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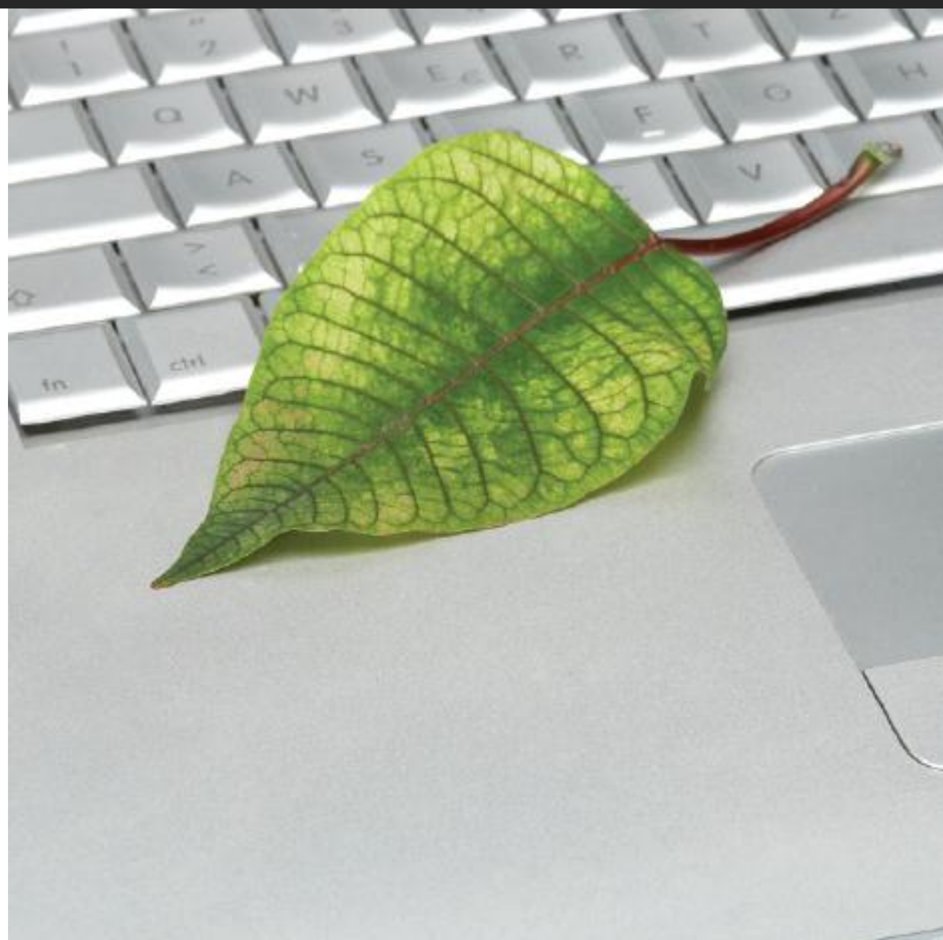

Seneca Footprinting Software Tool Supporting Research

METHODOLOGY DOCUMENT

May 9, 2012

Seneca

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INTRODUCTION

The following material was compiled by e3 Solutions Inc. to support the development of Seneca College's Environmental Footprinting Tool. The College, in conjunction with e3, developed a list of 25 pairs of activities. The software tool will select 10 questions for each user to answer, with two possible answers. Each answer will yield a relative score of 0 or 1, with 0 representing the lower GHG-intensive activity.

Users will receive a total score out of 10, along with a comparison against the median and total user average.

This document outlines the methodology and information sources that were used in determining relative scores. In most cases, a GHG figure in metric tonnes of carbon dioxide equivalent per year (t CO_2e/yr) was assigned to each figure. Often, these figures were calculated using e3's Carbon Accounting Tool (e3CAT), a software product used by many companies and organizations to calculate and track their greenhouse gas emissions. The high of each set of two received a relative score of 1.

This document also notes any assumptions that were made in calculating GHG figures or determining scores.

EXECUTIVE SUMMARY

No.	Activity	GHG/yr (t CO2e)	Relative Score	Difference/yr (t CO2e)
1	Public Transit	0.172	0	0.489
	Driving	0.661	1	
2	Seasonal Vegetables	0.097747573	0	0.024967767
	Imported Vegetables	0.12271534	1	
3	Microwave	0.034	0	0.024
	Stove (Electric Range)	0.058	1	
4	Walk	0	0	0.58
	Car	0.58	1	
5	Computer On	0.027	0	0
	Computer Off	0.027 *	1	
6	Staycation	0.086	0	3.874
	Flying	3.96	1	
7	Shower	0.002	0	0.002
	Bath (40 gal)	0.004	1	
8	Equivalent vegetables	0.02103	0	0.58897
	Beef	0.61	1	
9	Unplugged Music	0	0	0.274
	Electric	0.274	1	
10	Total for 4 AM	0.078149107	0	0.147126752
	Total for 4 PM	0.225275859	1	
11	Dishwasher	0.037	0	0.057
	Dishes by Hand	0.094	1	
12	Natural	0	0	0.008
	Solar Lighting	0.008	1	
13	Watch game on TV	0	0	0.008928571
	Go to the game	0.008928571	1	
14	Clothes Line	0	0	0.401
	Clothes Dryer	0.401	1	
15	Internet news (tablet)	0	0	0.04914
	Newspaper	0.04914	1	
16	MP3	0.004	0	0.028
	CD	0.032	1	
17	Beach	0.106	0	0.025
	Pool	0.131	1	
18	CFL	0.01	0	0.02
	Incandescent	0.03	1	

No.	Activity	GHG/yr (t CO2e)	Relative Score	Difference/yr (t CO2e)
19	Hybrid	2.124	0	2.117
	Conventional Car	4.241	1	
20	Green Bin	0.47284746	0	0.63976754
	Landfill	1.112615	1	
21	Use a rain barrel	0	0	0.00012
	Don't use a rain barrel	0.00012	1	
22	Fan		0	
	AC		1	
23	Tap Water		0	
	Bottled Water		1	
24	Landline		0	
	Cellphone		1	
25	Gift of Backyard Flowers		0	
	Gift of Chcolates		1	

This table lists relative scores for all 25 sets of activities to be used in the software tool. Those shaded in green represent activities supplied by Seneca College; blue represents those substituted by e3; yellow represents activities whose relative scores were developed exclusively with logical assumptions, and not calculations.

While the difference in GHG intensities between activity sets varies greatly, the purpose of these research was to establish relative emissions, hence a score of 0 or 1.

A NOTE ABOUT GLOBAL WARMING POTENTIALS AND CO_2 EQUIVALENT

This document makes many references to emission factors. Emission factors are proportions used in determining the quantity of a greenhouse gas emitted by an activity. Final emissions for all calculated activities are listed in metric tonnes of CO_2 equivalent (t CO_2e). The quantity of CO_2e is obtained by multiplying a quantity of greenhouse gas by its global warming potential GWP.

GWP is a number signifying the relative effect of a greenhouse gas on climate. The standard timeframe is 100 years. All GWP values use the global warming potential of carbon dioxide (CO_2) over 100 years as a basis. Therefore, CO_2 has a GWP of 1.

As an example, methane has a GWP of 25. This means that if 10 t of methane is the calculated emission, it will have the same effect on global warming over 100 years as 250 t of CO_2. For this reason, its stated equivalent would be 250 t CO_2e.

Here are the GWP values for greenhouse gases relating to the calculations employed in this document[1].

Gas	GWP
Carbon Dioxide (CO_2)	1
Methane	25
Nitrous Oxide	298

SCORING METHODOLOGY BY ACTIVITY

1. PUBLIC TRANSIT VS. DRIVING

Assumptions

- The car used in the comparison is in the mid-size class, running on gasoline
- Both vehicles travel a distance of 5 km, 5 days a week
- No highway travel
- Mass transit calculated using a bus running on diesel
- Based on a single occupant

Summary

Public Transit	0.172 t CO_2e/yr	0
Driving	0.661 t CO_2e/yr	1

Methodology

Values based the above assumptions were entered into the e3CAT system. In each case, the equation had the following format.

$days \cdot d \cdot 2 \cdot EF = GHG$ where *days* = 260 days (5 days a week)
d = distance traveled (one way)
EF = emission factor[2]
GHG = total emissions

[1] From 2007 IPCC AR4 p. 212.
[2] For a complete list of emission factors used in this document, see Appendix A.

2. SEASONAL VS. IMPORTED VEGETABLES

Assumptions

- Imported vegetables travel an average of 4500 mi
- Local vegetables travel an average of 100 mi
- Imported vegetables arrive by truck with a capacity of 44000 lb

Assertions

- Organic status does not impact travel distance of imported vegetables[3]
- Based on the average omnivore American diet[4]

Summary

Local	0.000567449 t CO_2e/yr	0
Imported	0.12271534 t CO_2e/yr	1

Methodology

Values were drawn from a previous set of calculations conducted by e3 for a U.S. client. An emission factor of 373.4774 g CO_2e/km travelled was used, which, accounting for unit conversion, equates to approximately 2.705 t CO_2e per imported trip and 0.060 t CO_2e per local trip.

Those figures were then divided by a 44000 lb truckload, and multiplied by an average vegetable diet of 415.4 lb of vegetables per year, yielding the figures shown above.

3. MICROWAVE VS. STOVE

Assumptions

- The stove is an electric range
- Both appliances are 2008 or newer
- Microwave oven is conventional (non-convection)

Summary

Microwave	0.034 t CO_2e/yr	0
Stove	0.058 t CO_2e/yr	1

[3] Based on a statement in Science Daily. For article excerpt, see Appendix B.
[4] See Appendix B.

Methodology

Average kWh/yr usage of the two appliances was sourced from an existing e3 methodology constructed for a U.S. client, based on data from Natural Resources Canada[5]. The values were 337.625 kWh/yr for the microwave and 583.812 kWh/yr for the stove. These values were inputted into the e3CAT system, using the following calculation for each greenhouse gas.

$E \cdot EF = GHG$ where *E* = Electricity consumed
EF = emission factor[6]
GHG = total emissions

4. 30 MIN. WALK VS. 5 MIN. DRIVE

Assumptions

- The car is mid-size class, using gasoline
- No highway travel
- Natural human emissions from walking are not factored
- Distance travelled is 4.167 km, 5 days a week

Summary

Walk	0 t CO_2e/yr	0
Drive	0.058 t CO_2e/yr	1

Methodology

Given the above assumptions, the emissions for walking will be 0. The distance of 4.167 km is based on the maximum distance a car could travel in 5 min. in a 50 km/h zone. These values were fed into the e3CAT system, and calculated using the following methodology.

$days \cdot d \cdot 2 \cdot EF = GHG$ where *days* = 260 days (5 days a week)
d = distance traveled (one way)
EF = emission factor[7]
GHG = total emissions

[5] See Appendix B.
[6] For a complete list of emission factors used in this document, see Appendix A.
[7] For a complete list of emission factors used in this document, see Appendix A.

5. COMPUTER ON VS. COMPUTER OFF

Assumptions

- Only desktop PCs are used
- Computers remain plugged in when off (no difference in phantom power load)
- Natural human emissions from walking are not factored
- A PC on for 8 hrs a day will spend 6 hrs at moderate use, 2 hrs in sleep, and 16 hrs off
- A PC on 24 hrs a day will spend 6 hrs at moderate use and 18 hrs in sleep
- Boot-up power consumption was not factored

Summary

Computer Off	0.027 t CO_2e/yr	0
Computer On	0.027 t CO_2e/yr *	1

Methodology

Data on the W consumption of a PC was taken from a study conducted by the University of Penn State[8]. The study compared boot-up/peak load, moderate use, sleep mode and phantom consumption for a range of devices. e3 took the average value of all desktop PCs in the study to derive W consumptions. These were 119.4444 W during use, 1.6 W during sleep, and 1.2 W when off.

These values were applied using the assumptions above over a 365 day period, yielding a consumption rate of 269.7593 kWh/yr for a computer shut off daily and 272.0953 kWh/yr for a computer on all the time.

$E \cdot EF = GHG$ where E = Electricity consumed
EF = emission factor[9]
GHG = total emissions

Clearly, the discrepancy in kWh/yr consumptions is not large, and consequently, the difference in t CO_2e/yr is less than 0.001 t. However, since the consumptions are distinct, a computer left on all the time has been assigned a relative score of 1.

[8] See Appendix B.
[9] For a complete list of emission factors used in this document, see Appendix A.

6. VACATION AT COTTAGE VS. FLY AROUND THE WORLD

Assumptions

- Cottage is 200 km away
- Air travel is to Acapulco, Mexico from Toronto
- Car is mid-sized class, running on gasoline
- Assumes a family of four

Summary

Car	0.088 t CO_2e/yr	0
Flying	3.96 t CO_2e/yr	1

Methodology

Emissions from both trips were calculated using the e3CAT software. Since emissions from flying are calculated by passenger, the resulting value was multiplied by 4.

$d \cdot EF = GHG$ where d = distance traveled (both ways)

EF = emission factor[10]

GHG = total emissions

7. SHOWER VS. BATH

Assumptions

- Both methods are assumed to be daily
- Shower is 10 min with a standard 2.5 gpm shower head
- Water heating is not considered
- Bath is filled to 40 gal

Summary

Shower	0.002 t CO_2e/yr	0
Bath	0.004 t CO_2e/yr	1

Methodology

Applying the above assumptions yields a gal/yr consumption of 9125 for showering and 14600 gal for bathing. Assumption figures were determined using information provided

[10] For a complete list of emission factors used in this document, see Appendix A.

by the Alliance for Water Efficiency[11]. These values were entered into the e3CAT system, and calculated using the following methodology.

$w \cdot EF = GHG$ where *w* = water consumption
EF = emission factor[12]
GHG = total emissions

8. SALAD VS. HAMBURGER

Assumptions

- Compares emissions due to beef with equivalent quantity of vegetables (bun, condiments, pickle, etc. not considered)
- Average American emits 2.19 t CO2e/yr due to food, 0.61 t of which is from beef (grain fed).
- Average American consumes 62.4 lbs of beef per year.
- Average American emits 0.14 t CO2e/yr from vegetables.
- Average American consumes 415.4 lbs of vegetables per year.

Summary

Salad	0.02103 t CO_2e/yr	0
Burger	0.61 t CO_2e/yr	1

Methodology

The assumptions above are based on a study conducted for a U.S. client, using data provided in a spreadsheet based on a report put out by the University of Chicago (http://www.scribd.com/doc/24163/CO2-Emissions-of-Foods-and-Diets), and on an average American omnivore's diet.

Based on these assumptions, the average annual emissions per lb from vegetable consumption is equal to 0.14 t divided by 415.4 lb, or 0.000337 t/lb. Multiplying this figure times the amount of meat consumed yields 0.02103 t CO2e/yr.

9. UNPLUGGED MUSIC VS. ELECTRIC MUSIC

Assumptions

- Unplugged music produced by acoustic guitar without mic

[11] http://allianceforwaterefficiency.org/Residential_Shower_Introduction.aspx.
[12] For a complete list of emission factors used in this document, see Appendix A.

- Electric music produced by electric guitar using a 15 W amp running at half-power
- Assume 1 hr of playing per day

Summary

Acoustic	0 t CO_2e/yr	0
Electric	0.274 t CO_2e/yr	1

Methodology

Applying the above assumptions, electric guitar music consumes 2737.5 kWh/yr of electricity.

$E \cdot EF = GHG$ where *E* = electricity consumption
EF = emission factor[13]
GHG = total emissions

10. LAUNDRY AT 4 AM VS. 4 PM

Assumptions

- Clothes are washed and dried using electric appliances, 2008 or newer, non-EnergySTAR
- Washing occurs from 4:00-5:00, drying from 5:00-6:00

Summary

4 AM	0.078149 t CO_2e/yr	0
4 PM	0.225276 t CO_2e/yr	1

Methodology

kWh/yr consumptions for electric clothes washers and dryers were drawn from previous research conducted by e3 for a U.S. client, using data from Natural Resources Canada[14]. Consumption rates were 473.9118 kWh/yr for washing and 855.968 kWh/yr for drying.

Time of use emission factors were supplied by a study conducted by Niagara College's Research Division on time of use emission factors in the Niagara Region[15]. This study provided an emission factor in g CO_2e/kWh for every hour of the day and every day of

[13] For a complete list of emission factors used in this document, see Appendix A.
[14] See Appendix B.
[15] See Appendix B.

the year. e3 took all the values for 4 AM, 5AM, 4 PM, and 5 PM, and calculated the averages. These averages were used to fulfill the EF component of the calculation.

The emissions shown in the summary represent the sum total emissions resulting from washing and drying.

$E \cdot EF = GHG$ where *E* = electricity consumption
EF = emission factor
GHG = total emissions

11. WASHING DISHES BY HAND VS. DISHWASHER

Assumptions

- Assumes one load equivalent per day
- Does not factor detergent use nor quality of cleaning
- Dishwasher uses a normal cycle

Summary

Dishwasher	0.037 t CO_2e/yr	0
By Hand	0.094 t CO_2e/yr	1

Methodology

Deriving the total emissions for each method involved determining emissions from base power consumption, as well as those resulting from water use. e3 obtained these values from a study conducted by Bonn University on both methods across seven European countries[16]. Power consumption over a one year period was calculated at 365 kWh for a dishwasher and 912.5 kWh by hand. Water use over a year was 5475 L for the dishwasher and 37595 L by hand.

These figured were fed to the e3CAT system, and calculated using the methodology below.

$E \cdot EF = GHG$(E) where *E* = electricity consumption
EF = emission factor[17]
GHG(E) = total emissions due to electricity

[16] See Appendix B.
[17] For a complete list of emission factors used in this document, see Appendix A.

$w \cdot EF = GHG(\mathrm{w})$ where w = water consumption

EF = emission factor[18]

$GHG(w)$ = total emissions due to water

$$GHG(E) + GHG(w) = GHG$$

12. NATURAL LIGHTING VS. SOLAR-POWERED LIGHTING

Assumptions

- Electric light is from a conventional 60 W bulb
- Bulb used for 8 hrs a day
- Does not account for heat loss from window, product footprint of lightbulb, etc.
- Solar power is photovoltaic

Summary

Natural Light	0 t CO_2e/yr	0
Solar-Powered Lightbulb	0.008 t CO_2e/yr	1

Methodology

A kWh/yr value, based on the assumptions above was applied to an emission factor (*EF*) of 46.5 g CO_2e/kWh for solar power generation. This factor is based on a UK study that takes into account the product cycle footprint of solar cells[19].

$E \cdot EF = GHG$ where E = electricity consumption

EF = emission factor

GHG = total emissions

13. WATCH GAME ON TV VS. ATTEND LIVE SPORTING EVENT

Assumptions

- TV is a flat screen
- Home emissions besides the TV were not included
- Game lasts three hours
- Based on 6 events a year

Summary

[18] For a complete list of emission factors used in this document, see Appendix A.
[19] See Appendix B.

TV	0 t CO_2e/yr *	0
Live	0.053571429 t CO_2e/yr	1

Methodology

The emissions due to electricity consumption of a flat screen TV were calculated through e3CAT using typical emission factors.

$E \cdot EF = GHG$ where *E* = electricity consumption
EF = emission factor[20]
GHG = total emissions

The resulting emissions were less than 0.001 t CO_2e/yr.

Emissions from live events took a figure of 5 t CO_2e per event attended by 560 people from a study conducted by UBC[21]. e3 divided this figure by the 560 spectators and multiplied by 6 events per year to obtain the annual emission figure shown in the summary.

14. CLOTHES LINE VS. CLOTHES DRYER

Assumptions

- Dryer is 2008 or newer
- Identical washer used in both cases (not material to calculation of difference)

Summary

Clothes Line	0 t CO_2e/yr	0
Dryer	0.401 t CO_2e/yr	1

Methodology

Since the clothes line consumes no energy and product footprints were not considered, emissions from line drying are 0. For a clothes dryer, an emission rate was by taking the average yearly emissions of a gas dryer and an electric dryer, based on the attached home audit study[22]. An electric dryer consumes 855.968 kWh/yr, while a gas dryer consumes 12775 kBTUs, or 13.4783385 GJ. A GJ translates into 26.8 m^3 of natural gas. These values were fed to the e3CAT system, and calculated using the following methodology.

[20] For a complete list of emission factors used in this document, see Appendix A.
[21] See Appendix B.
[22] See Appendix B.

$E \cdot EF = GHG$ where E = energy consumption
EF = emission factor[23]
GHG = total emissions

The average of both resulting yearly emissions was calculated to be the value shown in the summary.

15. INTERNET NEWS VS. NEWSPAPER

Assumptions

- Average newspaper weight of 225 g (approx. ½ lb)
- Readership of 6 days a week for 1 hr
- Product cycle footprint of tablet not considered
- Tablet used is the Apple iPad 2

Summary

Internet	0 t CO_2e/yr *	0
Newspaper	0.04914 t CO_2e/yr	1

Methodology

The power consumption of the iPad 2 was calculated to be 0.78 kWh/yr for 1 hr of reading 6 days a week, based on technical specifications provided by Apple[24]. Using the methodology below, emissions were calculated to be less than 0.001 t CO_2e/yr.

$E \cdot EF = GHG$ where E = electricity consumption
EF = emission factor[25]
GHG = total emissions

Product footprint emissions of hard-copy newspaper were derived from a study conducted by Axel Springer Verlag[26]. The study found that net emissions from 1 kg of newspaper were 0.7 kg CO_2e/kg newspaper.

Applying this factor to the assumptions above yielded the amount shown in the summary.

[23] For a complete list of emission factors used in this document, see Appendix A.
[24] http://support.apple.com/kb/SP622
[25] For a complete list of emission factors used in this document, see Appendix A.
[26] See Appendix B.

16. MP3 VS. CD

Assumptions

- CDs purchased in a retail store
- Purchase of 10 albums or equivalent singles per year

Summary

MP3	0.004 t CO_2e/yr	0
CD	0.032 t CO_2e/yr	1

Methodology

Emission factors were derived from a study by Carnegie Mellon University, Lawrence Berkeley National Laboratory, and Stanford University[27]. The study compared the energy and climate impacts of different music delivery methods. A cumulative emission factor was developed for each delivery method based on product cycle emissions.

$10 \cdot EF = GHG$ where *EF* = emission factor (per album or equivalent)
GHG = total emissions

17. TRIP TO BEACH VS. HOME POOL

Assumptions

- Beach is 20 km away
- Swimming frequency is once a week for a three month period
- Travel to beach via a mid-size car running on gasoline
- Pool has a capacity of 43.2 m3[28]
- Pool uses a conventional pump drawing 13.96 kWh per day[29]

Summary

Beach	0.106 t CO_2e/yr	0
Pool	0.131 t CO_2e/yr	1

[27] See Appendix B.
[28] http://www.ec.gc.ca/eau-water/default.asp?lang=en&n=5EA1D86E-1
[29] http://www.greenerbakersfield.com/2009/03/21/eco-swimming-pool-pump-is-a-great-investment/

Methodology

Emissions stemming from the first activity are generated by car travel to and from the beach. Given the assumptions above, averaging 4 trips per month, there are a total of 12 trips to the beach over a 3 month period. Therefore, the calculation is as follows.

$trips \cdot d \cdot 2 \cdot EF = GHG$ where *trips* = number of trips to the beach
d = distance traveled (one way)
EF = emission factor[30]
GHG = total emissions

Calculating the emission factors due to a home pool involves two sources. The emissions due to water use and the emissions generated through use of an electric pool pump. Given the assumptions above, yearly water use for the pool is 43.2 m^3, and yearly electricity consumption is 1284.32 kWh. These values were fed to the e3CAT system, with the resulting emissions calculated as follows.

$E \cdot EF = GHG(\mathrm{E})$ where *E* = electricity consumption
EF = emission factor[31]
GHG(E) = total emissions due to electricity

$w \cdot EF = GHG(\mathrm{w})$ where *w* = water consumption
EF = emission factor[32]
GHG(w) = total emissions due to water

$$GHG(E) + GHG(w) = GHG$$

18. CFL VS. INCANDESCENT

Assumptions

- Compares five 13 W CFL bulbs against five conventional 60 W bulbs
- Does not factor the product footprint of either bulb
- Each light is on for a total of three hours a day

Summary

CFL	0.01 t CO_2e/yr	0
Incandescent	0.03 t CO_2e/yr	1

[30] For a complete list of emission factors used in this document, see Appendix A.
[31] For a complete list of emission factors used in this document, see Appendix A.
[32] For a complete list of emission factors used in this document, see Appendix A.

Methodology

Based on the assumptions above, calculation of emissions was simply a matter of applying an emission factor to the total yearly kWh consumption. These values were 71.175 kWh/yr for CFLs and 328.5 kWh/yr for conventional incandescent.

$E \cdot EF = GHG$ where *E* = electricity consumption

EF = emission factor[33]

GHG = total emissions

19. HYBRID VS. CONVENTIONAL CAR

Assumptions

- The conventional car used in the comparison is in the mid-size class, running on gasoline
- Calculations are based on an average distance of 50 km per day with 25% highway travel

Summary

Hybrid	2.124 t CO_2e/yr	0
Driving	4.241 t CO_2e/yr	1

Methodology

Values based the above assumptions were entered into the e3CAT system. In each case, the equation had the following format. Since the above assumptions include some highway travel, the calculation methodology was slightly more complex.

$$days \cdot [(d \cdot 2 \cdot h \cdot EF(h)) + (d \cdot 2 \cdot l \cdot EF(l))] = GHG$$

where *days* = 365 days

d = distance traveled (one way)

EF(h) = highway emission factor[34]

EF(l) = local emission factor[35]

h = percent highway travel

[33] For a complete list of emission factors used in this document, see Appendix A.
[34] For a complete list of emission factors used in this document, see Appendix A.
[35] For a complete list of emission factors used in this document, see Appendix A.

l = percent local travel
GHG = total emissions

20. GREEN BIN VS. LANDFILL

Assumptions

- Compares solid waste for a household of four
- Average solid waste per Canadian is 383 kg/yr[36]
- 35% of household waste is compostable

Summary

Green Bin Compostables	0.472847 t CO_2e/yr	0
Compostables to Landfill	1.112615 t CO_2e/yr	1

Methodology

Based on the assumptions above, a family of four will dispose of 536.2 kg of compostable material a year, or 0.5362 t. Gauging the difference in relative emissions is accomplished by

The emission factors utilize were 0.8 t CO_2e/short ton of organic waste (from U.S. EPA WARM), and 83 kg Methane (which has a global warming potential 25 times that of carbon dioxide) per metric tonne of landfill waste. The resulting landfill waste emission factor is 2.075 t CO2e/metric tonne of landfill waste.

$W \cdot EF = GHG$ where *W* = electricity consumption
EF = emission factor[37]
GHG = total emissions

21. RAIN BARREL VS. HOSE

Assumptions

- Average rain barrel collection of 50 gal/month
- Does no factor product footprint of rain barrel

[36] http://www.statcan.gc.ca/daily-quotidien/051202/dq051202b-eng.htm
[37] For a complete list of emission factors used in this document, see Appendix A.

Summary

Rain Barrel	0 t CO_2e/yr	0
Hose	0.0012 t CO_2e/yr	1

Methodology

Using the assumptions above, the emissions due to use of an equivalent amount of water, 600 gal/yr, from conventional sources is calculated as follows.

$w \cdot EF = GHG$ where w = water consumption

EF = emission factor[38]

GHG = total emissions

IMPORTANT: As mentioned in the Executive Summary, the following four activity sets have their relative scores determined by logical assumptions, without calculation methodology.

22. FAN VS. AIR CONDITIONER

Summary

Fan		0
AC		1

Reasoning

A window AC unit is assumed to be more GHG intensive than a fan of similar cooling capacity because even if the fan had a cumulative power draw of equal or slightly greater value than that of an AC, the AC would leak refrigerants, such as R22, which have a global warming potential (GWP) many times more potent than the greenhouse gases associated with electricity consumption.

23. TAP WATER VS. BOTTLED WATER

Summary

Tap Water		0
Bottled Water		1

Reasoning

[38] For a complete list of emission factors used in this document, see Appendix A.

Bottled water is assumed to be more GHG intensive than bottled water because bottled water has a product footprint that would almost certainly exceed that of tap water. The consumption of the tap water equivalent of one 590 mL bottle of water a day has a GHG footprint of less than 0.001 t CO_2e/yr.

The footprint for a bottle of water must take into account the procurement of spring water, transportation of the finished product, manufacturing and disposal/reclamation of bottles, etc.

24. LANDLINE VS. CELLPHONE

Summary

Landline		0
Cellphone		1

Reasoning

Cellphone use, even if used mainly for texting, is assumed to be more GHG intensive than an equivalent use of a landline. Even comparing the Panasonic cordless landline (requires a plug) against the LG Rumor (not a smartphone), the wattage of the cellphone is still slightly higher.

Furthermore, if the average cellphone contract is three years, and each renewal comes with a new phone, a person could replace their cellphone as many as three times in the durability timeframe of a landline equivalent. This means that even if the material requirements are lower for a cellphone, the procurement, delivery, and retail footprint would be nearly triple.

25. GIFT OF BACKYARD FLOWERS VS. GIFT OF CHOCOLATES

Summary

Flowers		0
Chocolates		1

Reasoning

A gift of chocolates is assumed to have a higher footprint. Any emissions produced as a result of the eventual disposal of the flowers would be negated by the transportation footprint of the chocolates alone. In addition, almost all chocolate is made using milk, the production of which is GHG intensive in and of itself.

APPENDIX A: EMISSION FACTORS

Activity	Emission Factor	Source
Electricity	100 g CO_2 per kWh Electricity	Based on 2009 figures from NIR report (2011) for Ontario.
Electricity	0.01 g CH_4 per kWh Electricity	Based on 2009 figures from NIR report (2011) for Ontario.
Electricity	0.002 N_2O g per kWh Electricity	Based on 2009 figures from NIR report (2011) for Ontario.
Water	68 g CO_2 per m3 Water	Based on kWh/m^3 electricity factor from Sustainable Waterloo study (2010)[39].
Water	0.0068 g CH_4 per m3 Water	Based on kWh/m^3 electricity factor from Sustainable Waterloo study (2010)[40].
Water	0.00136 g N_2O per m3 Water	Based on kWh/m^3 electricity factor from Sustainable Waterloo study (2010)[41].
Bus Travel (local)	68 g CO_2e per km travel	Based on figures from DEFRA.

[39] See Appendix B.
[40] See Appendix B.
[41] See Appendix B.

Activity	Emission Factor	Source
Mid-Size Car (local, gasoline)	254.1 g CO_2 per km travel	Emission factors derived from Transport Canada fuel efficiency data and Canadian sales statistics spanning 1998 to 2008 multiplied by Environment Canada GHG emission factors for Light-Duty Gasoline Vehicles (Tier 1).
Mid-Size Car (local, gasoline)	0.0133 g CH_4 per km travel	Emission factors derived from Transport Canada fuel efficiency data and Canadian sales statistics spanning 1998 to 2008 multiplied by Environment Canada GHG emission factors for Light-Duty Gasoline Vehicles (Tier 1).
Mid-Size Car (local, gasoline)	0.0178 N_2O per km travel	Emission factors derived from Transport Canada fuel efficiency data and Canadian sales statistics spanning 1998 to 2008 multiplied by Environment Canada GHG emission factors for Light-Duty Gasoline Vehicles (Tier 1).
Air Travel	0.11 kg CO_2e per km per passenger	Jet fuel combustion factors normalized on a per-seat-kilometre basis for commercial aircraft obtained from WRI GHG Protocol supporting documentation.
Natural Gas	1879 g CO_2 per m^3 Natural Gas	Canada NIR Part 2, Table A-1 (Ontario)
Natural Gas	0.037 g CH_4 per m^3 Natural Gas	Canada NIR Part 2, Table A-2 (Ontario)
Natural Gas	0.035 g N_2O per m^3 Natural Gas	Canada NIR Part 2, Table A-2 (Ontario)