Conversion Factors used in the Taming Bigfoot Carbon Calculator: Documentation of Sources and Rationale

To the greatest extent possible, the conversion factors used in the calculator estimate the net effect of all the emitted greenhouse gases associated with an activity in any category. This is expressed as pounds of "effective carbon dioxide" (CO_2e) which attempts to equate the additional effective of other greenhouse enhancing gases with the amount of CO_2 necessary to cause the same greenhouse effect. Wherever possible, references for Jefferson County have been used so conversion factors most accurately reflect Jefferson County greenhouse gas emissions.

ENERGY

Electricity

The most recent data (for 2015) for the region including power supplied to Jefferson County by the Bonneville Power Administration is 0.0442 lbs. CO_2e/kWh. (http://arb.ca.gov/cc/reporting/ghg-rep/ghg-rep-power/acs-power.htm).

Propane

The conversion factor of 12.59 lbs. CO_2/gal. is taken from http://www.carbonfootprint.com/calculator.aspx

Wood

The Jefferson County Emissions Inventory states (p. 10 footnote): (1.035 lbs CO_2 per lb wood) x (2,737 lbs wood per cord of Douglas fir) = 2833 lbs. CO_2 per cord of wood. This equals 22.13 lbs CO_2/cu ft. Cord stacking causes cord density to be less than the pure wood density. Cedar is less dense and maple more dense than Douglas fir so it is a good average for this region. Moisture content matters as burning wet wood is inefficient because more of the heat must be used to evaporate the excess water in the wood. Air dried lumber generally can't be dried beyond 18%. Densities of various woods at 20% moisture content can be found at http://www.engineeringtoolbox.com/weigt-wood-d_821.html.

Some carbon calculators set wood burning for energy as carbon neutral noting that wood from quick-growing trees recapture the carbon emitted by burning. By harvesting subsequent wood fuel from those trees, the cycle is repeated. However, a number of factors lead us to include the direct carbon emissions of wood burning in our calculator. Foremost among these factors is the time scale of this cycle: even one of the fastest-growing, quickest carbon-sequestering trees that sprouts up today would require 50 years or more to absorb the carbon emitted by burning a single cord of wood (about the amount in a foot-thick 40-foot-long log). Also, the production

of slash from the harvesting process leads to reintroduction of much of the sequestered carbon back into the environment when it is burned. Finally, trees sequester carbon from all sources, not only from wood burning, making it more legitimate to include a carbon sink "credit" for tree-growth efforts, rather than limit the carbon offset effect to wood-burning alone..

Wood pellets

The conversion factor of 0.054 lbs. CO_2/lb. is taken from http://www.carbonfootprint.com/calculator.aspx

Heating oil

The conversion factor of 24.28 lbs. CO_2/lb. is taken from http://www.carbonfootprint.com/calculator.aspx

WATER

The calculation is limited to those on municipal water networks. Others with private wells pay for water supply through electricity expended by well pumps. Private septic systems are similarly accounted for through electricity usage. For municipal water supply, the conversion factor is 0.00039452 CO_2e/gallon of water used (Jefferson County Emissions Inventory). A slightly smaller amount of wastewater is produced as a byproduct of consuming this water.

From the same document, the actual ratio of wastewater to supplied water is 81.68% and the conversion factor of wastewater treatment is 0.004477 CO_2e/gallon. The higher value for wastewater reflects the additional energy required to treat wastewater.
Water bills usually don't include a separate metering of wastewater so for those sending wastewater into the municipal system, the assumed volume is equal to 81.68% of the water drawn.

PERSONAL TRANSPORTATION

Gasoline

19.64 lbs. CO_2 are produced by burning a gallon of gasoline that does not contain ethanol. Fuel with 10% ethanol reduces the CO_2 emission to 18.95 lbs. CO_2/gal. [Source: U.S. Energy Information Administration http://eia.gov]. The latter fuel is most common in Jefferson County so the lower conversion factor is used.

Diesel

22.38 lbs. CO_2 are produced by burning a gallon of diesel. [Source: U.S. Energy Information Administration http://eia.gov].

PUBLIC/SHARED TRANSPORTATION

Carpooling

Because fuel efficiency varies so widely among vehicles, an average mileage efficiency of 25 miles per gallon is assigned for simplicity. Miles traveled are then converted to gallons using this fuel efficiency value. Most carpooling is accomplished using 10E-gasoline powered vehicles, so the emission factor of 18.95 lbs. CO_2/gal. (see Gasoline, above) is used resulting in a conversion factor of 0.758 lbs. CO_2/mile.

Users may wish to account more precisely for vehicles with better (or worse fuel efficiency). The best means to do this is to adjust the miles travelled using the formula:
M = m x 25 / MPG, where m is the actual miles travelled, MPG is the actual fuel efficiency and M is the adjusted miles travelled that would then be entered on the report. Attempting to adjust for different fuel types is likely less significant.

Business vans/shuttle

Diesel fuel is assumed along with an average fuel efficiency of 10 mpg for these vehicles which are typically larger and carry more passengers. Using the above diesel factor of 22.38 lbs. CO_2/gal. results in a conversion factor of 2.238lbs. CO_2/mile.

Bus

The emission conversion factor for bus travel varies depending on type of fuel used, service area (urban or rural) and number of passengers. http://www.carbonfund.org references **EPA Climate Leaders** (table 3, page 5) with an average emission factor for bus travel of 0.107kgs CO_2/passenger mile (or 0.236 lbs. CO_2/passenger mile) but this works out to an average busload of 19 passengers. On the other hand, http://www.fta.dot.gov/documents/PublicTransportationsRoleInRespondingToClimateChange.pdf (page 2) gives a national average of 0.653 lbs. CO_2/passenger mile and a specific value for King County, WA of 0.492 lbs. CO_2/passenger mile (page 10). We chose the middle value, which also is close to the average of all three values.

Train

From http://www.carbonfund.org, the CO_2 emissions for rail travel vary by distance of the trip. On average, commuter rail emits 0.175 kgs CO_2 per passenger mile and subway trains emit 0.159 kgs CO_2 per passenger mile, and long distance trains (i.e., intercity rail) emit 0.145 kgs CO_2 per passenger mile (Source: *EPA Climate Leaders*, table 2, page 5). These factors may overestimate emissions in Washington State but are used in lieu of more regionally specific data. An average value of 0.16 kgs CO_2/passenger mile (0.353 lbs. CO_2/passenger mile) is used.

Ferry

In 2009, Washington State Ferries transported 22.4 million passengers over 9 routes totaling 85.5 nm in 167,355 sailings while using 17 million gallons of biodiesel [Source: http://www.wsdot.wa.gov/ferries/]. Using these data to derive network-wide averages, the average route is 9.5 nm. (11mi.) and the total distance travelled is 1,829,190 miles with a fuel efficiency of 0.108 miles per gallon. Biodiesel produces 22lbs. CO_2e/gal, so the emission rate is 204 lbs. CO_2e/mile. This is distributed among all passengers: 134 per sailing. The net result is a carbon emission factor of 1.525 lbs. CO_2e/mile.

Airplane

From http://www.carbonfund.org, an average carbon emission factor for air travel is 0.277 kgs CO_2/ passenger mile (0.61 lbs CO_2/passenger mile). Much like vehicle emissions, this number varies widely by the size of the airplane and the distance travelled as well as the number of stops (i.e., more fuel-hungry take-offs and landings). A good site to find this detail is http://blueskymodel.org/air-mile.

NON-RECYCLED GARBAGE

From the Jefferson County Emissions Inventory (pg. 12-13), 20,800 tons of solid waste generated 3457 tons of CO_2e (including transportation of the waste). This results in a ratio of 0.166, so 10 lbs of waste produce 1.66 lbs of CO_2e.

FOOD

Meat

From http://shrinkthatfootprint.com/shrink-your-food-footprint, USDA reports meat has a 0.77 ton CO_2e per year per capita footprint. Assuming one serving per day, a conversion factor of 4.22 lbs CO_2e/serving is used.

Local Source

The carbon calculator website http://www.carbonfootprint.com/calculator.aspx offers three options for the proportion of food purchased locally (all, most, none). The values used were 0% local is 0.09 metric tons CO_2e (198 lbs.) to 100% is 0.02 metric tons CO_2e (44.2 lbs.). From these, a linearly scaled coefficient of -1.539 lbs CO_2e /% was derived and is used.

Organic fruits & vegetables

The carbon calculator website http://www.carbonfootprint.com/calculator.aspx offers three options for proportion of fruits grown organically (all, some, none). Using the two extremes, "all organic" is 0 metric tons CO_2e and "no organic" is 0.03 metric tons CO_2e (66.15 lbs CO_2e), a linear scaling factor of 0.6615 lbs CO_2e/% was derived and is used.

SHOPPING

Clothing

By inputting a wide range of dollars spent in the carbon footprint calculator http://coolclimate.berkeley.edu/calculator, a linear scaling coefficient of 1.2 lbs. CO_2e/dollar spent was derived and is used.

Paper reading material

By inputting a wide range of dollars spent in the carbon footprint calculator http://coolclimate.berkeley.edu/calculator, a linear scaling coefficient of 0.65 lbs. CO_2e/dollar spent was derived and is used.