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Carbon Footprint Calculator FORMULAS, ASSUMPTIONS AND SOURCES



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Introduction:

The Climate Action Partnership (CAP) carbon footprint calculator requires a number of formulas and is premised upon a number of assumptions. This document was compiled to provide details of the formulas and assumptions of the upgraded Carbon Footprint Calculator on the CAP website (www.cap.org.za/calculator).

Abbreviations used:

- U = User
- V = Variable

Formulas: = tCO₂e

Electricity

User enters:

- Ua) What tariff category do you fall under (Dropdown list: Lifeline user (under 450kwh per month), low domestic user (between 450-1500kwh per month), high domestic user (more than 1500kwh per month))
- Ub) Average monthly electricity bill
- Uc) Monthly electricity consumption in kWh (optional)

If average monthly bill is given:

If Lifeline user:

If bill = R0.00 then average estimated tCO₂e = $\frac{25\text{kwh}}{1000} * 12$

If bill = R33.00-R99.00 then average estimated tCO₂e = $\frac{([Ub/66c]+50)/1000*12}{}$

If bill = R120.00-R360.00 then average estimated tCO₂e = $\frac{([Ub/80c]+50)/1000*12}{}$

If Low domestic user:

Estimated tCO₂e = $\frac{([Ub/0.97c]/1000)*12}{}$

If High domestic user:

$$\text{Estimated tCO}_2\text{e} = ((U_b/0.82c)/1000)*12$$

If average kWh is given then:

$$\text{Total (actual) tCO}_2\text{e} = U_c/1000*12$$

Assumptions:

- Line user is someone who uses the first 50kwh which are provided by the municipality at no cost and who uses less than 450kWh per month.
 - For users whose monthly bill is R0.00 we assume that kWh consumption to be an average of 25kWh (between 0-50kWh).
 - For a low domestic consumption user the average cost per kWh usage is 97c/kWh (Average in the range of price 88c-106c/kWh)
 - For a high domestic consumption user the average cost per kWh is 82c/kWh (Average in the range of 73c-91c/kWh)
 - 1 Kg CO₂ = 1.00 kWh
 - Tariffs used are according to the tariff increase of Eskom as of the 1st of July 2010.
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Fires

User enters:

- Ua) Average number of braais per month in summer
- Ub) Average number of home fires per month in winter
- Uc) Wood / Charcoal / combination of wood and charcoal
- Ud) Kg amount

Variables:

- Va) Fuel (wood/charcoal/combination)
- Vb) Number of fires in winter
- Vc) Number of braais in summer
- Vd) Kg amount: If Ud is blank (no amount) assume 5kgs per fire

Formula – tons CO₂e emitted per annum:

Tons CO₂e from fires in winter:

If Va is *Wood* then:
$$[(V_b*6]*(500/1000)*V_d)*3.5]/1000$$

If Va is *Charcoal* then
$$[(V_b*6)*(700/1000)*V_d)*3.5]/1000$$

If Va is *Combination* then
$$[V_b*6* (600/1000)*V_d)*3.5]/1000$$

Tons CO₂e from braais in summer:

If Va is *Wood* then:
$$[(V_c*6)*(500/1000) V_d)*3.5]/1000$$

If Va is *Charcoal* then
$$[(V_c*6)*(700/1000)*V_d)*3.5]/1000$$

If Va is Combination then

$$[Vc*6* (600/1000)*Vd]*3.5]/1000$$

Total tCO₂e = tCO₂e winter fires + tCO₂e braais

Assumptions:

- Carbon in wood = 50%; carbon in charcoal = 70%; carbon in a combination of wood and charcoal 60%.
- Summer is 6 months of the year and winter is 6 months of the year.

Transport

User enters per vehicle:

- Ua) Type of vehicle (*dropdown selection*: walk/bicycle, motorbike, sedan, SUV/bakkie, minibus taxi; local bus; long distance bus; train)
- Ub) Type of fuel (petrol or diesel)
- Uc) Engine size (dropdown selection: Hybrid; Under 350; 351-1100; 1101-1300; 1301-1500; 1501-1800; 1801-2000; 2001-2500; 2501-3000; 3001-4000; Over 4000)
- Ud) Fuel consumption per 100km (if known)
- Ue) Annual distance travelled (in km)

If the user selects public transport, sections Ub, Uc, Ud will not be entered and the drop down lists will automatically read N/A.

Variables per vehicle:

- Va) Fuel type
- Vb) Annual distance travelled
- Vc) Vehicle fuel efficiency factor (motorbike 0.75; sedan 1; SUV/bakkie 1.25)
- Vd) kg CO₂ / litre fuel (petrol 2.3 and diesel 2.7)
- Ve) Fuel consumption per 100km (if known)
- Vf) Estimated fuel consumption (This number has to be looked up in the AA consumption table (below))

For Ve: AA consumption table: Source <http://www.aa.co.za/content/62/vehicle-operating-costs/> September 2010

Engine size	L/100km(Petrol)	L/100km (Diesel)
N/A	0	0
Hybrid	4.5	4
Under 350	3.0	2.5
351-1100	5.0	4.5
1101-1300	7.9	4.0
1 301 - 1 500	7.78	5.0
1 501 - 1 800	8.47	6.0
1 801 - 2 000	9.49	6.9
2 001 - 2 500	10.24	9.18
2 501 - 3 000	11.00	10.18
3 001 - 4 000	12.33	11.27
> 4 001	14.73	13.49

Assumptions:

- Type of fuel refers to the tCO₂ emissions of the exhaust pipe of the vehicle and not the full life cycle of the production of the fuel.
- It is assumed that an SUV/bakkie is 25% less efficient and a motorcycle 25% more efficient than a sedan vehicle, due to vehicle mass.
- CO₂ emissions are 2.3 kg CO₂ per liter petrol and 2.7 kg CO₂ per liter of diesel (chemical fact from numerous sources).

- Where the accurate fuel consumption of a vehicle is not known, the fuel consumption assumed for the various engine sizes is shown above, as reported in the AA 2010 tables –
[See <http://www.aa.co.za/content/62/vehicle-operating-costs/>]

If V_a is private vehicle, then tons CO_2e emitted per annum:

If V_e is known, then:

$$[V_e * V_c * (V_b/100) * V_d] / 1000$$

If V_e is unknown, then:

$$[V_f * V_c * (V_b/100) * V_d] / 1000$$

Subtotal CO_2e = tCO_2e vehicle 1 + tCO_2e vehicle 2 + tCO_2e vehicle 3

If V_a is minibus taxi; local bus; long distance bus; train, then tons CO_2e emitted per annum:

For Minibus: $(V_b * 0.0433 \text{ kg } CO_2/km) / 1000$

For Local bus: $(V_b * 0.1115 \text{ kg } CO_2/km) / 1000$

For Long distance bus: $(V_b * 0.0306 \text{ kg } CO_2/km) / 1000$

For Train: $(V_b * 0.0611 \text{ kg } CO_2/km) / 1000$

Subtotal CO_2e = tCO_2e minibus + tCO_2e local bus + tCO_2e long distance bus + tCO_2e train

Total tCO_2e = tCO_2e private vehicles + tCO_2e public transport

Flights (recreational and business)

User enters:

Ua) Number of return flights for each local destination

Ub) Number of return flights for each international destination

Uc) User selects flight class (dropdown selection: economy or business/first)

Variables:

For each destination:

Va) Number of return flights

Vb) Tons CO_2e per person per flight (Refer to table of tCO_2e according to travel destination)

Vc) Flight class (1 economy class; 1.5 first class/ business)

Formula – tons CO_2e emitted per annum per destination:

For each destination, if V_c = Economy, then

$$V_a * V_b$$

For each destination, if V_c = First class or business class, then

$$V_a * V_b * 1.5$$

Total: Add tCO_2e for each destination together

Assumptions:

- Aviation tCO_2e per person per return flight are estimated using the International Civil Aviation Organization carbon emissions calculator [<http://www2.icao.int/en/carbonoffset/Pages/default.aspx>].
- The methodology applies the best publicly available industry data to account for various factors such as

aircraft types, route specific data, the average consumption of fuel per flight, the distance travelled passenger load factors and cargo carried.

(see http://www2.icao.int/public/cfmapps/carbonoffset/carbon_calculator.cfm for full methodology).

- Flying economy class is assumed to be 50% more efficient than flying business or first class.
- tCO₂e per person per return flight is based on the most direct flight path including connecting flight where applicable.

Waste

User enters:

Ua) number / percentage of wheelie bin(s) filled per week (Drop down list: No bin; 1/6 (sixth of a bin); 1/3 (third of a bin); 1/2 (half of a bin); 2/3 (two thirds of a bin); 1 (one bin); 1 1/2 (one and a half bins); 2 (two bins); 2 1/2 (two and a half bins); 3 (three bins))

Ub) select if paper/ cardboard is recycled

Uc) select if metals recycled

Ud) select if plastic recycled

Ue) select if glass recycled

Uf) select if user composts

Variables:

Va) Number/percentage of wheelie bin(s) filled per week

Vb) Weeks per annum (52)

Vc) Mass per bin (60kg)

Vd) Kg CO₂e per kg thrown away (estimated from recycling calculations below)

If don't recycle, then: $Vd:a+b+c+d+e+f$

a) Recycled paper/ cardboard=2.13kg*0.25

b) Recycled metals=2.2*0.04

c) Recycled plastics=3.3kg*0.11

d) Recycled glass=1.03kg*0.13

e) Composts=0.62 kg*0.29

f) Other=1.83 kg*0.18

If recycle any of above (a to e), then: Remove that variable from Vd addition.

Total tons CO₂e emitted per annum = $Va*Vb*Vc*Vd/1000$

Assumptions:

- Municipal wheelie bins are estimated to hold 60kg waste each.
- The kg CO₂e emitted per kg of each type of waste includes both the production and decomposition emissions. There are no SA studies on CO₂ emissions per kg waste (including production) so these are estimates based on French figures (see http://www.manicore.com/anglais/documentation_a/greenhouse/waste.html).