# Zero Avoidable Waste in Construction

What do we mean by it and how best to interpret it. A recommendation from the Green Construction Board.

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The **Green Construction Board**

# Contents



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The full list of all those involved is provided in Appendix A.

# FOREWORD

## David Pinder

## Chair of the Green Construction Board

Since I was appointed Chair of the Green Construction Board (GCB) in March 2018, I am proud to be part of a group that is championing the delivery of a more environmentally sustainable construction agenda, which is fundamental to the UK achieving its clean growth, decarbonisation and resource efficiency goals. It is a privilege to work with industry experts with such a wealth of knowledge, and also the vision and passion to deliver a future with zero waste in construction and a cleaner environment. I would like to extend my sincere thanks to the team who have worked hard to produce this excellent report.

## Robert Pearce and Jane Thornback

## Co-Chairs of the GCB Resources & Waste Task Group

The Green Construction Board was invited to work with BEIS and Defra to develop an interpretation of zero avoidable waste in construction and subsequently to develop a route map of how it might be delivered. We agreed to chair a time-limited Task Group to this end. The need for such an interpretation and route map arises from the government Resources and Waste Strategy published in 2018 which aims to eliminate avoidable waste of all kinds by 2050, this includes construction waste.

This first report examines what we might mean by the term ***zero avoidable waste in construction,*** and makes a recommendation of how best to interpret it. Inevitably issues that might at first glance seem simple and straightforward are in reality complex. The report therefore discusses in some depth the criteria and issues that impinge on such an interpretation and why we have arrived at the text we have.

The report has been delivered by the GCB Resources and Waste Task Group and ably developed with technical support from Katherine Adams. It has been a privilege to convene a group of industry experts who have in-depth knowledge and expertise of resource use and waste in the construction sector and we look forward to working with them plus others when we tackle a potential route map of how we might get there.

The GCB's predecessor, the Strategic Forum for Construction, developed a 5 year Action Plan for halving waste to landfill between 2008 and 2012 and measured progress against an established baseline both in absolute terms and relative to construction output. As the GCB we have produced a Knowledge Resource for circular economy thinking and Top Tips for different parts of the construction lifecycle for embedding circular economy thinking into construction. We are delighted that many other groups across the sector are now producing their own guidance for their own constituencies.

Going forward, the construction sector is changing as digitalisation and offsite manufacturing take greater prominence. The Construction Sector Deal developed under the Industrial Strategy and agreed between industry and government seeks to develop a construction industry fit for the future using the most advanced techniques and delivering goals of greater productivity, new skills, lower carbon, and greater business opportunities. These new technologies will have a key role to play in helping to deliver a more resourceful and less wasteful industry, one that is able to design from the outset for more durable and adaptable buildings and structures and which help create a digital memory of what has gone into a structure, how it has been maintained, repaired or replaced and thus at end of life what materials are available for reuse, recycling or recovery. Understanding the interplay between material choices, carbon reduction, durability and adaptability must be underpinned by life cycle assessment across the whole construction life cycle. Demonstrating the commercial viability and business case for such changes is the key to sustainable outcomes.

The Task Group aims to deliver the route map for achieving zero avoidable waste in construction during 2020.

# 1. Executive Summary - Zero Avoidable Waste in Construction

***Zero Avoidable Waste (ZAW) in construction means preventing waste being generated at every stage of a project's lifecycle, from the manufacture of materials and products, the design, specification, procurement and assembly of buildings and infrastructure through to deconstruction. At the end of life, products, components and materials should be recovered at the highest possible level of the waste hierarchy, i.e. reused before being recycled, whilst ensuring minimal environmental impact.***

1. The government's Resources and Waste Strategy (2018)[1] aims 'to eliminate avoidable waste of all kinds by 2050' in England. This includes waste from a wide variety of sectors such as plastics, textiles, food and includes construction. This piece of work aims to advance the concept of zero avoidable waste in construction by providing a working interpretation. We have deliberately not called it a definition to avoid confusion with the complex legal definitions of waste within the EU Waste Framework Directive, which is transposed into UK law by various national regulations, and which determines the legal framework required for storage, management, transport and disposal of materials and products classified as waste. The geographic scope of the report is England, although of course there are close synergies with Wales, Scotland and Northern Ireland.

2. The report has been funded and contributed to by the Department for Business, Energy and Industrial Strategy (BEIS) and carried out by the Green Construction Board's Resources and Waste Task Group in collaboration with the Department for Environment, Food & Rural Affairs (Defra).

3. By construction we mean both buildings and infrastructure. The scope of ZAW we have adopted is the waste generated from all stages of the construction lifecycle - from manufacture, distribution, design, procurement, construction, maintenance, refurbishment and demolition / deconstruction at end of life of the structure. Offsite manufacturing is also included.

4. The construction sector is the largest user of materials in the UK and produces the biggest waste stream in terms of tonnage. Waste Statistics collated by Defra show that in 2016, 63 % (120 million tonnes) of the total waste stream in England (189 million tonnes) was attributed to construction, demolition and excavation waste (C,D&E). Of this an estimated 60 million tonnes (50%) was construction and demolition waste and 51 million tonnes (43%) was excavation waste, the remaining 9 million tonnes (8%) was dredging spoil. However, the government statistics also record that over 90% of the construction and demolition waste (C&D) is recovered, much of which is heavy materials such as concrete, brick and asphalt which is downcycled for future use as aggregates. This still leaves nearly 5 million tonnes sent to landfill, about which little is known. For excavation waste an estimated 47% (23 million tonnes) was recovered, with the remaining 26 million tonnes disposed of. The challenge is to

[1] Defra (2018) Resources and Waste Strategy, HM Government London. Available at https://www.gov.uk/government/publications/resources-and-waste-strategy-for-england

understand how much of this C,D&E waste is unavoidable and thus how much is avoidable, and subsequently what the road to Zero Avoidable Waste in construction can look like.

5. At every stage of the construction process there are different opportunities for different professions in construction to reduce waste, and reuse or recycle products, components and buildings, and for materials to move up the waste hierarchy so that ultimately material resources can continue to flow around a circular economy. These opportunities are available to clients, designers, material suppliers, product manufacturers, distributors and construction and demolition contractors. The waste management industry is also important in enabling those in construction to improve their waste performance. The government has a key role to play in the setting of policy and regulation, as a construction client and building owner, as well as ensuring statistics are gathered to measure and monitor material use. The government is preparing a Waste Prevention Programme (WPP) in which construction will feature as a key sector.

6. **Avoidable** construction waste is interpreted as materials, products or components that can be prevented from becoming waste and this is the primary objective of '*zero avoidable waste in construction*' in line with the waste hierarchy. Examples include designing out waste for new buildings by designing for better resource efficiency and for deconstruction and disassembly, efficient manufacturing processes, extending the life of buildings, disassembly for reuse and reducing surplus materials. If waste cannot be prevented then the secondary objective is for waste to be kept at its highest level by following the waste hierarchy, which in descending order of preference, is preparing for reuse (for example repair or remanufacture), closed-loop recycling (where waste is used as a feedstock in the same process) and open-loop recycling (where waste is used as a feedstock for a different purpose). If waste can be managed in this way, then it is 'avoidable' as it has a further use and is not being disposed of to landfill or as energy recovery.

7. However some of the waste produced by the building and infrastructure sector may be **unavoidable**. Some waste is considered unsuitable for further use, for example materials that are now considered hazardous such as asbestos, asbestos contaminated materials, or material treated with persistent organic pollutants. All other waste is avoidable waste, in that it can either be prevented, reused or recycled.

8. This understanding has led us to our interpretation of zero avoidable waste in construction. For those who want to further understand the factors and issues which we have considered in arriving at this interpretation, then please find more details in the report. Factors considered include: geographic scope; what we mean by construction waste; the boundary for ZAW; the waste hierarchy; the different types of waste generated; the different construction life cycle stages; and avoiding unintended consequences of greater environmental impact preferably by carrying out a life cycle assessment.

9. With this interpretation of ZAW in place, the Green Construction Board Task Group will start work on a route map of how Zero Avoidable Waste can be delivered, identifying recommendations and timescales for industry and for government.

## 2. Introduction

The government's Resources and Waste Strategy (2018)[2] is applicable to England and has the ambition 'to eliminate avoidable waste of all kinds by 2050'. This includes waste originating from the construction sector, both buildings and infrastructure. A short study, funded by BEIS and carried out by the Green Construction Board's Resources and Waste Task Group has worked in collaboration with Defra to explore how we might interpret "*zero avoidable waste in construction*" and to arrive at a working interpretation of the term. We have specifically not called it a definition so as not to confuse with legal definitions of waste within the EU Waste Framework Directive.

This report includes an in-depth discussion of the factors that have been considered to arrive at an interpretation of *zero avoidable waste in construction*. It will also help inform a subsequent route map to be prepared by the end of 2020 to deliver the ambition, identifying recommendations and timescales for industry and government.

The Green Construction Board's Resource and Waste Task Group includes representatives from across the construction lifecycle as well from government, notably Defra and the Department for Business, Energy and Industrial Strategy (BEIS). Technical expertise has been provided by Katherine Adams. The ideas have been developed and discussed in four meetings of the Task Group from February to June 2019 (see Appendix A for a list of Task Group members). A summary of relevant government policies and strategies is included in Appendix B.

The following factors have been considered relevant to the development of a working interpretation of what could be meant by the phrase *zero avoidable waste in construction* and these are discussed in depth in the following sections.

- Geographic scope
- What do we mean by construction waste?
- Boundary of zero avoidable waste
- The Waste Hierarchy
- The different types of waste and the different construction life cycle stages
- Avoiding unintended consequences – minimising environmental impact

It should be noted that it is not within the remit of this short study to develop a methodology to measure progress to *zero avoidable waste in the construction sector*, although the question of the availability of material and waste data has informed our approach.

[2] Defra (2018) Resources and Waste Strategy, HM Government London. Available at https://www.gov.uk/government/publications/resources-and-waste-strategy-for-england

## 3. Construction material and waste statistics

In developing the working interpretation of ZAW, it is necessary to understand the volume of materials used in the construction sector and the amount of waste generated and its recovery routes. The following data is from government statistics collated by Defra[3,4]. The data presented is a snapshot of waste performance in England and is not a detailed analysis of the construction sectors waste management. There is lot more we need to know and understand around data and where materials / waste go in reality. Such knowledge is necessary to identify priority areas in the routemap towards ZAW - how much of this waste is unavoidable and consequently how much waste in the construction industry is avoidable.

***Material usage***

- Around 250 million tonnes of non-metallic mineral ores were consumed domestically in 2016. Most are likely to be used in the construction sector (both for buildings and infrastructure) [5]. However there is a lack of information on the breakdown of these materials and where they were used.

***Construction sector waste generation***

- An estimated 120 million tonnes of construction, demolition and excavation (CD&E) waste was produced in 2016.
- Of this, an estimated 9 million tonnes was navigational dredging spoil.
- Of the remaining 111 million tonnes, 60 million tonnes (54%) is construction and demolition waste and the remaining 51 million tonnes (46%) is excavation waste.
- A proportion of industrial waste (estimated 9.5 million tonnes produced in England in 2016) may come from construction product manufacturing activities, but the amount is unknown.

***Recovery of construction sector waste***

- Defra statistics indicate that 92% of non-hazardous construction and demolition waste was recovered in some form (55 million tonnes) in 2016
- 99% of navigational dredging spoil is either recovered or deposited into water.
- 47% of excavation waste (soils) was recovered, with 12 million tonnes backfilled and a further 11 million tonnes recycled in 2016[6].

***Disposal of construction sector waste***

- Nearly 5 million tonnes (8%) of non-hazardous construction and demolition waste was landfilled in 2016
- 53% of excavation waste (soils) was disposed of (equivalent to 26 million tonnes, in 2016

Limitations and ongoing developments for national waste data are discussed in Section 11.

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[3] Defra (2017) Digest of Waste and Resource Statistics – 2017 Edition. Available at https://www.gov.uk/government/statistics/digest-of-waste-and-resource-statistics-2017-edition

[4] Defra UK Statistics on Waste: 14th February 2019 Available at: https://www.gov.uk/government/statistics/uk-waste-data

[5] Data taken from the UK Environmental Accounts: 2018. Available at: https://www.ons.gov.uk/economy/environmentalaccounts/bulletins/ukenvironmentalaccounts/2018#material-flow-accounts

[6] There is a discrepancy of 2 million tonnes for soils, with 51 million tonnes generated, and 49 million tonnes being recorded as sent for treatment.

## 4. Geographic scope

The remit of the Resources and Waste Strategy, the Green Construction Board and the Construction Sector Deal is England. It follows therefore that the geographical scope for the target of *zero avoidable waste in construction* in this context is England.

However, it is acknowledged that whilst there are some differences in policy, regulation and organisational support across Wales, Scotland and Northern Ireland, in reality they are very similar in their nature and ambition and thus synergies will be sought with these other nations especially when considering an implementation route map as many industries operate across the UK as a whole and would welcome consistency of approach[7]. It is also essential how much C,D&E waste travel across internal borders as we do not want to reach zero avoidable waste in England by sending it elsewhere.

## 5. What do we mean by (construction) waste?

The concept of waste and the reuse, recycling of materials and products is inextricably bound up with the legal definition of waste as this determines what is called waste and thus the legal permits required for the storage, management, transport and disposal of materials and products classified as waste. To reach a concept of *zero avoidable waste in construction*, it is essential therefore to understand what is waste and how it might become "end of waste or a by-product", and be utilized as a resource.

Where waste achieves end of waste status, or where residues are regarded as achieving by-product status and so are never regarded as waste (via quality protocols, code of practices, the Environment Agency's Definition of Waste Service, self-assessment etc.) these will be included within the working interpretation of *zero avoidable waste*. This may include large quantities of materials that are either never defined as waste in the first instance or are recorded as waste, but their quantities, once returned to "non-waste" are not recorded. How this material is measured and recorded poses a challenge as most is not included in government national waste data and statistics.

Considerations include:

- Currently the legal definition for waste is from the EU Waste Framework Directive[8] which is transposed into UK law via various national regulations. There have been occasions when our national courts along with European courts have interpreted this definition, with a substantial body of case law now in existence.

- Where material is regarded as waste it should be managed properly in accordance with relevant legislation e.g. Environmental Permitting Regulations[9] which includes the aspects of transport, storage, treatment and use.

[7] For example, Wales has 'Towards Zero Waste (by 2050); Scotland aim is to reduce total waste arising by 11% by 2025 and landfill to less than 5%; Northern Ireland has the 'Delivering Resource Efficiency' strategy
[8] European Commission Directive 2008/98/EC on waste (Waste Framework Directive). Available at: http://ec.europa.eu/environment/waste/framework/
[9] The Environmental Permitting (England and Wales) Regulations 2016. Available at: http://www.legislation.gov.uk/uksi/2016/1154/contents/made

- It can be surprisingly difficult to decide whether something is a waste, a by-product, is discarded intentionally or not intentionally etc. and as such this can be a limiting factor for the reuse of waste and the use of recycled and secondary materials. Defra acknowledges this in the government Resources and Waste Strategy and continues to develop its guidance and processes. An example of this in construction is provided by a product manufacturer which uses pulverized fuel ash (PFA) from Drax power station in its concrete blocks. This PFA was covered by a Quality Protocol and therefore not considered as a waste. However, when Drax started to move away from coal to biomass, the Protocol did not cover this new ash/material, which means that the manufacturer must now re-visit this via a self-assessment or via a submission to the Environment Agency's Definition of Waste Service, which may incur cost and time.

- There is guidance available from Defra to assist with the concept of 'end of waste'[10], as well as 13 Quality Protocols / End of Waste Frameworks (including one for aggregates)[11]. There is also the Environment Agency's pay to use 'Definition of Waste Service', which provides an opportunity to formally seek the Environment Agency's view about the waste status of material including those that potentially achieve end of waste or by-product status.

- Guidance is also available for excavation waste, such as the Definition of Waste Code of Practice (DoWCoP)[12] for moving and reusing of soils, and not classifying them as waste.

- L,ooking to the future and the implementation of circular economy thinking, whereby the concept of waste moves to one of resources and material flows, there is likely to be more attention given to the end of waste and by-product status.

## 6. Boundary of Zero Avoidable Waste

Another major consideration for the working interpretation of *zero avoidable waste in construction* is what is meant by construction. Is it just the construction process itself, or should it include manufacturing, in use and demolition etc.? A consideration therefore of the scope is essential.

It is the view of the GCB Task Group that the scope of *zero avoidable waste in construction* is the construction lifecycle starting with the waste generated from manufacturing of construction products, through on site construction processes, in use during repair and maintenance, and at end of building / structure life from demolition/deconstruction.

This is shown in Figure 1 overleaf) for the construction life cycle stages (A3-C4) based on the European CEN TC350 Sustainability of construction works set of standards.

[10] Available at https://www.gov.uk/government/publications/legal-definition-of-waste-guidance
[11] A list of quality protocols is available at https://www.gov.uk/government/collections/quality-protocols-end-of-waste-frameworks-for-waste-derived-products
[12] CL:AIRE (2011) The Definition of Waste: Development Industry Code of Practice. Available at: https://www.claire.co.uk/projects-and-initiatives/dow-cop/28-framework-and-guidance/111-dow-cop-main-document

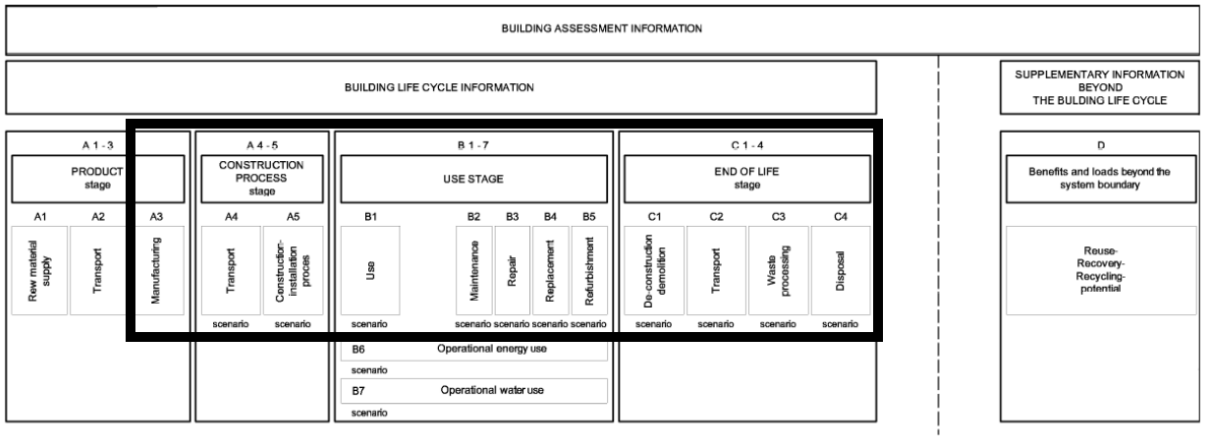


**Figure 1: Scope of *zero avoidable waste in construction* using the CEN TC350 Sustainability of construction works life cycle[13]**

A major challenge will be how data is gathered, recorded and communicated, especially as some of these wastes are not coded as 'construction' waste. They are coded as manufacturing waste and therefore are not recorded as 'construction'. For example, material waste from a manufacturing plant could be coded differently to that originating from a construction or demolition site. Similarly, construction waste cannot be distinguished from demolition waste, using the national waste data.

Other considerations are:

- The interpretation should cover both buildings and infrastructure.

- Waste from the extraction of materials (i.e. mining and quarrying), is not included as different legislation is in operation, and some of this waste such as mining ore may occur in other countries if materials are imported. However, it is acknowledged that this waste accounts for a considerable amount of waste in England with Minerals UK[14] estimating that in 2014 that there were 84.3 million tonnes of mineral waste from mining and quarrying, though some waste from such as slate and coal has been stockpiled for a long time. Moreover, there are a further 50 million tonnes of quarry fines arising every year from quarry processes[15], which would be reduced if more recycled and secondary aggregates are used.

- When construction materials/products have been imported, the waste generated during their extraction or manufacturing is out of scope. This accounts for around 18 million tonnes of non-metallic materials (in 2014), around 8.5% of our overall usage[16]. Other data shows an imported

[13] Diagram sourced from CEN TC350 Seminar - Implementation of EN 15804 - Draft Agenda (updated) - On 2013-06-20; Available at: portailgroupe.afnor.fr/public_espacenormalisation/centc350/ressources.html
[14] Data has been taken from http://nora.nerc.ac.uk/id/eprint/513956/1/Mineral%20Waste%20in%20the%20UK.pdf
[15] Sourced from: https://www.bgs.ac.uk/mineralsuk/mines/aggregates.html
[16] Defra (2017) Digest of Waste and Resource Statistics – 2017 Edition. Available at https://www.gov.uk/government/statistics/digest-of-waste-and-resource-statistics-2017-edition

value of construction products of £18 billion in 2018[17]. For example, the largest construction material imported is sawn wood; the logging activity in the forest and at the timber mill will create wood waste in the country of origin (such as Sweden or Canada), but such waste at source will not be considered in scope for the working interpretation of *zero avoidable waste* in England. The same applies to a product such as a boiler manufactured in Europe and imported complete into the UK.

- The expected increase in offsite manufacturing could mean that more waste is recorded in statistics as being generated from manufacturing rather than classified in statistics as construction sector waste.

## 7. The Waste Hierarchy

The concept of the waste hierarchy, as shown in Figure 2 has been embedded within the working interpretation of *zero avoidable waste in construction*, in line with the government's Resources and Waste Strategy and the legislation following (currently) the EU Waste Framework Directive. The government is preparing the national Waste Prevention Programme which will include the construction sector as one of the key sectors.

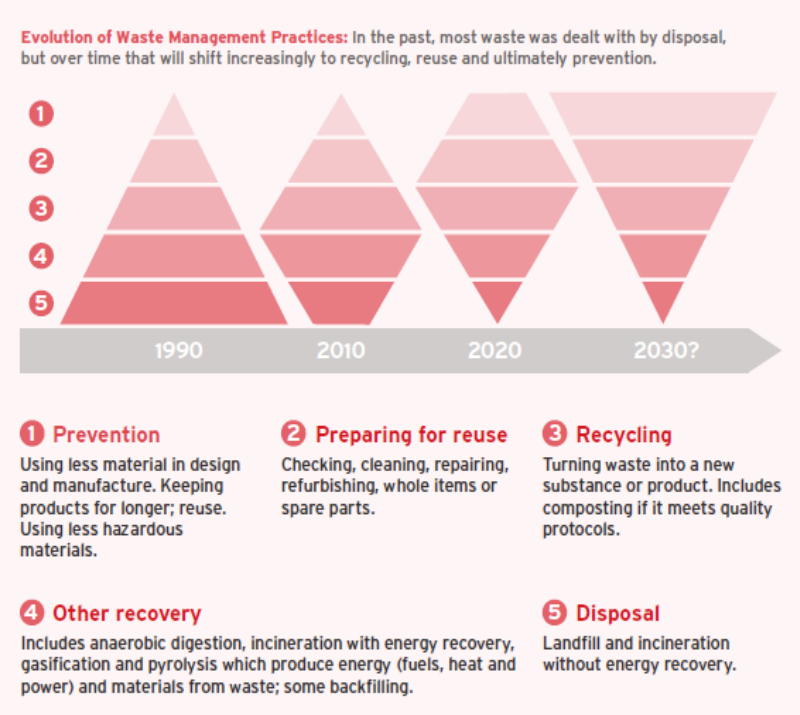


**Figure 2: The waste hierarchy and its evolution[18]**

[17] BEIS Monthly Statistics of Building Materials and Components - Commentary, June 2019. Available at: https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/813407/19-cs7_-_Construction_Building_Materials_-_Commentary_June_2019.pdf

[18] Sourced from Defra (2018) Resources and Waste Strategy, HM Government London. Available at https://www.gov.uk/government/publications/resources-and-waste-strategy-for-england

The primary objective for *zero avoidable waste in construction* is at the top of the waste hierarchy i.e. waste prevention and reuse where possible. As such the aim of the working interpretation is not to focus on lower value recycling and other recovery, and in any case most construction and demolition waste is already 'recovered' in some form (over 90% in the UK). The working interpretation of 'avoidability' allows for several areas of emphasis:

***Prevention:***

- For new buildings and infrastructure, the focus, where feasible, should be on waste prevention throughout the lifecycle. This includes designing a building to be adaptable, longer lasting, and capable of being repurposed or deconstructed for reuse.

- For existing buildings and infrastructure, demolition waste can be avoided by extending their lifetime.

- Manufacturing waste can be prevented by putting material back into the manufacturing process and being more efficient by designing it out.

- Waste arising from the construction process can be prevented through designing out waste, reducing surplus and excess construction materials and the better storage and management of materials. Avoiding single use disposable tools and packaging and increasing longevity of tools, equipment and plant will also help to reduce waste.

***Preparing for reuse, recycling and other recovery:***

- For the 55 million tonnes of non-hazardous construction and demolition waste that is recovered, the focus is to move this up the waste hierarchy into higher value reuse and recycling applications, without causing an adverse environmental impact and of course meeting the requirements of building regulations and other codes for a safe built environment. Importantly, there is also potential to prevent some of this waste occurring, although the proportion of this is not known.

- For existing buildings and infrastructure, the focus is on the recovery of materials and products, if the building's life cannot be extended or retrofitted. Examples include:
    - The remanufacture of items for further use, such as electrical equipment, although there are few examples in the construction industry.
    - Closed loop recycling, whereby waste is used in the same process, for example the use of clean offcuts and surplus plasterboard waste back into the plasterboard manufacturing process.
    - Open loop recycling, whereby waste is used in an alternative process, for example the use of waste glass into glass wool insulation[19].

- 23 million tonnes of excavation waste (47%) is recovered, of which 12 million tonnes is recovered as 'backfill', which is defined as any recovery operation of suitable non-hazardous waste for the purposes of reclamation in excavated areas or for engineering purposes in

[19] For example see: https://www.knaufinsulation.co.uk/why-knauf-insulation/veolia-partnership

landscaping. Backfilling can be an important activity, and using waste instead of virgin materials is likely to be beneficial. In some circumstances the soils could perhaps have been recycled rather than backfilled.

- One of the key principles of circular economy, is for materials to be maintained at their highest value and to avoid downcycling. However, this is not currently measured, though it is assumed that most of waste in the construction sector is downcycled (loses its value).

***Disposal:***

- For the estimated 29 million tonnes of construction, demolition and excavation waste that is disposed of, the focus is where possible, to move it away from landfill.

## 8. The different types of waste from the different construction life cycle stages

The waste from each life cycle stage of the construction process is considered separately in terms of the waste types, the activity generating it, the ability for it to be avoided and/or recovered, along with the role of offsite. These are described in more detail below.

- ***Waste from manufacturing activities:*** This will depend on the processes used, as it is often reused back into the manufacturing process and often not ever classified as a waste. This will include waste generated from offsite manufacture. With the move to more offsite manufacture, there is a need to understand the waste generated at the plant versus generated onsite. A few studies[20] have shown a reduction in waste generation, but it is less clear on the actual types of waste produced.

- ***Excavation waste***: This is largely soils, coming from the groundworks of construction projects or from infrastructure projects such as roads and railways such as Crossrail and from utilities maintenance. Whilst there can be opportunities to reduce from cut and fill, this is not the case for activities such as tunneling. Large projects can impact on the waste figures and can produce a large amount of excavation waste. Excavation waste (largely soils and stones) was around 53 million tonnes of waste in 2014. Excavation waste is defined as waste by the EU Waste Framework Directive, though as soil and stones are largely inert, it is not clear what priority to assign it.

- ***Construction waste on construction sites:*** This is generated from new build activities such as during the installation of products. Wastage may occur for a variety of reasons such as over-ordering, poor storage, design changes and workmanship. Packaging waste is also produced. Wastage rates are important here, to provide an appreciation of how much waste is avoidable and there remains the need for new research to better understand wastage rates. Construction waste will include all types of materials. Some will be mixed, making recovery more difficult.

[20] For example several WRAP studies such as Waste Reduction Potential of Offsite Volumetric Construction : http://www.wrap.org.uk/sites/files/wrap/VOLUMETRIC%20-%20Full%20case%20study.pdf and Current Practices and Future Potential in Modern Methods of Construction http://www.wrap.org.uk/sites/files/wrap/Modern%20Methods%20of%20Construction%20-%20Summmary.pdf

Previous studies have shown that waste from new build activities (excluding excavation) range from 7.7 to 12.7 tonnes million annually[21].

- ***Fit-out waste and refurbishment waste:*** This will differ in the types of materials as it includes elements that are defined as construction products such as plasterboard, doors and joinery. It also includes elements subject to different definition that are not construction products per se such as light fittings, HVAC and so on. This can encompass waste from the products being taken out which is unavoidable but could possibly be reused (therefore not a waste) as well as waste from the installation of new products including packaging. This is difficult to estimate and there is no current means of measuring how much waste there is due to its classification as either construction or demolition waste.

- ***Existing buildings:*** demolition waste is avoidable if the building lifetime is extended or elements of the buildings are reused. For buildings where these aspects have not been designed in, the focus should be on what can be done with demolition waste, estimated to be around 40-50 million tonnes[22]. By tonnage, most demolition waste is inert (around 80% of the National Federation of Demolition Contractors (NFDC) member's waste arisings) and used as hardcore. Of this, according to the NFDC, half of it is reused on site.

- ***Demolition waste***: Some of this cannot be avoided. Certain hazardous waste, for example asbestos or legacy wastes, are materials that have been used in the past which are either no longer used or are severely restricted. These are usually hazardous such as persistent organic pollutants (POPs). There may also be other hazardous waste generated from excavation, construction and refurbishment, which is unavoidable. The total amount of hazardous CD&E waste is estimated to be 1 million tonnes in 2014, although the total may be higher due to underreporting.

- ***New buildings:*** At the end of their life, demolition waste may be avoided through designing for deconstruction and subsequent reuse.

The amount of waste generated will also be influenced by different trends within the sector. For example, at the end of a recession there may be more demolition and excavation waste as many projects with groundworks may be starting at the same time. It should also be noted that a lot of waste from excavation, construction, refurbishment and demolition will be from small companies (SMEs) where the waste is relatively small in quantity and from many disparate locations. The exact quantity of this is not known. Also, as these companies are smaller, they may have less opportunities to reduce and recover this waste.

[21] Data has been taken from the CRWP Summary: Benchmarks for Construction Waste, for 2008 and 2009. Available at: http://www.wrap.org.uk/sites/files/wrap/Benchmarks%20and%20Baselines%20Summary.pdf
[22] Based on figures provided by the NFDC and the author's estimates.

## 9. Avoiding unintended consequences – minimizing environmental impact

When defining any policy or target it is important to understand any potential wider implications and thus any unintended consequences. As such the working interpretation includes the requirement '*whilst ensuring minimal environmental impact'.* There could be instances whereby avoiding waste could create more of an environmental impact. Consideration also needs to be given to the relationship with other important areas such as material usage and efficiency, energy usage and the emission of greenhouse gases. For example:

- There could be material that is used inefficiently (e.g. over specification of structural materials) but produces no or little waste. Therefore, waste prevention is likely to be achieved, but with the use of more materials and the related impact of this.

- More materials may be used to achieve an anticipated longer life for a building resulting in the building less likely to be demolished, and therefore less demolition waste occurring. For example, by designing beams for more loading to make the building more adaptable for future use. This may mean more environmental impact and embodied carbon from the outset. It could be argued that this may not necessarily be the best course of action when we need to be reducing carbon in the atmosphere now.

- Recycled content or recycling may be a more energy intensive option with greater environmental impact. For example, through the transportation of waste in circumstances where there are no local recycling plants or where a chemical process of melting and reforming uses lots of energy. Similarly, downcycling of materials may be a better option if it is replacing the use of primary materials. It is essential that life cycle assessment underpins choices.

- There may be more end of life issues for offsite systems, as they may have more complex materials/products combined that are harder to separate. Further study is needed here. Likewise, the advent of new materials and technologies may not always consider end of life implications such as embedding of sensors, glass coatings or self-healing materials.
- The increasing focus on reducing plastic could have an impact for *zero avoidable waste in construction* as plastic packaging is used to avoid waste as it provides product protection from damage.

A briefing note is included as Appendix C outlining how waste is considered within life cycle assessment which results in information in an Environmental Product Declaration.

## 10. Measurement of waste

Consideration also needs to be given to the effect of the metrics used to measure waste. Currently waste is measured in tonnage which means heavy materials dominate. However, much of this is inert and has a lower environmental impact than other materials and most of it is recovered, around 90% according to the Mineral Products Association[23]. If instead we measure in volume, then

[23] MPA (2019) From waste to resource: a UK Mineral Products industry success story. Available at: https://mineralproducts.org/documents/MPA_Inert_Waste_Feb2019.pdf

different materials, such as insulation and packaging, become more important. A different set of materials may dominate if we look at environmental impact in terms of their manufacture. Also, other materials may dominate if we look at the environmental effects of landfill. In the government's Resources and Waste Strategy, Defra has referenced a move to impact-based targets and indicators, initially focusing on greenhouse gas emissions and natural capital outcomes.

## 11. A note on data - the requirement for robust and timely data

This study has used waste figures from Defra for 2016, though the Minerals Products Association has also produced statistics for construction, demolition and excavation waste data for 2014 UK-wide. Both these sources use the same data which is from permitted facilities and activities collected via the Environment Agency. Whilst it is not in the remit of this study to develop a methodology to measure progress for *zero avoidable waste in construction,* current limitations to these waste figures and material statistics are highlighted.

- Whilst around 250 million tonnes of non-metallic mineral ores were consumed domestically in 2016, there is a lack of information on the breakdown of these materials and where they were used.
- There is a need to consider construction, demolition and excavation waste data separately. Whilst excavation waste data can be separated in national waste statistics, construction and demolition waste data is usually lumped together, making it difficult to understand the amount that is potentially 'avoidable'.
- Manufacturing waste data, as already mentioned, may also be classified differently to construction and demolition waste.
- There are lots of assumptions made about construction, excavation and demolition waste data in terms of their recovery and disposal routes. For example, how much is landfilled or recovered via energy incineration after being treated at a waste transfer station.
- The descriptions and codes that are used for material usage and waste are not always the same, which can make it difficult to track material flows.
- There is a lack of granularity for waste types and recovery routes for the amount arising, as a lot is classified as mixed waste.
- It can be difficult to know the source and cause of waste, particularly for new construction.
- Understanding the types of waste originating from the construction sector that are used as feedstock back into the same or other products, thereby negating the need for primary materials, would be beneficial.
- There is currently no requirement to record waste materials that have been declared non-waste

Defra and the Environment Agency are aware of these limitations which also apply to waste originating from other sectors. As such, Defra is working on developing better waste data through the creation of smart waste tracking systems and the establishment of a National Materials Hub. Moreover, digitalisation and the understanding and better knowledge it will bring to our infrastructure and building assets may aid in the reduction and recovery of materials, as well as better data through waste tracking systems. This is a key focus of the Construction Sector Deal and the Transforming Construction Challenge Fund.

## Appendix A: Members of the GCB Resources and Waste Task Group

| **Name** | **Affiliations** |
|---|---|
| Katherine Adams | ADW Developments, Loughborough University and BRE (Principal Technical Author) |
| Jane Anderson | Open University and UK Expert on European CEN 350 & EN15804 standards. Co-Author of the BRE Green Guide to Specification. |
| Noemi Arena | Costain |
| Heidi Barnard | Saint-Gobain British Gypsum and Chair CPA Packaging Task Group. (*No longer at Saint Gobain*). |
| Howard Button | National Federation of Demolition Contractors (NFDC) |
| Gary Clark | Wilkinson Eyre and Chair of RIBA Sustainable Futures Group |
| Fionnula Conway | BEIS, GCB Co-Secretariat |
| David Crowhurst | BRE and Chair of BSI B/558 Committee on life cycle standards for construction, the UK Shadow Committee for CEN TC 350 |
| Maya De Souza | Defra |
| Hattie Emerson | Mace |
| Peter Kelly | ISG and Chair of CIWM Construction and Demolition Waste Group |
| David Manley | Forterra and Chair of the Resource Efficiency Action Plans for bricks, blocks and precast concrete |
| Louis Mercier | Defra |
| Joel Murray | Defra |
| Kate Nicholls | Defra |
| Oladipo Okusaga | BEIS |
| Dr Mohammed Osmani | Loughborough University and Chair BS 8895 Committee on designing for resource efficiency |
| Robert Pearce | Haskoll Architects and GCB Board Member, Resources and Waste (Chair) |
| Sam Ralph | Defra |
| Simon Rowley | BEIS |
| Mike Sansom | Steel Construction Institute |
| Susie Tomson | PSCG |
| Guy Thompson | Mineral Products Association and Concrete Centre |
| Jane Thornback | GCB Co-Secretariat and CPA Sustainability Advisor, GCB Resources and Waste Co-Chair |
| James Winpenny | Defra |
| Graham Winter | Waste Strategy Team, Environment Agency |

## Appendix B: Relevant Government Strategies

***Resources and Waste Strategy[24]***

The Resources and Waste Strategy published in 2018 applies to England and sets out how the government will preserve material resources by minimising waste, promoting resource efficiency and moving towards a circular economy in England. It is in line with the 25 Year Environment Plan, in which the government pledged to leave the environment in a better condition for the next generation. The Strategy includes high level ambitions of eliminating avoidable plastic waste over the lifetime of the 25 Year Plan (2042), doubling resource productivity, and eliminating avoidable waste of all kinds by 2050. The Strategy has sections on sustainable production, helping consumers take more considered actions, resource recovery and waste management, waste crime, food waste, leadership, research and innovation and measurement.

***Waste Prevention Programme[25]***

The Waste Prevention Programme (WPP) is a requirement of the revised EU Waste Framework Directive (2008/98/EC) and was last produced for England by Defra in 2013. The aim of the programme is to *'improve the environment and protect human health by supporting a resource efficient economy, reducing the quantity and impact of waste produced whilst promoting sustainable economic growth'*. The programme includes several measures such as standards for reuse, leasing models, repair of products, a waste prevention loan fund and a set of metrics though none are specifically targeted at the construction sector. A new programme is expected in 2020 with the construction sector likely to feature as a priority sector.

***Industrial Strategy[26]***

The Industrial Strategy, published in 2017, is a White Paper which is based on five foundations for productivity: ideas, people, infrastructure, business environment and places. The Strategy sets out four grand challenges for the UK and the wider economy including artificial intelligence and data revolution, clean growth, the future of mobility and the needs of an ageing society and intends to support innovation to help deliver a new industrial revolution to address these challenges. The Strategy includes a number of commitments including financial support to progress these challenges such as Industrial Strategy Challenge Fund programmes. The construction sector is identified as a priority business sector and a Construction Sector Deal is part of the Strategy.

***Industrial Strategy: Construction Sector Deal[27]***

The Construction Sector Deal sets out an ambitious partnership between the industry and the government that aims to transform the sector's productivity through innovative technologies and a more highly skilled workforce. The Sector Deal builds on Construction 2025[28], published by the

[24] Defra (2018) Resources and Waste Strategy, HM Government London. Available at https://www.gov.uk/government/publications/resources-and-waste-strategy-for-england

[25] For more details go to: https://www.gov.uk/government/publications/waste-prevention-programme-for-england

[26] HM Government (2017) Industrial Strategy Building a Britain fit for the future, London. Available at: https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/664563/industrial-strategy-white-paper-web-ready-version.pdf

[27] https://www.gov.uk/government/publications/construction-sector-deal

[28] https://www.gov.uk/government/publications/construction-2025-strategy

government and the Construction Leadership Council (CLC) in 2013, and provides the framework for a sector that delivers:

- a 33% reduction in the cost of construction and the whole life cost8 of assets
- a 50% reduction in the time taken from inception to completion of new build
- a 50% reduction in greenhouse gas emissions in the built environment –supporting the Industrial Strategy's Clean Growth Grand Challenge
- a 50% reduction in the trade gap between total exports and total imports of construction products and materials

These goals will be met by focusing on three areas: digital techniques, offsite manufacturing and whole life asset performance. The government and the sector are investing in the Industrial Strategy Challenge Fund (ISCF) Transforming Construction programme, as well as supporting training and infrastructure projects.

## Appendix C: Briefing note on Waste and Recovery, Environmental Product Declarations, Building Life Cycle Assessment

*By Jane Anderson, ConstructionLCA Ltd*
July 2019

This briefing note sets out how waste and recovery are dealt with in Environmental Product Declarations (EPD) and Building Life Cycle Assessment (LCA).

EPD are now widely used to provide information about the environmental impacts of manufacturing, using and disposing of construction products. The European Standard, EN 15804:2012+A1:2013 sets out Product Category Rules for the development of EPD for construction products, to ensure that all types of construction products are assessed consistently using the same methodology and approaches. EN 15804+A1 has been widely adopted not only in Europe, but in North and South America and Australasia and there are now over 6000 EPD for construction products to EN 15804 available globally. There are around 200 EPD covering UK produced construction products.

EN 15804 divides the product life cycle into four stages and then into Information Modules:

- The product stage (Modules A1-A3) covering all processes from extraction from nature until the product is ready to leave the factory gate (Cradle to gate);
- The construction stage (Modules A4-A5) covering transport to site and installation on site;
- The use stage (Modules B1-B7) covering emissions from the product in use, and maintenance, repair and replacement over its service life in the building, and any energy or water consumed by the product in use; and
- The end of life stage (Modules C1-C4) covering demolition/deconstruction, transport to waste processing and waste processing and disposal.

These stages and modules cover the product life cycle, so cover what is within the System Boundary. All Modules beyond the factory gate are assessed on the basis of scenarios. Scenarios shall be realistic and representative of one of the most probable alternatives and shall not include processes or procedures that are not in current use or which have not been demonstrated to be practical using current processes and approaches.

***How is waste assessed in the EN 15804 methodology for EPD?***

Based on the Polluter Pays principle, the product life cycle and system boundary also includes all processes in relation to use of recovered material and fuel from the point at which the recovered material or fuel stops being waste (the “end of waste state”) and all processes in relation to treatment and recovery of waste until it stops being waste (the “end of waste state”). So the System boundary is the End of Waste state.

EN 15804 also uses a “100:0” recycling allocation methodology – so all the impacts of using primary materials and recovered material from the point it enters the product system are allocated to the product and no impacts from production are allocated to any future recycling. This means that recovered materials entering the product system do not bring with them any impacts from the previous system.

The End of Waste state is defined using the terms of the EU Waste Framework Directive; the criteria to define when the end of waste state is reached are:

- The recovered material, product or construction element is commonly used for specific purposes;
- A market or demand, identified e.g. by a positive economic value, exists for such a recovered material, product or construction element;
- The recovered material, product or construction element fulfils the technical requirements for the specific purposes and meets the existing legislation and standards applicable to products;
- The use of the recovered material, product or construction element will not lead to overall adverse environmental or human health impacts.

As the Directive is transposed into legislation in each Member State, there are differences in the way in which these criteria are interpreted. Equally in some Member States use of some recovered materials or products is not common or there is not yet a market or demand, whereas in others the market is well developed, so there are reasons why for the same material it might be a waste in one place and a recovered material in another.

But within Europe, you can tell when a recovered material or secondary fuel enters your system based on the point at which it stops being covered by Waste legislation and starts being covered by product legislation such as REACH for example.

***How is the benefit of recovery in the next product system recognised in EN 15804 EPD?***

Beyond the system boundary, Module D of an EPD provides information about the benefits of recovery in the next product life cycle. This is because the "100:0" recycling methodology used gives all the benefit of recycling to the product using the recycled material and does not show any benefits to products which are recycled. Module D should not be added to Modules A-C to give a total impact for the product as this will be double counting the benefits of recycling at both the input and output side, and will contravene the use of a consistent product system boundary applied at both the input and output side. As with other modules beyond the factory gate, Module D is also assessed using current approaches in common use.

***How is waste and recovered material reported in EPD?***

EPD include a number of inventory indicators which describe flows of waste and recovered material.

At the input side, the following indicators are provided:

- Use of secondary material - kg
- Use of renewable secondary fuels - MJ, net calorific value
- Use of non renewable secondary fuels - MJ, net calorific value

These indicators are normally manually calculated just for the foreground system (the system within the manufacturer's control) based on the inputs used. Unfortunately, most LCA databases do not include this information within the LCI for datasets, though it might be in the textual

documentation. This is because the International Life Cycle Database (ILCD) nomenclature does not include it.

Use of secondary material will not be directly translatable to "recycled content". This is because the use of secondary material is measured as the material enters the product system. Recycled content would need to take account, for example, of loss of material through wastage or loss of moisture content for example. However, comparing Use of secondary material to the mass of the product's declared unit (the **reference** unit for the EPD) will give a good indication of the recycled content of the product.

On the output side, the following indicators are provided:

- Hazardous waste disposed - kg
- Non hazardous waste disposed - kg
- Radioactive waste disposed – kg

Article 3(1) of the new Waste Framework Directive (WFD) defines waste as 'any substance or object which the holder discards or intends or is required to discard'. Under Article 3(19) WFD, the definition of 'disposal' is: 'any operation which is not recovery even where the operation has as a secondary consequence the reclamation of substances or energy.' So in this context, "waste disposed" means waste which is sent to either landfill or to incineration with energy recovery below 60%. Bear in mind that waste sent for recovery may not be 100% recovered thus can also result in waste sent to landfill or incineration. Energy recovery processes will also result in ash which may be sent to landfill.

These indicators are normally manually calculated for A1-A3 just for the foreground system (the system within the manufacturer's control) based on the waste being disposed **of in landfill or incineration** with energy recovery of <60% efficiency. This is because LCI databases based on ILCD do not include this information (at present ecoinvent does include this). This means that a product may be associated with large quantities of waste disposal in the supply chain (for example during extraction) which are not measured using this indicator.

They are also calculated for the gate to grave modules based on the amount of waste sent to landfill or incineration with energy recovery efficiency <60% in the specific scenario for each module.

*For example, if in A5 (construction), the product declared unit is 1 kg and the wastage is non-hazardous and 5%, with 100% sent to landfill, then in A5, 0.1 kg will be reported as Non hazardous waste disposed.*

There are also recovery indicators:

- Components for re-use - kg
- Materials for recycling - kg
- Materials for energy recovery - kg
- Exported energy - MJ per energy carrier.

Again, these are normally manually calculated just for the foreground system based on the material/fuel or energy leaving the system boundary, and are not normally found in LCI Databases based on ICLD. They are also calculated for the gate to grave modules based on the amount of recovered material, secondary fuel or recovered energy leaving the system in each module.

*For example, if in C3 (End of life recovery), the product declared unit is 1 kg, with no further processing required before the waste reaches the end of waste when it arrives at the waste*

*processor, with 50% sent to energy recovery and 50% sent to recycling, then in C3, 0.5 kg will be reported as materials for recycling and 0.5 kg will be reported as materials for energy recovery.*

***EPD and the Circular Economy***

As mentioned above, EPD use the 100:0 approach to recycling which recognises the benefit of recycling for those using recycled material. This approach has been used in construction because most construction products have very long lives – there is therefore a greater focus on trying to recognize and encourage recycling now rather than potential benefits at end of life in many years time, when recovery infrastructure may be very different. Construction is, in fact, one of the major users of recycled material but could use more recycled material and could reduce the amount of downcycling which is used. The CIRIA Mass Balance, published in 2002, identified that construction products used nearly 70 million tonnes of recycled, reused or secondary materials, around 18% of the total mass of final products sold.

Recovery at end of life for construction is also already high, DEFRA figures suggest 88.9% for construction, demolition and excavation waste, although the figures across Europe vary more widely and much of the recycling is “downcycling”. But again, the existing high recovery rates suggest that the focus is correct to be more on current use of recycled content.

Some suggest that including Module D in the calculation of impact by adding it to the impacts for the product life cycle (A-C) accounts for the Circular Economy. However, this is a misunderstanding, as it double counts the benefit of recycling at both the input and output side. Also, using the EN 15804 calculation rules, there is no real difference in the impacts for A-C+D for a virgin product, which is 100% recycled at end of life, and a 100% recycled product of the same material which itself is also 100% recycled (truly circular). This does not seem to be correct in terms of encouraging the use of recycled material as we must do to achieve a circular economy.

**Construction Leadership Council**

The Construction Leadership Council (CLC) draws together government with business leaders from across the sector with the aim of reducing the time to build and the cost whilst also improving sustainability outcomes. Through the Construction Sector Deal it has identified three key enablers to deliver this transformation: digitalisation to deliver better, more certain outcomes, off-site manufacturing to improve productivity, quality and safety, and by addressing whole life performance to improve energy performance, lower emissions and reduce running costs. The Council has Co-Chairs, one a leader from industry and the other the government Construction Minister. The CLC works through a number of different workstreams and task groups.
www.constructionleadershipcouncil.co.uk

**Green Construction Board**
The Green Construction Board (GCB) is the sustainability workstream of the Construction Leadership Council. Participants are key members of the UK construction and property industry. Its main role is to advise government and the built environment industry on the regulatory and policy framework and actions required to overcome barriers to the delivery of green buildings and infrastructure as well as to promote the commercial opportunities of sustainable construction. Progress on activities is reported via the GCB Chair into the Construction Leadership Council.
www.constructionleadershipcouncil.co.uk/workstream/sustainability/

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