Briefing to Sustainability Guide 01

In October 2021 the CWCT published its first sustainability guidance paper, *An introduction to sustainability in facades* (SG01) [1]. The purpose of the paper is to educate and position the façade industry to meet the challenges of the climate emergency and Net Zero Carbon (NZC) targets set into law in the UK.

Please refer to the accompanying Climate Jargon Buster [2] for guidance on the common terms and phrases associated with the field of sustainability.

This briefing note provides a high-level overview to the topics introduced in SG01. Access to the full 40-page guidance document is available for free to all Members of the CWCT, and available to purchase for non-members.

Background

The atmospheric concentration of carbon dioxide, a greenhouse gas (GHG), has been increasing at an accelerating rate since the industrial revolution. The concentration of carbon dioxide is recorded on an hourly basis at Mauna Loa Observatory, Hawaii. This plot of this data is known as the Keeling Curve, presented in Figure 1.

The United Nations' Intergovernmental Panel on Climate Change (IPCC) has established that there is a direct and broadly linear correlation between the atmospheric GHG concentration and the average global surface temperature on land and in the oceans [3]. Moreover, the relationship between average surface temperature and frequency of extreme events is highly non-linear. For example, nearly 700 million people will be exposed to extreme heat waves at least once every 20 years in a 1.5°C world, but more than 2 billion people in a 2.0°C world [4].

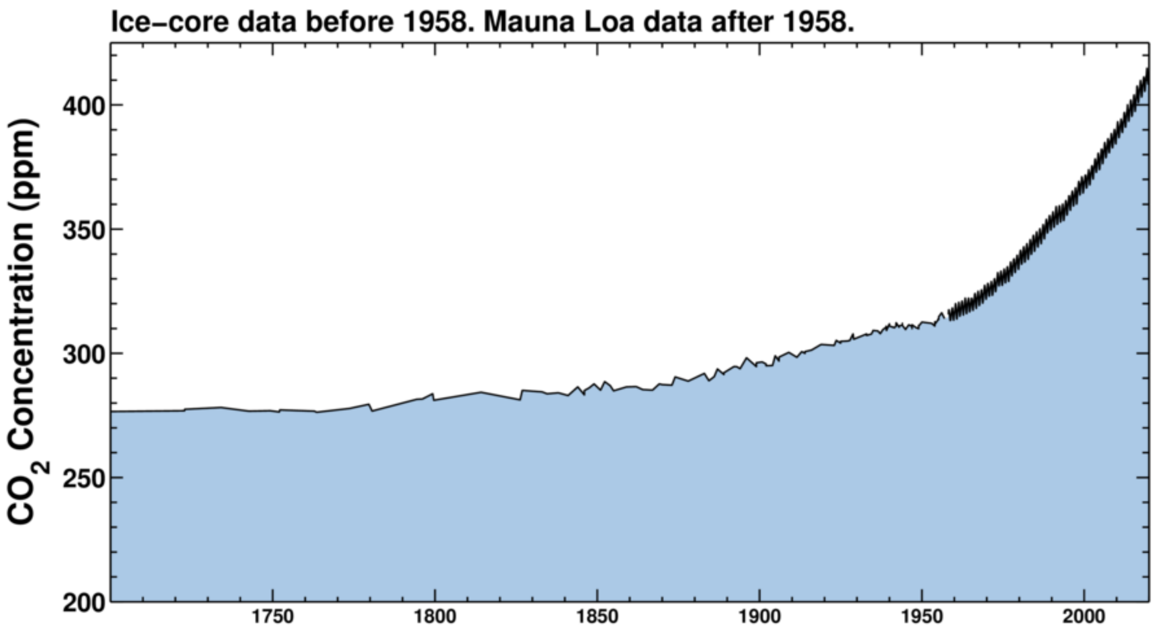

Figure 1: Atmospheric carbon dioxide concentrations since 1700 [6]

There is a consensus of opinion amongst climate scientists that limiting the global average temperature rise to 1.5°C above pre-industrial levels offers the best chance of minimising the severity of consequent climate change and severe weather events. The 2015 Paris Agreement [7] put into the writing the commitment to limit global warming to well below 2°C, preferably to 1.5°C. A recent assessment of the pledges from COP26 highlights that a significant shortfall that remains between the 2030 targets and 1.5°C target, with the current 2030 targets on track to deliver 2.4°C temperature rise by the end of the century [8].

In June 2019, the UK parliament passed legislation requiring the government to reduce the UK's net emissions of greenhouse gases by 100% relative to 1990 levels by 2050 [9]. Clients, both public and private, are similarly setting their own target dates for NZC which typically lie within a range from 2030 to 2050. The building and construction sector is reported to account for close to 40% of energy related CO_2 emissions [10], and for occupied buildings the façade accounts for a significant proportion of those emissions.

Greenhouse gases and carbon accounting

Greenhouse gases (GHG) help sustain life on the planet as we know it. There are six main GHG recognised in the Kyoto Protocol: carbon dioxide (CO_2), methane (CH_4), nitrous oxide (N_2O), hydrofluorocarbons (HFCs), perfluorocarbons (PFCs) and sulphur hexafluoride (SF_6). All of these are generated by human activity, although some are also produced through natural causes.

To account for the variation in the warming potential of each GHG the indicator Global Warming Potential (GWP), measured in units of carbon equivalent ($kgCO_2e$), has been established. It is common to find 'carbon equivalent' informally simplified to 'carbon'.

Façade designers wishing to quantify the impact of their designs on climate change are required to calculate the GWP of their designs. In accordance with BS EN 15978, this calculation is undertaken and reported against a number of defined life cycle modules (A1 – A5, B1 – B7, C1 - C4 and D). Environmental Product Declarations (EPDs), supplied by manufacturers, provide the base data used to calculate the GWP of façade systems.

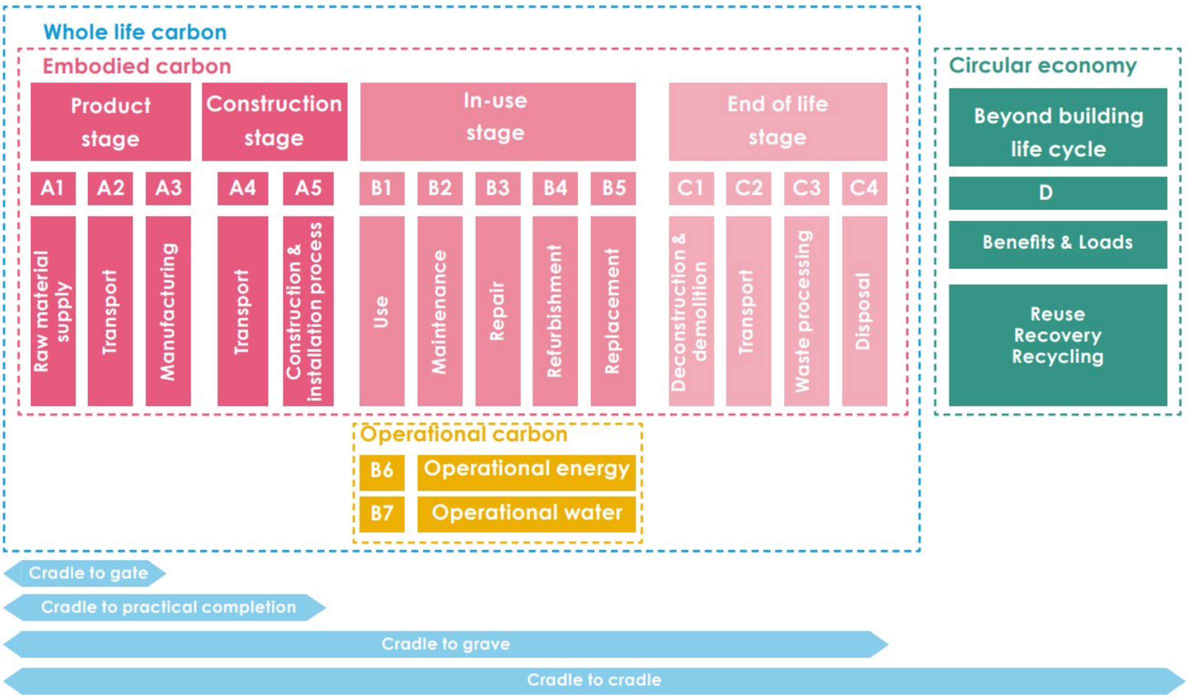

Figure 2: Life cycle modules from LETI guidance [11] figure adapted from BS EN 15978

The process of reporting GWP against life cycle modules enables designers to understand how much and when their designs contribute emissions over the life cycle of a built asset. To facilitate this understanding further the definitions of 'Embodied Carbon' and 'Operational Carbon' are used, see Figure 2.

Embodied carbon

Embodied carbon refers to the total GWP emissions generated to produce, maintain, deconstruct and dispose of a built asset. In the context of life cycle modules, the embodied carbon refers strictly to life cycle modules A1-A5, B1-B5 and C1-C4 (Figure 2).

Figure 3 below gives an indicative scale of the embodied carbon, ‘cradle-to-gate’, for some different materials and façade elements.

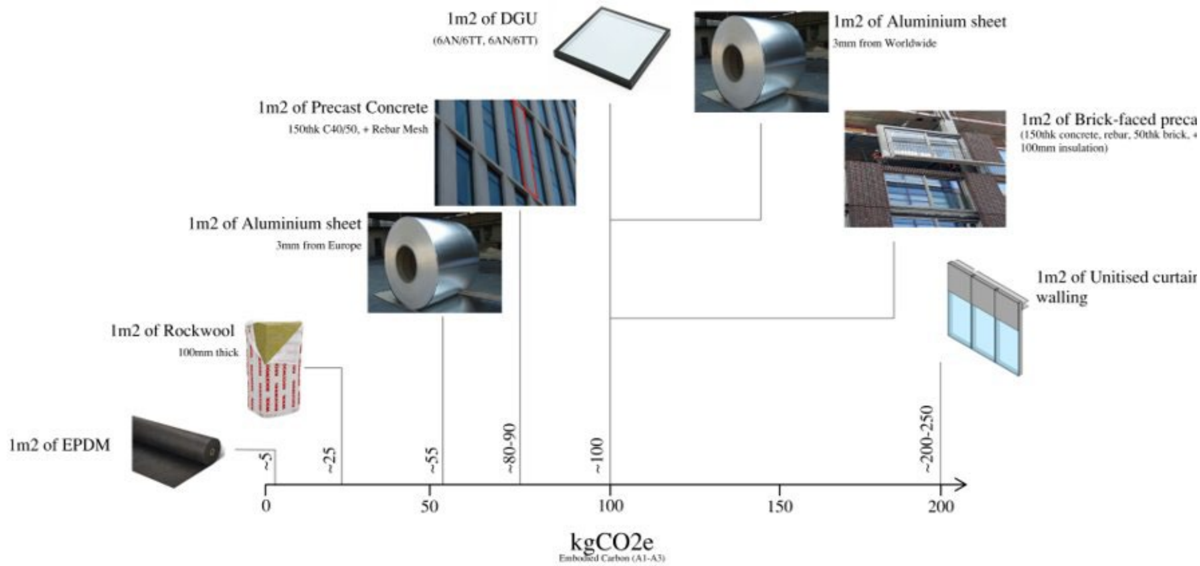

Figure 3: A sense of scale on the embodied carbon of different assemblies (life cycle modules A1 to A3 only). Data based on manufacturer EPDs and ICE V3 Database.

Historically for buildings the embodied carbon was a relatively small part of the total emissions when compared to operational carbon emissions. However, in recent decades considerable focus has been placed on lowering the operational carbon emissions of buildings by reducing the energy consumption from heating, cooling, lighting, and ventilation. Improved operational efficiency and decarbonisation of the UK energy grid has led to the embodied carbon to become a growing percentage of the total emissions and hence a key driver in the design of façade systems.

The designer’s ability to reduce the embodied carbon in a façade reduces over time in a project's design development and critical decision-making phase. At an early stage where many options are on the table, the potential for decision making and change may be up to 100% when even the need to go ahead with a project can be challenged. At the latter stages the ability to drive down the embodied carbon reduces as the range of alternatives narrows and performance targets for each discipline become more fixed.

A hierarchic approach, adapted from the PAS 2080 framework, provides a useful tool for considering how embodied carbon reduction may be achieved on a project.

1. Building nothing
2. Build less
3. Build clever
4. Build efficiently

Operational carbon

Operational carbon refers to the GWP emissions arising from all energy and water consumed by a building in use. In the context of life cycle modules, the operational carbon refers strictly to life cycle modules B6 and B7 (Figure 2).

Facades play a significant role in achieving low operational carbon. A 'fabric first' approach adopts passive measures to reduce the demand for heating, cooling and artificial lighting through well-insulated walls and levels of glazing and shading appropriate for the building use, climate, site orientation and exposure. The optimal facade design for a given building also depends on internal factors including density of occupation, wall-to-floor ratio, and the acceptable comfort conditions of its occupants. Because of these different factors, building codes rarely prescribe precise facade designs, instead stating limits for performance criteria. The facade performance parameters that are presently used to quantify energy use are: U-value, thermal bridging ψ- and χ-values, airtightness, g-value, shading, light transmission.

To meet the UK's commitment to becoming net-zero by 2050, new buildings will have to be designed to net-zero standards by 2030, and at which time a large programme of retrofitting existing buildings will need to have begun. Where space heating dominates the operational energy demand, typical in most UK housing, designers will be required to minimise U-values, thermal bridging and air leakage. This may lead to a consistent adoption of triple glazing, and thicker wall build-ups to accommodate more insulation.

Facade design for low-carbon offices is more complex, as the proportion of energy used on lighting, cooling, heating and MEP systems varies greatly from building to building. The optimal design will need to be explored iteratively, but typically cooling, lighting and HVAC are the dominant components. Cooling is reduced by limiting solar gain through the use of appropriate areas of glazing, spectrally selective glazing and/or shading devices. Natural ventilation can be beneficial in reducing summertime cooling load if designed properly and holistically within the building's overall climate strategy, but equally must be controlled in winter to avoid conflict with the heating system.

U-values requirements are often less onerous in offices as internal heat gains from occupants and computers offset heat losses through the façade. In these situations, with higher internal heat gains, the use of very highly insulating walls and features such as triple glazing may increase the cooling demands of the building. Furthermore, triple glazing will also have a higher embodied carbon than double glazing and in some situations may not present a net benefit in a whole-life carbon assessment.

SG01 provides further discussion on operational carbon considerations, future trends and consideration for the building performance gap.

Environmental Product Declarations (EPDs)

An EPD attempts to provide quantified environmental information for a construction product or service on a harmonized and scientific basis. The information within the EPD provides the basis of the assessment of the environmental impact of façade systems or buildings.

All construction products and materials declare the environmental impact against the life cycle modules identified in BS EN 15804 [(13)]. Typically, the following minimum modules are declared; modules A1 - A3 (product stage), modules C1 - C4 (end-of-life stage) and module D (beyond the product life cycle stage). This minimum requirement is referred to as a '*cradle to gate with modules C1-C4 and D'* EPD and all data is reported on a declared unit of measure.

The process of creating an EPD first requires the definition of a product using the appropriate Product Category Rules (PCRs) set out in industry standards. The PCRs define the boundaries to the scope of assessment, thus ensuring a consistency to the reporting of similar products to a market. After product definition, a Life Cycle Assessment (LCA) study can be undertaken by appropriately qualified sustainability consultants using a variety of software and assessment tools. The EPD is then created and delivered as a document or report following a series of verification reviews; it is then ready for registration and publication.

Façade materials

As the need to calculate the embodied carbon grows, façade designers will rapidly be required to scrutinise the selection, procurement and durability of all the materials and components that build up our facades.

Figure 4 presents an overview of the GWP for life cycle modules A1 to A3 (cradle-to-gate) of commonly used façade materials. It should be noted that Figure 4 presents the intensity of GWP in each material (expressed in $kgCO_2e/kg$)., To understand their contribution to a façade system's overall GWP consideration needs to be given to how much of each material is used (i.e. the product of material mass and GWP). In this regard, Figure 3 provides a useful sense of scale.

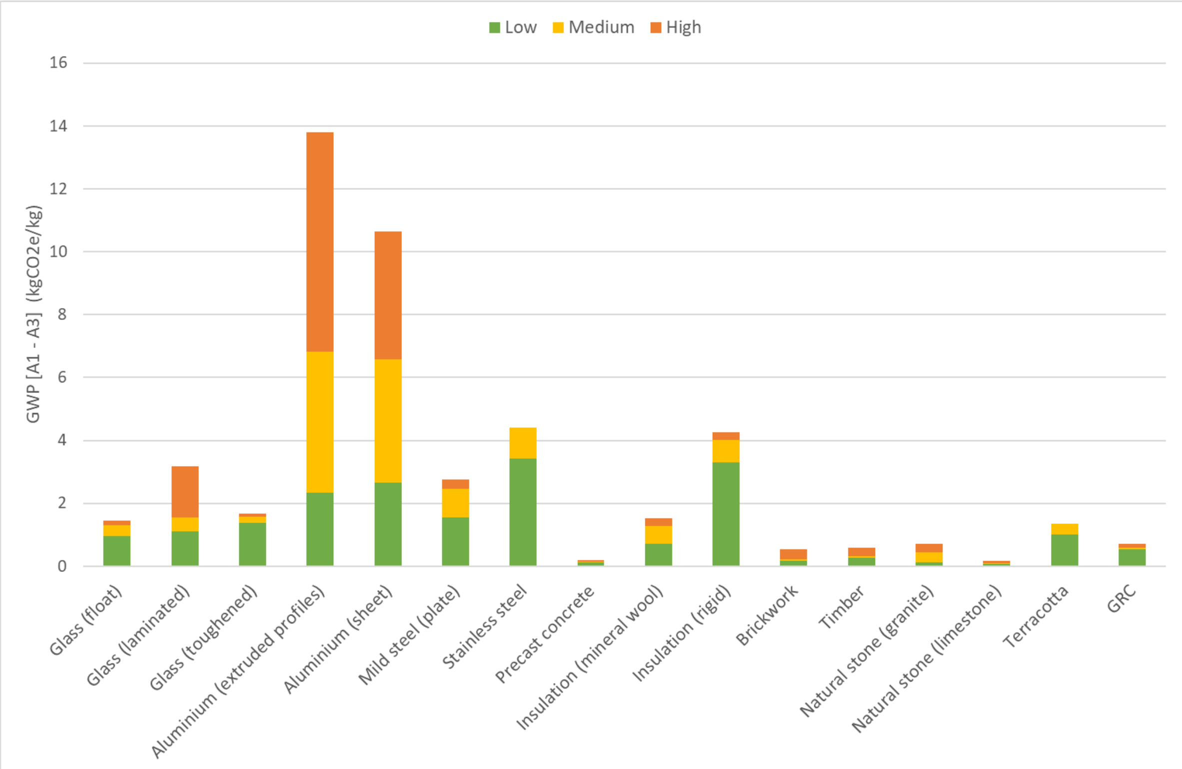

Figure 4: GWP [A1-A3] of typical façade materials. Data source: ICE Database V3.0, V2.0, Supplier EPDs, Oekobaudat database (refer to SG01 for details)

A full breakdown of typical façade materials, their embodied carbon and reuse/recycling potential is presented in SG01.

Future work

There is a growing body of work around the issue of sustainability, and what this might mean for construction in general. There is however a lack of detailed guidance on how sustainability principles should be applied to the design of façade and cladding systems. For those seeking to build their awareness in this field, the SG01 document provides a foundational introduction to this topic.

References

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