# 2011 CALCULATION PARAMETERS
# Reduced GHG Emissions

**Travelling**

1. To go to work or class, I walk or bike:

   To calculate the reduction of GHG emissions associated with walking or biking, the impact avoided by not using a car for an average commuting distance of 7.8 km, twice daily and for 48 weeks a year must be determined. The emission factor of solo driving is 0.238 kg $CO_2$ eq./pers.km[1] and the emission factor of walking or biking is estimated at 0 kg $CO_2$ eq/pers.km.

   [1] Ecoinvent Database: www.ecoinvent.ch

2. To go to work or class, I use public transit:

   To calculate the reduction of GHG emissions associated with public transit, the impact of public transit must be deducted from the impact of using a car for an average commuting distance of 7.8 km twice daily and 48 weeks a year. The emission factor of solo driving is 0.238 kg $CO_2$ eq./pers.km[1] and the emission factor of a city bus is 0.032 kg $CO_2$ eq./pers.km[2].

   [1] Ecoinvent Database: www.ecoinvent.ch

   [2] Ecoinvent Database: www.ecoinvent.ch ("Operation, regular bus/CH", factor of 1.31 kg $CO_2$ eq./km, average of 39 occupants/bus)

3. To go to work or class, I carpool:

   To calculate the reduction of GHG emissions associated with carpooling, the impact of carpooling must be deducted (2 individuals per car) from the impact of using a car for an average commuting distance of 7.8 km twice daily and 48 weeks a year. The emission factor of solo driving is 0.238 kg $CO_2$ eq./pers.km[1] and the emission factor of one person carpooling is simply half of it: 0.119 kg $CO_2$ eq/pers.km.

   [1] Ecoinvent Database: www.ecoinvent.ch

4. I walk or bike instead of using my car for short trips.

   To calculate the reduction of GHG emissions associated with walking or biking instead of using the car for short trips, the impact avoided by not using a car for a distance of 2 km, four times per week must be determined, for a total of 416 km short trips per year. The emission factor of solo driving is 0.238 kg $CO_2$ eq./pers.km[1] and the emission factor of walking or biking is estimated at 0 kg $CO_2$ eq/pers.km.

   [1] Ecoinvent Database: www.ecoinvent.ch

5. Depending on the situation or my needs, I choose to:

   a) not own a car or give mine up altogether

   To calculate the reduction of GHG emissions associated with not owning a car, the impact avoided by not using a car for a whole year must be determined by assuming that the annual distance covered in kilometres covered is 20,000 km and that the car fuel consumption is 8.6[1] litres per 100 km. The emission factor per litre of the car is 2.4 kg $CO_2$ eq./litre[2].

   [1] Transport Canada
   [2] The Office de l'efficacité énergétique and the Ministry of Sustainable Development, Environment and Parks

   b) use a car-sharing service instead of having my own vehicle

   To calculate the reduction of GHG emissions associated with car-sharing the impact of car-sharing must be deducted from the impact of using a car by assuming that the annual reduction of the distance covered in kilometres after becoming a member of Communauto is 2,750 km[1]. In addition, the annual distance covered in kilometres covered is assumed to be 20,000 km and the fuel consumption of an average-sized car and a Communauto car are 8.6 litres and 6.5 litres per 100 km[2] respectively. The emission factor per litre of the car is 2.4 kg $CO_2$ eq./litre[3].

   [1] Average of values based on a survey by Communauto and a survey by Transport Research Board
   [2] Transport Canada
   [3] The Office de l'efficacité énergétique and the Ministry of Sustainable Development, Environment and Parks

   c) use a fuel-efficient vehicle (6.5 l/100 km)

   To calculate the reduction of GHG emissions associated with using a fuel-efficient vehicle, the impact of a car considered "eco-efficient" must be deducted from the impact of using an average-sized car. The annual distance covered in kilometres covered is assumed to be 20,000 km and the fuel consumption of an average-sized car and an eco-efficient car are 8.6 litres and 6.5 litres per 100 km[2] respectively. The emission factor per litre of the car is 2.4 kg $CO_2$ eq./litre[2].

   [1] Transport Canada
   [2] The Office de l'efficacité énergétique and the Ministry of Sustainable Development, Environment and Parks

6. I am ecodrive-wise and do not let the engine idle needlessly When I have to use a vehicle.

   To calculate the reduction of GHG emissions associated with ecodriving, reductions in the impact associated with the following must be added up:
   1) Stopping the car engine four minutes a day (half of waiting time);
   2) Reducing the speed on the highway from 110 km/h to 90 km/h;
   3) Adjusting tire pressure regularly.

The annual distance covered in kilometres covered is assumed to be 20,000 km and the fuel consumption of the car is 8.6 litres per 100 km[1]. The emission factor per litre of the car is 2.4 kg $O_2$ eq./litre[2].

To calculate the reduction of the impact achieved by stopping the engine, the fuel consumption is assumed to be 0.03 litre per minute[3].

In addition, it is assumed that a motorist drives on a highway 50% of the time. By reducing speed on the highway from 110 km/h to 90 km/h, a motorist reduces fuel consumption by 20%[4] and by adjusting the pressure of tires on a regular basis, fuel consumption is reduced by 1%[4].

[1] Transport Canada
[2] The Office de l'efficacité énergétique and the Ministry of Sustainable Development, Environment and Parks
[3] CAA: Primer on Automobile Fuel Efficiency and Emissions (10 minutes = 0.3 litre)
http://www.caa.ca/primer/english/scribd-primer.htm
[4] CAA 2009: **Primer on Automobile Fuel Efficiency and Emissions**
http://caa.ca/primer/documents/primer-eng.pdf

**Home**

7. I set my thermostat(s) at 17 °C at night and 20 °C during the day.

   Setting thermostats to pre-set temperatures results in a 15%[1] energy cut. To calculate this energy saving, the impact associated with the annual home heating per household of 1,237 kg $CO_2$ eq./household[2] must be multiplied by 15%.

   [1] Canada Mortgage and Housing Corporation
   http://www.cmhc-schl.gc.ca/fr/co/enlo/efenreco/efenreco_004.cfm
   [2] Calculated based on OEE: Secondary Energy Use and GHG Emissions by End-Use
   http://oee.nrcan.gc.ca/corporate/statistics/neud/dpa/tablestrends2/res_qc_2_e_4.cfm?attr=0

8. I improve the energy efficiency of my home by caulking the windows and sealing air leaks.

   Heat loss due to air leaks is assumed to be 30%[1]. To calculate energy cuts made by caulking windows and sealing air leaks, the impact associated with the annual home heating per household of 1,237 kg $CO_2$ eq./household[2] must be multiplied by 30%.

   [1] Agence de l'efficacité énergétique du Québec
   http://www.aee.gouv.qc.ca/mon-habitation/conseils-pratiques/etancheite/
   [2] Calculed based on OEE: Secondary Energy Use and GHG Emissions by End-Use
   http://oee.nrcan.gc.ca/corporate/statistics/neud/dpa/tablestrends2/res_qc_2_e_4.cfm?attr=0

9. I replace my old oil heating system with a high-efficiency system:

   To calculate the reduction of GHG emissions associated with the replacement of an old heating system, the impact related to the new heating system must be deducted from the impact related to oil heating.

   The energy consumption for heating per household in Quebec is calculated by assuming that the number of households in Quebec as 3,307,000 with an average energy consumption of 66 GJ/household[1].

   Emission factors used for calculations are the following:

| Parameter | Value | Unit | Source |
|---|---|---|---|
| Oil Heating Emission Factor | 91 | kg $CO_{2eq}$ / GJ | Data average from the Office de l'efficacité énergétique, Hydro Québec (GHG emissions of heating options) and the ecoinvent database www.ecoinvent.ch |
| Electric Heating Emission Factor | 7 | kg $CO_{2eq}$ / GJ | |
| Natural Gas Heating Emission Factor | 67 | kg $CO_{2eq}$ / GJ | |
| Geothermal Energy Heating Emission Factor | 6 | kg $CO_{2eq}$ / GJ | |
| Biomass Heating Emission Factor | 12 | kg $CO_{2eq}$ / GJ | |

[1] Calculated based on OEE: Secondary Energy Use and GHG Emissions by End-Use http://oee.nrcan.gc.ca/corporate/statistics/neud/dpa/tablestrends2/res_qc_2_e_4.cfm?attr=0

10. I opt for wood and reusable or reused materials when renovating.

    To calculate the reduction of GHG emissions associated with using wood and renewable materials for renovation, the reductions of the impact associated with the following must be added up:

    1) Using wood to renovate the floor of a kitchen (changing the ceramic floor);
    2) Using recycled paint instead of fresh paint to renovate a kitchen;
    3) Reusing a sink;
    4) Reusing bricks for a kitchen wall.

    It is assumed that wood and ceramic have comparable service life cycles by disregarding the differences in the care and end of service life of the materials. In addition, it is assumed that the impact of a gallon of recycled paint is four times less than a gallon of fresh paint and that five gallons of paint are needed to paint a kitchen. Transportation and operations involved in recycling the bricks and the sink are disregarded.

Parameters used to calculate these reductions are the following:

| Parameter | Value | Unit | Source |
|---|---|---|---|
| Using wood to renovate the floor of a kitchen (replacing the ceramic) | | | |
| Dry Hardwood Density | 750 | $kg/m^3$ | http://www.engineeringtoolbox.com/wood-density-d_40.html |
| Hardwood Impact | 112.5 | kg $CO_{2eq}$ /$m^3$ | Ecoinvent Database www.ecoinvent.ch |
| Ceramic Tile Impact | 0.878 | $CO_{2eq}$ /kg | Ecoinvent Database www.ecoinvent.ch |
| Quantity of Tiles per $in.^2$ | 0.5 | kg/ $in.^2$ | http://www.deq.state.or.us/lq/sw/wasteprevention/greenbuilding.htm |
| Quantity of Wood per $in.^2$ | 0.0850 | kg/ $in.^2$ | http://www.deq.state.or.us/lq/sw/wasteprevention/greenbuilding.htm |
| Average Surface Area of a Kitchen | 200 | $in.^2$ | Assumption |
| Using recycled paint instead of fresh paint to renovate a kitchen | | | |
| Impact of a Gallon of Paint | 2.75 | kg $CO_{2eq}$ /kg of Paint | Ecoinvent Database www.ecoinvent.ch |
| Impact of a Gallon of Recycled Paint | 0.688 | kg $CO_{2eq}$ /kg of Paint | Assumption: 4 times less GHG http://www.ecohabitation.com/actualite/peintures-latex-Boomerang-obtiennent-certification-EcoLogo |
| Density of Recycled Paint | 1.2 | kg/l | Ecoinvent Database www.ecoinvent.ch |
| Reclaiming a Sink | | | |
| Impact of a New Sink (stoneware) | 72.3 | kg $CO_{2eq}$ /sink | http://www.inies.fr/ |
| Reusing bricks for a kitchen wall | | | |
| Impact of a Brick | 0.238 | kg $CO_{2eq}$ /kg of Brick | Ecoinvent Database www.ecoinvent.ch |
| Density of a Brick | 785 | $kg/m^3$ | http://srdata.nist.gov/insulation/insul_search_menu_12.asp |
| Number of Bricks per Wall | 535 | Bricks | Calculated |
| Dimension of a Brick | 0.00105 | $m^3$/Brick | http://www.nrc-cnrc.gc.ca/eng/ibp/irc/cbd/building-digest-169.html |
| Surface of a Brick | 0.0103 | $m^2$ | Calculated |
| Dimension of the Wall | 7.53 | $m^2$ | Assumption |
| Brick Surface Ratio /(mortar + brick) | 0.73 | | Calculated |

**Waste**

11. I recycle the materials accepted by my municipality.

To calculate the reduction of GHG emissions associated with recycling materials accepted by a municipality, the impact of avoiding landfill and the difference between the impact of recycling and the impact of avoiding blank materials manufacturing must be determined. The annual generation of waste considered is 3,150,000 tonnes[1] and the recyclable portion of waste includes 20% (by weight) of newspaper and paperboard and 16% (by weight) of plastic, glass and metal[2]. Emission factors used for calculations are the following:

| Parameter | Value | Unit | Source |
|---|---|---|---|
| GHG Emission Factor of Paper Landfill | 0.021 | kg $CO_{2eq}$ /kg Landfill Paper | Ecoinvent Database www.ecoinvent.ch (newspaper, cardboard and paper average) |
| GHG Emission Factor of Blank Paper and Cardboard | 0.53 | kg $CO_{2eq}$ /kg Landfill Paper | ADEME, *Guide des facteurs d'émissions* -version 5.0 |
| GHG Emission Factor of Plastic, Glass and Metal Landfill (60% plastic, 20% glass, 20% metal) | 0.031 | kg $CO_{2eq}$ /kg Landfill Plastics | ecoinvent (average of mixed plastics, glass and steel) |
| GHG Emission Factor of Blank Plastic Manufacturing | 0.80 | kg $CO_{2eq}$ /kg Blank Plastics | Estimated Average Based on ADEME, *Guide des facteurs d'émissions* -version 5.0 |
| GHG Emission Factor of Blank Metal Manufacturing | 1.50 | kg $CO_{2eq}$ /kg Blank Metal | Estimated Average Based on ADEME, *Guide des facteurs d'émissions* -version 5.0 |
| GHG Emission Factor of Blank Glass Manufacturing | 0.28 | kg $CO_{2eq}$ /kg Blank Glass | ADEME, *Guide des facteurs d'émissions* -version 5.0 |
| GHG Emission Factor of Recycled Plastic Manufacturing | 0.30 | kg $CO_{2eq}$ /kg Recycled Plastic | Estimated Average Based on ADEME, *Guide des facteurs d'émissions* -version 5.0 |
| GHG Emission Factor of Metal Manufacturing from Recycled Materials | 0.40 | kg $CO_{2eq}$ /kg Recycled Metal | Estimated Average Based on ADEME, *Guide des facteurs d'émissions* -version 5.0 |
| GHG Emission Factor of Glass Manufacturing from Recycled Materials | 0.16 | kg $CO_{2eq}$ /kg Recycled Glass | Estimate Based on ADEME, *Guide des facteurs d'émissions* -version 5.0 |

[1] Recyc-Québec, Bilan 2008 de la gestion des matières résiduelles
[2] Recyc-Québec, caractérisation des matières résiduelles 2006

12. I have my old electronic appliances recycled.

To calculate the reduction of GHG emissions associated with recycling old electronic appliances, reductions of the impact associated with reusing appliances (hence, the avoiding production of new appliances) and recycling appliances (hence, avoiding manufacturing production of blank materials) must be added up.

Consider that a person recycles one computer and two cellular phones. Also consider that in 25% of cases, electronic appliances are reconditioned and reused, while in 75% of cases, they are recycled.

Parameters used to calculate these reductions are the following:

| Parameter | Value | Unit | Source |
|---|---|---|---|
| Computer Recycling | | | |
| Impact of Recycling a Computer and CRT Screen (materials credit only) | 73.9 | kg $CO_{2eq}$ /(ordinateur + écran) | Ecoinvent Database www.ecoinvent.ch |
| Impact of Recycling a Computer and Screen (mechanical disassembly) | 15.3 | kg $CO_{2eq}$ /(ordinateur + écran) | Ecoinvent Database www.ecoinvent.ch |
| Cellular Phone Recycling | | | |
| Average Weight of a Cellular Phone | 133 | g/ Cellular Phone | ADEME 2008 http://www.ademe.fr/internet/telephone-portable/site-web/portable.pdf |
| Impact of Recycling a Cellular Phone (materials credit only) | 3.75 | kg $CO_{2eq}$ /kg Cellular Phone | Ecoinvent Database www.ecoinvent.ch |
| Impact of Recycling (mechanical disassembly) | 1.4 | kg $CO_{2eq}$ /kg Cellular Phone | Ecoinvent Database www.ecoinvent.ch |
| Computer and Cellular Phone Reconditioning and Reuse | | | |
| Impact of Production of a Computer | 269 | kg $CO_{2eq}$ /Computer | Ecoinvent Database www.ecoinvent.ch |
| Impact of Production of a Screen (LCD) | 335 | kg $CO_{2eq}$ / Computer | Ecoinvent Database www.ecoinvent.ch |
| Computer Service Life | 3.5 | years | CFER, referring to RIS International Ltd. 2003 |
| Screen Service Life | 3.5 | years | Assumption based on the computer's assumption |
| Extension of Service Life, Second Service Life | 2 | years | Assumption |
| Impact of Production of a Cellular Phone | 13.5 | kg $CO_{2eq}$ / Cellular Phone | ADEME 2008 http://www.ademe.fr/internet/telephone-portable/site-web/portable.pdf |
| Cellular Phone Service Life | 2.5 | years | Recyc-Québec http://www.recyc-quebec.gouv.qc.ca/Upload/Publications/Fiche-tic.pdf |
| Extension of Service Life, Second Service Life | 1.5 | year | Assumption |

13. I compost at home or I have organic matter collected by my municipality.

    To calculate the GHG emissions reduced by composting organic matter, the impact of landfill organic matter (0.8 kg $CO_2$eq/kg landfill)[1] must be determined and multiplied by the annual quantity of organic waster per household (178 kg of organic matter /person) [2].

[1] US EPA, Solid Waste Management and Greenhouse Gases
http://www.epa.gov/climatechange/wycd/waste/SWMGHGreport.html#documentation
[2] Calculated based on *Recyc-Québec, Bilan 2008 de la gestion des matières résiduelles*

**Food**

14. I purchase in-season and local foods.

    To calculate the GHG emissions reduced by purchasing local foods, a value estimated through a study on local food consumption is used: 370 kg $CO_2$eq/pers.year[1].

[1] Engelhaupt, E. (2008). Do Food Miles Matter? Environmental Science & Technology, 42, 3482.

15. I avoid purchasing plastic bottles and I use a reusable bottle.

    To calculate the reduction of GHG emissions associated with using a reusable bottle, the impact of manufacturing such a bottle must be subtracted from the impact of manufacturing and transporting plastic bottles.

    The number of PET (polyethylene terephthalate) water bottles used on average by each Quebecker is assumed to be 91[1] per year and that the weight of one PET bottle is 35 g[1].

    It is assumed that a reusable bottle is composed of 50 g of steel[2] and that its service life is five years[2].

[1] Calculated based on Recyc-Québec's
http://www.recyc-quebec.gouv.qc.ca/Upload/Publications/Fiche-contenants-boissons.pdf
[2] Klean Kanteen water bottle (Vivre sans plastique) www.kleankanteen.com/products/klean-kanteens.html

16. I go meat-free one day per week.

    To calculate the reduction of GHG emissions achieved when removing meat from one's diet, the impact associated with 52 days without meat per year must be determined, assuming that the average meat consumption is 0.2 kg/day[1]. The emission factor is 8.5 kg $CO_2$eq/kg of meat[2], which is an average of the emission factors for beef, lamb, pork and chicken.

[1] Statistics Canada:
http://www.statcan.gc.ca/pub/82-620-m/82-620-m2006002-eng.pdf
[2] Average between Greenpeace values. LCA Food 2008 and ADEME,
*Guide des facteurs d'émissions* – version 5.0

**Citizen Commitment**

17. I convince five of my relatives to participate in Défi Climat

    No calculation parameters are available for this action.

18. I become involved in my community and I encourage the implementation of community services such as compostable waste collection or public transit.

    No calculation parameters are available for this action.

**For the Daring**

19. A zero car month: I travel solely by public transit or active means of transportation for 30 days.

    To calculate the reduction of GHG emissions associated with 30 days without a car, the impact related to active means of transportation and public transit must be deducted from the impact of using a car (average commuting distance of 7.8 km, twice daily). Calculations are based on two days per week of walking or biking and three days of using public transit. The emission factor of solo driving is 0.238 kg $CO_2$eq./pers.km[1], the emission factor of a bus is 0.032 kg $CO_2$ eq./pers.km[2] and the emission factor of walking and biking is estimated at 0 kg $CO_2$eq./pers.km.

    [1] Ecoinvent Database www.ecoinvent.ch
    [2] Ecoinvent Database www.ecoinvent.ch ("Operation, regular bus/CH", factor of 1.31 kg $CO_2$ eq./km, average of 39 occupants/bus)

20. Three minutes max in the shower: I always take quick showers.

    To calculate the reduction of GHG emissions associated with a three-minute shower, the impact of a one-minute shower must first be determined by calculating the number of joules required to heat 9.5 l of water (the average flow of a shower) from 8°C to 41°C, assuming that water heater efficiency is 97%[1]. Then, by assuming that an average shower lasts twelve minutes[2], the reduction of the impact is calculated by multiplying the number of joules per minute of shower (1.4 MJ/minute) by nine minutes (12 - 3 minutes). Lastly, the energy consumption is multiplied by the electricity emission factor in Quebec: 0.006 kg $CO_2$eq/MJ[3].

    [1] NRCAN, Drain Water Heat Recovery Characterization and Modeling.
    [2] http://www.slate.fr/story/9919/combien-de-temps-passez-vous-sous-la-douche
    [3] Hydro-Québec, Émissions atmosphériques des options de chauffage http://www.hydroquebec.com/developpementdurable/documentation/pdf/options_energetiques/ges_chauffage.pdf

21. A zero waste week: I do not generate any non-recyclable or non-compostable waste for seven days.

    To determine the reduction of GHG emissions of a week without generating waste, it is assumed that the average Quebecker recycles 56% of recyclable waste and composts 12% of organic matter generated[1]. Then, the impact avoided by increasing the recycling rate to 93% (the maximum potential currently estimated by RECYC-Québec)[1] and the composting rate to 100% are added together. Given that 7% of remaining materials cannot be recycled, the zero waste goal should be achieved by avoiding the purchase of products with packaging that cannot be recycled or composted, such as food packaged in polystyrene. The emission factor of polystyrene production is assumed to be 3.4 kg $CO_2$eq./kg[2].

    The impact avoided is associated with a reduction of…

    1) 12% to 100% of organic matter landfill: 2.4 kg $CO_2$ eq./week
    2) 56% to 97% of recyclable matter landfill (also a reduction of the difference between the impact of avoiding blank materials manufacturing and the impact of recycling): 0.27 kg $CO_2$eq./week
    3) 0.54 kg of polystyrene (by avoiding the purchase of over-packaged products): 1.8 kg $CO_2$ eq/week

    [1] Calculated based on Recyc-Québec's Bilan 2008 de la gestion des matières résiduelles
    [2] Ecoinvent Database www.ecoinvent.ch

22. A meat-free month: I remove meat from my menu for 30 days.

    To calculate the reduction of GHG emissions achieved when removing meat from one's diet for 30 days, the impact associated with 30 days without meat must be determined, assuming that the average meat consumption is 0.2 kg/day[1]. The emission factor is 8.5 kg $CO_2$eq/kg of meat[2], which is an average of the emission factors for beef, lamb, pork and chicken.

    [1] Statistics Canada: http://www.statcan.ca/francais/research/82-620-MIF/82-620-MIF2006002.pdf
    [2] Average between Greenpeace values. LCA Food 2008 and ADEME,
    *Guide des facteurs d'émissions* - version 5.0