



CARBON FOOTPRINT CALCULATOR DOCUMENTATION

## TABLE OF CONTENTS

INTRODUCTION.....	2
VEHICLE FUEL CONSUMPTION CALCULATOR .....	3
HOME ENERGY USE CALCULATOR .....	5
AIR TRAVEL CALCULATOR .....	7
TOTAL CARBON FOOTPRINT CALCULATION .....	8

## INTRODUCTION

*Carbon Footprint to Forests* has developed a carbon calculator for the three lifestyle categories that make up the majority of an individual's or family's carbon footprint:

- vehicle fuel consumption;
- home energy use;
- air travel.

The calculator allows interested parties the flexibility of calculating one, two, or all three of their carbon footprint categories.

The calculator is based on the most up-to-date greenhouse gas (GHG) emission factors and statistics, all of which are referenced in this document. Several assumptions have been integrated into the calculator design to optimize its ease of use. All assumptions have been based on reputable and publicly-available sources, and are explained in the appropriate section of this calculator documentation.

As an added measure of quality control, the calculator has been reviewed by a leading third-party expert on energy and GHG emissions, whose statement confirming the validity and accuracy of the calculator is provided in Appendix A.

*Carbon Footprint to Forests* hopes that this calculator is both a fun and informative tool for you to use as you become more aware of your personal or family carbon footprint.

## VEHICLE FUEL CONSUMPTION CALCULATOR

The calculator uses a GHG emission factor published by *Environment Canada's 2011 National Inventory Report*<sup>1</sup>. It is assumed that gasoline is the fuel type used.

The calculator estimates the GHG emissions based on two key variables:

- annual distance traveled;
- fuel efficiency of the vehicle (based on vehicle category).

The calculator requires users to input the type of vehicle that they drive and their distance traveled (as a weekly or annual total). When users select their vehicle category from a list (Table 1) the average fuel efficiency for that vehicle category will be assigned to their carbon footprint calculation (see Equation 1).

Users can enter multiple vehicles into one carbon footprint calculation, as it is common for individuals or families to have multiple vehicles that should be calculated. The total vehicle fuel consumption footprint would be a sum of all individual vehicle calculations.

$$\text{GHG}_v = d / 100 * fe * Ef / 1000 \quad \text{(Equation 1)}$$

### Where:

$\text{GHG}_v$  = carbon footprint from vehicle use in metric tonnes of GHG

$d$  = annual distance driven in km (if user enters a weekly total it will be multiplied by 52)

$fe$  = fuel efficiency of vehicle category in litres / 100 km (Table 1)

$Ef$  = GHG emission factor for gasoline (2.44 kg GHG / litre gasoline)

---

<sup>1</sup> GHG emission factor of 2.44 kg GHG/litre gasoline was obtained from the 2011 Environment Canada National Inventory Report (<http://www.ec.gc.ca/Publications/default.asp?lang=En&xml=A07ADA2-E349-481A-860F-9E2064F34822>). The emission factor includes the combined impact of carbon dioxide, methane, and nitrous oxide that is released from the combustion of gasoline.

VEHICLE CATEGORY	FUEL EFFICIENCY (l / 100 km)
Small / Mid-size Car	10.35
Small / Mid-size Car (Hybrid)	6.17
Large Car	12.65
Minivan	12.06
Small Pickup	12.67
Standard Pickup / Van	14.9
SUV / Crossover	12.39
SUV / Crossover (Hybrid)	8.97
Motorcycle	3.9

**Table 1:** The fuel efficiency ( $f_e$ ) that is entered in Equation 1. Average fuel efficiency for each vehicle category except motorcycle was obtained from the 2010 EPA Fuel Economy Statistics ([www.fueleconomy.gov](http://www.fueleconomy.gov)). EPA average fuel economy values were converted from MPG to litres per 100 km. The average fuel efficiency for motorcycles was obtained from the Greenhouse Gas Protocol's Mobile CO<sub>2</sub> calculation tool, available for download at [www.ghgprotocol.org](http://www.ghgprotocol.org).

## HOME ENERGY USE CALCULATOR

Home energy GHG emissions are generated from a combination of electricity usage and energy used to heat and/or cool the home (e.g. natural gas, fuel oil). The calculator uses a GHG emission factor determined using *Natural Resources Canada's Energy Use Data Handbook 1990-2010*<sup>2</sup>.

The only input required of users for the home energy carbon footprint calculation is the category of home that they occupy. Three categories are available to select:

- Small house or apartment;
- Medium house;
- Large house.

Some assumptions have been made about the size of each home category (Table 2). These assumptions pertaining to the average size of each category are the key variable that determines the annual GHG emissions from home energy use (see Equation 2).

This simplified approach prevents users from having to determine their annual consumption of electricity and other energy sources (natural gas, heating oil) from invoices.

$$\text{GHG}_h = \text{area} * \text{Ef} / 1000 \quad \text{(Equation 2)}$$

### Where:

$\text{GHG}_h$  = carbon footprint from home energy use in metric tonnes of GHG

$\text{area}$  = assumed floor space of home in square feet (based on average area for user's home size selection)

$\text{Ef}$  = GHG emission factor for home energy use (3.5 kg GHG / square foot)

---

<sup>2</sup> GHG emission factor of 3.5 kg GHG / square foot for residential structures was determined using statistics published in the Energy Use Data Handbook 1990-2010 by Natural Resources Canada (<http://oee.nrcan.gc.ca/publications/statistics/handbook2010/handbook2013.pdf>). Total residential floor space was obtained on page 27 of the document and was converted to square feet using a factor of 10.764. Total residential GHG emissions (including electricity) were obtained on page 9 of the document.

<b>Home Size Category</b>	<b>Square Footage Range</b>	<b>Square Footage Average</b>	<b>GHG Emission Factor (kg / sq ft)</b>
Small House / Apartment (up to 2 bedroom)	Less than 1500 square feet	1200	3.5
Medium House (3 or 4 bedroom)	1500 – 2500 square feet	2000	3.5
Large House (5+ bedroom)	Over 2500 square feet	3000	3.5

**Table 2:** The average home size in square feet (*area*) that is entered in Equation 2. Average square footage is assigned for the specific home size category selected by the user. The GHG emission factor for residential home energy use was determined using statistics of total residential floor space and total residential GHG emissions found in Natural Resources Canada’s Energy Use Data Handbook 1990-2010.

## AIR TRAVEL CALCULATOR

The calculator uses different GHG emission factors based on the length of the flight<sup>3</sup> – a short-haul flight emits more GHG per unit distance than a long-haul flight due to the greater portion of the trip spent in the take-off and landing phases. Emission factors used in the calculator are shown in Table 3.

The air travel calculator requires users to enter trips (one-way or return) by flight length category. The calculator automatically assigns an average distance traveled for each flight length category to prevent users from having to enter specific origin/destination information for each trip taken.

Users can enter multiple air travel trips into one carbon footprint calculation, as it is common for individuals or families to take multiple trips in one year. The total air travel footprint would be a sum of all individual flight calculations.

$$\text{GHG}_a = d * Ef / 1000 \quad \text{(Equation 3)}$$

### Where:

$\text{GHG}_a$  = carbon footprint from air travel in metric tonnes of GHG

$d$  = flight distance in km (refer to Table 3 for average flight distance for each category). Note that if user specifies a round-trip then the distance is multiplied by 2.

$Ef$  = GHG emission factor based on flight distance (refer to Table 3)

---

<sup>3</sup> GHG emission factors obtained from the *GHG Protocol Mobile Combustion CO2 Emissions Calculation Tool (Version 1.3)*, developed by the World Resources Institute (WRI) and the World Business Council on Sustainable Development (WBCSD). Available for download at [www.ghgprotocol.org](http://www.ghgprotocol.org).

<b>Flight Category</b>	<b>Average One-Way Distance (km)</b>	<b>GHG Emission Factor (kg / km)</b>
Short Haul (less than 1 hour flight time)	400	0.18
Medium Haul (1 – 3 hours flight time)	1500	0.126
Long Haul (3 – 6 hours flight time)	3500	0.11
Extended (over 6 hours flight time)	8000	0.11

**Table 3:** The GHG emission factor ( $E_f$ ) in kg GHG/km traveled and average one-way flight distance ( $d$ ) that is used in Equation 3. Emission factors and flight length are based on the user-defined flight category that is selected.

## TOTAL CARBON FOOTPRINT CALCULATION

A user's total carbon footprint is simply the sum of all individual sub-totals from the three carbon footprint categories (see Equation 4):

$$\text{GHG}_{\text{total}} = \text{GHG}_v + \text{GHG}_h + \text{GHG}_a \quad (\text{Equation 4})$$