

Carbon calculators

Introduction

This report looks at current, web-based carbon calculators available in December 2010 for use individually or in groups. It reviews calculators which are free and could be used either infrequently, maybe annually, or regularly to measure and report the footprint of people individually or in groups.

Background

Personal carbon calculators are intended to help individuals and households determine their carbon footprint. Carbon footprint is defined here as the total annual emissions of greenhouse gases, expressed as the equivalent amount of carbon dioxide, associated with the activities of an individual or household. In reality, depending on its degree of sophistication, a calculator may calculate, or simply estimate, emissions from the direct use of energy (e.g. electricity, natural gas and vehicle fuel), from indirect (secondary) use (e.g. public transport, food, clothes, other purchases), and even the share of emissions attributable to individuals from national infrastructure. One useful guide as to what should be included is provided by an estimate of the relative proportions of UK household emissions in 2004 (Fig.1).

It is not easy to equate these components of direct energy use with the categories in Fig.1

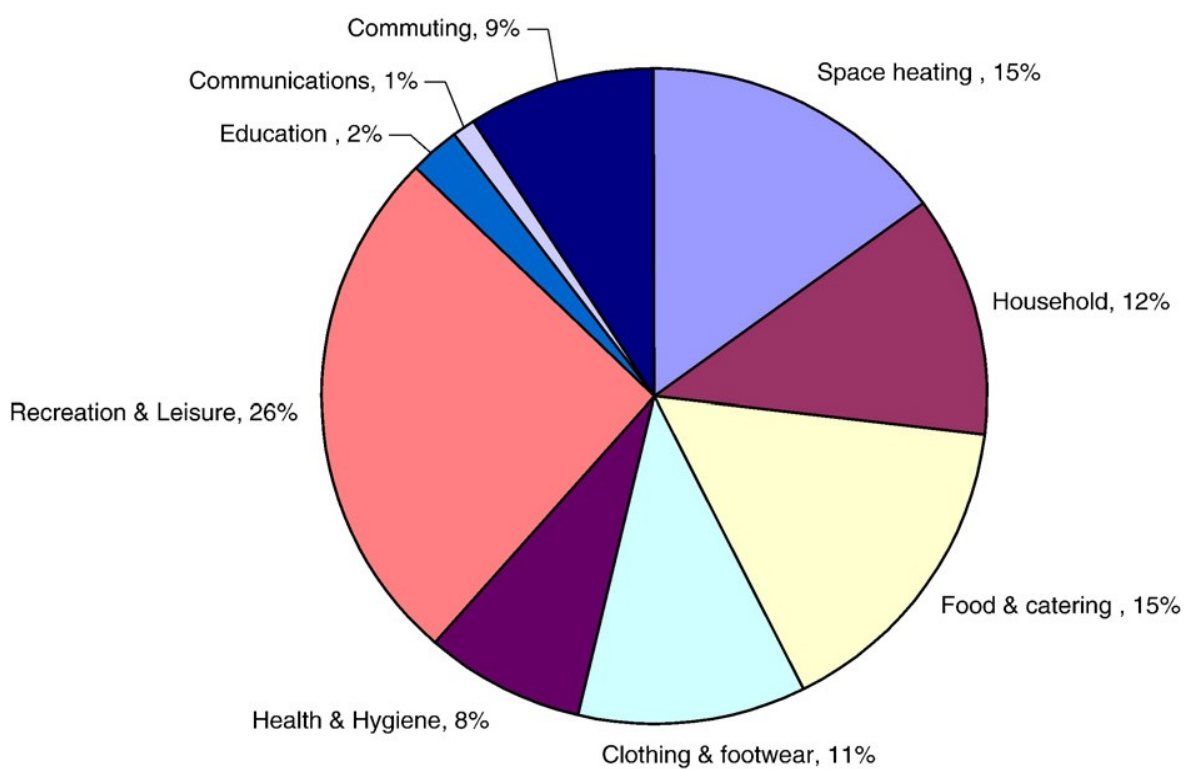


Figure 1. CO2 emissions allocated to high level functional uses for an average UK household (2004); from Druckman & Jackson, 2009.

but clearly it is important to include the best estimates of several significant contributions to emissions from indirect energy use such as recreation and leisure, food and catering etc.

Obviously a balance has to be struck between accuracy and ease of use. For example, a calculator that is based on insufficiently accurate estimates of the emissions from component activities is likely to be next to useless in detecting the relatively small decreases in footprint from year to year that may encourage an individual or household to persevere with changing their behaviour.

Available calculators

This study took as its starting point the 249 calculators listed by www.environmenttools.co.uk in December 2010. When only free calculators were considered and business and specialised calculators were omitted, the number of calculators fell to 87. We then rejected those calculators which invited users to use offsetting because offsetting is not favoured by WinACC as an appropriate way to attempt to reduce one's carbon footprint. We mostly, but not entirely, ignored calculators based overseas because they use assumptions inappropriate to UK lifestyles or worked in physical units that would be unfamiliar to many UK users.

Of the 23 calculators that remained, after applying the above constraints, about half were faulty to some degree (Table 1). This highlighted the importance of finding a calculator on a web site that is well maintained. The only simple way to check this is to use the calculator regularly over a period of time; this was not done as part of our review. Finally, five calculators were identified that are designed for users who want to input data, such as meter readings, on a regular basis and/or to compare themselves with other members of a group. These calculators are considered separately.

Table 1. Calculators that presented problems on first logging in or operationally

Calculator	URL of web site
Global action plan	www.carboncalculator.com/
Food carbon calculator	www.foodcarbon.co.uk/
EC calculator	www.mycarbonfootprint.eu/
World Resources Institute	www.safeclimate.net/calculator/
EC calculator	www.mycarbonfootprint.eu/
Readyourmeter	www.readyourmeter.org/
Google UK	www.google.co.uk/carbonfootprint/
Carbon footprint calculator	www.carbonfootprint.com/calculator.aspx
Repak	carboncalc.repak.ie/repak_calculator.php
Best foot forward	http://www.bestfootforward.com/footprintlife.htm

Thus eleven calculators suitable for occasional use and five suitable for regular use remained to be evaluated and these are discussed in more detail below.

Calculators designed for occasional data input

A number of criteria were used to compare calculators. These are somewhat arbitrary but were chosen in an attempt to include all significant contributions to an individual's carbon footprint (see Table 2 in the Appendix). Air travel is included as a separate item because

the calculation of emissions from aviation is contentious, depending on the value of the Radiative Forcing Index (RFI) which is used, and also because these emissions can constitute a very significant proportion of the footprint of some individuals. The eleven calculators reviewed, and the sources of carbon emissions that they include, are listed in Table 3 in the Appendix and described below.

1. **ActOnCO₂** (carboncalculator.direct.gov.uk/index.html). The ActOnCO₂ campaign is said to be 'a key part of the Government's plan to help tackle climate change'. This calculator calculates emissions from home energy use (and attempts to treat heating and lighting, and appliances separately), public transport, personal transport and flying. It is not made very clear that the calculator gives the user's *personal* share of a household's emissions but assumes that *all* the private vehicle emissions are attributed to the user alone. The flying calculation assumes an RFI of one which is generally thought by experts to be much too low. The calculator also asks for a lot of extraneous information, some of which is not required for the calculations if meter readings are input yet takes time to complete. Food and waste are omitted. The calculator offers suggestions for how to reduce one's footprint.
2. **Bioregional** (calculator.bioregional.com/ short version). BioRegional is an entrepreneurial charity which, working with B&Q, initiates and delivers practical solutions that aim to help us to live within a fair share of the earth's resources. The calculator is designed using methodology of the Stockholm Environmental Institute, York. It comes in two versions, long and short. The short version asks fewer questions. It covers almost all the criteria in Table 2, except 'capital expenditure on other new items', but only *estimates* the emissions from these categories. Finally, the calculator provides details of the user's *ecological* footprint but, rather unhelpfully, only the total carbon footprint is given with no attribution of the emissions to the component categories. The calculator offers suggestions for how to reduce one's footprint.
3. **Bioregional** (calculator.bioregional.com/ long version). This calculator covers all the features that appear in the short version but in addition it estimates the effect of capital expenditure on new items. Additionally it calculates, rather than estimates, the emissions from home energy use, and private and public transport. The emissions from flights are crudely estimated using a zoned map of the world and an indeterminate RFI. All other factors are estimated. See section 2 above for further information.
4. **BP calculator** (bpenergylab.bp.com/Calculator.aspx). This calculator is a product of BP, the oil company. The only item it calculates is home energy use, and then only roughly. It also estimates emissions from private transport, public transport and waste and recycling. The provision for entering distances travelled is crude and imprecise. Flights are described only as short-haul and long-haul with no indication of the RFI used in the calculation. Results are given in kWh/yr with the option of CO₂ emissions in tonnes. The calculator offers no suggestions for how to reduce one's footprint.
5. **CAT Carbon Gym** (arbocngym.cat.org.uk/carbongym/?q=calculate/the_calculator). This calculator originates from the Centre for Alternative Technology. Emissions are estimated and not calculated. A broad basket of contributions to emissions is included; only capital expenditure on new items and money spent on the home are excluded from the list of principal activities in Table 2. An RFI of 2.27 is used for

flights. The calculator includes estimates of the emissions from national infrastructure, goods and services, which is not really appropriate in the current context since the user has only very indirect and limited control over these factors. The calculator offers no suggestions for how to reduce one's footprint.

6. **EcoPrivate** (www.ecospeed.ch/). EcoPrivate is described as an online software tool from EcoSpeed, a company based in Zurich that provides climate software solutions. This Swiss site has English language pages. It offers beginner and expert versions; the latter is very thorough. Unfortunately meter readings are only requested at the end after one has replied to a lot of effectively irrelevant questions. Otherwise emissions from private and public transport are calculated but flying emissions are only estimated from distance estimates provided on a map of the world. Likewise emissions from food, consumerism and leisure are estimated. Users need to know some continental units such as the floor area of their home in m² and the efficiency of their car in litres per 100 km. The technological mix of Swiss power stations may not match that of UK stations. The final total is given in watts per person and not in tonnes of CO₂. The calculator offers no suggestions for how to reduce one's footprint.
7. **EST calculator** (www.energysavingtrust.org.uk/calculator/start). This is the calculator of the Energy Saving Trust. It is based on, and only slightly different from, the ActOnCO₂ calculator. Users have to register to use the site. It calculates home energy and private vehicle emissions and estimates emissions from public transport and flying (using an RFI of about one). Like the ActOnCO₂ calculator this one asks for a lot of extraneous information, some of which is not required for the calculations. The calculator offers suggestions for how to reduce one's footprint.
8. **NEF calculator** (nef.org.uk/actonCO2/carboncalculator.asp). This is the calculator of the New Economics Foundation, a registered charity which is 'an independent think-and-do tank that inspires and demonstrates real economic well-being'. The calculator is rather simple. It calculates emissions from just home energy use, private vehicles (roughly) and flying (using a probably realistic RFI of 2.7). Thus a large swathe of possible sources of emissions is ignored. The calculator offers suggestions for how to reduce one's footprint.
9. **Resurgence** (www.resurgence.org/education/carbon-calculator.html). Resurgence has been in existence for 40 years and was granted charitable status in 2006. It is now established as an educational trust. Its aim is to help create a world based on justice, equality and respect for all beings. The calculator considers all the factors in Table 2 except for expenditure on home accommodation, and waste and recycling. Home energy use is treated very thoroughly. Private and public transport emissions are calculated roughly. Aviation emissions are estimated using an RFI of 2 for domestic flights and an RFI of 3 for long haul flights. Emissions from food, consumerism and capital expenditure are estimated and are calculated roughly for leisure activities. The calculation is complicated by the addition, unlike most other calculators, of an annual share of the embodied energy in one's private vehicle(s) and a share of national infrastructure. The calculator offers no suggestions for how to reduce one's footprint.
10. **Warwick University carbon calculator** (www.carboncalculator.co.uk/calculator.php). This is the calculator of the Carbon Footprint Project Group of Warwick University. It is necessary to register before

using the site and then log in at each subsequent entry. The calculator roughly calculates the emissions from home energy use, private transport and public transport, including flights (but with an unstated RFI). On re-entering the calculator we encountered an error message at the end of the private and public transport (road and rail) section which stopped us proceeding to the next step. The calculator offers suggestions for how to reduce one's footprint.

11. **WWF calculator** (footprint.wwf.org.uk/home/calculator_complete). WWF-UK is the UK arm of the WWF Network (formerly the World Wildlife Fund), 'the world's leading environmental organisation' founded in 1961 and now active in over 100 countries. WWF-UK is a charity and company limited by guarantee. The calculator only estimates home energy use and private vehicle use but it does a rough calculation for public transport emissions including flights (with an RFI of 2.7). It estimates emissions from food, consumerism, pets, and waste and recycling. The calculator offers suggestions for how to reduce one's footprint.

Calculators designed for regular data input

Five calculators were identified that are designed to accept regular meter readings aided by graphical displays. These are described below and listed in Table 4 in the Appendix.

12. **Carbon Account** (www.thecarbonaccount.com/). The Carbon Account calculator was built by [Torchbox](#), a web development company with a strong focus on environmental issues. It is necessary to register to use this web site. The Carbon Account calculator computes emissions per household from the home, private vehicles and flights, which can all be updated separately, and provides a graphical display. Beware that the actual units displayed on some gas meters are in hundreds of cubic feet; this site expects the input to be in cubic feet (100 times the meter reading). The calculator allows for the power station/renewables mix of different electricity suppliers. Based on the number plate of your car the calculator looks up the make and model and retrieves the relevant emissions factor (g CO₂/km) in order to calculate emissions from the estimated annual mileage entered by the user. After calculating the distance travelled for each flight and deciding whether the flight was short-haul, medium-haul or long-haul the calculator assumes CO₂ emissions of 0.15, 0.10 or 0.11 kg CO₂/km, respectively, adjusted for the class of travel, and then applies an RFI of 2.7. A detailed explanation is available for all the calculations even though no advice is provided on how to reduce one's footprint. Group comparisons are possible by adding the details of friends.

13. **WeSave** (www.wesave.org.uk/enter.php). The WeSave calculator is supported by BVSC, a registered charity which supports voluntary action in the city of Birmingham. To enter the WeSave calculator one has to complete a form before being emailed a password. I received my (manually dispatched?) password after 24 hours. When you first enter the site you have to decide whether or not to share your data with others. The calculator will accept electricity, gas and water meter readings or amounts consumed since the last entry; it also asks the prices paid. It does not yet, although there is a tab for this, allow for personal transport. I could not discover how to calculate my footprint. The site appears to provide advice on how to 'improve' one's carbon footprint but this simply means one has to answer a large number of detailed questions about energy use which are superfluous if one has entered meter readings. Basically it was felt that this site was underdeveloped and not easy to use.

14. **CarbonDiet** (www.carbondiet.org). The Carbon Diet calculator expects the user to log in regularly and is designed for users in one of six English-speaking countries including the UK. It calculates emissions from separate 'accounts' for electricity, natural gas and for each car owned by the individual or household. The calculator expects regular inputs as energy is consumed and not figures of annual consumption (although these can be created by using past meter readings). For example, you have to enter gas or electricity meter readings; you cannot enter the total annual car mileage but only the amount of fuel bought each time you top up the tank. The calculator takes some account of electricity suppliers which offer renewable energy when calculating emissions. It outputs a graph of CO₂ emissions per day for gas and electricity over the period of time for which readings are input. It also calculates emissions from flights using an RFI of about 2.5. Navigation around the site is fairly complicated. It lists actions that can be taken to reduce emissions, and one can tick any that have been completed. Groups of friends can be added to compare emissions. Has a seemingly little used discussion forum section.

15. **imeasure** (www.imeasure.org.uk). This calculator was created by Oxford University's [Environmental Change Institute](http://www.environmentalchangeinstitute.org), part of the UK Energy Research Centre. Registration is necessary. The calculator is extremely basic since it only calculates emissions from gas and electricity meter readings. It expects readings to be input every week; if a week is missed, the calculator interpolates. There is scope to input cost per unit from one's own bills. This does not take account of standing charges (which, according to one's arithmetical ability, one could build into the rates per unit). The calculator asks whether you are on a green electricity tariff and says, oddly, that this does not affect your CO₂ output results. The results are presented as a graph of CO₂ emissions (or cost) per week for gas and electricity over the period of time for which readings are input. The site provides an option to compare one's per-head carbon emissions with those of people living in similar properties. It was not possible to change the number of occupants once it had been entered initially. One can create a carbon club, with whose members you can compare results. Has a reasonably well used discussion forum section. It has links to relevant sites giving background information on climate change, more energy efficient living etc, but little on the site itself. An advantage of registering is that one is sent a weekly electronic newsletter which is quite interesting to read.

16. **zapcarbon** (www.zapcarbon.com). Zapcarbon appears to be a small company founded in 2006 by Andrew Smith. The site has been endorsed by Chiltern District Council and South Bucks District Council. One has to register to use this calculator. It accepts only gas and electricity meter readings. The calculator computes electricity usage in kWh/day over the latest period (between the latest two readings) and the equivalent kg CO₂/day emitted. It compares this graphically with previous usage. It does not, though, use the gas readings, and therefore only gives the emitted CO₂ due to electricity use which, if oil or gas is used for heating, is a minor part of the total emissions. The site gives good, basic, easily understandable suggestions as to how energy use can be reduced in the home. It also gives basic information on climate change and related issues. There is some information on how one may initiate energy saving competitions between communities although it isn't obvious how one can compete or compare with other individuals.

Choosing a calculator

As already mentioned, in choosing the 'best' calculator a balance has to be struck between accuracy and ease of use. We distinguish between calculators for occasional users (1-11), and for regular users (12-16) which may also be suitable for group use.

Calculators for occasional users (1-11)

Regarding accuracy, it seems appropriate to choose calculators that make the most use of easily available quantitative information such as home energy use (electricity and gas meter readings which appear on utility bills) and the mileage of private vehicles (which is easy to record and, for cars older than 3 years, can be deduced from annual MoT certificates). On this basis calculators 2, 4, 5, 10 and 11, which do not take account of such quantitative information, are rejected.

Emissions from flying are known to be a significant part of some people's footprints and therefore attention was next paid to the RFI that the calculator employs. According to expert opinion an RFI of at least 2 (many calculators use 2.7 or 3) is appropriate. Therefore calculators 1 and 7 are rejected because they use an RFI of about one. The RFI used by calculator 3 could not be ascertained.

Calculator 6 was rejected because it does not provide emissions in tonnes of CO₂. It also behaved erratically at times.

Using the above criteria we are left with calculators 8 (NEF calculator) and 9 (Resurgence). Calculator 8 is not favoured because it covers, only partially, the direct use of energy and omits indirect (secondary) sources of emissions. **This leaves Resurgence as the sole comprehensive calculator which is recommended for occasional use.**

Calculators for regular and/or group use (12-16). Calculator 13 is not convenient to use. Calculators 12 (Carbon Account) and 16 (zapcarbon) have a user friendly format that should be easy to follow; calculator 15 (imeasure) and calculator 14 (Carbon Diet) were judged to be less user friendly than 12 and 16. It's harder to navigate around calculator 14 than 15 or 16. Calculators 15 and 16 are rather simple because they cover only the direct use of electricity and/or gas whereas calculators 12 and 14 include in addition emissions from flights, which can be a very significant part of some individual's emissions. Calculators 12 and 14 also allow for the inclusion of electricity from a green supplier. However, calculator 12 is easier to use and more accurate in calculating car emissions. **In conclusion therefore the Carbon Account calculator is recommended as the best calculator for regular or group/club use.**

Conclusion

In conclusion, the Resurgence calculator is currently the only comprehensive calculator we would recommend for occasional use.

For regular use, to meet the needs of those who want to input meter and other readings on a regular basis or to 'compete' in groups to reduce their carbon footprint, we recommend Carbon Account. This calculates the direct emissions from electricity, natural gas, cars and flights although it does not estimate, let alone calculate, indirect emissions.

Bob Whitmarsh and Brian Shorter
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APPENDIX

Table 2. Activities useful for inclusion in an ideal carbon footprint calculator

	Principal activity		Sub-activity
1.	Home energy use (excluding renewable energy)	1.1	mains electricity
		1.2	natural gas
		1.3	heating oil
		1.4	coal
		1.5	LPG (bottled gas)
		1.6	wood pellets
2.	Personal vehicle fuel	2.1	car, van (non-business) etc
		2.2	motorbike
3.	Public transport (including holiday travel)	3.1	national train
		3.2	international train
		3.3	bus
		3.4	coach
		3.5	plane
		3.6	other (hired car, taxi, tram, Underground, ...)
4.	Food	4.1	food eaten at home
		4.2	food eaten away from home
5.	Consumerism (ignoring second-hand goods)	5.1	new white goods
		5.2	new e-goods
		5.3	new clothing
		5.4	new luxury items
		5.5	other new expenditure (furniture, ...)
6.	Leisure	6.1	paid accommodation (hotels, guest house, B&B, room, etc.)
		6.2	paid self-catering accommodation
		6.3	hobbies
		6.4	pets
7.	Home accommodation	7.1	home improvements
		7.2	home servicing and repairs
8.	Capital expenditure on other new items	8.1	new vehicle
9.	Waste and recycling	9.1	food waste
		9.2	recycling

Table 3. Summary of the eleven calculators studied in detail

No.	Name	URL	Advice given	Categories catered for									
				1	2	3	3.5	4	5	6	7	8	9
1	Act on CO2	carboncalculator.direct.gov.uk/index.html	Yes	c	(c)	c	c						
2	Bioregional	calculator.bioregional.com/ (short version)	Yes	e	e	e	e	e	e	e	e	e	e
3	Bioregional	calculator.bioregional.com/ (long version)	Yes	c	c	c	e	e	e	e	e	e	e
4	BP calculator	bpenergylab.bp.com/Calculator.aspx	No	(c)	e	e	e						e
5	CAT Carbon Gym	http://carbongym.cat.org.uk/carbongym/?q=calculate/the_calculator	No	e	e	e	e	e	e	e			e
6	EcoPrivate	www.ecospeed.ch/	No	e (c)	c	c	e	e	e	e			
7	EST calculator	www.energysavingtrust.org.uk/calculator/start	Yes	c	c	e	e						
8	NEF calculator	nef.org.uk/actonCO2/carboncalculator.asp	Yes	c	(c)		c						
9	Resurgence	www.resurgence.org/education/carbon-calculator.html	No	c	(c)	(c)	e	e	e	(c)		e	
10	Warwick University carbon calculator	www.resurgence.org/education/carbon-calculator.html	Yes	(c)	(c)	(c)	(c)	e					
11	WWF calculator	footprint.wwf.org.uk/home/calculator_complete	Yes	e	e	(c)	(c)	e	e				e

c = calculated; (c) = roughly calculated; e = estimated

Table 4. Summary of calculators designed for regular data input

No.	Name	URL	Advice given	Categories catered for									
				1	2	3	3.5	4	5	6	7	8	9
12	Carbon Account	www.thecarbonaccount.com/	No	c	c		c						
13	WeSave	www.wesave.org.uk/enter.php	No	c									
14	Carbon Diet	www.carbondiet.org	Yes	c	c		c						
15	imeasure	www.imeasure.org.uk	No	c									
16	zapcarbon	www.zapcarbon.com	Yes	c									

c = calculated; (c) = roughly calculated; e = estimated