

Learnings from the government's Act on CO₂ Carbon Calculator for the UK domestic sector

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Abstract

In June 2007, the UK government, in partnership with the Energy Saving Trust, launched its first official carbon calculator aimed at the general public. The main aims of the calculator were to:

- educate the British public regarding what a carbon footprint is

- allow the public to calculate their own footprint quickly and easily and compare this with national averages and other comparators
- provide the user with a personalised 'Action plan' with tips and actions based on their individual answers (a first in terms of existing calculator tools) in order to help them reduce their carbon footprint.

Two years after launch the Calculator had proven exceedingly successful. In the first 24 months it had attracted over 1.7 million unique visitors and has an unprecedented completion¹ rate of 40% (for which it has won a 'Best Use of Web' award in the New Media Age awards 2008, among other awards).

The completion rate is particularly exceptional as the user has to answer up to 70 questions regarding their Home Heating, Lighting and Appliances, Personal Transport and Flights, and the questionnaire can take up to 10 minutes to complete.

The questions cover all aspects of the fabric and heating systems of the home, as well as covering both ownership and, most importantly, usage of all the major domestic energy-using products and appliances, and hence have provided a very rich dataset in which approximately 500,000 footprints have been analysed to reveal the most comprehensive view of UK consumer's energy use ever created.

This paper will discuss the main findings of the learnings from analysis of calculator use and the dataset, and provide a commentary of what this means for UK domestic energy consumption.

Introduction

¹ The completion rate in Web speak is the number of people who successfully complete the whole application. Hence for the calculator it represent users who complete all three sections and receive their total carbon footprint

Over the last 2 to 3 years there has been an explosion in the number of 'carbon footprinting' tools available to the UK public. These tools vary from the 'single issue' calculation, where they are invited to calculate their carbon footprints for an individual flight for example, to a 'whole house' approach to calculating all the fuel they use for their heating, lighting and powering appliances.

The main concern with the plethora of tools available was that there was no standardised methodology or even any consistency in the carbon factors and assumptions made. This led to a confusing situation where the public could complete a number of different calculator tools, using the same lifestyle answers, and get dramatically varying answers in terms of the tonnage of CO₂ that their journey or home emits.

This inconsistency does little to help educate the British public on what a carbon footprint is; what exactly a tonne of carbon represents; and can cause confusion and scepticism where, for example, a consumer can shop around on various carbon offsetting websites to find the smallest amount of CO₂ that they then pay to offset a flight.

In early 2007, the UK's Department of Environment, Food and Rural Affairs (DEFRA) and Energy Saving Trust partnered in a project to create the first official UK government-backed carbon footprint calculator. Its aim was to build a robust, transparent methodology as well as coming to a consensus around government departments as to which assumptions and factors to use when calculating the footprint. The aim was to make this underlying methodology and code 'open source' to allow any interested party to replicate the model and calculations, and hence

produce the same result without having to start development from scratch, but giving them the freedom to create any frontage to their calculator that they required.

Another important aim of the project was to product a calculator that gave the user as much choice as possible. Previously, the vast majority of calculators have only allowed calculations when the user could supply bill data of some kind – either the Kilowatt hours (KWh) they used or the amount of money they paid for their energy through billing. This had the effect of alienating a great number of users who were unaware of their Kilowatt hours of use and also had no idea of how much their energy bills amounted to. Hence it was a key deliverable of the project that the calculator would allow people to complete the calculator without having to put in any bill data whatsoever. The other information collected regarding their house type, age and heating system, alongside information about ownership and use of their appliances, would provide enough data to perform modelled calculations which would give the user a reasonably approximately estimate of their carbon footprint for their Home and Appliance sections.

The calculator would also allow users to choose to calculate either a 'Household' or an 'Individual' footprint. The household approach was the more common approach of other calculators of the time, but it was deemed useful to allow people to calculate their individual footprint to attain a 'per capita' carbon footprint comparator.

The Act on CO₂ Calculator

Calculator questions

The resulting calculator, Version 1.2, was created in 3 separate sections, namely:

- Home (including heating, hot water and lighting)
- Appliances
- Travel (including car and motorcycle ownership and use and flights taken)

As users completed each section they would get an interim CO₂ footprint from that area of their lifestyle. Only when they complete all 3 sections would they get their combined total, Results and Action Plan.

The number of questions totalled approximately 70, but most users would not have to answer all questions as secondary questions would only be triggered on an affirmative answer in a preceding primary question.

The Home section includes questions about the type, age and number of bedrooms of a dwelling, as well as the main heating fuel & age of system and types of insulation (if present). This amount of detail allows for a modelled approximation of the heating footprint of the home to be calculated in the absence of any bill data. The model is based on a BREDEM calculation, but is simplified to reduce the number of questions needed to be asked. This section also contains questions about ownership of renewable energy technologies and the number of traditional (incandescent) versus energy efficient (CFL) light bulbs in the home.

The Appliances section asks detailed questions about appliances in the main areas of the home and is divided into 'functions' for ease of completion, namely: Kitchen; Entertainment and Study. All the main large electricity consuming products are covered – i.e. all main white goods: consumer electronics and ICT. These are estimated to cover approx 80-95% of electricity use in a typical home. Where bill data is supplied, and the total electricity used (calculated from the bill data) does not

tally with the answers given by the user, the excess is attributed to a category entitled 'Other' in the results section. This 'Other' section is deemed to contain all other appliances such as irons, vacuum cleaners, hairdryers etc., that are not explicitly covered in the calculator itself.

The Transport section covers ownership and use of motorised vehicles – cars and motorbikes, as well as touching upon use of public transport. Domestic, short haul and long haul flights are covered. This section will not be discussed for the purposes of this paper.

Please Note: since end of June 2009 the Calculator has been upgraded to Version 2.0. This new upgraded version contains a new 'Other transport' section which includes all forms of public transport, taxis, European trains (from UK) and ferries. It also includes data for renewable technologies and insulation measures. However, for the purposes of this paper we are concentrating on Version 1.2 as we have not analysed any data using the new Version 2.0.

Users and results

From the date of launch² to end June 2009 the total number of unique visitors to the Calculator had been: 1,700,000.

The 'conversion' factor, i.e. the number of people who complete the user journey through to the result section has remained at a near constant 40% throughout the life of the tool. The conversion factor is seen as unusually high for a transactional web-based tool that is completed on a voluntary basis, i.e without any 'reward' for

² 20th June 2007

completion or need to complete for another purpose, tax returns being a good example of this type of transaction. Google, for example, has quoted a 7-9% conversion rate as being an acceptable standard for a similar type of web tool.

The high conversion factor has resulted in over 500,000 complete user footprints being stored within the database. This data set provides an unprecedented level of coverage of data on the homes and energy-using habits of the UK population.

The 'bounce rate' of the calculator, that is the percentage of people who get to the homepage of the site and go no further is 15% - this is industry average for websites.

The average time spent on the site by all users, including those that do not complete the calculation as well as those who 'bounce' off the site is approximately 6-7 minutes. If we discount the 15% that 'bounce', i.e. go no further than the home page and bring the average down, this would take the time spent on site of all other users to 8-9 minutes or more. Hence the original objective that the calculator should not take longer than 10 minutes to complete seems to have been achieved.

Interestingly, the biggest loss of users comes after the first section is completed, in this section the attrition rate is approximately 45%. Users tend to stay the course if they get through the second section – the loss rate here falls to around 20% of the remaining 55%. Finally, and unusually, we then lose around 8% of the rest (44%) at end of the Transport section – which is a disappointment as they have finished all the questions by this point.

In terms of how users find the Calculator website, the breakdown is as follows:

Direct traffic (i.e. typing address directly into browser or clicking through from an online advert): 37.08%

This level of direct traffic is primarily attributable to a number of high profile advertising 'Act on CO₂' campaigns that have been undertaken by the UK Government over the past 18 months that overtly point the public to the Calculator website. Campaigns have been through the media of TV, Radio, poster and online. With the online adverts, a direct 'click through' to the homepage has been significantly more successful in directing users to the site than then other methods.

Referring sites: 47.62%

The most popular referring sites have been:

- Directgov [government's main information website and the host for the calculator site]
- Google
- Thefwa.com [the Favourite Website Award site]
- DfT [Department of Transport]
- Facebook

Search terms: 14.84%

The most popular search terms used to find the calculator through Search Engines are as follows:

- Act on CO₂
- Carbon footprint
- Carbon calculator

- CO2 calculator
- Global warming

Interestingly, 'climate change' is not sited in this top five search terms.

Trends in User inputs

One of the most unexpected trends of the calculator has been the number of people who do input their bill data as opposed to those that do not. It has been consistently 50:50 throughout the life of the calculator, which was unexpected as it was assumed that the percentage would be much lower for users with known available bill data.

This could be partly explained by the large price rises in heating fuels and electricity in the UK over the previous 12 months. UK citizens are now very aware of the size of their energy bills as they typically top £1000 for an average family in a 3-bed semi-detached home.

Another interesting, but disappointing, finding is the very low level of users who 'register' their details with the calculator. Registration (which entails supplying email address and name, no address details are required) was made a voluntary feature of the calculator as it was felt that forcing users to register at the start of the journey would be too off-putting for many users, a large factor in this was seen to be because it is governmental website, and people in the UK can be very mistrustful of anything with a governmental stamp.

Registering one's details allows for much more functionality. For example, all answers and the resulting footprint are stored and are easily retrievable when the

user logs back in. The user can update answers if changes have been made to their lifestyle or if they have purchased more efficient equipment or appliances. If changes are made to the answers, it is then possible to view the results and compare the previous footprint to the new one³. In addition an email is sent every 3-6 months to remind the user to return to the calculator site to update answers.

To date, the number of people who register their details has hovered around the 2% level. This is exceedingly low and disappointing. In user studies that have been carried out since launch, the biggest barrier to registering is the 'mistrust' factor, alongside the worry that the individual will be bombarded with emails from the site and even have their details passed on to 3rd parties. These are all unfounded worries, but it is proving difficult to dispel these fears.

Results from the analysis of footprint profiles

The analysis of the footprint data was primarily undertaken to allow the implementation of a new piece of functionality in Version 2.0 entitled 'People like you'.

The first version of the calculator allowed users to compare their carbon footprint to the UK national average for the domestic sector. This was a highly averaged top-down approach of calculating what the average household's CO₂ emissions are based on taking the national total of domestic CO₂ emissions and dividing by the number of UK dwellings (approximately 26million).

³ please note: this functionality is no longer available in the new Version 2.0

This approach was sufficient in putting an individual household's emissions into a context of a national average, however it had many limitations in that the housing stock and family unit structure within the UK has much variation and hence could only give a very approximate idea of whether that particular household is doing well or otherwise in terms of its carbon emissions.

'People Like You' functionality

The 'compare with other users' (People like you) tool is new to V2.0 of the Act on CO₂ Calculator and is based upon the anonymised aggregated footprint data profiles discussed above and gathered over the past two years from responses to the Calculator since its launch. This new section allows the user to compare themselves to people (who have also filled in the Calculator) who have similar circumstances. This comparison is made in terms of house and heating characteristics; the number of people in the home and whether they are located in an urban or rural area (relevant for travel).

The purpose of this functionality is for the user to more specifically tailor comparisons to fit their own circumstances and lifestyles. This variation in the comparison has been intentionally limited to criteria where a particular parameter has a direct and significant relationship to the energy use / CO₂ emissions. Specifically the parameters available for selection and their impacts on the comparison result are summarised in the following Table 1, with the full dataset for this section provided in Appendix 1.

Table 1: Comparison parameters available for the “Compare with other users’ section and their impact on the comparison results for individual sections

Parameter	Selections	Impact on the comparison?		
		Home	Appliances	Travel
Number of People in Household	1, 2, 3, 4, 5+, All	No*	Yes	Yes
House Type	Bungalow, Flat/Maisonette, House Detached, House Semi-Detached, House Terraced, All	Yes	No	No
Age of Property	Pre 1930, 1930-1995, Post 1995, All	Yes	No	No
Number of Bedrooms	0/1, 2, 3, 4, 5+, All	Yes	No	No
Primary Heating Fuel	Biomass, Coal, Electricity, Gas, LPG, Oil, All	Yes	No	No
Urban or Rural	Urban, Rural, All	No	No	Yes
Total number of individual data combinations		1008	6	36**

Notes: * It was necessary to exclude the number of people in the household as a parameter impacting on the Home comparison result in order to maximise the number of profiles used in the calculation of the average figures for each

combination of parameter selections.

** Includes additional variation depending on whether the profile was created on a 'per individual' or 'per household' basis.

The rationalisation for the impact on comparisons can be illustrated as follows:

1. The number of bedrooms is a relevant proxy for the size of a property, which directly affects the amount of energy needed to heat it. However, for example whether an equivalent property is located in an urban or rural setting should not have an impact on heating requirements.
2. Conversely, for travel, the property characteristics have essentially no impact on the need for travel. However, properties set in a rural setting are generally further from services and are more poorly served by public transport compared to urban areas. Therefore the average emissions resulting from personal transport (i.e. cars, motorcycles) and public transport will likely be different for households in urban versus rural areas. The number of people directly affects the household travel requirements.
3. The energy use of electrical appliances is not affected by the type or location of the building they are used within. The use /energy consumption of appliances (and the resulting CO₂ emissions) is only affected by the number of people (in a household) using them.
4. The number of people in a household will primarily affect the energy consumption for water heating (and to a much lesser extent the space heating). However, there was a need to maximise the number of profiles for

each combination of parameters, so it was necessary to exclude the number of people in the household as a parameter impacting on the comparison result. This was deemed reasonable, since the number of bedrooms in a property also has a good correlation to the number of people in the household and is much more significant in terms of the impact on space heating requirements.

Important Limitations of this function include that the 'Compare with other users' dataset is based solely upon responses to the Act on CO₂ Calculator. There are therefore a number of important caveats / limitations that must be borne in mind in considering the results:

- For some combinations of different parameter selections there were relatively very few numbers of profiles. As such, the results are not necessarily representative of the national average for any given combination of parameters.
- Responses to bill questions were predominantly in units of currency (and/or number of deliveries for coal, oil, LPG), rather than the more accurate units of energy (i.e. annual kWh) or yearly total volume or mass. Differences in the actual fuel prices and the relative change in energy prices for different fuels in the period of operation of the calculator may have led to systematic errors.
- Differences in the actual relative size (i.e. total floor area, given a similar number of bedrooms) and insulation and heating performance of properties utilising different primary heating fuels may mean comparisons between different fuels are not representative of their performance on more equivalent terms.

These limitations manifest as a number of peculiarities in the current dataset. The most obvious example is the fact that in a number of cases the home footprint for households using coal, oil or LPG is similar or even lower than apparently similar households using gas. This anomaly is likely partly due to the fact that the method of estimating consumption for coal, oil and LPG is likely to be prone to the largest errors out of all the fuels and this is coupled with homes using LPG or coal having the smallest sample size. In addition, many coal fired homes have open fires rather than central heating and energy consumption would be expected to be lower in these homes. Only a third of respondents with solid fuel heating have boilers. Coal fired homes also had higher electricity emissions than gas (on average by 250kgCO₂) which could indicate increased electric secondary heating.

The dataset is more consistent for the Appliances and Travel sections, where average figures are consistently based upon a much larger number of responses. However, these sections are not necessarily more representative of the national average, as responses did not necessarily come from a balanced cross-section of UK society. There is likely to be a degree of bias therefore in the results towards the more affluent members of the population (who often travel more and use more /energy intensive electrical equipment).

Conclusions

The Act on CO₂ calculator has proved a popular and useful tool in the education of the British public in terms of improving their carbon literacy. The popularity and number of carbon footprints completed within the calculator has allowed in-depth analysis of a large number of UK household's lifestyle details which have assisted in the creation of some good benchmark figures for how much carbon dioxide is

generated from the various types of homes and appliances within the UK. This in itself has allowed the tool to develop and become more useful to users who can now benchmark themselves against other UK citizen who have similar lifestyles – hence ideally provoking them into action and carbon reductions if they find themselves with a much higher footprint than their norm group.

There is much more analysis to perform on this large and detailed dataset. This will be something that will be actioned in the coming months

References

The Act on CO₂ Calculator site, Department of Energy and Climate Change:

<http://carboncalculator.direct.gov.uk/index.html>

Methodology paper for the Act on CO₂ Calculator, v2.0 September 2009,

Department of Energy and Climate Change

http://decc.gov.uk/en/content/cms/what_we_do/change_energy/tackling_climate/index_co2_action/calculator/calculator.aspx