

### How is this Calculated?

LivClean's Carbon Calculator is designed for Canadian, US and International use. Data and emissions factors were obtained from the Canadian GHG Registries provided by the Canadian Standards Association, Transportation Canada, US environmental protection agency, US Department of Energy, and the Energy Information Administration.

- Home Calculator:

GHG emissions for a home is quantified according to records of energy use obtained from utility records wherever possible (electricity, natural gas, fuel oil, and propane). Utility records in conjunction with fuel specific GHG emission factors are used to calculate GHG emissions. This calculation is repeated for each of the fuels used in the home with emission factors found below.

In the case that utility records are not available, the GHG emissions may be estimated less precisely by floor space (available only for Canadian households).

Equation 1: Estimating GHG emissions for a home using utility records:

$$Home_{EUE} = \sum_{allfueltypes} \{ EmFactor_{fueltype} * EnergyConsumption_{fueltype} \}$$

Where:

**Home<sub>EUE</sub>** = Home energy use GHG emissions per year

**EmFactor<sub>fueltype</sub>** = Emission factor for electricity or primary fuel (see below)

**EnergyConsumption<sub>fueltype</sub>** = Energy used in a year, by type of primary fuel (in litres) or electricity (in kWh or m<sup>3</sup>)

Equation 2: Estimating GHG emissions for a home using floor space:

$$Home_{EUE} = EmFactor_{hometype} * HomeArea$$

Where:

**Home<sub>EUE</sub>** = Home energy use GHG emissions per year

**EmFactor<sub>hometype</sub>** = Emission factor for home specifics (see below)

**HomeArea** = Total floor area for the home building in m<sup>2</sup> or square feet

The emission factors involved are:

Electricity: Electricity emission factors are available per country, US state and Canadian Province

Canada:

Province	t/Kwh
AB	0.000930
BC	0.000020
MB	0.000010
NB	0.000366
NL	0.000015
NS	0.000549
NT	0.000249
NU	0.000249
ON	0.000180
PEI	0.000192
QC	0.000006
SK	0.000810
YK	0.000249

Source: GHG protocol - [http://www.ghgregistries.ca/emission\\_estimation\\_resources\\_e.cfm](http://www.ghgregistries.ca/emission_estimation_resources_e.cfm)

US:

State	TOTAL emissions
	t/KWh
AK	0.00049432
AL	0.00060805
AR	0.00055757
AZ	0.00052552
CA	0.00024497
CO	0.00086676
CT	0.00036465
DC	0.00110327
DE	0.00091537
FL	0.00060806
GA	0.00063618
HI	0.00078517
IA	0.00086511
ID	0.00006066
IL	0.00051075
IN	0.00094699
KS	0.00085952
KY	0.00093324
LA	0.00053319
MA	0.00057285
MD	0.00061338
ME	0.00033550
MI	0.00061124
MN	0.00072333
MO	0.00083775
MS	0.00055600
MT	0.00072214
NC	0.00055564
ND	0.00105467
NE	0.00072842
NH	0.00035756
NJ	0.00032594
NM	0.00087811
NV	0.00065353
NY	0.00037572
OH	0.00080369
OK	0.00070886
OR	0.00018209
PA	0.00056450
RI	0.00043759

SC	0.00040545
SD	0.00053590
TN	0.00057110
TX	0.00061480
UT	0.00095389
VA	0.00054252
VT	0.00000211
WA	0.00015019
WI	0.00078024
WV	0.00087458
WY	0.00102125
<b>U.S.</b>	<b>0.00060298</b>

Source: US environmental protection agency - <http://www.epa.gov/cleanenergy/egrid/index.htm>

World:

<b>Country</b>	<b>t/Kwh</b>
Australia	0.000924
Austria	0.000197
Belgium	0.000289
Canada	0.000223
Denmark	0.000358
Finland	0.000239
France	0.000083
Germany	0.000539
Greece	0.000887
Ireland	0.000699
Italy	0.000525
Japan	0.000417
Luxembourg	0.000387
Netherlands	0.000479
New Zealand	0.000159
Norway	0.000005
Portugal	0.000511
Spain	0.000443
Sweden	0.000048
Switzerland	0.000022
Turkey	0.000584
United Kingdom	0.000475
United States	0.000676
Argentina	0.000317

Brazil	0.000093
Chile	0.000333
China	0.000839
Columbia	0.000157
Ecuador	0.000256
India	0.000999
Mexico	0.000593
Pakistan	0.000482
Peru	0.000148
Singapore	0.000731
Venezuela	0.000251

Source: Energy Information Administration – Electricity Emission Factors 2002  
[http://www.eia.doe.gov/oiaf/1605/emission\\_factors.html](http://www.eia.doe.gov/oiaf/1605/emission_factors.html)

Natural Gas: 0.00189 tonnes/m<sup>3</sup>  
 Fuel Oil: 0.00274 tonnes/litre  
 Propane: 0.00153 tonnes/litre

Emission Intensities for a home based on floor space:

Province	Atlantic	Quebec	Ontario	Manitoba	Sask.	Alberta	British Columbia
GHG emission intensities CO <sub>2</sub> e(tonnes/ M <sup>2</sup> /year)	0.10637	0.07953	0.12733	0.08798	0.14038	0.24122	0.08763

Source: CSA Canadian Hotel GHG Emission Calculator

Assumptions:

- Space Heating by Natural gas
  - Space Cooling by Electricity
  - Lighting by Electricity
  - Water Heating by Natural Gas
  - Auxiliary Motor by Electricity
- Vehicle Calculator:

GHG emissions for a vehicle is based on the vehicle’s total annual fuel consumption.

Fuel consumption is estimated using the vehicle’s fuel efficiency as provide by US Department of Energy and based on the vehicle’s year, make, model, and the distance travel per year. Total fuel consumption is then multiplied by the appropriate emission factors to calculate GHG emissions in tonnes of CO<sub>2</sub> equivalents per year.

If the year, make and model of the vehicle is unknown, the calculator estimates emissions based on average fuel efficiencies for various vehicle sizes. Fuel efficiency of various sizes is provided by Transport Canada.

Equation 3: Estimating GHG emissions for a vehicle:

$$Vehicle_{Emissions} = \sum_{allvehicletypes} \{VKT_{vehicletype} * FuelEff_{vehciletype} * EmInt_{fueltype}\}$$

Where:

**VehicleEmissions** = Total GHG emissions from vehicle per year  
**VKT<sub>VehicleType</sub>** = Total vehicle kilometres travelled by vehicle type per year  
**FuelEff<sub>VehicleType</sub>** = Fuel efficiency of specified car  
**EmInt<sub>FuelType</sub>** = GHG emission intensity by fuel type (see below)

The GHG emission intensity by fuel type (EmInt<sub>FuelType</sub>) are:

Gasoline: 0.00250 tonnes/litre  
Diesel: 0.00279 tonnes/litre

Source: US Department of Energy -  
<http://www.fueleconomy.gov/>  
Transport Canada -  
<http://www.tc.gc.ca/programs/environment/UTEC/GhgEmissionFactors.aspx>

- Flight calculator:

GHG emissions for a flight is estimated on passenger kilometers traveled. Distance traveled will be calculated by the great circle distance ([http://en.wikipedia.org/wiki/Great\\_circle\\_distance](http://en.wikipedia.org/wiki/Great_circle_distance)) along with latitudes and longitudes of departure and arrival locations. The great circle distance is the most direct route after accounting for the curvature of the earth.

Equation 4: Great circle distance

$$EarthRadius = 6371$$

$$\Delta lat = lat1 - lat2$$

$$\Delta long = long1 - long2$$

$$a = \sin\left(\frac{\Delta lat}{2}\right) * \sin\left(\frac{\Delta lat}{2}\right) + \cos(lat1) * \cos(lat2) * \sin\left(\frac{\Delta long}{2}\right) * \sin\left(\frac{\Delta long}{2}\right)$$

$$c = 2 * a \tan 2\left(\sqrt{a}, \sqrt{1-a}\right)$$

$$distance = EarthRadius * c$$

Where:

**EarthRadius** = Radius of the earth in kilometers  
**lat1** = Latitude of departure location  
**lat2** = Latitude of arrival location  
**long1** = Longitude of departure location  
**long2** = Longitude of arrival location  
**distance** = Total distance traveled in kilometers

Total flight distance is then multiplied by the appropriate emission factors, to calculate GHG emissions in tonnes of CO<sub>2</sub> equivalents per flight. Flight emission factors vary for long haul, medium haul or short haul flights.

Equation 5: Estimating GHG emissions for a flight

$$Flight_{Emissions} = \sum_{alltravel} \{PKT_{type} * EmInt_{type}\}$$

Where:

**FlightEmissions** = Total GHG emissions from flights per year  
**PKT<sub>type</sub>** = Total passenger kilometers traveled by type per year  
**EmInt<sub>type</sub>** = GHG emission intensity by type of trip (see below)

The GHG emission intensity by type of trip (Emlnttype) are:

Mode	Emission Intensity CO2e (tonnes/PKT)
Short haul (under 500 km) small jet (e.g., Dash 8), all seating	0.00014
Medium haul (500 to 1600 km) regional jet (e.g. CRJ-2), economy seating	0.00012
Medium haul (500 to 1600 km) regional jet (e.g. CRJ-2), business class	0.00017
Medium haul (500 to 1600 km) turbo prop (e.g., NexGen Q400), all seating	0.00011
Long haul (over 1600 km) large jet (e.g., Boeing 767), economy seating	0.00011
Long haul (over 1600 km) large jet (e.g., Boeing 767),business class seating	0.00021

Source: CSA Canadian Hotel GHG Emission Calculator