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Guidance for the calculation of carbon brainprints of higher education institution activities

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Purpose

This document is intended to provide a guide to assessing a carbon brainprint. It was developed as the project case studies were conducted, starting from a set of general principles and becoming more specific.

Glossary and abbreviations

GHG	greenhouse gas
GWP	global warming potential of a GHG relative to carbon-dioxide
GWP100	global warming potential, 100 year horizon (implied if not otherwise stated)
LCA	life cycle assessment or life cycle analysis

Definitions

The carbon brainprint of university research, consultancy or teaching is an estimate of the change in GHG emissions resulting from its known and predicted outcomes in practice. This may arise from introduction of new equipment and methods, or from modification of existing equipment, processes and behaviour. The carbon brainprint is limited to the effects directly attributable to the university, not those arising indirectly, whether positive or negative. It is not limited to emissions included in the UK national inventory or resulting from UK business activity.

Note that “carbon brainprint” should not have initial capitals, except when grammatically necessary or when referring to the project title. It may be abbreviated to “brainprint” where there is no ambiguity.

The retrospective brainprint is the annual emissions reduction, or the total to date, from the known application of the activity. For example, for a technical development it means the emissions reduction from those systems where it is installed. The prospective brainprint is the predicted future emissions reduction. The most conservative estimate is provided by the total of the existing and planned applications over the best available estimate of their working life. Where applications are expected to continue, the prospective brainprint will need to be based on a realistic uptake model. The reliability of this model should be reflected in the uncertainty analysis. In the case of a new development, especially a behavioural rather than technical one, the uncertainty is likely to be large.

The direct effects to be assessed are discussed further below. Examples of indirect and excluded effects include:

a. For a technical innovation, further innovations that may arise in future, and similar innovations by other organisations.

b. Behavioural changes in the client organisation other than those recommended, and any similar changes in other organisations.

c. Secondary changes in behaviour, such as increased use of a transport system when its fuel efficiency increases and hence its cost decreases.

The units for GHG emissions are kg CO_2e/year or total kg CO_2e over the lifetime of the product or innovation being studied, based on global warming potential with a 100 year time horizon (GWP100).

General principles

Where appropriate the principles of the IPCC (IPCC, 2006), PAS 2050:2008 (BSI, 2008) and Carbon Trust good practice (Carbon Trust, 2009) should be applied as guidance. However, a carbon brainprint is not an assessment of the life cycle GHG emission of a specific good or service. In particular, the emphasis is mainly on total changes in emissions, not the functional unit, and general estimates rather than product-specific ones may be required. Consequently, carbon brainprint estimates should not make false claims of PAS 2050 compliance.

The standard guidance (IPCC, 2006) for the preparation of inventories is that they should be accurate, in the sense of being neither over nor underestimates so far as can be judged, and uncertainties should be reduced as far as possible. These are sound principles for brainprints, but it is important not to exaggerate the benefits. Therefore, where there is doubt, the brainprint should err on the side of underestimation. If the effect is expressed as a proportional change from a baseline emissions estimate, it means that this estimate also should be conservative.

The estimates of the GWPs of some gases are still being revised by climate research. In general, those used should be based on the current scientific consensus, such as IPC (2006). These may be different from the values used for national inventories, which use earlier estimates to maintain consistency. The GWPs used should be reported to allow re-evaluation if they change.

The statement of emissions should give the baseline emissions and the change (either as a value or relative to the baseline) whenever possible.

Carbon brainprints must be kept distinct from carbon footprints. In particular, a funder or HEI must not report a brainprint to offset its carbon footprint, because it will also be reported in the footprint reduction of the end user, which would lead to double-counting.

System boundaries

A carbon brainprint report should clearly describe the spatial, temporal and conceptual boundaries of the system considered. These may be narrower than for a full LCA. For example, where a technical or operational modification changes the energy consumption of a piece of equipment or a process, but does not otherwise affect its life cycle, an LCA of the equipment is not required. However, where the modification involves the introduction of new components, their life cycle should be included.

The system boundaries should be defined for each brainprint study, but the following should be observed unless otherwise specified:

- Full lifecycle emissions that may be changed by the application, including transport and the upstream emissions of energy carriers, but excluding capital (such as plant use to manufacture a piece the equipment).
- A cut-off level of 1% based on environmental relevance. In this case, environmental relevance means carbon-dioxide equivalent emissions, so a flow accounting for less than 1% of the total may be neglected on the basis of an approximate assessment.
- No general cut-off applies to the time period, but the assessment is in terms of GWP100 so the period chosen should not certainly not exceed 100 years. A typical horizon might be 10 or 20 years, except for long-term infrastructure projects. The uncertainty analysis should include the unreliability of long-term predictions.

Any carbon brainprint statement should make clear whether it is retrospective (historical) or prospective (predictive). Where it is prospective, the report should describe or reference the uptake model used.

Attribution

Attribution means the association of the GHG reduction effects within a brainprint calculation to partners in that activity. The term was chosen by analogy with the carbon footprint attribution, which refers to distributing a footprint amongst smaller units, for example individuals within a national footprint. It is preferred to ‘allocation’, because this is used in life-cycle assessment to refer to the association of burdens with multiple products, for example the different fuel oils produced by a refinery.

Where there are multiple HEIs or other research partners involved in a development, the total brainprint may be used for assessment of the project or sector, but an agreed distribution of attribution is required for institutional reporting to avoid double-counting. In the absence of other methods, the proportion of the funding received may be used.

Attribution is not required between funders and HEIs because these are different levels of aggregation, analogous to national inventories and industry footprints. For example, a research council may report the total brainprint of the projects it funds, which will also be reported by the HEIs receiving the funds. In principle, the total brainprint of all funders, including the private sector, would be equal to the total brainprint of all the HEIs funded.

It is not normally necessary to attribute a brainprint between HEIs and private sector clients, provided that only the direct effects are included. The benefits will normally be reported as part of the brainprint of the HEIs and the footprint reduction of the clients or end users. As brainprints and footprints are distinct, there is no double counting; by definition, a footprint reduction is needed to for there to be a brainprint. Where a joint development has occurred in which some of the emissions reduction would have been achieved without the HEI, these are not direct effects, so should be excluded. Any such attribution should be based on actual not hypothetical contributions: benefits should not be excluded because they *could* have been achieved by employing a different HEI or private research.

Level of detail

The guidance for greenhouse gas inventories (IPCC, 2006) distinguishes different tiers of assessment:

> A *tier* represents a level of methodological complexity. Usually three tiers are provided. Tier 1 is the basic method, Tier 2 intermediate and Tier 3 most demanding in terms of complexity and data requirements. Tiers 2 and 3 are sometimes referred to as *higher tier* methods and are generally considered to be more accurate.

For example, Tier 1 may be based on total national fuel consumption within a sector, Tier 2 may subdivide this by companies and types of equipment, and Tier 3 is often highly specific and model based. The most detailed form of Tier 3 assessment is LCA.

For a carbon brainprint, which is by definition specific to some process or activity, the appropriate level of detail will usually correspond to Tier 2 or Tier 3. In some of the project case studies, the best estimate of the outcome available was from industry data, such as "[a saving of] 60 million litres of diesel fuel [over 3 years]", referring to a specific group of operators. For such cases a simple Tier 2 approach using relevant nation emission factors was appropriate. For other cases, especially for developments that had not yet been taken into practice, the data available meant that a model-based or LCA method was the only option. In general, the apparent precision available from Tier 3 methods is rarely likely to be needed, especially given the uncertainties that are usually present, so simpler methods should be preferred whenever possible.

Uncertainty analysis

Uncertainty analyses should adopt the IPCC principle of presenting 95% confidence bounds. That is, they should give a central estimate (mean, median or mode as appropriate) with upper and lower bounds such that the probability of being below the lower bound is 2.5% and of being above the upper bound is 2.5%.

Uncertainty may be present in all the variables and parameters, including activity data (e.g. distance travelled by a vehicle in one year), life cycle inventories and standard emission factors. The normal procedure should be to use Monte-Carlo simulation to estimate the combined effect of the sources of uncertainty simultaneously. Where there are known correlations between variables these should be included, because they may increase or reduce the overall uncertainty. In accordance with the cut-off limit, variables may be treated as certain where the uncertainty is less than 1% (or coefficient of variation is less than 0.5%). If some variables are highly uncertain and contribute that uncertainty directly to the emissions estimate, judgement may be exercised in omitting uncertainty in better determined variables.

Where possible, uncertainty estimates should taken from published sources or derived from data. If not, the guidance in Table 1 (extracts from Wiltshire *et al.*, 2009) may be useful.

Scope and limits to applicability

The types of activity likely to be appropriate are

- Research and development leading to a new piece of equipment with lower operational or construction and disposal emissions.
- Research and development leading to a modification to existing equipment leading to lower operational or construction and disposal emissions.
- Research and development leading to improved operation of existing systems.

- Training aimed directly at individuals who control or influence operations.
- Research, development and promotion of methods to produce measurable behavioural change affecting greenhouse gas emissions.

Those unlikely to be appropriate include

- General education that cannot be linked to effects on behaviour.
- Pure and strategic research.

Procedures

The expected phases of a brainprint study and the main sections of a report are:

- System description
- Boundary definition
- Data gathering
- Assessment of emissions
    - baseline emissions (not always available)
    - change of emissions
    - retrospective and prospective brainprint
- Uncertainty analysis

Table 1. Suggested uncertainty estimates where data are not available

Variable	Coefficient of variation
Direct energy recording	
Electricity meter reading	1%
Gas meter reading	1%
Gas calorific value	1%
Diesel pumped supply readings	1%
Petrol pumped supply readings	1%
LPG delivery or pump purchase	1%
Combustion emissions per unit energy	
Electricity, mains	5%
Gas, mains	1%
Diesel	2%
Petrol	1%
LPG	1%
Transport	
Distances	2%
Fuel use per t-km or km (if standard value)	10%
Fuel use per unit activity if from vehicle refuelling records and odometer	1%
Weights and volumes	
Weighbridge (commercial)	2.5%
Weighbridge (government)	1%
Weight of heterogeneous material from bulk volume	25%
Weight of homogeneous material from bulk volume	10%
Weight of wastes taken away by skip or container load and paid for by the load not individual weight	25%
Expert judgment (where not covered elsewhere)	
Very familiar with circumstances	5%
Moderately familiar with circumstances	15%
Unfamiliar with circumstances	25%

References

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