SUSTAINABILITY

and the

Civil Engineering Surveyor

A white paper

Chartered Institution of

Civil Engineering Surveyors

September 2024

Executive summary

This white paper is the result of a number of drivers, from an identified need within the CICES membership to understand more about how their actions (and inactions) can impact sustainability deliverables, to the wider societal and geopolitical urgency of the ongoing climate emergency crisis.

It aims to better define the current landscape of sustainability, its understanding in civil engineering surveying terms, how it is being addressed by organisations in the sector and what further steps still need to be taken.

The paper also highlights the need for early engagement of civil engineering surveyors during procurement and initial project stages, in order to leverage their professional expertise to deliver cost savings, tighten deadlines and most importantly, identify positive impacts that can be made from a sustainability aspect.

Lastly, it incorporates existing examples of such impacts already being made by CICES members and signposts to available resources that civil engineering surveyors can access in order to support their own efforts to help clients, employers and colleagues make more informed decisions about sustainability.

Introduction

Our profession faces a challenge: how to address the immediate and longer-term effects of climate change and develop more sustainable ways of working. You'll be aware of (and possibly helping shape) plans that your own organisation has to reduce its environmental impact.

It's self-evident that, currently, the levels of training provision, investment and assessment within the wider built environment industry- let alone the civil engineering surveying sector - are insufficient to achieve the required goals.

Members of the Chartered Institution of Civil Engineering Surveyors (CICES) have been asked to provide their expertise and experience to help assess:

- The current situation from the point-of-view of the civil engineering surveyor (CES)
- What the institution can realistically expect to do about it

Document status

This document is intended to remain, updateable and adaptable, in order to endure as a guide, in step with our profession and our planet.
It is clearly aligned to one of our institution's three 'Golden Threads' (sustainability) but should also acknowledge and reflect the other two (digitalisation and EDI).

In producing a white paper such as this, CICES members and contributors should regard all three as threads that will remain central to the institution and wider society as a whole. And as these threads develop as core themes throughout our professional and personal lives, it's hoped that this document should reflect this and continue to evolve along with our understanding and practices.

What this document is:

A current view on 'sustainability and the civil engineering surveyor', aiming to provide guidelines for what CICES members can do to help enable a sustainable society and minimise our impact on developing the world, as professionals working in the construction of society's infrastructure.

What this document is not:

A climate change 'explainer', or list of reasons to support sustainability - there is no discussion about whether we have a problem to solve or not. Indeed, it is assumed the reader is familiar with the following sentiment - if not the exact quote: 'Take only memories, leave only footprints.'[1]

In understanding the context of such a statement, we can better respond to the requirements of sustainability in today's society, which will of course change again over the next 25 years.

1 This maxim is often attributed to Suquamish and Duwamish leader Chief Seattle, who was known for his 'powerful, bittersweet plea for respect of Native American rights and environmental values'.

Sustainability

This paper assumes a certain amount of prior knowledge but clarification of certain areas is required for a common understanding. For the purposes of the document, we use the meaning of sustainability from the United Nations Brundtland Commission's 1987[2] definition:

'Meeting the needs of the present without compromising the ability of future generations to meet their own needs.'

When the word 'sustainability' is heard, it is reasonable to imagine an ideal of living 'in harmony' with the environment. But some may struggle to understand how they can change their lifestyle to lower their impact and influence on climate change. Or worse, they may dismiss or ignore it as pointless and already too late to fix.

Economist Kate Raworth provides clear context and a startpoint on how we need to behave sustainably and the constraints we need work within societally, with her illustration of the concept of 'Doughnut Economics'.[3] This is a development similar to the concept of the nine 'planetary boundaries' outlined since 2009 by the Stockholm Resilience Centre.[4]

It also seems sensible as civil engineering surveyors to align our thinking with the 17 'Sustainable Development Goals' (SDGs) defined by the United Nations.[5] For example, Goal Nine:

'Build resilient infrastructure, promote inclusive and sustainable industrialization and foster innovation.'

What is the context for the civil engineering surveyor?

The CICES motto: omnia metimur quae videmus, translates as 'we measure all that we see'. Our daily duty is to track, report and inform project stakeholders to make better decisions for everyone impacted by construction.

As described in the 2016 publication, 'Survey4BIM and the Digital Plan of Works'[6], our members can be involved at all stages of an asset's life cycle and therefore have a professional duty to uphold whenever consulted. This includes checking and challenging these measurements to understand the uncertainties.

What will we address?

We are required to discuss the existing CICES sustainability policy in terms of what the CES can contribute to act sustainably in relation to the four topics highlighted above.

But we also aim to deliver ideas and suggestions on what could (and should) become 'business as usual' in considering the ideals of:

- Leading by example
- The concept of marginal gains
- The idea of 'think global and act local'

What does our sustainability maturity look like?

In April 2023, CICES members were surveyed via email to ascertain what sustainability means in the context of the CES. The survey focussed on three areas: economic, environmental and social responsibility, as defined below.

- Economic

(Striking a balance between costs and environmental & social benefits of civil engineering projects)

- Environment

(Reducing the environmental impact caused by civil engineering projects)

- Social

(Improving the quality of lives of people and communities through civil engineering projects and associated activities)

This survey was an example of highlighting the requirement within the profession to apply 'Systems thinking' - fundamental to any assessment of sustainability, it's application and in which context(s) it should be considered.

A November 2023 executive summary by the US based National Academy of Construction[7] defines Systems Thinking as:

'...a fundamentally new skillset that the construction industry requires. Today's engineers must understand the psychological, cultural, economic, political and environmental implications of their decisions.'

2 http://www.un-documents.net/our-common-future.pdf

3 https://www.kateraworth.com/doughnut/

4 https://www.stockholmresilience.org/research/planetary-boundaries.html

5 https://sdgs.un.org/goals

6 https://survey4bim.wordpress.com/wp-content/uploads/2017/08/survey-and-the-digital-plan-of-works.pdf

7 https://www.naocon.org/wp-content/uploads/Member-Viewpoint-Systems-Thinking-For-the-Construction-Industry.pdf

The submissions of 120 responders (representing approximately 2.67 percent of membership) were collated and analysed in terms of how each of the three definitions was seen to apply to A) their employer or organisation and B) their institution (CICES).

It should be acknowledged that, from a surveyed membership of over 4,700 individuals, 120 responses does not represent an ideal uptake - but without further follow-up surveying of members, it's impossible to establish to what extent this lack of engagement was due to disinterest or simply lack of clear knowledge.

However, the responses received still serve to give an indication of the overall perception of how sustainability is currently understood, discussed and applied within the employer organisations of CICES members.

Upon analysing the responses, it was apparent that more weight was placed on the environment and social sustainability than on economic sustainability. It also became clear that a further, more holistic, definition of sustainability in this context was required, that would:

- Provide a heightened emphasis on enhancing (rather than merely minimising the impact on) various stated areas, while also retaining a viable commercial focus
- Highlight the need for appropriate management of any unavoidable impacts, including engagement of communities and stakeholders as much as possible in the project needs assessment
- Widen the focus area to incorporate more than just civil engineering projects

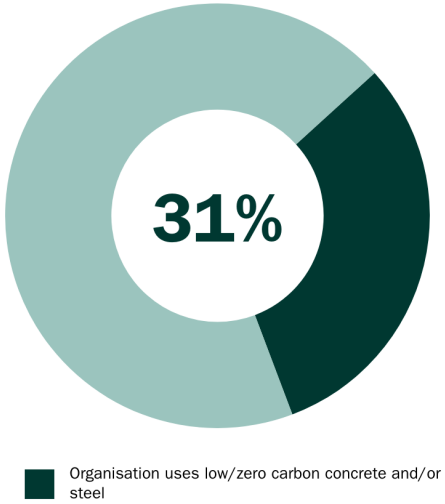
This new definition - suggested, refined and reached by consensus - runs as follows:

'To minimise the negative effects of construction on the environment and society, while also improving the quality of life for people in the communities where we operate, all while maintaining a profitable business.'

Environmental sustainability

Most of the survey respondents (93 percent) said that their organisations address environmental sustainability through the 'use of standard delivery streams', with the next most selected options being 'reduced business travel/opting for virtual meetings' and 'electrification of fleet'.

While the first two options are easy wins, it's encouraging to see 70 percent of respondents have witnessed fleet electrification in their organisations, which is one of the key priorities of the UK government's agenda on Net Zero.



However, based on the responses, the majority of the organisations tend to stick with the standard delivery streams instead of exploring low-carbon alternatives. This is further affirmed by the responses where only 31 percent of respondents confirmed that their organisations use low/zero carbon concrete and/or steel. This may be due to a lack of awareness, cost considerations and/or supply chain constraints.

On the other hand, it's encouraging to see that 61 percent of the respondents are working to an environmental management standard like ISO14001 and 52 percent are procuring locally sourced materials where appropriate.

It's interesting that 36 percent of the respondents said that flexible working is supported by their organisations - a popular trend post covid, which helps reduce Scope 1 and 2 organisation-level emissions.

'Use of renewable energy sources' scored low, with only 21 percent of respondents seeing it adopted in their organisation, reflecting the industry-wide slower uptake - however, the greening of the grid sees no need for this.

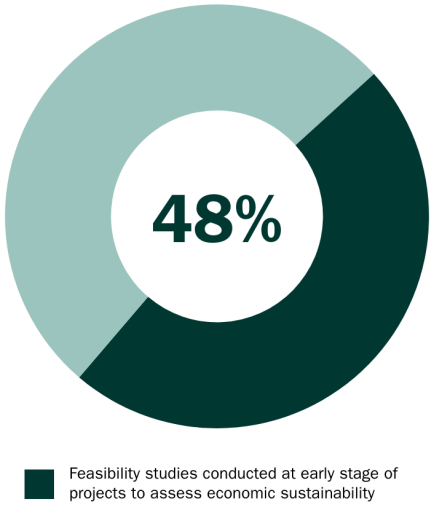
Economic Sustainability

Economic sustainability is practised mainly by 'appraising alternative options', 'engaging the project team earlier on in the project' and 'hybrid working' as per the survey findings.

Half of all respondents said their organisations opt for standardised materials to achieve economic sustainability.

This suggests that the industry believes that the use of standardised materials reduces both emissions and costs.

But it's important to note that this only considers capital cost - and an industry-wide application of life cycle costing and carbon assessments in evaluating alternatives is lacking.



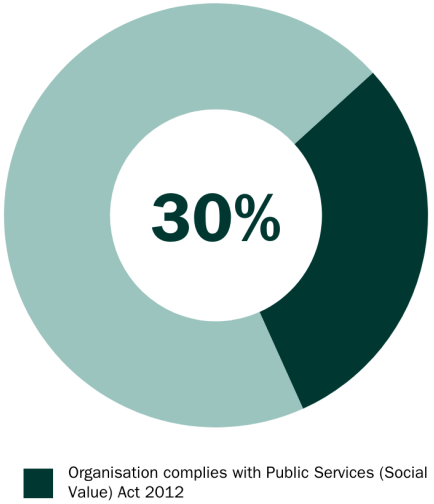
Furthermore, 48 percent of respondents said feasibility studies are conducted in early stages of projects to assess the economic sustainability of projects, which is surprising as it is expected that almost all civil engineering projects bypass this stage to justify public spending.

With regards to Design for Manufacture, Assembly and Disassembly (DfMAD), only a quarter of the respondents have witnessed their organisations supporting DfMAD.

Social Sustainability

'Prioritising employee safety' was voted as the primary way of ensuring social sustainability in civil engineering organisations, followed by 'engaging with educational establishments to share best practices' and 'ensuring fair pay'.

Nearly 50 percent of the respondents have said that their organisations 'invest in community projects' to support communities within which they operate and support employees through 'company social groups' and other 'initiatives in the workplace' to improve employee wellbeing.



However, only 30 percent of respondents noted that their organisations comply with the Public Services (Social Value) Act 2012[8], which requires people who commission public services to think about how they can also secure wider social, economic and environmental benefits.

This low number may be due to a lack of awareness or of communication from the top management to the lower levels of employees on how their projects comply with the act.

8 https://www.legislation.gov.uk/ukpga/2012/3/enacted

What can we do?

The reality of sustainability

For surveyors on site - both commercial and geospatial - it's a challenge to identify how to reconcile the idea of sustainability with the processes of the profession. In many instances, the work a CES is engaged in can destroy habitats - but on the other hand, humanity requires improvement and development in housing and infrastructure. For this reason, it's potentially easier to see what actions can be taken at a pre-design stage regarding sustainability to try to minimise the negative impacts.

Not least, the application of a 'Systems thinking' type mindset, as highlighted earlier in this paper, should help a CES form a more holistic view of projects from the outset and better enable them to make the most appropriate recommendations for clients and other stakeholders.

The recommendations and suggestions of an 'evergreen' white paper would help give the surveyor at site level the confidence of knowing they have the support of the institution behind them. And by signposting to existing resources, such as EPC Certificates and the Energy Saving Trust[9], CICES can support members in making better choices in understanding how their own personal actions can contribute to sustainable efforts.

9 https://energysavingtrust.org.uk/

Early engagement

It is apparent that there is a growing sense of urgency among CICES membership and the wider profession about the current climate emergency. And while the evocative impact of media-friendly statements such as 'you can't have business on a dead planet' is clear, it is incumbent on civil engineering surveyors to work towards more tangible and positive outputs.

Regardless of personal motivations for entering and progressing within the profession, all civil engineering surveyors are dependent on environments for work and livelihood. The institution, via this white paper, needs to establish recommended actions and leadership, to support each member on their own sustainability journey.

It is also the intention of CICES to do everything possible to support civil engineering surveyors in ensuring their unique expertise isn't overlooked when it comes to facilitating discussions around sustainability. Employers, designers, engineers, developers and other stakeholders need to be made aware that civil engineering surveyors can draw on a wealth of specialist expertise that is often underutilised for a variety of reasons.

Client education and clear signposting to these skillsets is essential if civil engineering surveyors are to influence decisions made at the very outset of a project. This early engagement is essential if those relevant parties want to make better decisions based on the specialist knowledge of our professionals.

For example, the capital cost of any sustainability objectives needs to be allowed for in the cost plan and funding envelopes for projects. Without this measure in place at an appropriately early stage, projects run the risk of funds for sustainability objectives being reduced or removed altogether.

In another potential example, a project may be required to attain a certain standard, such as the ISO 14000 family of standards for environmental management, or PAS2050[10]/PAS2060[11]. In such instances, it makes commercial sense to engage a CES at an early stage to assess whether an alternative, more cost-effective standard (e.g. BREEAM[12]) can be recommended.

The rail sector provides an example of how early engagement can yield effective measurement and tracking of carbon impact from concept to completion. The Rail Safety and Standards Board's 'Rail Carbon Tool'[13] is used to help inform key decisions to better meet sustainability objectives. But to be truly effective, it needs to be included in the project requirements from the outset so that suppliers can price resources accordingly.

Adequately remitting sustainability goals and methods from the outset removes the complexities associated with incorporating these requirements at a later stage, such as potential time or cost impacts.

10 https://knowledge.bsigroup.com/products/specification-for-the-assessment-of-the-life-cycle-greenhouse-gas-emissions-of-goods-and-services?version=standard

11 https://knowledge.bsigroup.com/products/specification-for-the-demonstration-of-carbon-neutrality-1?version=standard

12 https://breeam.com/about/

13 https://www.rssb.co.uk/sustainability/net-zero-carbon-rail/rail-carbon-tool

Early engagement of a civil engineering surveyor helps to embed objectives from the start and results in better advice on benefits and capital costs. Often, the capital costs associated with achieving sustainability goals can be offset by - or at least measured against - the many benefits they bring.

Of course, if the benefits of early engagement are numerous and varied, it follows that a lack of involvement of a civil engineering surveyor at an initial stage of a project life cycle can have a negative impact.

For example, projected cost plans may not adequately allow for time and outlay required to correctly embed sustainable practices into the activity schedule. These should be remitted to a civil engineering surveyor, so suppliers can be better informed on which route to take and resources to allow for.

Further chances can also be missed during the procurement process, as supply chain partners may be able to offer new suggestions for achieving client goals, which can then be incorporated as part of the tendering process.

But without the input of a civil engineering surveyor at this crucial stage, it is far less likely that any procurement model will have this window of opportunity embedded in it.

If interventions are made early in a project lifecycle, the more accurate the included stated objectives and outputs will be. And if these 'baseline' sustainable goals are prioritised in the project requirements and incentivised correctly, they're more likely to be met successfully.

Case study: Early stakeholder engagement, Network Rail GNGE Project

This project involved a massive level-crossing enhancement and bridge reconstruction program, impacting numerous stakeholders. Cogitamus was recruited to manage communications and reduce project risks. Their strategy centered on early stakeholder identification and engagement, including direct interaction with 30 communities through public exhibitions and meetings. They established a Key Stakeholder Group and maintained ongoing communication with various parties.

This engagement also aided stakeholder understanding of the project journey and intentions, resulting in better risk management, clear buy-in to the specifications and designs, lessening the potential for costly reworking at a later stage.

The engagement program served to inform, consult and build partnerships, helping to align work phases with local needs. The completed project left a positive community legacy and was nominated at the National Transport Awards.

Further reading: https://cogitamus.co.uk/case_study/stakeholder-engagement

The role of a commercial CES: Be sustainability competent, engage early in the procurement process, advise clients on sustainable alternatives considering the life cycle of the asset and support decision-making processes.

The role of a geospatial CES: Understanding that 'everything happens somewhere' is a key to sustainable decision making. Advising clients early on existing situations allows better or alternative solutions to be correctly evaluated for impact.

Circular economy

'A circular economy (CE) sees products and materials recycled, repaired and reused, and waste from one industrial process becomes an input into another.'

ChathamHouse.org[14]

Circular economy is often pigeonholed as a strategy for waste management or recycling - both already familiar to the engineering surveyor operating in the infrastructure sector. But if we frame the circular economy model in broader terms, then there is significant scope for our profession to take advantage of a diverse range of opportunities. A helpful illustration of this is presented on the website of The Ellen MacArthur Foundation[15], one of the leading authoritative voices for the circular economy.

A circular economy contributes to several SDGs directly or indirectly, such as:

- SDG 6 (Clean Water and Sanitation)
- SDG 7 (Affordable and Clean Energy)
- SDG 9 (Industry, Innovation and Infrastructure)
- SDG 11 (Sustainable Cities and Communities)
- SDG 12 (Responsible Consumption and Production)
- SDG 13 (Climate Action)
- SDG 15 (Life on Land)

All by ensuring efficient use of resources and minimising degradation, waste and emissions.

As an economic system, the circular economy leads to an outcome where materials never become waste and nature is regenerated. Products and materials are kept in circulation through processes like maintenance, reuse, refurbishment, remanufacture recycling, and composting. It can be a key enabler to tackle global issues such as climate change, resource scarcity, biodiversity loss, waste and pollution.

But to understand how this applies to construction or engineering specifically, it helps to consider construction's 'carbon debt'. This refers to the embodied carbon already locked into existing buildings and infrastructure - the things that are already built. If we consider the traditional, linear approach to construction, the way we design, construct and eventually demolish our built environment is entrenched in the linear 'take-make-waste' economy.

The UK Green Building Council's report: 'Trends in Sustainable Solutions in the Built Environment 2023'[16] states that:

Globally, the built environment currently accounts for around 50% of global resource extraction. In the UK, construction, demolition and excavation generated 62% of total UK waste in 2018.

The UK Government has long since acknowledged the importance of addressing issues such as the above statistics, with the introduction of measures such as the Circular Economy Package policy statement.[17]

But the impacts that matter need to be seen in practice as well as in theory - it is crucial that active recommendations are taken forward and applied, not simply stated.

By leading on the drive to a circular economy, UK professionals can help their employers avoid negative perceptions such as 'greenwashing' or 'inactivity', as well as provide a better example to emerging or mature economies where built environment development is growing exponentially, particularly outside of Europe.

Because, regardless of individual nation commitments and guidelines for implementing a built environment circular economy, the overall global trajectory is a concerning one.
The ongoing international demand for building materials and resources such as steel, cement, aluminium and energy is not sustainable at current rates.

'The total square footage of buildings worldwide is expected to double by 2060 to accommodate population growth, mostly in developing countries. Essentially, the construction sector will add the equivalent of New York City every month, for the next 40 years.'

The Carbon Almanac, 2022.[18]

In 2014, the global cement industry produced 2.5bn metric tonnes of carbon dioxide emissions - more than any country other than China or the United States - and almost nine percent of all human-caused carbon emissions.[19] With every kilo of cement produced resulting in an equivalent kg of CO2 emitted, this is an issue that needs to be addressed, with more urgency

14 https://www.chathamhouse.org/topics/circular-economy

15 https://www.ellenmacarthurfoundation.org/circular-economy-diagram

16 https://ukgbc.org/solutions/trends-in-solutions-2023/

17 https://www.gov.uk/government/publications/circular-economy-package-policy-statement/circular-economy-package-policy-statement

18 The Carbon Almanac (Godin et al, 2022)

19 https://www.scientificamerican.com/article/solving-cements-massive-carbon-problem/

than we're currently witnessing.

But demand for cement and concrete has been growing steadily in the decade since then and is predicted to reach between 12-23 percent above 2014 levels by 2050. This forecast is underlined by the fact that 4.3bn metric tonnes of cement were produced in 2021.

When considering what a CES can do to address this trajectory, it makes sense to heed the recommendations of the Ellen MacArthur Foundation[20]:

'By rethinking the way we design our built environment, using new technologies and innovative business models, we can realise more value from existing assets, keep resources and building materials in the economy and stop them from becoming waste.'

There is widespread recognition, both in our profession and related ones, that the replacement of buildings and infrastructure will invariably entail high energy and resource consumption. In addition to the aforementioned embodied carbon, the energy used in the potential demolition, recycling and disposal of waste - even before any new works commence - adds up to a significant level of consumption.

With that in mind, it's clear that more needs to be done by stakeholders in terms of communicating the benefits of improving existing buildings and infrastructure, rather than removing and replacing. And of course, the lower levels of financial outlay involved may be the first factor to move the needle, even for those parties less convinced of the sustainability merits of the circular economy. As an advocate for advancing both historic preservation and green building practices by highlighting the importance of existing buildings, it's worth the CES remembering the phrase coined by former president of the American Institute of Architects, Carl Elefante[21], who said:

'The greenest building is the one that is already built.'

Case study: Circular economy, Tideway Thames Tunnel

Sustainable innovation applied throughout the full journey of the Thames Tunnel aimed to reduce the amount of carbon intensive material used, by including environmental teams early in the planning stages and by utilising carbon assessments.

Environmental and financial value was added to the project as follows:

- Redesigning the shaft base slab from a flat bottom to a dome used 1500m^3 of concrete compared to an estimated 3500m^3
- Reducing the lining thickness over a 12.6km central section of tunnel saved 16 percent in the volume of concrete used.
- Maximizing the volume of cement replacement using waste products from industrial processes such as Pulverised Fuel Ash (PFA)

As a result of these actions, the case study anticipates a saving of 31 percent in materials compared to the original design, substantial labour cost savings due to improved productivity and a carbon saving of 1379.4t CO2.

Further reading: https://www.bitc.org.uk/wp-content/uploads/2020/09/BITC_Casestudiesdoc_AdvancingCircularConstruction_September2020.pdf

The role of a commercial CES: Be aware of circular economy principles and application, consider the upgrade and maintenance of existing structure where possible, rather than opting for demolition and rebuilding supported by robust assessment, promote circular thinking throughout.

The role of a geospatial CES: If you know what you have, better and more pragmatic decisions can be made earlier in the design phase. High precision measurement techniques and site recording/documentation should enable a higher confidence in construction methods. For example, an understanding of what can be achieved with today's setting out technology could mean that over-specification of foundation, to account for position errors, could reduce the amount of concrete poured and the size of foundation dug.

20 https://www.ellenmacarthurfoundation.org/topics/built-environment/overview

21 https://carlelefante.com/insights/the-greenest-building-is/

Biodiversity net gain

The Environment Act 2021 provides a vast amount of previously undescribed protections for the environment including the concept of 'biodiversity net gain'.

Put simply, any construction project that involves stripping back land and removing biodiversity will be required to reinstate that same level of biodiversity, plus 10 percent. So it's reasonable to posit that organisations that are able to upskill their surveyors to accurately measure and quantify biodiversity on a site to establish a baseline, should see as a result that same value and more being returned to that same location.

In addition, according to the act, in the event of that 10 percent gain not being achievable on that particular site, the same increased level of biodiversity is required to be offset somewhere else.

As this legislation becomes more understood by stakeholders, biodiversity offset providers are going to need accurate baseline data, provided by surveyors. This will then equip ecologists to design management plans to uplift the biodiversity - actions that should be enabled as a result of the work of surveying professionals at the forefront of this significant change in environmental protection. As the 'skill' (or what our Royal Charter refers to as the 'art and science') of surveying is in the appraisal and understanding of a site - not in merely recording measurements - those same survey professionals should have input on said design management plans.

If CICES members and civil engineering surveyors don't embrace the concept of biodiversity sustainability and the legal obligation of net gain, that role will inevitably be ceded to others that lack the required geospatial competencies. In many cases, the roles of site engineers and clerks of works are disappearing, with compliance responsibility being placed on the constructor, along with the responsibility and associated costs of correcting any failures.

Achieving biodiversity net gain helps achieve SDG 15 (Life on Land), through mitigating negative impacts on biodiversity as well as compensating, leading to net positive outcomes for nature.

No two civil engineering projects are ever the same, which is why civil engineering surveyors need to maintain pressure on stakeholders to achieve the required standards of supervision.

The role of a CES: Civil engineering surveyors are often tasked with creating vegetation and arboreal surveys. The importance of this work cannot be understated in relation to the Environment Act of 2021. As CICES members, 'We measure all that we see' - and that includes biodiversity before and after a construction project.

Sustainable procurement

Sustainable procurement in construction helps achieve SDG 12 (Responsible Consumption and Production), via innovative supply chains.

As highlighted prior, for the CES, there is typically more focus on the environment and carbon than on the economic aspects of sustainability.

Notwithstanding the pressures on infrastructure funding over the forthcoming years, there will still be the requirement to comply with legal obligations relating to sustainability matters.

Organisations - particularly major infrastructure clients - that are working to promote sustainability shouldn't focus solely on the 'headline' aspect of net zero carbon and should consider other sustainable headings, such as the type covered by the Public Services (Social Value) Act 2012[22], including:

'How what is proposed to be procured might improve the economic, social and environmental well-being of the relevant area...'

Procurement is considered sustainable when the 'Triple Bottom Line' (people, planet and profit/prosperity) forms part of the decision-making in addition to the traditional performance metrics of cost, quality and time (UKGBC, 2023).[23]

Examples of such considerations include:

- People: social impact of procurement decisions, including health & safety, fair pay, EDI and upholding human rights
- Planet: environmental impact of procurement decisions, including embodied emissions associated with the whole life cycle, waste, pollution and biodiversity net gain
- Profit/Prosperity: economic impact of procurement decisions. While making a profit is important, it is recommended that this is balanced with social and environmental aspects of procurement, such as long-term economic sustainability through creating innovative business models, new sustainable markets and wealth regeneration.

Any business that achieves the ISO20400 Sustainable Procurement standard[24] shouldn't consider it merely as an aspect of management and compliance - but also how it can be applied to economic and social sustainability.

Case study: Sustainable procurement, Stockholm Metro Nacka project awarded Excellent

The project aimed to increasing the city's public transport capacity by extending the Stockholm Metro system and used CEEQUAL framework to achieve sustainability outcomes.

Ways in which the team ensured sustainable procurement during the project include:

- Competent project team: this comprised individuals with sustainability expertise, including the client team.
- Early engagement: a children's book was developed to give to schools and day care facilities near the project, to allow children to better understand how and why it was happening. This early engagement meant stakeholders were more informed and helpd minimise the perceived disruption.
- Land use and landscape: the location decision was made based on different environmental aspects, including ground condition, traffic situation, technical conditions and impact on neighbours.
- Ecology and biodiversity: the placement and size of the establishment areas were adapted to minimise the impact on the surroundings. Investigations were carried out and inventories produced to map protected animal and natural environments.
- Physical resources: the contractor was required to have a systematic approach to social responsibility regarding product and material selection, as well as specific follow-up of the identified products. In addition, the client required the contractor to use 100 percent certified renewable energy during construction and handle all waste according to guidelines.

Further reading: https://breeam.com/web/bre-group/case-studies/stockholm-metro-nacka-project-awarded-excellent

The role of a CES: Be sustainability competent, engage early in the procurement process with the design team wherever possible, be aware of carbon intensive materials or operations and advise appropriately on low carbon options.

22 https://www.legislation.gov.uk/ukpga/2012/3/enacted

23 https://ukgbc.org/wp-content/uploads/2023/03/Sustainable-Procurement.pdf

24 https://www.iso.org/standard/63026.html

Whole life carbon assessment, costing, measurement and monitoring

Whole life carbon assessment contributes to SDG 9 (Industry, Innovation and Infrastructure), SDG 11 (Sustainable Cities and Communities), SDG 12 (Responsible Consumption and Production) and SDG13 (Climate Action), by ensuring economic activities take environmental goals into consideration during decision-making.

A major contribution that civil engineering surveyors can make to promoting sustainability is the routine measuring, interpreting and reporting on the data of all aspects of projects, regardless of individual discipline and specialism.

The 2022 Global Status Report for Buildings and Construction[25], released close to the latest round of climate talks in Egypt, COP27, finds that the sector accounted for over 34 percent of energy demand and around 37 percent of energy and process-related CO2 emissions (operational and embodied carbon) in 2021. According to the UN, this leaves the sector off track to decarbonize by 2050.

Such statements demand immediate action on the part of the CES, to contribute to measurement and monitoring of emissions in our projects - particularly as such processes form part of our core competencies.

Before emissions can be minimised, they must first be meaured. Conveniently, carbon assessments can be done in tandem with cost assessments (known as a 'dual currency appraisal'), due to the nature of the inputs and measurement techniques involved, allowing economic and environmental goals to be considered simultaneously.

These dual currency appraisals should start during early design stages of projects, so that recommendations can be made regarding alternative design/procurement solutions, to achieve an optimum balance between cost and carbon, as the reduction potential is very high during the early stages of projects. However, this potential reduces drastically as the design develops, leaving minimal options to be considered or scope for radical changes, resulting in time and resource inefficiencies.

The use of a tool to facilitate the assessment of life cycle costing, carbon, environmental and societal issues would aid decision making and subsequent monitoring of implementation and achievement. In September 2023, RICS published the second edition of the Whole Life Carbon Assessment Standard[26] (September 2023), which includes guidance specific to infrastructure but doesn't address potential social impacts with the same vigour. This is the case with many other assessment tools available in the market, as the process can be complex.

Further viable resources include BREEAM Infrastructure (formerly CEEQUAL)'s evidence based sustainable assessment rating scheme for civil engineering infrastructure[27], HACT's UK Social Value Bank calculator[28], One Click LCA's life cycle assessment and environmental database[29], the International Cost Management Standard (ICMS)[30].

During any life cycle costing process, a civil engineering surveyor should ensure they pay particular attention to monitoring, in order to dissuade statements of apparently noble intentions without follow-through or delivery, intentionally or otherwise.

Case study: Life cycle assessment, High Speed 2 (HS2) London Euston Railway Station

A baseline whole life carbon footprint for the station building was calculated over a design life of 120 years, using the One Click LCA 'EN 15978' indicator. The One Click LCA Revit plugin was used to extract materials data and quantities from a combined project BIM model.

Various design options were appraised and compared against the baseline design, which led to a 14 percent reduction in whole life carbon emissions by RIBA Stage 2. Carrying out a life cycle assessment allowed the project to achieve two innovation credits under the BREEAM New Construction 2014 scheme, providing an additional one percent to the overall score. The project is expected to achieve BREEAM Excellent as a minimum.

25 https://www.unep.org/resources/publication/2022-global-status-report-buildings-and-construction

26 https://www.rics.org/profession-standards/rics-standards-and-guidance/sector-standards/construction-standards/whole-life-carbon-assessment

27 https://breeam.com/breeam-infrastructure

28 https://hact.org.uk/tools-and-services/uk-social-value-bank/

29 https://oneclicklca.com/

30 https://icms-coalition.org/

Further reading: https://oneclicklca.com/en/resources/case-studies/london-euston-railway

Case study: Life cycle assessment, Scottish Water drones and laser technology cut carbon emissions

Targeted personnel mobilisation to site resulted in almost immediate carbon emission reductions. Inspections could be carried out by teams of two, rather than 15, in a safer and also more efficient way, while the combined lidar and image data capture provided significant amounts of actionable information in an effective manner.

This is a clear example of how geospatial expertise and technology can be applied, to provide the data and information to enable better decisions to be made earlier and at more impactful frequencies, during construction and operation of utilities.

The outcome of using reduced resources to capture more information is less disruption, due to smarter work management. In theory, Scottish Water will be equipped with the knowledge to necessitate digging only when required, in a targeted way, rather than in the more exploratory fashion seen historically.

As the case study acknowledges, the earlier any required repair and maintenance work is carried out following an inspection, the lower the financial and environmental impact.

Further reading: https://www.scottishwater.co.uk/About-Us/News-and-Views/2022/09/230922Drone

The role of a commercial CES: Awareness of carbon assessment methodologies and the tools available for civil engineering projects (plus an understanding of their limitations) and promoting dual currency appraisals in projects.

The role of a geospatial CES: Measure accurately and capture the reality of the site in a way that adds value to all reporting. Focus on relevant metrics such as ground changes, tracking machines and so on.

Sustainability and regulation

Within life cycle costing, environmental and societal issues are not typically assigned economic value and cost - but there is no reason why they can't be, or even detailed within the specifications of contractual conditions.
For example, under the requirement to meet the 'Environment Act 2021', it could be stipulated that compliance with a system that promotes sustainability through best practice, such as the Civil Engineering Environmental Quality Assistant System, (CEEQUAL) was a specific requirement.

One possible reason that such details aren't typically included currently is the fact that the tangible benefits of addressing such issues need to be not discrete from (and more clearly communicated to) the parties responsible for making the economic decisions. There is an argument that legislation or regulation may be required to satisfactorily achieve this goal, as is demonstrably seen with landfill and aggregate taxes, for example.

Indeed, the power of Government in implementing sustainability cannot be underplayed - if legislation and guidance satisfaction is required contractually, for clients, funders and specifiers, it will always be more likely to happen than if it is merely a 'desirable'.

During creation of tendering documents, some clients may express concerns that including too much information in specifications can push prices up. But even without referring to irrefutable figures, it's reasonable to assume that a significant percentage of professionals in the civil engineering surveying sphere and beyond believe that the challenges of dealing with

climate change and environmental destruction will incur less of a cost than doing nothing.

As any number of recent studies indicate, the current states of the planet, climate and various ecosystems - in relation to how they're affected by human activity - are on course to worsen significantly if no changes are seen. Examples include the Global Tipping Points Report[31] and science.org's research article titled: 'Exceeding 1.5 °C global warming could trigger multiple climate tipping points'[32].

While the immediate and short-term expenditures can be considerable, the future benefits of committing to action (rather than resorting to inaction) - both financial and more widely societal - are potentially immense. The responsibility for such commitments lies with organisations leading by example, rather than waiting for industry or legislative pressure.

One example that civil engineering surveyors should be aware of is the Construction Leadership Council's 'Five Client Carbon Commitments'[33] initiative, unveiled in April 2024 and which includes the adoption of PAS 2080 Carbon Management in Infrastructure Standard[34]. Among the first to sign up to these commitments are Anglian Water, Heathrow, the Lower Thames Crossing, National Highways, Northumbrian Water and Sellafield Ltd.

The civil engineering surveyor must signpost to such examples and drive change within their own organisation to commit to taking the initiative as leaders, rather than followers.

Fulfilling responsibilities and standards

At the other end of the scale from specification and procurement stipulations sits another significant aspect of sustainability in terms of what a project represents upon completion and delivery. All works should be assessed in terms of their legacy of competence - will a project sustain what it has been designed to do, in the manner it was designed to do it?

As civil engineering surveyors, CICES members need to feel empowered to state to a client that they are responsible for ensuring that what is being paid for corresponds to what was designed. The ISO 14001[35] is a scalable standard, facilitating positive impacts on environments from individual or domestic levels to large-scale influence at a corporate or construction site level.

Another standard that can be applied to organisations of any size or sector is the BSI verification to PAS 2060 standards certification of carbon neutrality.[36] This internationally recognised and audited standard proves to a potential client an achievement beyond commitment and is likely to prove a clear consideration for many parties when it comes to selecting suppliers.

PAS 2060 can also be applied to specific products, services, projects or events, making it an ideal tool for many civil engineering surveyors working individually or within smaller teams to accurately assess the validity of the sustainability associated with their work. It's even sensitive enough to cover the vehicle emissions for both business travel and commuting, which is typically an individual surveyor's biggest carbon footprint.

Similarly, the PAS 2080 Carbon Management in Infrastructure standard[37] applies to any individual involved in the delivery of infrastructure projects, including asset owners/managers, design and build team members and supply chain.

These areas of standardisation are constantly evolving as new data, emerging technologies and other best practice innovations are developed and implemented. It is incumbent on the civil engineering surveyor to endeavour to stay abreast of such progressions in order to remain consistently able to give recommendations and deliver value with clarity, confidence and competence.

The role of a CES: Keep up-to-date with regulations and frameworks on sustainability affecting your profession and the wider construction sector.

31 https://global-tipping-points.org/

32 https://www.science.org/doi/10.1126/science.abn7950

33 https://www.constructionleadershipcouncil.co.uk/news/the-five-client-carbon-commitments/

34 https://www.bsigroup.com/en-GB/products-and-services/assessment-and-certification/product-certification/certify-your-commitment-to-a-more-sustainable-built-environment-carbon-management-in-infrastructure-pas-2080/

35 https://www.iso.org/standard/60857.html

36 https://www.bsigroup.com/globalassets/localfiles/en-th/pas-2060/pas2060_carbon_neutrality_flyer-th.pdf

37 https://www.bsigroup.com/en-GB/insights-and-media/insights/brochures/pas-2080-carbon-management-in-infrastructure-and-built-environment/

Sustainability competency

Continuing Professional Development (CPD) of CICES members should not be underestimated in the broader conversation about sustainability.

Members should strive to keep up-to-date with the advancement of discussions around sustainability in the industry and educate themselves through formal and informal CPD to stay current and sustainability competent.

This consideration runs through all of the themes discussed in this paper. By building an expert understanding of sustainability through the application of best practice, third party tools and rigorous assessment, this will become as recognisable a part of the CICES member's arsenal as any of the other stated specialist competencies.

Surveyors with such acute awareness of their own carbon emissions and that take steps to reduce them will be sought after by construction companies keen to hire specialists and reduce their overall carbon footprints.

The CICES member should, where possible, look to lead by example within their particular specialism or area of interest, via incremental actions that can effect positive change, with the necessary support of the institution.

By taking the responsibility as pioneers, educators and signposters, civil engineering surveyors can lead the way for our industry and ultimately, the planet.

The role of a CES: Engage in CPD activities to keep up-to-date with discussions and debate on sustainability affecting your profession and the sector and share best practices with others..

Recommended responses/actions

When formulating a response to the 'status quo', as defined in this document, the civil engineering surveyor - whether geospatial or commercial - should aim to interpret and apply the following main topics (below), as defined in our Sustainability Strategy 2021-2030[38]:

- Carbon (embodied and emitted)
- Social (including the work of Equity, Diversity & Inclusion - or EDI)
- Circular economy and waste

In addition to these broader spheres, a civil engineering surveyor should also aim to ensure they are taking appropriate actions and observing best practice as a professional working in, or adjacent to, construction and civil engineering - industries not always celebrated for their sustainability credentials.

Therefore, CICES has identified the following action points to help facilitate this:

Action 1
Potential creation of a document similar to the BIM Plan of Works, led by CICES Sustainability Committee.

Action 2
Promotion of increasing skill and knowledge in sustainability issues through CPD.

Action 3
Creation of a CICES hub of tools and guidance.

38 https://www.cices.org/hawkfile/464/original/Sustainbility%20strategy%202021-2030.pdf

Appendix/ recommended reading items

- RICS Whole Life Carbon Assessment (WCLA) for the built environment (second edition)
- Kate Raworth Doughnut Economics
- UN Sustainable Development Goals explained
- Survey4BIM Digital Plan of Works
- ISO 20400 Sustainable Procurement
- Environment Act 2017
- ISO 14001 Environmental Management
- BSI Verification to PAS 2060 - Demonstrate carbon neutrality
- Ellen MacArthur Foundation - Circular economy diagram
- The Carbon Almanac - It’s not too late

Sustainability glossary of terms

- Absolute zero - The target of zero emissions is absolute - there are no negative emissions options or meaningful “carbon offsets.” Absolute Zero means zero emissions.
- Adaptation - Anticipating the adverse effects of climate change and taking appropriate action to prevent or minimise the damage they can cause or taking advantage of opportunities that may arise.
- Afforestation – The conversion (of land) into forest, esp. for commercial use.
- Biodiversity – Biodiversity is the number of distinct varieties or types within a group of living systems: distinct genes in a species, species in an ecosystem, or ecosystems in a biome. Biodiversity is important for its own sake, and human survival depends upon it.
- Carbon dioxide (CO2) emissions – Carbon dioxide (CO2) is released into Earth’s atmosphere mostly by the burning of carbon-containing fuels and the decay of wood and other plant matter.
- Carbon footprint – A carbon footprint is the total amount of greenhouse emissions that result directly and indirectly either from an individual’s lifestyle, a company’s operations, or the full life cycle of a product or service.
- Carbon negative - The net effect of removing carbon dioxide from the environment rather than adding it.
- Carbon neutral – Any CO2 released into the atmosphere from a company’s activities is balanced by an equivalent amount being removed, called offset.
- Circular economy - An economic system that replaces the ‘end-of-life’ concept with reducing, alternatively reusing, recycling, and recovering materials in production/ distribution and consumption processes. A circular economy is one that produces no waste and pollution, by design or intention. It keeps products, parts, and materials at their highest use and value at all times.
- Climate – Climate is the weather experienced by a given location, averaged over several decades.
- Climate breakdown - A more recent term used to reflect the severity of the impact of carbon emissions. It describes the fact that the climate conditions that have been present for at least the past 10,000 years, during which human civilization has developed, are no longer stable.
- Climate change – From the United Nations Framework Convention on Climate Change (UNFCCC): a change of climate which is attributed directly or indirectly to human activity that alters the composition of the global atmosphere and which is in addition to natural climate variability observed over comparable time periods.
- Climate emergency - Serious and urgent problems that are being caused or likely to be caused by changes in the world’s weather, in particular the world getting warmer because of human activity increasing the level of carbon dioxide in the atmosphere.
- Climate justice - A term and a movement that acknowledges climate change can have differing economic, social, public health, and care impacts on underprivileged individuals and communities.
- Conscious consumption - A social movement based on an increasing awareness of the impact individual and group purchasing decisions can have on the environment, consumers’ health and life for all. Alongside price and quality, environmental considerations are playing an increasing part in a purchase decision.
- Corporate Social Responsibility (CSR) - A concept whereby companies integrate social and environmental concerns in their business operations and in their interaction with their stakeholders on a voluntary basis.
- Decarbonisation - The process of stopping or reducing carbon gases, especially carbon dioxide, being released into the atmosphere as the result of a process, for example the burning of fossil fuels.
- Deforestation – A reduction in the area of a forest resulting from human activity.
- Ecosystems - All the living things in an area and the way they affect each other and the environment.
- Electrification - Switching from fossil fuels burned at a building to using electricity to meet a building’s energy needs. Transition to greater use of electricity in commercial and multifamily buildings is important to take advantage of increasingly decarbonized electricity.
- Embodied carbon - The total GHG emissions that are generated to produce an asset. These emissions include those created by manufacturing, extraction processes, transportation and the assembly of every product and individual element of an asset.
- Environmental aspectE - Element of an organisation’s activities or products or services that interacts or can interact with the environment.
- Environmental impact - Change to the environment, whether adverse or beneficial, wholly, or partially resulting from an organisation’s environmental aspects.
- Environmental Management System (EMS) - An EMS is like other management systems, such as those that manage quality or safety. It assesses an organisation’s strengths and weaknesses, helps identify and manage significant environmental impacts, saves money by increasing efficiency, helps ensure compliance with environmental legislation

and provides benchmarks for improvements.

- Environmental, Social, Governance (ESG) - Environmental, social, and governance (ESG) criteria are a set of standards for a company's operations that socially conscious investors use to screen potential investments. Environmental criteria consider how a company performs as a steward of nature. Social criteria examine how it manages relationships with employees, suppliers, customers, and the communities where it operates. Governance deals with a company's leadership, executive pay, audits, internal controls, and shareholder rights.
- Fast fashion - Media name for the trend to produce, sell, buy and dispose of items of clothing more quickly. Another term applied is often disposable fashion where an item of clothing can be bought for less than the cost of a coffee and muffin. The cost of an item means the cost of repair is often higher than the item's price itself.
- Fossil fuels – A fuel from natural resources to be found on our planet. Oil, gas and coal have been formed from living organisms over the past millions of years. There is a finite supply, and the fuel sources are non-renewable. As well as being non-renewable, the use of these fuel sources releases carbon dioxide into the environment, resulting in climate change and the heating of our planet.
- Global Recycle Standard (GRS) - The GRS is an international, voluntary, full product standard that sets requirements for third-party certification of recycled content, chain of custody, social and environmental practices and chemical restrictions.
- Global warming – Global warming is understood to result from an overall, long-term increase in the retention of the sun's heat around Earth due to blanketing by "greenhouse gases," especially CO2 and methane.
- Green bonds - Fixed income instrument linked to projects focusing on driving a lower carbon environment, socially sustainable future or just generally socially positive outcomes.
- Green energy - Any energy type that is generated from natural resources, such as sunlight, wind, or water. The key to these energy resources is that they don't harm the environment through factors such as releasing greenhouse gases into the atmosphere.
- Greenhouse effect - The greenhouse effect is a process that occurs when gases in Earth's atmosphere trap the Sun's heat. The greenhouse effect can lead to global warming if there are too many GHG's in the atmosphere.
- Greenhouse gases – Gases, such as carbon dioxide and methane, that tend to trap heat radiating from the Earth's surface, thus causing warming in the lower atmosphere.
- Greenwashing - Marketing and Advertising activities that mislead consumers and make them believe a company is doing more than they actually are with regards to environmentally friendly products or services.
- GRI (Global Reporting Initiative) - GRI: The Global Reporting Initiative (GRI) is the global standard setter for sustainability reporting creating a common language for organisations to report on.
- HFC (Hydrofluorocarbons) - Organic compounds made of hydrogen, fluorine, and carbon. They replaced the vilified halons and chlorofluorocarbons that were found to contribute to the loss of the planet's ozone layer.
- IPCC (Intergovernmental Panel on Climate Change) - Created to provide policy makers with regular scientific assessments on climate change and its implications and potential future risks, as well as to put forward adaptation and mitigation options.
- ISO 14001 - Internationally recognized and accepted approach to implementing an effective environmental management system. Balancing corporate commercial goals with environmental responsibilities.
- Keystone species - A species that has a disproportional impact on the environment relative to its presence or scale. It helps define how many and what type of other species evolve in a community.
- Meaningful carbon credit – Projects that are aligned with our Purpose agenda and that provide social value across one of three categories (1) Just transition (avoid fossil fuel), (2) Climate justice (avoid risk from climate change) and (3) Future financing (investments in nature-based solutions).
- Net Zero – Activity releases net-zero carbon emissions into the atmosphere.
- Nonrenewable resources – Any naturally occurring, finite resources that diminish with use, such as oil and coal.
- Offset – Carbon avoidance – Projects focused on preventing emissions from being released e.g. creation of a wind farm/ investment in solar cookstoves.
- Offset - Carbon removal – Projects focused on removing emissions already released e.g. reforestation/ sea grass restoration/ geological storage.
- Paris Agreement - The major global climate agreement signed in Paris at COP21 in December 2015 (COP26 was held in Glasgow in 2021). The deal states 'great concern' around the importance of holding global temperature increase to less than two degrees above pre-industrial levels. They are focused on pursuing efforts to preferably reduce this to 1.5 degrees. It is a legally binding international treaty.
- Reforestation - Bringing the forest back to an area where it was destroyed. The restoration

process of destroyed or damaged forest.

- Renewable - Energy sources that are naturally replenished, rather than getting depleted when used.
- Science Based Target - A set of goals developed by a business to define a clear pathway to reducing GHG emissions. A target is defined as science based if it has been developed in line with the scale of change needed to keep global warming between 1.5°C and 2°C degrees. The SBTi (science-based target initiative) was developed as a partnership between CDP, the UN Global Compact (UNCG), the World Resources Institute (WRI) and World Wildlife Foundation (WWF).If all companies across the world adopt agreed and measurable targets in line with SBTi, we stand a much greater chance of achieving the goals laid out in the Paris Agreement. See SBT for reference. https://sciencebasedtargets.org/
- Science Based Target Initiative -
- Scope 1: Covers direct emissions from owned or controlled sources.
- Scope 2: Covers indirect emissions from the generation of purchased electricity, steam, heating and cooling consumed by the reporting company.
- Scope 3: The broadest category and includes all other indirect emissions that occur in a company's value chain.
- Sustainability – At its broadest level, environmental or global sustainability refers to Earth's ability to continue functioning in a manner that supports humans and other ecosystems.
- United Nations Sustainable Development Goals (UN SDGs) - The 2030 Agenda for Sustainable Development, adopted by all United Nations Member States in 2015, provides a shared blueprint for peace and prosperity for people and the planet. The 17 Sustainable Development Goals (SDGs) are an urgent call for action by all countries - developed and developing - in a global partnership. They recognize that ending poverty and other deprivations must go hand-in-hand with strategies that improve health and education, reduce inequality, and spur economic growth – all while tackling climate change and working to preserve our oceans and forests. https://www.un.org/sustainabledevelopment/
- Waste reduction – Waste reduction, also known as source reduction, is the practice of using less material and energy to minimise waste generation and preserve natural resources.
- Zero carbon - Causing or resulting in no net release of carbon dioxide into the atmosphere.

Contributors

Co-chairs

David Bennett, FCInstCES, FCIM, MCIPR, Director of Corporate Communications, Topcon Positioning Systems
Andrew Evans PhD, FCInstCES, CEng, Senior Product Manager, Topcon Positioning Systems
Michele Victoria PhD BSc(Hons)QS FHEA MCIOB APGBCSL, Course Leader, quantity surveying and commercial management, Robert Gordon University

Contributors

Hassan Ahmadi MCInstCES
Louis Akeh
John Bacon HonFCInstCES FRICS FCIArb FICE
Chuma Banjwa MCInstCES MRICS
George Bothamley FCInstCES
Amy Bowyer MCInstCES
Stewart Bradley FCInstCES MCIArb
Simon Commins FCInstCES
Michael Day GCInstCES
Mehbub Dayaji MCInstCES
Dennis Gedge MCInstCES CEng MICE
Barney Green AssocRICS MCInstCES
Matt Haigh PGDip NCTJ
Barry Hiscox FCInstCES
Mike Hopkins MCInstCES
Richard Horsfall FCInstCES
Trevor Isaac MCInstCES
Andrew Leisk FCInstCES
J Anthony Mercure MScConsLaw PGDBM DipLaw FCIArb FCInstCES
Grace Ngwenya GCInstCES MSc Eng Geomatics
Adam Rogers MCInstCES
Jack Rowley FCInstCES
Oliver Shamu MCInstCES
John P Thompson MCInstCES MRICS
Philip Wilson FCInstCES
Robert Wren DProf Law LLM MSc MBA FCInstCES FRICS FCIOB FCIArb FCIPS CEnv
Kamarakeh Yayah GCInstCES

Reviewers

Rama Dunayevich, Global Impact Partnership Lead, Autodesk
Anne-Marie Friel, Partner, Pinsent Masons
Sheena Zhang, AEC Sustainability Specialist, Autodesk