 as pounds of CO_2 per year.

Cell C22= total amount of CO_2 in pounds of CO_2 per year is equivalent to 12.81 empty 100- car freight trains calculated in cell C22. A 100 car train is assumed to weigh 6,625,985.41 pounds per train. The weight of a 100 car freight train was determined by taking the average train engine weight and adding the weight of an empty train car multiplied by 100. This can be found at http://answers.yahoo.com/question/index?qid=20061007151346AAWdaRL. These calculations are: 12,125.41 lbs + 30 tons*100 *2204.62 = 6,625,985.41
12,125.41 lbs being the weight of the train engine
30 tons being the weight of an empty train car
2204.62 being the number of pounds in a metric ton

County Energy - sheet 7

Cells A6-A12 are the types of heating systems used in Stevens County with units of energy in parenthesis

Cells B6-B12 are the number of homes in each heating energy category

Cells C6-C 12 provide the amount energy units used per year per home. Units are given in A6-A12 and were obtained from the following sources.

REF 1. http://www.usa.com/stevens-county-mn-housing--historical-house-heating-fuel-data.htm as derived from U.S. Census American Community Survey.

REF 2. http://www.epa.gov/cleanenergy/energy-resources/refs.html These can be found under the heading "calculation".

Calculations

Note: Due to rounding, performing the calculations given in the equations below may not return the exact results shown.

1. Electricity: 12,258 kWh per home × 1,216 lbs CO_2 per megawatt-hour generated × 1.075 MWh delivered/MWh generated × 1 MWh/1,000 kWh × 1 metric ton/2,204.6 lb = 7.268 metric tons CO_2/home.

2. Natural gas: 66,000 cubic feet per home × 0.0544 kg CO_2/cubic foot × 1/1,000 kg/metric ton = 3.59 metric tons CO_2/home

3. Liquid petroleum gas: 464 gallons per home × 1/42 barrels/gallon × 219.3 kg CO_2/barrel × 1/1,000 kg/metric ton = 2.42 metric tons CO_2/home

4. Fuel oil: 551 gallons per home × 1/42 barrels/gallon × 429.61 kg CO_2/barrel × 1/1,000 kg/metric ton = 5.64 metric tons CO_2/home

5. Kerosene: 108 gallons per home × 1/42 barrels/gallon × 426.31 kg CO_2/barrel × 1/1,000 kg/metric ton = 1.10 metric tons CO_2/home

Total CO_2 emissions for energy use per single-family home: 7.268 metric tons $CO_2$for electricity + 3.59 metric tons CO_2 for natural gas + 2.42 metric tons CO_2 for liquid petroleum gas + 5.64 metric tons CO_2 for fuel oil + 1.10 metric tons CO_2 for kerosene = **20.02 metric tons CO_2 per home per year**.

Home energy use

In 2009, there were 113.6 million homes in the United States; of those, 71.8 million were single-family detached homes and 6.7 million were single-family attached homes for a total 78.5 million single-family homes* nationally (EIA 2012). On average, each home consumed 12,258 kWh of delivered electricity, 66,000 cubic feet of natural gas, 464 gallons of liquid petroleum gas, 551 gallons of fuel oil, and 108 gallons of kerosene (EIA 2012, EIA 2013a).

The national average carbon dioxide output rate for generated electricity in 2009 was 1,216 lbs CO_2 per megawatt-hour (EPA 2012), which translates to about 1,307.2 lbs CO_2 per megawatt-hour for delivered electricity (assuming transmission and distribution losses at 7.5%) (EIA 2013a, 2013b; EPA 2012).

The average carbon dioxide coefficient of natural gas is 0.0544 kg CO_2 per cubic foot (EPA 2012a). The fraction oxidized to CO_2 is 100 percent (IPCC 2006).

The average carbon dioxide coefficient of distillate fuel oil is 429.61 kg CO_2 per 42-gallon barrel (EPA 2012b). The fraction oxidized to CO_2 is 100 percent (IPCC 2006).

The average carbon dioxide coefficient of liquefied petroleum gases is 219.3 kg CO_2 per 42-gallon barrel (EPA 2010b). The fraction oxidized is 100 percent (IPCC 2006).

The average carbon dioxide coefficient of kerosene is 426.31 kg CO_2 per 42-gallon barrel (EPA 2012b). The fraction oxidized to CO_2 is 100 percent (IPCC 2006).

Total single-family home electricity, natural gas, distillate fuel oil, and liquefied petroleum gas consumption figures were converted from their various units to metric tons of CO_2 and added together to obtain total CO_2 emissions per home.

Cell C6= the average of 47,453 ft.^{3} of natural gas used per home per year, data obtained from REF 1 With the conversion factor of 0.0000545 metric tons of CO_2 per cubic foot of natural gas used in cell D6 from REF 2.

Cell C7 = the average number of gallons of LP gas used per home per year, data obtained from REF 1
With the conversion factor of 0.00567738 metric tons of CO2 per gallon of LP gas used in cell D7 from REF 2.
.
Cell C8 = the average number of kilowatt hours of electricity used per home per year, data obtained from REF 1 With the conversion factor of 0.00062758 metric tons of CO_2 per kilowatt hour of electricity used in cell D8 from REF 2.
.
Cell C9 = average number gallons of fuel oil used per home per year, data obtained from REF 1 With the conversion factor of 0.01022881 metric tons of CO_2 per gallon of fuel oil used in cell D9 from REF 2.
.
Cell C10= average number of courts avoid use per home per year, data obtained by adding the average number of cords burned by a Minnesota household for Wood space heaters and centralized heating systems found under the heading “Activity Levels” on page ten of http://www.epa.gov/ttn/chief/conference/ei14/session9/broderick.pdf. With the conversion factor of 3.00 metric tons of CO_2 per cord of wood used in cell D10 from REF 2.
.
Cell C11= average number of tons of “other fuels” used per home per year, data obtained by averaging the number of kilograms used by pellet appliances found under the heading “pellet fuel appliances” at http://energy.gov/energysaver/articles/wood-and-pellet-heating. It was then multiplied by 4,775 Kwh/ton obtained from http://www.biomasscommodities.com/wp-content/uploads/2011/03/Why-Wood-Pellets.pdf and by.000016MT CO_2/Kwh.

Cells E6-E12 represents the pounds of CO_2 produced taking the metric ton result in cells D6-D12 divided by 2204.6 pounds per metric ton to get the total pounds of CO_2 produced.

Cells B14, D14 and E14 represent the totals for housing energy in the county.

Cell C22 = 6.44, weight of 6.44 empty 100-car freight trains. A 100 car train is assumed to weigh 6,625,985.41 pounds per train. The weight of a 100 car freight train was determined by taking the average train engine weight and adding the weight of an empty train car multiplied by 100. This can be found at

http://answers.yahoo.com/question/index?qid=20061007151346AAWdaRL. These calculations are: 12,125.41 lbs + 30 tons*100 *2204.62 = 6,625,985.41
12,125.41 lbs being the weight of the train engine
30 tons being the weight of an empty train car
2204.62 being the number of pounds in a metric ton.

Data for the number of Utility gas, LP gas, Electricity, Fuel oil/ kerosene, coal, wood, solar energy, other fuel and no fuel can be found for the same counties as travel at http://www.cleanenergyresourceteams.org/files/westcentralplan.pdf.

The amount of wood cord burned per house can be found on page ten under the heading "activity levels" at http://www.epa.gov/ttn/chief/conference/ei14/session9/broderick.pdf. This is a state average

"Other fuel" is considered to be wood pellets and the conversion coefficient can be found by converting Mt of pellets to KWh found at http://www.biomasscommodities.com/wp-content/uploads/2011/03/Why-Wood-Pellets.pdf and translating that to CO_2 emissions using the coefficient from http://www.stovesonline.co.uk/fuel-CO2-emissions.html

County Waste - Sheet 8

Much of the information included in this sheet was provided by Bill Kleindl, Stevens County Environmental Services and Planning and Zoning Administrator from the annual report provided to the state and is gratefully acknowledged.

Cells B6-B37 contain the various types of waste and recycling material.

Cells C6-C37 contain the weight of each type of waste and recycling material expressed in metric tons.

Cells D6-D37 are the product of the weight in metric tons of the CO_2 produced or prevented by the method of disposal and 2204.62 to convert the weight of the CO_2 from metric tons to pounds

Cells E6-E37 are the product of the weight of material in cells C6-C37 multiplied by the specific CO_2 conversion factor for that material to yield the metric tons of CO_2 produced or prevented

Cell E6 = the CO_2 emitted in metric tons from the landfill and is the product of C6 times the CO_2 conversion factor, 1.365 metric tons of CO_2 per metric ton of Landfill material obtained from http://dx.doi.org/10.1016/j.energy.2006.03.034 More to come when I get a password from the librarians

Cell E7 = total amount of CO_2 emitted as a result of incineration and is the product of C7 multiplied by the CO_2 conversion factor 0.769 tons of CO_2/ ton waste multiplied by 0.907185 which is the number of short tons in a metric ton Obtained from the abstract of *Incineration and co-combustion of waste: accounting of greenhouse gases and global warming contributions.* at http://web.ebscohost.com.ezproxy.morris.umn.edu/ehost/detail?sid=ee23dcbf-b6f5-48b7-ae28-41b64b1dd96e%40sessionmgr11&vid=1&hid=18&bdata=JnNpdGU9ZWhvc3QtbGl2ZQ%3d%3d#db=eih&AN=45565912. This data can be found by averaging the range kilograms CO_2 released per metric ton of CO_2 (803 to 735) and then converting from kilograms to metric tons.

Cell E9 = the total metric tons of CO_2 emitted by the county landfill and incinerator operations and represents the sum of cells E6-E8.

Cell E13 = the total amount of CO_2 saved by recycling all types of paper.

Cell E14 = total metric tons of CO_2 prevented by recycling corrugated paper using the factor 4.0 metric tons of CO_2 per metric ton of corrugated paper obtained from http://www.stopwaste.org/home/index.asp?page=1162 in the blue side bar. This was multiplied by 0.907185 to convert the amount in tons from C14 to metric tons.

Cell E15= total metric tons of CO_2 prevented by recycling Magazines using the EPA's iWARM to convert metric tons of CO_2 per metric ton of magazines obtained by inputting the data in the waste column and then in the recycled column at http://epa.gov/epawaste/conserve/tools/warm/Warm_Form.html. This was multiplied by 0.907185 to convert the amount in tons from C15 to metric tons.

Cell E16 = total metric tons of CO_2 prevented by recycling mixed paper using the factor 4.3 metric tons of CO_2 per metric ton of mixed paper obtained from http://www.stopwaste.org/home/index.asp?page=1162 in the blue side bar. This was multiplied by 0.907185 to convert the amount in tons from C16 to metric tons.

Cell E17 = total metric tons of CO_2 prevented by recycling newsprint using the factor 2.5 metric tons of CO_2 per metric ton of newsprint obtained from http://www.popularmechanics.com/science/environment/recycling/4291576 under the heading newsprint. . This was multiplied by 0.907185 to convert the amount in tons from C17 to metric tons.

Cell E18 = total metric tons of CO_2 prevented by recycling office paper using the factor 4.3 metric tons of CO_2 per metric ton of office paper obtained from http://www.stopwaste.org/home/index.asp?page=1162 in the blue side bar. This was multiplied by 0.907185 to convert the amount in tons from C18 to metric tons.

Cell E19 = total metric tons of CO_2 prevented by recycling phone books using the factor 1.967 metric tons of CO_2 per metric ton of phone books obtained under the heading "Did you know?" at http://www.deq.state.or.us/programs/sustainability/phonebooks.htm. This was multiplied by 0.907185 to convert the amount in tons from C19 to metric tons.

Cell E20 = total metric tons of CO_2 prevented by recycling metals obtained from adding the results from cells E21-E23
Cell E21 = total metric tons of CO_2 prevented by recycling aluminum using the factor 10 metric tons of CO_2 per metric ton of aluminum obtained under the heading aluminum at http://www.popularmechanics.com/science/environment/recycling/4291576. This was multiplied by 0.907185 to convert the amount in tons from C21 to metric tons.

Cell E22 = total metric tons of CO_2 prevented by recycling ferrous and nonferrous metal using the factor 4 metric tons of CO_2 per metric ton of ferrous and nonferrous metal obtained by inputting the data in the waste column and then in the recycled column at http://epa.gov/epawaste/conserve/tools/warm/Warm_Form.html. This was multiplied by 0.907185 to convert the amount in tons from C22 to metric tons.

Cell E23 = total metric tons of CO_2 prevented by recycling steel/tin cans using the factor 1.88 metric tons of CO_2 per metric ton of steel/tin cans obtained in the introduction under savings per tonne in the first table at http://www.tatasteeleurope.com/file_source/StaticFiles/SustainableSteel%20KeyMessages.pdf . This was multiplied by 0.907185 to convert the amount in tons from C23 to metric tons.

Cell E24 = total metric tons of CO_2 prevented by recycling glass using the factor .34 metric tons of CO_2 per metric ton of glass obtained under the heading glass at http://www.popularmechanics.com/science/environment/recycling/4291576. This was multiplied by 0.907185 to convert the amount in tons from C24 to metric tons.

Cell E25 = total metric tons of CO_2 prevented by recycling all plastic obtained by adding the results from cells E26-E28.

Cell E26 = total metric tons of CO_2 prevented by recycling HDPE plastic using the factor 1 metric tons of CO_2 per metric ton of HDPE plastic obtained from the 4th bullet point at http://www.bottle2bottle.com/education-zone.asp. This was multiplied by 0.907185 to convert the amount in tons from C26 to metric tons.

Cell E27 = total metric tons of CO_2 prevented by recycling other plastic using the factor 1.7 metric tons of CO_2 per metric ton of other plastic obtained under the heading PET at

http://www.popularmechanics.com/science/environment/recycling/4291576. This was multiplied by 0.907185 to convert the amount in tons from C27 to metric tons.

Cell E28 = total metric tons of CO_2 prevented by recycling PET plastic using the factor 1.7 metric tons of CO_2 per metric ton of PET plastic obtained under the heading PET at http://www.popularmechanics.com/science/environment/recycling/4291576. This was multiplied by 0.907185 to convert the amount in tons from C28 to metric tons.

Cell E29 = total metric tons of CO_2 prevented by recycling banned material obtained from adding the results from cells E30-E36.

Cell E30 = total metric tons of CO_2 prevented by recycling major appliances using the factor 10 metric tons of CO_2 per metric ton of major appliance obtained by taking CO_2 saved by recycling 1 refrigerator found at http://www.bottle2bottle.com/education-zone.asp and finding the number of refrigerators in one ton which was calculated to be 1/0.907185. This was multiplied by 0.907185 to convert the amount in tons from C30 to metric tons.

Cell E31 = TBD

Cell E32 = total metric tons of CO_2 prevented by recycling used oil filters using the factor .2061 metric tons of CO_2 per metric ton of used oil filters obtained from the second paragraph at http://green.wikia.com/wiki/Oil_filter_recycling. This was multiplied by 0.907185 to convert the amount in tons from C32 to metric tons.

Cell E33 = TBD

Cell E34 = total metric tons of CO_2 prevented by recycling waste tires using the factor .716 metric tons of CO_2 per metric ton of waste tires obtained from the first paragraph at http://www.cmtirerecyclingequipment.com/Public/14864/FinalRubberTireRecyclingCarbonFootprint.pdf. This was multiplied by 0.907185 to convert the amount in tons from C34 to metric tons.

Cell E35 = total metric tons of CO_2 prevented by recycling electronics using the factor 54 metric tons of CO_2 per metric ton of electronics obtained by inputting the data in the waste column and then in the recycled column at http://epa.gov/epawaste/conserve/tools/warm/Warm_Form.html. This was multiplied by 0.907185 to convert the amount in tons from C35 to metric tons.

Cell E36 = TBD

Please note the results in the "D" column were reached by multiplying the corresponding number in the "E" column by 2204.62 to get the result in pounds of CO_2 produced or prevented.

Cells C38-E39 = the totals for garbage and recycling for the respective columns.

Cell D46 = total amount of CO_2 produced by waste in pounds of CO_2 per year is equivalent to 2.03 empty 100- car freight trains. A 100 car train is assumed to weigh 6,625,985.41 pounds per train. The weight of a 100 car freight train was determined by taking the average train engine weight and adding the weight of an empty train car multiplied by 100. This can be found at http://answers.yahoo.com/question/index?qid=20061007151346AAWdaRL. These calculations are: 12,125.41 lbs + 30 tons*100 *2204.62 = 6,625,985.41
12,125.41 lbs being the weight of the train engine
30 tons being the weight of an empty train car
2204.62 being the number of pounds in a metric ton.

Tons of material recycled can be found for MN counties on page A-14 at http://www.pca.state.mn.us/index.php/data/score/score-reports-archive.html

County Food – Sheet 9

The carbon footprint for the county food consumption represents a very simplistic approach in can be considered a first approximation until better data is available. Based on the literature citation by Heller and Keoleian, 2000, who found that it required approximately 7.3 cal of fossil fuel energy to make 1 cal of food energy.

For these purposes the word calorie when referring to food or fossil fuels is taken to mean kilocalorie

The number of children and adults in Stevens County was taken from http://quickfacts.census.gov/qfd/states/27/27149.html. This is based on the 2012 population estimate for Stevens County. The estimate only gives a percentage of children so the total population (9663) was multiplied by the percentage in decimal form (.211) to get the number of children. This number (2038) was then subtracted from the total population estimate to get the number of adults (7625)

Cell BC5 = the average number of calories consumed by an adult per day. This data can be found under the heading “calorie trends” at http://www.livestrong.com/article/347737-the-average-american-daily-caloric-intake/. As taken from the USDA

Cell BC6 = the average number of calorie calories consumed by a child per day. This data was obtained by averaging the total male and female child daily caloric intake from http://www.cdc.gov/nchs/data/databriefs/db113.htm.

Cell DE5 = the daily fossil fuel calories for an adult which is the product of Cell BC5 multiplied by 7.3 kcal of fossil energy per 1 kcal of food energy multiplied by the factor 1.25. 1.25 representing that an average individual will waste 25% of their food. This can be found in the first sentence under the heading Losses in Households in the form of a percentage at http://www.nrdc.org/food/files/wasted-food-IP.pdf.

Cell DE6 = the daily fossil fuel calories for a child which is the product of Cell BC6 multiplied by 7.3 kcal of fossil energy per 1 kcal of food energy multiplied by the factor 1.25. 1.25 representing that an average individual will waste 25% of their food. This can be found in the first sentence under the heading Losses in Households in the form of a percentage at http://www.nrdc.org/food/files/wasted-food-IP.pdf.

Cell F5 **=** annual CO_2 emissions for an adult expressed in pounds of CO_2 which is the product of cell DE5 times 365 days in the year times 22.38 lbs of CO_2 in a gallon of diesel fuel divided by 35004.06135029614 kcal in a gallon of diesel fuel. To get from the unit of kcal fossil fuel to the unit lbs CO_2 you have to multiply by lbs CO_2/kcal fossil fuel. I chose diesel fuel because it is the most common fuel used in big rig trucks which is the most common medium to transport food. 22.38 lbs of CO_2 in a gallon of diesel fuel was obtained from in the second paragraph of http://www.eia.gov/tools/faqs/faq.cfm?id=307&t=11. 35004.06135029614 kcal in a gallon of diesel fuel was obtained by entering 1 into the gallons [US] diesel oil at http://www.convertunits.com/from/kilogram+calorie/to/gallon+%5BU.S.%5D+of+diesel+oil.

Cell F6 **=** annual CO2 emissions for a child expressed in pounds of CO2 which is the product of cell DE6 times 365 days in the year times 22.38 lbs of CO_2 in a gallon of diesel fuel divided by 35004.06135029614 kcal in a gallon of diesel fuel. To get from the unit of kcal fossil fuel to the unit lbs CO_2 you have to multiply by lbs CO_2/kcal fossil fuel. I chose diesel fuel because it is the most common fuel used in big rig trucks which is the most common medium to transport food. 22.38 lbs of CO_2 in a gallon of diesel fuel was obtained from in the second paragraph of http://www.eia.gov/tools/faqs/faq.cfm?id=307&t=11. 35004.06135029614 kcal in a gallon of diesel fuel was obtained by entering 1 into the gallons [US] diesel oil at http://www.convertunits.com/from/kilogram+calorie/to/gallon+%5BU.S.%5D+of+diesel+oil.
.

Cell G5 = the CO_2 emissions from food consumption by an adult expressed in metric tons as the result of F5/2204.62 to yield metric tons of CO_2 emitted in a year.

Cell G6 = the CO_2 emissions from food consumption by a child expressed in metric tons as the result of F6/2204.62 to yield metric tons of CO_2 emitted in a year.

Cell B10 = the adult population in Stevens County in 2012.

Cell B11 = the child population in Stevens County in 2012.

Cell F10 = the annual CO_2 emissions by the adult population for food expressed in pounds of CO_2 calculated as a product of Cell F5 and Cell B10.

Cell F11 = the annual CO_2 emissions by the child population for food expressed in pounds of CO_2 calculated as a product of Cell F6 and Cell B11.

Cell G10 = the annual CO_2 emissions by the adult population for food expressed in metric tons of CO_2 calculated as a product of Cell G5 and Cell B10.

Cell G10 = the annual CO_2 emissions by the child population for food expressed in metric tons of CO_2 calculated as a product of Cell G6 and Cell B11.

Cell F12 = is a total annual CO_2 emissions from the population of Stevens County for food expressed in pounds of CO_2 per year.

Cell G12 = is a total annual CO_2 emissions from the population of Stevens County for food expressed in metric tons of CO_2 per year.

Cell B17 = the equivalent weight of CO_2 emissions as equivalent to the weight of 7.93 empty 100-car freight trains. . A 100 car train is assumed to weigh 6,625,985.41 pounds per train. The weight of a 100 car freight train was determined by taking the average train engine weight and adding the weight of an empty train car multiplied by 100. This can be found at http://answers.yahoo.com/question/index?qid=20061007151346AAWdaRL. These calculations are: 12,125.41 lbs + 30 tons*100 *2204.62 = 6,625,985.41
12,125.41 lbs being the weight of the train engine
30 tons being the weight of an empty train car
2204.62 being the number of pounds in a metric ton.

The number of kilocalories of required to create a kilocalorie of food was determined by Martin C. Heller and Gregory A. Keoleian 2000. LIFE CYCLE-BASED SUSTAINABILITY INDICATORS FOR ASSESSMENT OF THE U.S.FOOD SYSTEM.
The Center for Sustainable Systems, Report no. CSS00-04, Ann Arbor, Michigan, December 6, 2000.
59 p., tables, figures, appendices.
This document is available online: http://www.umich.edu/~css
The Center for Sustainable Systems
430 East University, Dana Building
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http://www.umich.edu/~css

Page 42, paragraph 3
In total, providing the 3800 kilocalories of food energy available per capita per day in the United States is estimated to consume 10.2 quadrillion BTUs annually. This represents about
10% of the total energy consumed in the United States [148]. By our estimates, **therefore, it takes about 7.3 units of (primarily) fossil energy to produce one unit of food energy in the U.S. food system.** This estimate is somewhat lower than others presented. Pimentel [130] and Hall [150] both put the ratio of output food energy to input energy at 1:10. In this spreadsheet, we will assume that it takes 7.3 cal of fossil fuel energy to produce 1 cal of food energy in the US.

County Totals- page 10

Cell F4= Total CO_2 produced in a year by Stevens County in pounds. This was found by adding 'Waste for County'!D41+'Energy for County'!C17+'Travel for County'!C17+'Food for County'!F10+'Food for County'!F11

Cell G5= Total CO_2 produced in a year by Stevens County in metric tons. This was found by adding 'Waste for County'!E41+'Energy for County'!C16+'Travel for County'!C16+'Food for County'!G10+'Food for County'!G11

Cell G8= the equivalent weight of CO_2 emissions as equivalent to the weight of empty 100-car freight trains. A 100 car train is assumed to weigh 6,625,985.41 pounds per train. The weight of a 100 car freight train was determined by taking the average train engine weight and adding the weight of an empty train car multiplied by 100. This can be found at http://answers.yahoo.com/question/index?qid=20061007151346AAWdaRL. These calculations are: 12,125.41 lbs + 30 tons*100 *2204.62 = 6,625,985.41
12,125.41 lbs being the weight of the train engine
30 tons being the weight of an empty train car
2204.62 being the number of pounds in a metric ton.