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Introducing lifecycle and whole life carbon thinking

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Built Environment Context

Key words:

- Life Cycle Assessment: technique – environmental impacts –all stages of a products life – raw material extraction – materials processing to disposal/recycling.
- Whole Life Carbon: emissions resulting from construction and use of an asset over its entire life.
- Transition to a Circular Economy: promoting resource efficiency – extract maximum value from resources – recovery – reuse – end of service life.

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Lifecycle

Lifecycle is the life of a project/product/system from its conception through to end of life, decommissioning or disposal.

The lifecycle stages include:

- Raw materials acquisition
- Manufacturing
- Distribution/retail
- Use/Reuse/Maintenance
- Recycle/Waste management

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Thinking

Dictionary definitions:

Noun: The process of considering or reasoning about something.

Adjective: Using thought or rational judgement; intelligent.

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So What? (1)

- The buildings and construction sectors combined are responsible for over a third of global energy consumption and nearly 40% of total direct and indirect CO2 emissions. According to the International Energy Agency.

- 66% of countries in the world lack mandatory building energy codes in 2018, meaning more than three billion square metres were built without mandatory performance requirements that year.

- Enormous potential to cut emissions remains untapped due to the widespread use of less energy efficient technologies, a lack of effective policies and insufficient investment in sustainable buildings.

- Renewable energy and energy efficiency only account for 55% of global emissions. The remaining 45% of emissions are associated with making products and circular-economy strategies applied to the four key industrial materials of cement, steel, plastic and aluminium could help reduce emissions by 40% by 2050 (The Ellen MacArthur Foundation).

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So What? (2)

- The World Green Building Council estimates that, globally, construction accounts for 11% of carbon emissions.
- Construction industry stakeholders must respond by designing and building to Whole Life Carbon principles.
- According to the think- tank Circle Economy, some 100 billion tonnes of virgin materials are being consumed annually by business. Less than 10% of these materials are believed to be effectively reused or recycled.
- There is a direct link between models of consumption and climate change. The Ellen MacArthur Foundation has stated that some 45% of global annual emissions will only be tackled through transitioning to closed-loop value chains.

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Concepts considered in the LCA/WLC Process

- Systems thinking
- Linear economy
- Circular economy
- Cradle to gate
- Cradle to grave
- Whole Life carbon accounting
- Climate change impact

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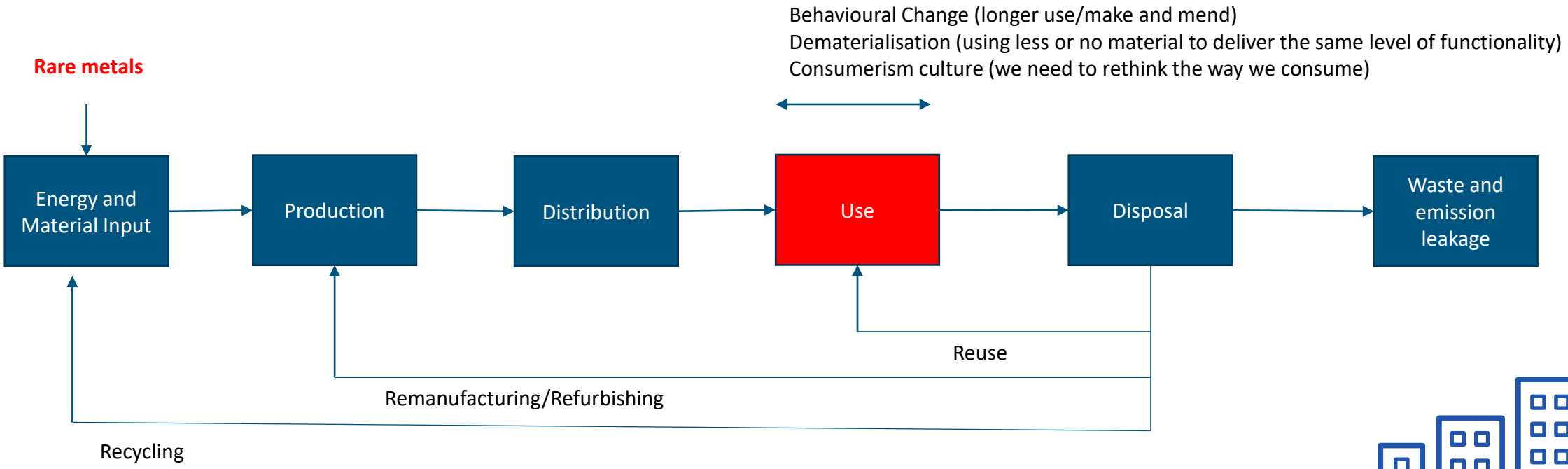
LINEAR ECONOMY: Take, Make, Consume and Dispose

CIRCULAR ECONOMY



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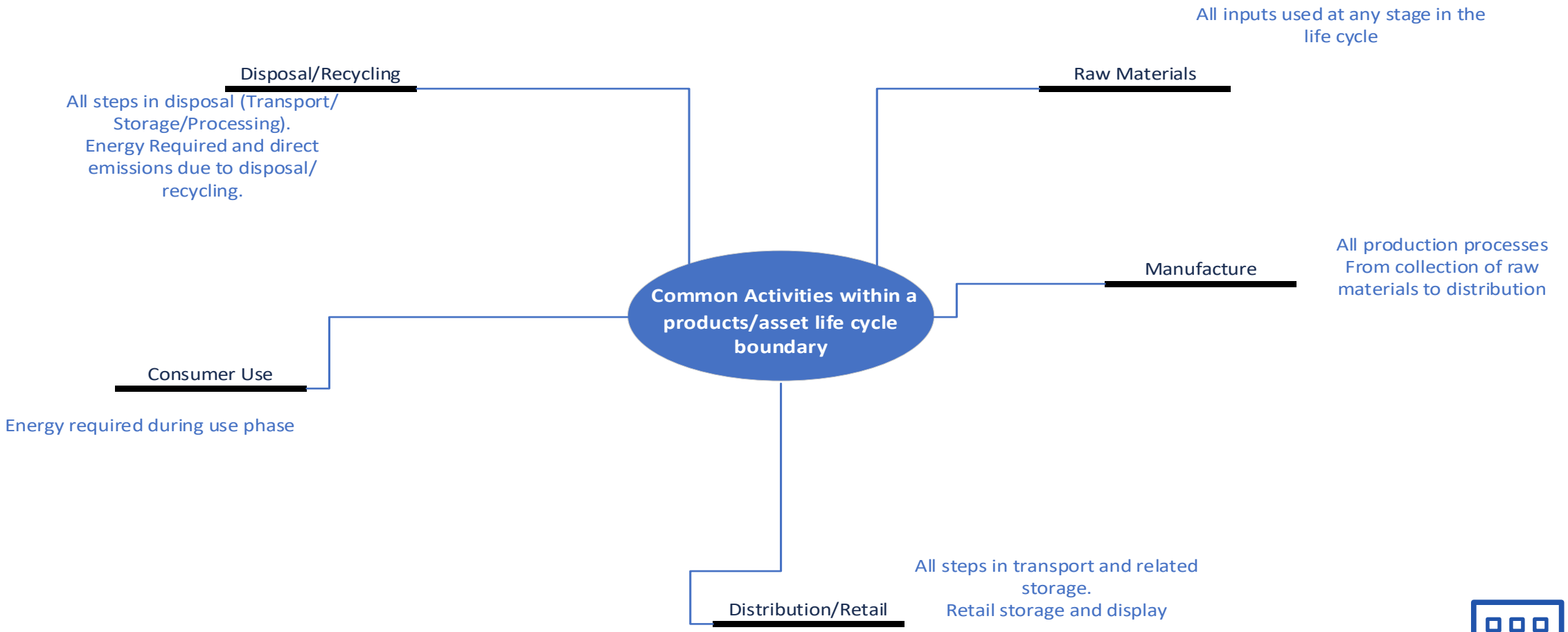
Stages in Life Cycle Assessments: 1.Scope, 2.Inventory Analysis, 3. Impact Assessment, 4. Interpretation of data.



Source: Adapted from PAS 2050

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‘The whole is greater than the sum of its parts’

Aristotle

- In this context systems thinking focuses on ‘the big picture’ when trying to understand and address the challenges faced during the transition to a decarbonised economy and Net Zero carbon emissions targets.
- A system is a group of components (including elements and relationships) that are linked in an organised manner. This encompasses culture, business environments and technological innovation.
- The components are affected by being included in the system, and are changed if they leave it.

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'A system is a perceived whole whose elements 'hang together' because they continually affect each other over time and operate toward a common purpose'.

Peter Senge – The Fifth Discipline Field book: Strategies and tools for building a learning organisation.

INPUTS

Raw materials

Energy/Fuels

SYSTEM

OUTPUTS

Waste heat
Solid waste
Emissions to air
Emissions to water
Usable products

Before carrying out analysis, the boundaries of the operations that together produce the process or product have to be defined.

Adapted from: Porteous

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INPUTS

- Energy
- Raw Materials
- All inputs used at any stage in the life cycle
- Processes for each stage.

Data

- Inventory analysis
- Impact assessment
- BS EN ISO 19650

Life cycle Stages

- Raw materials acquisition
- Manufacturing
- Distribution/Retail
- Use/Reuse/Maintenance
- Recycle/Waste management

TYPICAL GENERIC ACTIVITIES INCLUDED WITHIN A PRODUCT/ASSET LIFE CYCLE BOUNDARY

OUTPUTS

- Atmospheric emissions
- Waterborne wastes
- Solid wastes
- Waste heat

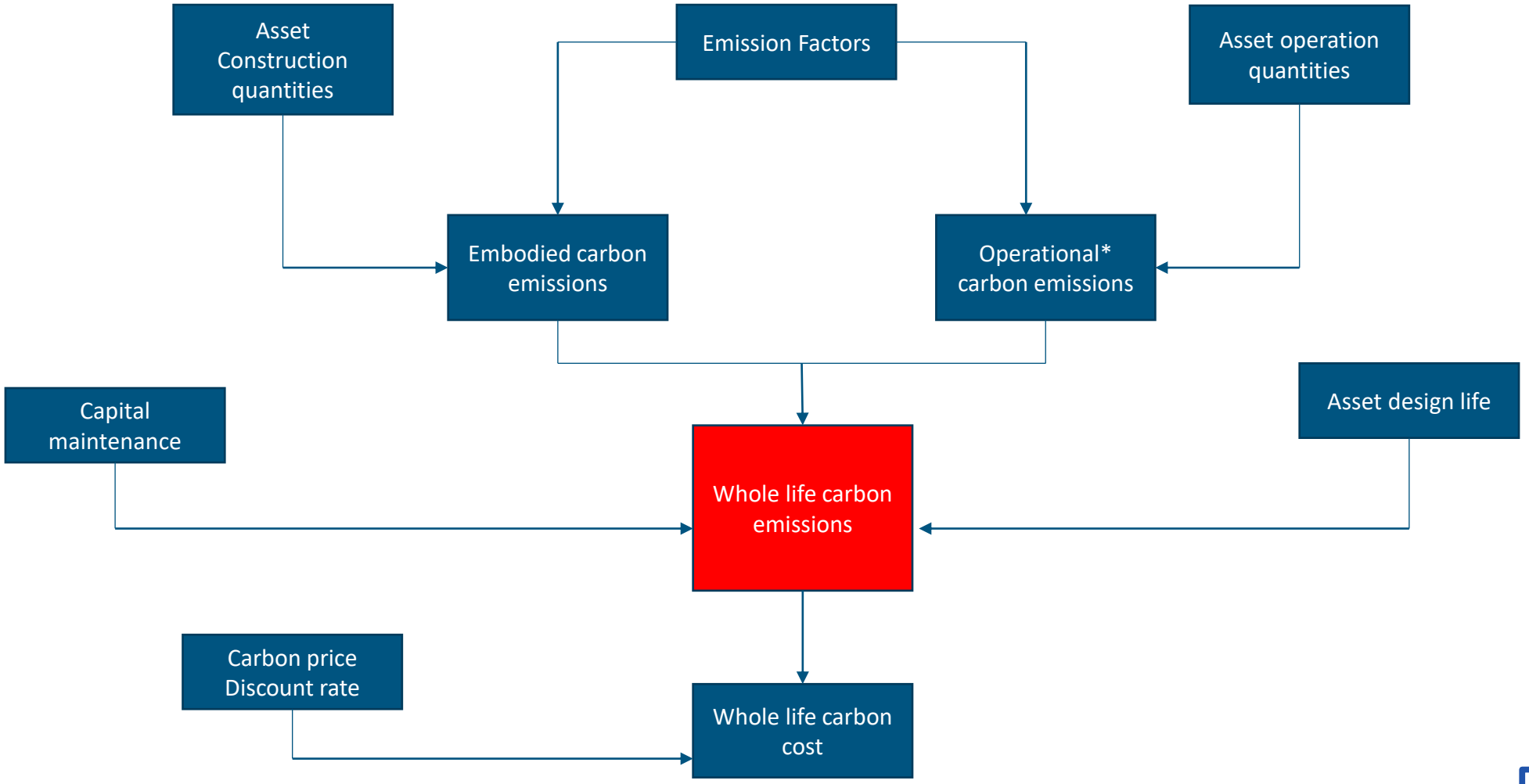
Interpretation of data

For each process step

- Material inputs
- Product/Asset Output
- Co-Products/Assets
- Waste

Whole Life Carbon Accounting Process [Example]

Source: UKWIR Report Ref. 12/CL/01/15



*Change in future annual Operational emissions.

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The CIOB Code of Practice for Project Management for Construction and Development, 5th Edition – Briefing Note 2.01 'Key Sustainability Issues'.

Recommends as a key action that the lifecycle impacts of materials and equipment are considered by the project team and that these are considered during the selection of construction methods.

Another key action is to make the project team aware of the principles of designing for deconstruction and consider the whole life of services components for recycling or reuse at the end of their life.

Best Practice

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Examples of Best Practice Resources and Tools

- BSRIA Guide [BG 52/2013]: Life Cycle Assessment – An introduction.
- BSRIA Guide [BG 10/2011]: Embodied Carbon – The Inventory of Carbon and Energy (ICE)
- [BSI] Guide to PAS 2050: Specification for the assessment of the life cycle greenhouse gas emissions of goods and services.
- The Green Guide to Specification, 4th edition, BRE.
- BS EN ISO 14040: 2006 +A1:2020 Environmental Management – Life cycle assessment.
- BS EN ISO 15978: 2011 Sustainability of Construction Works – Assessment of environmental performance of buildings.
- PAS 2080: Specification for managing whole-life carbon in infrastructure.

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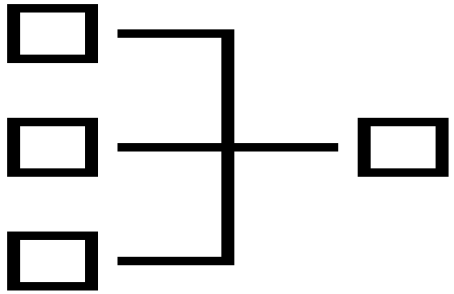
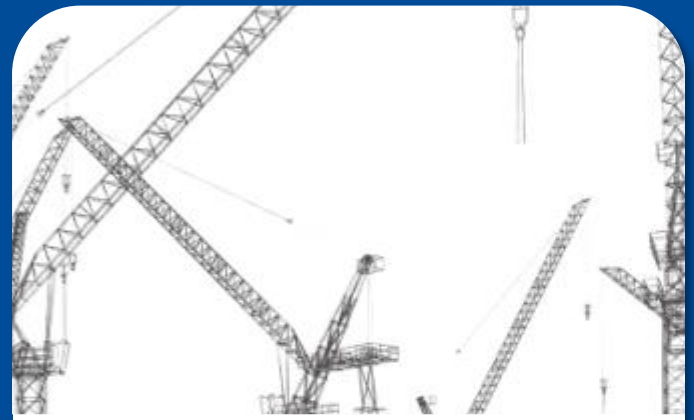
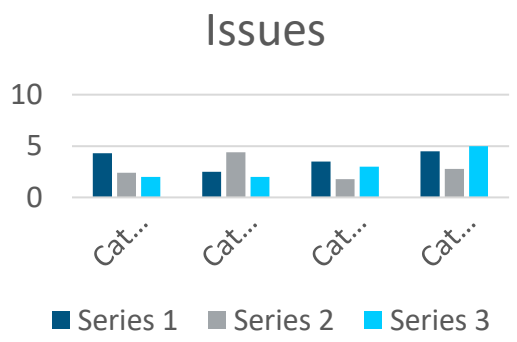


Work/Product Breakdown Map

Scope → System → Outcomes

Process Maps





Reporting

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Example Tools	Country of Origin
One Click LCA	Finland
eToolLCD	Australia
IES VE	UK
BRE Impact database	UK
Sturgis Carbon Calculator	UK
UKCoMDat	UK

Data bases that cover EPD/LCA for construction materials and products.

E.g. UKCoMDat offers embodied energy and carbon including 24 environmental impact indicators at each life cycle stage of the product (according to their publicity statements).
The BRE IMPACT database for construction Products has approx. 350 datasets that are Compliant with EN 15804

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So, what do we make of the thinking behind life cycle and whole life carbon?

- The key drivers moving forward must be keeping up with innovation; digitalisation and communication; systems thinking, continuous professional development and behavioural change.
- Digitalisation and communication will dominate the future, powered by electricity, via information management technologies that include Building Information Management.
- Digitalisation and communication technologies will rely on rare metals extraction which in turn rely on supply to meet exponential demand in the future.
- The potential of product standards to address industrial emissions.
- We need to clearly understand future thinking behind life cycle and whole life carbon to meet the challenges of a decarbonised future.

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2. *Code of Practice for Project Management for Construction and Development, 5th Edition* [Wiley Blackwell]
3. UK Water Industry Research Report ref. 12/CL/01/15: *A framework for accounting for embodied carbon in water industry assets.*
4. Mayor of London, *Whole Life Cycle Carbon Assets Guidance*, Preconsultation Draft.
5. Alice Ross, *Investing to Save the Planet,* [Financial Times].
6. Guillaume Pitron, *The Rare Metals War: the dark side of clean energy and digital technologies*, [SCRIBE].
7. P. Molthan-Hill (Ed.), *The Business Students Guide to Sustainable Management: Principles and Practice,* Second Edition, (Routledge).
8. Ellen MacArthur Foundation, *Completing the Picture: How the Circular Economy Tackles Climate Change Report* (2019)
9. Kathryn Bourke et al, Building Research Establishment (BRE), *Achieving Whole Life Value in infrastructure and buildings.*
10. Guide to *PAS 2050: How to assess the carbon footprint of goods and services.*

Recommended Reading

1. *Options for incorporating embodied and sequested carbon into the building standards framework*, A report prepared by Aecom for the Committee on Climate Change.
3. Climate Change Committee briefing document: *The Potential of Product Standards to Address Industrial emissions.*
4. Nick Chater, Climate Change Committee briefing document: *Net Zero after Covid: Behavioural Principles for Building Back Better*.
5. David Cheshire, *Building Revolutions: Applying the Circular Economy to the Built Environment*, [RIBA Publishing].
6. Regeneration of the Built Environment from a Circular Economy Perspective, Stefano Della Torre et al, [Springer Open].
7. The United Nations Sustainable Development Goals,.
8. UK Green Building Council, *Embodied Carbon: Developing a Client Brief.*
9. RICS Professional Statement: *Whole Life-Cycle Carbon Assessment for the Built Environment – 2017.*
10. The Ellen MacArthur Foundation, *Circulytics – the circular economy measurement tool.*