Quantification of carbon emissions is an important part of carbon management. The quantification method can have a large influence on results. PAS 2080 does not specify a normative quantification method. It is therefore up to the discretion of the practitioner to select an appropriate calculation method for their needs and that fits with the requirements of PAS 2080.

PAS 2080 requires that any chosen quantification method needs to assess and reasonably minimize uncertainty and yield accurate, consistent and reproducible results. PAS 2080 covers many of the important considerations, such as defining boundaries, setting a functional unit, data quality rules and requirements for uncertainty assessment.

However, there are a number of other areas that are influential to results. Practitioners should therefore consider these in order to have a consistent and robust quantification method. These include, but are not limited to:

- **Allocation for recycling and reuse** – This is important for handling of recycled and reused materials where a consistent method is needed to account for the benefit of using recycled materials, but also for recovering materials at the end of lifetime. This is an influential method point.

- **Co-product allocation** – This is important for multi-output production systems and covers co-products and by-products. This is mainly important at the product level, but it can also apply to use of combined heat and power, which produces both heat and power, but consumes a single energy source.

- **Biogenic materials** – This is important where there is a notable use of natural materials, such as timber, which sequesters carbon in the growing of the trees. If carbon sequestration benefits are included in calculations it’s important that assumptions are transparently reported.

- **Land use change** – This is considered in some carbon footprint methods, but not all.

Methods often exclude some items from the boundary by default. Two commonly excluded items are employee transport to and from place of work, and energy from manual human labour. These are typically neglected.

Some methods have requirements for treating the use of green electricity tariffs for electricity provided by the national grid. Accounting for the carbon emissions associated with green electricity tariffs has been an area of debate. The issue arises in countries, like the UK, where the average amount of renewables is already factored into the electricity emissions factor for the national grid, which means that accounting for it as zero-to-low carbon would result in double counting of the benefits.
For those new to the subject of carbon accounting the above issues can be a lot to absorb. Therefore, it is often wise to start initially working with a just small number of good quality and consistent carbon databases, to model the carbon footprint, or to use a capable tool which has applied a consistent method and data itself. However, for more detailed studies, and to truly achieve a robust and consistent study, understanding the above and having them as part of a carbon footprint quantification method is important.

There are many carbon footprint quantification methods, or standards, in the public domain. A selection of them are discussed below.

**PAS 2050:2011 - Specification for the assessment of the life cycle greenhouse gas emissions of goods and services, British Standards Institute (BSI)**

PAS 2050 was the first standard dedicated to carbon footprinting of goods and services. PAS 2050 was initially released in 2008, and revised in 2011. PAS 2050 is not a construction specific standard. PAS 2050 is a product and service level standard, but the method can be applied to a full construction asset, as many studies have done. There are numerous studies in the construction sector that have used, and continue to use, the PAS 2050.

PAS 2050 is a detailed carbon footprint standard that covers cradle to grave assessment (and therefore all of the infrastructure work stages). It contains detailed requirements on key issues, including allocation, primary data collection, land use change, biogenic carbon, and more. PAS 2050 is one of the more prescriptive standards, generally offering a high level of comparability between studies. However, at the same time it generally requires a high level of primary data to be collected.


The original GHG Protocol is a very successful standard on carbon accounting for company reporting of their organisational carbon footprint. This should not be confused with the newer standard, the GHG Protocol for Products, which was released in 2011 - around the same time as the PAS 2050:2011 revision. The GHG Protocol for Products is very similar in its calculation method to the PAS 2050. This is no co-incidence, the WRI and the BSI worked together to align the two standards as much as they possibly could before their release. One of the main differences in the GHG Protocol for Products and PAS 2050 is in the reporting requirements where the former has more expensive reporting requirements in some areas.

**GHG Protocol for Corporate Value Chain: 2011 - Corporate Value Chain (Scope 3) Accounting and Reporting Standard, World Resource Institute (WRI) and World Business Council for Sustainable Development (WBCSD)**

This standard, from the GHG Protocol series, is specifically to measure the scope 3 (embodied carbon of purchases) impact of an organisation. It allows companies to assess their entire value chain emissions impact and identify the most effective ways to reduce
emissions. It is appropriate for to apply at an organisational (company) level, rather than for a construction asset.

**EN 15804:2012 – Sustainability of construction works — Environmental product declarations — Core rules for the product category of construction products, British Standards Institute (BSI)**

The EN 15804 was originally realised in 2012, with a corrigendum released in Feb 2014 (for information the amended standard is BS EN 15804:2012+A1:2013). It is a construction specific standard, focused at the construction product level. Unlike PAS 2050 and the GHG Protocol for Products, the EN 15804 is an official standard, released across Europe.

EN 15804 is not just dedicated to carbon accounting, it covers over twenty different environmental and resource use categories. However, it may also be used to calculate carbon only results, in the form of a climate declaration. EN 15804 was designed to produce Environmental Product Declarations (EPD) for construction products and therefore many PAS 2080 studies are likely to use EN 15804 data.

EN 15804 is the product level standard that feeds into EN 15978, described next.

**EN 15978:2011 - Sustainability of construction works — Assessment of environmental performance of buildings — Calculation method**

EN 15978: 2011 is a construction specific standard that sits above the EN 15804, although it is designed for buildings, rather than infrastructure. At the time of writing there was no infrastructure focused carbon footprint calculation method. However, the quantification section of PAS 2080 has been influenced by this standard.

Strengths of the EN 15978 include detailed boundary setting, where it uses the modular approach referenced in the PAS 2080 (modules A1, A2, B1, C1, D…etc), and detailed requirements on how to model results when the required service life (RSL) is different to the reference service period (RSP). This can essentially be used to model results when the lifetime of design options, or key products, are different than the required service life, for example if a required service life is set at 20 years but one of the design options can last 25 years (or indeed only 15 years). This is a situation that often arises in construction and which the EN 15978 (and accompanying EN 15804) handles best.

**Summary**

There are many carbon footprint quantification methods. This can be confusing to those new to the subject. However, the methods mentioned in this article offer a robust base to help meet the requirements of PAS 2080.

Only two of the methods mentioned in this article are construction specific, EN 15804 as a product level standard, and EN 15978 as a construction level standard. These are official EU wide ISO standards and therefore their influence should be expected to grow. It could therefore be a good place to start for construction products and projects.
Despite there being several carbon methods to choose from, in the authors experience once a carbon assessment has been completed to one method, it is usually a more minor task to convert the results to another method. Furthermore, practitioners often have to consider data to multiple calculation methods. For example, when assessing an entire construction asset, carbon data for material ‘X’ may only be available to PAS 2050, but for material ‘Y’ it may only be available to EN 15804. Likewise, different carbon database and tools have their own calculation method. Experienced carbon practitioners become adept at tackling such issues and combing such data in a robust manner. For such complexities, those new to the subject may be better starting their journey by using a single carbon assessment tool, to ensure that the data and results are consistent in method, or to consider enlisting the help of an experienced carbon expert.

Whilst there are many things to consider to ensure that a robust quantification method is in place, it is important to recognise that once there is enough confidence in the accuracy and consistency of quantification approach a study should move onto the higher goal – to achieve real carbon reductions.