Intervention #6
Whole life carbon data

Intervention point

To effectively reduce whole life carbon emissions in the building system, targets and benchmarks need to be developed. This can only be achieved if stakeholders commit to collect, share and analyse sufficient data on emissions in all stages of a building's life cycle.

Current situation

Whole life carbon emissions result from the materials, construction and use of a building over its lifetime, including its demolition and the disposal of residue. These carbon emissions can be classified as:

- operational: emissions from the energy consumption related to heating, cooling and lighting.
- embodied: emissions from construction, renovation and demolition process including the energy consumption of those activities, material extraction, manufacturing and transportation.[1]

Operational carbon represents the majority of built environment emissions. Therefore, it has been the main focus for decarbonisation activity by the real estate industry to date. Yet, embodied carbon emissions are also hugely significant. The Global Alliance for Buildings and Construction (GlobalABC) estimates that, of the 37 percent global emissions from the built environment, 27 percent is operational, and 10 percent is embodied.[2]

To limit global warming to 1.5°C, there is a science-based global carbon budget, and the remaining share of the EU building sector is estimated at between 12 and 15Gt of CO2e.[3] Unless the pace of decarbonisation of the industry is accelerated, this will be used up some time in the 2030s.[4]

The real estate industry must assess and tackle whole life carbon emissions – operational and embodied carbon – together. However, at present, evaluation and decision-making on whole life carbon is severely hampered by a lack of data.

To date, operational carbon and energy efficiency improvements have been the main focus of decarbonisation activities in the built environment,[5] mainly through legislation such as the introduction of Energy Performance Certificates (EPCs)[6] and associated measures to reduce the energy consumption of buildings.

However, embodied carbon represents 10 percent of global emissions,[7] and is hugely important to address if climate goals are to be taken seriously. Compared to operational carbon, embodied emissions are difficult to measure. Measurement requires self-assessment and transparency by manufacturers, construction companies and all other value chain links, and it is impossible to ascertain levels from the finished product alone.[8]

A recent study by Danish consultancy firm Ramboll estimated that the average building in Europe has 600 kg CO2e/m2 of embodied carbon emissions over its life cycle. This means that 10 sq m of floor space roughly equals the current annual emission of an average EU citizen.[9]

The World Business Council for Sustainable Development (WBCSD) and Arup report similar figures, with an upfront embodied carbon (before the building is in operation) average between 500-600 kg CO2e/m2, and further 300 kg CO2e/m2 of in-use embodied carbon across a number of case studies.[10]

Furthermore, as buildings get more efficient operationally, the relative impact of embodied carbon increases. For example, France's energy mix is relatively low carbon due to high use of nuclear power – compared to, for example, Germany's, which is still more reliant on coal. Assuming new buildings in France are operationally efficient and electrified, embodied carbon in such buildings can represent up to 75 percent of a new building's projected whole life carbon footprint.[11] Major retrofit works produce significant embodied carbon of in some cases up to 20 percent of life cycle emissions.[12]

It remains an imperative to ensure buildings become more energy efficient, but the carbon emitted in the processes of construction or retrofitting must also be kept at a minimum, which necessitates in many cases striking a balance between embodied and projected operational emissions, ultimately to optimise a building's whole life carbon footprint.[13,14,15]

To proceed and make effective headway on this challenge requires whole life cycle measurement, data collection and tracking at an asset and portfolio level so that targets and limits to emissions can be determined and met.

For operational emissions, the targets for the 1.5°C goal are already set out in the Carbon Risk Real Estate Monitor pathways (CRREM). These were developed in collaboration with the Science-based Targets initiative (SBTi).[16] Operational emissions can easily be calculated from a building's energy bills, which makes tracking relatively simple. For more information on operational emission and science-based targets, see the *C Change Intervention #7 Net zero targets for the built environment*.

Measurement and target setting for embodied emissions is more complicated. The amount of embodied emissions that will be emitted is for the most part determined in the design stage of the building, where operational efficiency and construction emissions are planned. Striking the right balance here is the key challenge, both for new buildings as well as for major retrofits. The goal is to establish limits and benchmarks for embodied emissions in new builds and retrofits while simultaneously meeting operational targets. Key actors in this crucially important step are architects, engineers and construction companies, which need to gear their efforts towards the 1.5°C target.

For limits, targets and benchmarks to be defined, and enforced later on, they must be supported by consistent and accurate measurement of whole life carbon data. Whole life carbon data is a missing key component in making effective progress on the decarbonisation of the built environment. Gathering this data entails compiling a catalogue of all materials and processes used in the construction and operation of a building, amounting to what is known as a whole life cycle carbon assessment (WLCA),[17] or alternatively life cycle assessment (LCA).[18,19] For example, the WBCSD's Building System Carbon Framework[20] is a simple way to transparently measure and report whole life carbon emissions.

WLCA databases are important in assessing whole life cycle emissions and associated impacts accurately, but they can further be used to offer data-driven cases for the use of alternative materials, as well as combinations with – and better use of – existing ones.[21]

The aim is to regulate embodied carbon with standardised calculation methods as well as cost-efficient and robust processes[22] alongside meeting operational carbon targets. Yet, mandatory whole life carbon measurement through WLCAs is a blind spot in EU policy.[23] Only five EU countries (Denmark, Finland, France, the Netherlands, and Sweden) have introduced regulation on whole life carbon emissions.[24]

The major problem to date is that data for comparisons to establish benchmarks is either non-existent or is not being disclosed. Measuring and disclosing whole life carbon is not an EU requirement for renovations or new builds, although this is changing. In the revised Energy Performance of Buildings Directive (EPBD), "life-

cycle global warming potential (GWP)" must be calculated for all new buildings from 2030, and for large buildings from 2027.[25]

It is evident that the industry is at the start of its journey towards standardising whole life carbon data collection. Policy makers are similarly only just beginning to introduce regulation around it. By March 2022, in an ongoing study to establish current levels of embodied carbon in buildings, Ramboll was only able to identify five EU countries in which there were more than 50 sets of sufficient WLCA data,[26] demonstrating this lack of evidence.

Progress is nevertheless being made. At COP27 in November 2022, Arup announced a new international database of over 1,000 buildings which it plans to use to assess expected whole life carbon emissions of the architecture, engineering and construction (AEC) links of the value chain[27], indicating a positive development towards potential benchmarks and limits.

While measurement and regulation of whole life carbon emissions from the built environment are under development, WBCSD points out that it remains possible to significantly reduce both operational as well as embodied emissions today. In a report from early 2023, WBCSD and Arup show strategies available for AEC organisations through which embodied emissions can at least be halved using today's technologies[28]. Significant reductions in building emissions should already be high on the agenda for organisations operating in the building sector.

What is being done?

Ramboll along with BUILD, the Department of the Built Environment at Aalborg University, and Belgian university KU Leuven have been researching the reduction of embodied carbon with the aim of persuading EU policy makers to take action. Funded by the Laudes Foundation, the research resulted in a report series[29] investigating topics necessary for embodied carbon reduction, namely:

- the data challenge posed by embodied carbon.
- the need to set baselines around how much embodied carbon is emitted in current construction processes.
- target setting based on the global 1.5°C aligned carbon budget.
- ideas to bring the prevailing excess levels of embodied carbon in line with carbon budget-aligned measures.

The European Commission (EC) has commissioned Ramboll and KU Leuven to conduct a second study, this time with the Buildings Performance Institute Europe (BPIE). This study is aimed at reducing whole life carbon in buildings by supporting the EC to make a whole life carbon reduction roadmap.[30] The goals are to establish a baseline for embodied carbon emissions of buildings across European regions and demonstrate how embodied carbon in European buildings may evolve by 2050. It will also set out the trajectory towards climate objectives for operational carbon, and identify and assess potential solutions to whole life carbon emissions.

In parallel, the World Green Building Council (WorldGBC) has launched #BuildingLife.[31] The campaign is centred on WorldGBC's EU Policy Whole Life Carbon Roadmap[32] outlining key EU policy interventions, regulatory measures and tools to achieve decarbonisation of the built environment. It adds recommendations of which the European Commission should adopt in its actions.

In parallel, ten European Green Building Councils – Croatia, Finland, France, Germany, Ireland, Italy, the Netherlands, Poland, Spain and the UK – are working on, or have already published, national and regional decarbonisation strategies to achieve the mix of private sector action and public policy necessary to tackle the whole life impact of buildings.

In attempting to accelerate the EU Green Deal in the building sector, WorldGBC's councils are creating a roadmap demonstrating how EU buildings policy can adopt whole life carbon targets and launching a new whole life carbon commitment within WorldGBC's Advancing Net Zero project. It will also support the development of a building product database, holding information about the full environmental impact of different building materials. Its work is being supported by establishing leadership groups on a European and national level and a communications plan to

promote the whole life cycle approach to Members of the European Parliament, policymakers and industry leaders.

SBTi is developing 1.5ºC aligned pathways for operational and embodied emissions of buildings (see the *C Change Intervention #7 Net zero targets for the built environment*). In addition, it is developing guidance for emissions accounting, reporting and target setting for all stakeholders within the sector: developers, owners, architects, engineers and buildings.

WBCSD has been doing extensive work to provide insight into best practice for WLCAs through case studies.[33] It has also proposed the Building System Carbon Framework,[34] an assessment tool to provide a simple template and a common language to represent carbon emissions in the buildings and construction system.

In early 2023, WBCSD released the report *Net zero buildings: Halving construction emissions today*,[35] which examines how much embodied carbon reduction can already be achieved in buildings through better design and construction methods.

The EC is attempting to standardise data collected for WLCAs, as well as trying to promote its Level(s) framework, which is a voluntary system that building specialists in Europe can adopt to measure, report, and share the environmental performance of their buildings.[36] The vision behind Level(s) is to provide a common data language for the environmental performance of buildings.[37]

Countries such as Sweden, Finland, France and the Netherlands have developed their own WLCA methodologies,[38] currently independent of Level(s). However, the recast of the EPBD could establish Level(s) as the main framework so that it is used to gather data for EU-wide target-setting and benchmarking and, ultimately, the introduction of regulation.

Within the real estate industry, the Low Carbon Building Initiative (LCBI) was launched in 2022, and brings together ten owners and managers as founder sponsors to promote low carbon buildings and reduce the CO2 emissions of European real estate by half (measured in a life cycle analysis). LCBI aims to be the missing link between European standards that are well known to specialists (EN15804+A2, EN 15978) but applied in different ways, and the European Union's Level(s) reference system. This will enable it to establish a calculation standard that will make all projects comparable, wherever they are in Europe. After the ongoing pilot phase, LCBI aims to become a unified label measuring the carbon footprint of real estate based on a life cycle analysis.

The Royal Institution of Chartered Surveyors (RICS) is developing the second edition of its Whole Life Carbon Assessment for the Built Environment,[39] a standard which mandates a methodology to track all carbon emissions from production of materials, construction process, use and disposal of built assets over their entire life cycle.
For 2023, GRESB introduced changes for whole life carbon as part of its real estate standards. Participants are now required to report on quantitative embodied carbon metrics relating to development projects completed within the reporting year, along with the scope of what is included in the measurement. Metrics should be reported separately for new construction and major renovation projects.[40]

Possible next steps

Addressing whole life carbon requires parallel initiatives, all of which are in need of industry support. The most important gap for effectively reducing whole life carbon is the lack of information. Going forward, the real estate industry needs to:

- adopt the measurement of whole life carbon in all buildings.
- transparently share consistent carbon intensity data to develop benchmarks in common database.
- plan future developments (retrofit or new builds) with these carbon benchmarks as a core metric informing decision-making.

Collaboration across the highly fragmented value chain will be vital. Investments into buildings are undertaken by finance and asset management, but the emissions take place during the construction and operation of the asset. Therefore, they technically fall outside of their economic activity. Levers for reducing these emissions are largely

found within design and engineering, as well as materials production. Well-informed and decarbonisation-oriented decision-making needs to draw on the expertise of all stakeholders along the value chain to be effective.

How to get involved

- Consider using Level(s) as the framework to conduct your WLCA. This is most likely to become the harmonised instrument used to compare and contrast whole life carbon data across Europe. Various private sector WLCA assessment consultants are available to assist real estate actors in this process.
- Contribute to the whole life carbon roadmap study carried out by Ramboll, BPIE and KU Leven for the European Commission.
- Support WorldGBC's #BuildingLife campaign.
- Contribute to the wider stakeholder conversation on SBTi Buildings Sector Pathways and Guidance. The consultation on sector guidance is open until 16 July 2023.
- Use WBCSD's Building System Carbon Framework and submit your project as a case study. Find the template here.

About C Change

C Change is a ULI-led programme to mobilise the European real estate industry to decarbonise. We're a movement empowering everyone to work together for a sustainable future. We connect the brightest minds from across the value chain. We challenge barriers, share expertise, and champion innovation to move swiftly to accelerate solutions that will transform our industry and protect our planet. C Change means real change.

C Change was formed in late 2021 by a group of leading real estate players that was united in its aim to focus on collaboration to ensure companies large and small have access to practical solutions and education on decarbonisation.

About these intervention briefings

This is one of a suite of intervention points developed as part of the C Change programme. Intervention points are specific places within a system where we can target action, interrupting business as usual to drive transformation. Of course, systems are dynamic environments that are always in flux. We expect movement over time, and will update this document as prevailing and anticipated trends change shape. This briefing was researched in 2022 and published in 2023.

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2 Tracking progress: GlobalABC
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4 p.9 Ibid
5 edie: EU to start measuring embodied carbon emissions from buildings
6 Despite being an important step, EPCs are not sufficient as tool for decarbonising the built environment - see C Change technical briefing on Building Renovation Passports and on Energy Efficiency Data
7 What you need to know about Embodied Carbon | GRESB
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