Interreg France (Channel Manche) England
European Regional Development Fund

BLUEPRINT to a Circular Economy

EUROPEAN UNION

Welcome to the BLUEPRINT Circular Economy Roadshow

The session will begin soon

projectblueprint.eu

Interreg France (Channel Manche) England
European Regional Development Fund

BLUEPRINT to a Circular Economy

EUROPEAN UNION

Can we remove waste from the construction industry?

Wednesday 11 May, 09:00-11:00

Housekeeping

This session will be recorded

Use the chat/Q&A box for your questions

Please leave feedback

Interreg
France (Channel Manche) England
European Regional Development Fund

BLUEPRINT to a Circular Economy

EUROPEAN UNION

Can we remove waste from the construction industry?

Chair's welcome

Duncan Baker Brown, BakerBrown

Interreg France (Channel Manche) England
European Regional Development Fund
BLUEPRINT to a Circular Economy
EUROPEAN UNION

Can we remove waste from the construction industry?

1. Andrew Buchanan, Materials Processing Institute
2. Gary Elliott, Elliott Wood Partnership
3. Dr Teresa Aparisi, UCL

Can we remove waste from the construction industry?

Speaker slides…

Materials Processing Institute

1944 - 2019 75 YEARS OF INNOVATION

The role of materials in a circular economy

Can we remove waste from the construction industry?

Andrew Buchanan, Materials Processing Institute

11th May 2022

Agenda

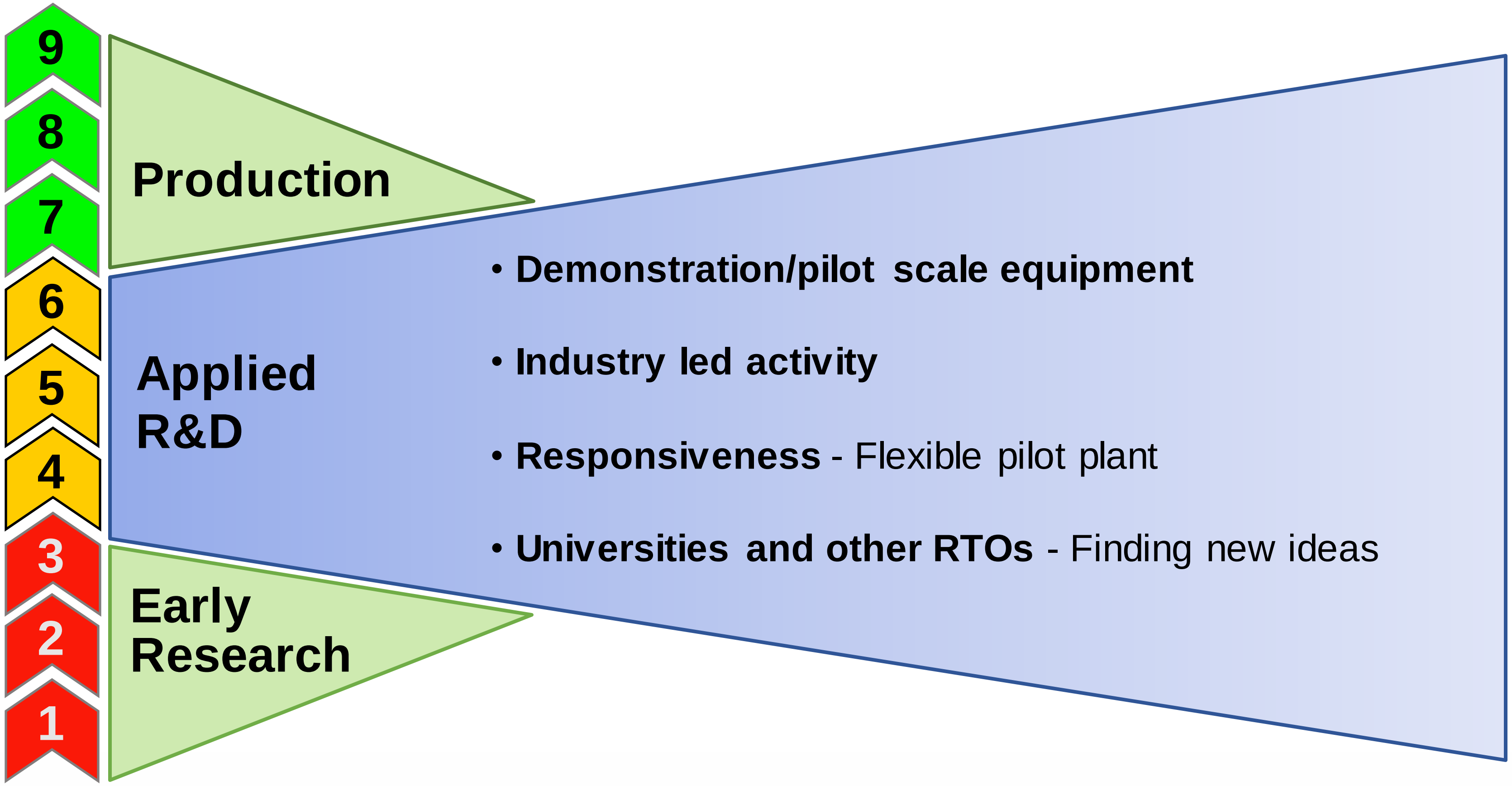
- Introduce the Materials Processing Institute
- The Circular Economy; Principles, Benefits and Challenges
- Industrial Symbiosis
- Steelmaking and steelmaking bi-products
- Tools for understanding and maintaining value; LCA and MSA

Materials Processing Institute

Materials Processing Institute

Materials Processing Institute

Our Position in the Innovation Landscape



Materials Processing Institute

Research Groups

Advanced Materials

- Energy applications – fuel cells, hydrogen, etc
- Civil nuclear - steels, advanced modular reactors
- Metal powders – for additive manufacturing

Circular Economy

- Raw materials security – providing greater economic stability
- Promotion of recycling – and strong secondary markets
- Reduce waste and support sustainable use of Natural Capital

Industrial Decarbonisation

- Hydrogen and its use in industry
- Carbon capture usage and storage (CCUS)
- Offshore wind and renewables

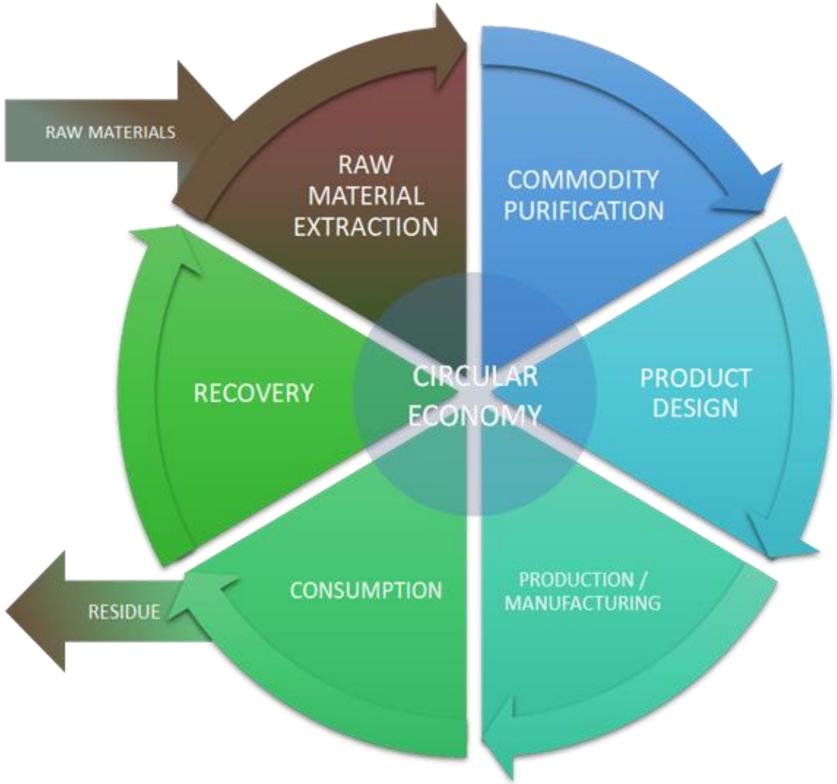
Digital Technologies

- Digitalisation of foundation industry processes
- Machine learning
- Data analytics

Materials Processing Institute

PRISM

Circular Economy

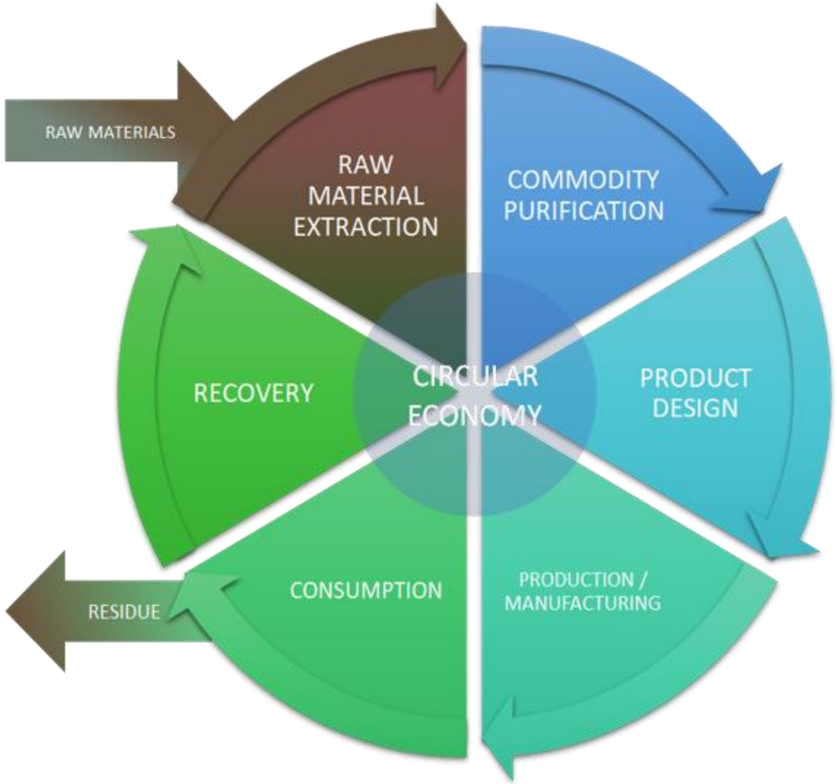


Principles

1. Minimise raw material consumption
2. Maximise yield
3. Design for extended and second life
4. Low/Zero waste manufacturing using sustainable materials
5. Reduce consumption
6. Imbed recovery in design

Materials Processing Institute

Circular Economy



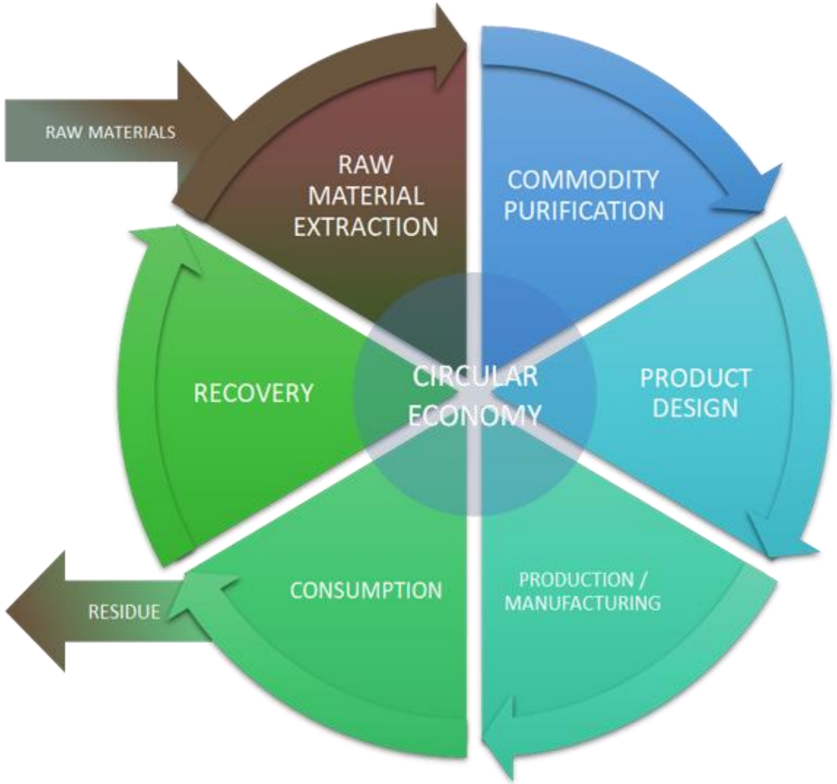
Principles

1. Minimise raw material consumption
2. Maximise yield
3. Design for extended and second life
4. Low/Zero waste manufacturing using sustainable materials
5. Reduce consumption
6. Imbed recovery in design

Circular economy is not just about waste management and zero landfill

Materials Processing Institute

Circular Economy

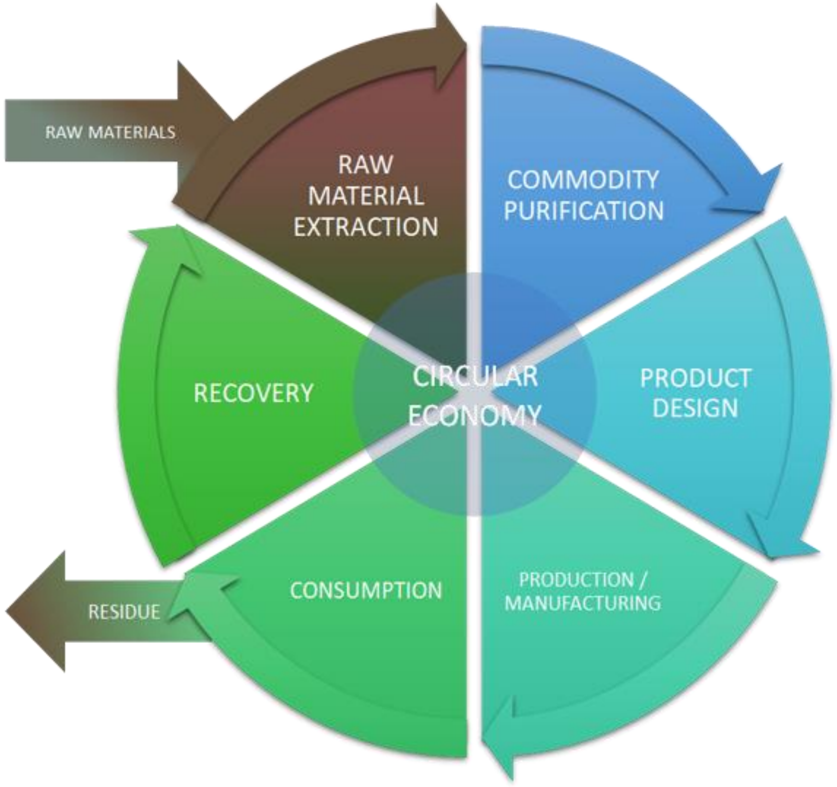


Benefits

1. Raw materials security supports economic stability and reduced reliance on raw material imports
2. Strong secondary materials market supports manufacturing resilience
3. New, low carbon recovery technologies for critical materials supports innovation
4. Waste reduction and minimised environmental impact improves biodiversity

Materials Processing Institute

Circular Economy

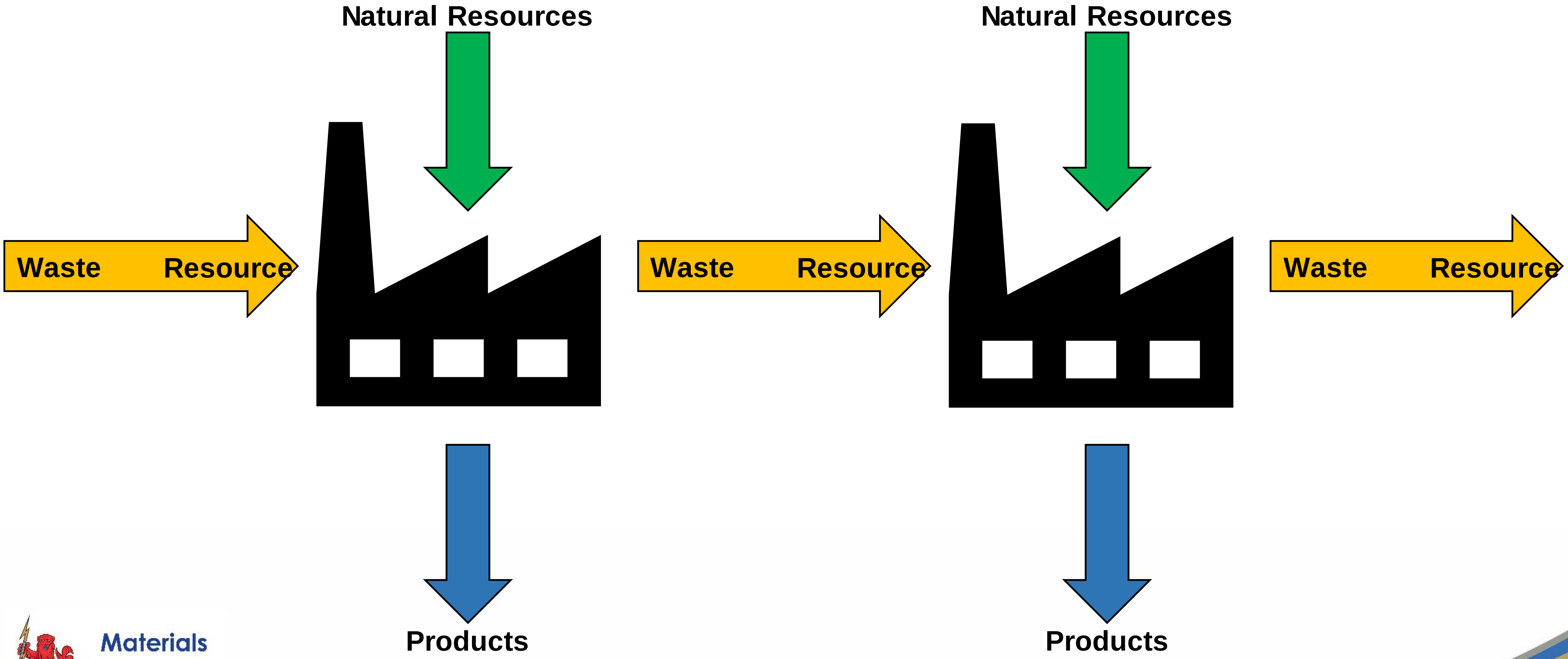


Challenges

1. Society is engineered to consume and dispose
2. Population growth = rapid consumption increase
3. Demand outstripping supply of finite reserves
4. Decarbonisation can challenge circularity

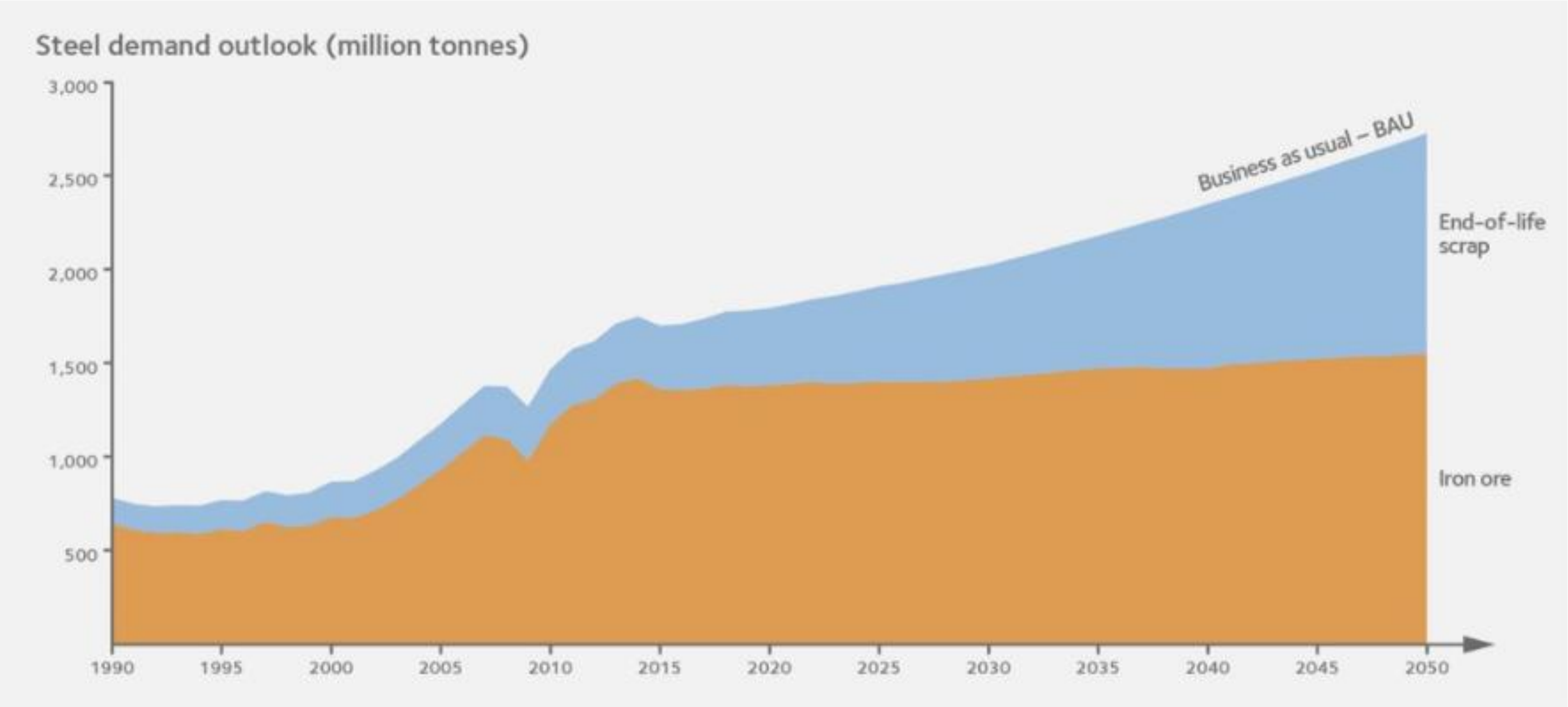
Materials Processing Institute

Industrial Symbiosis



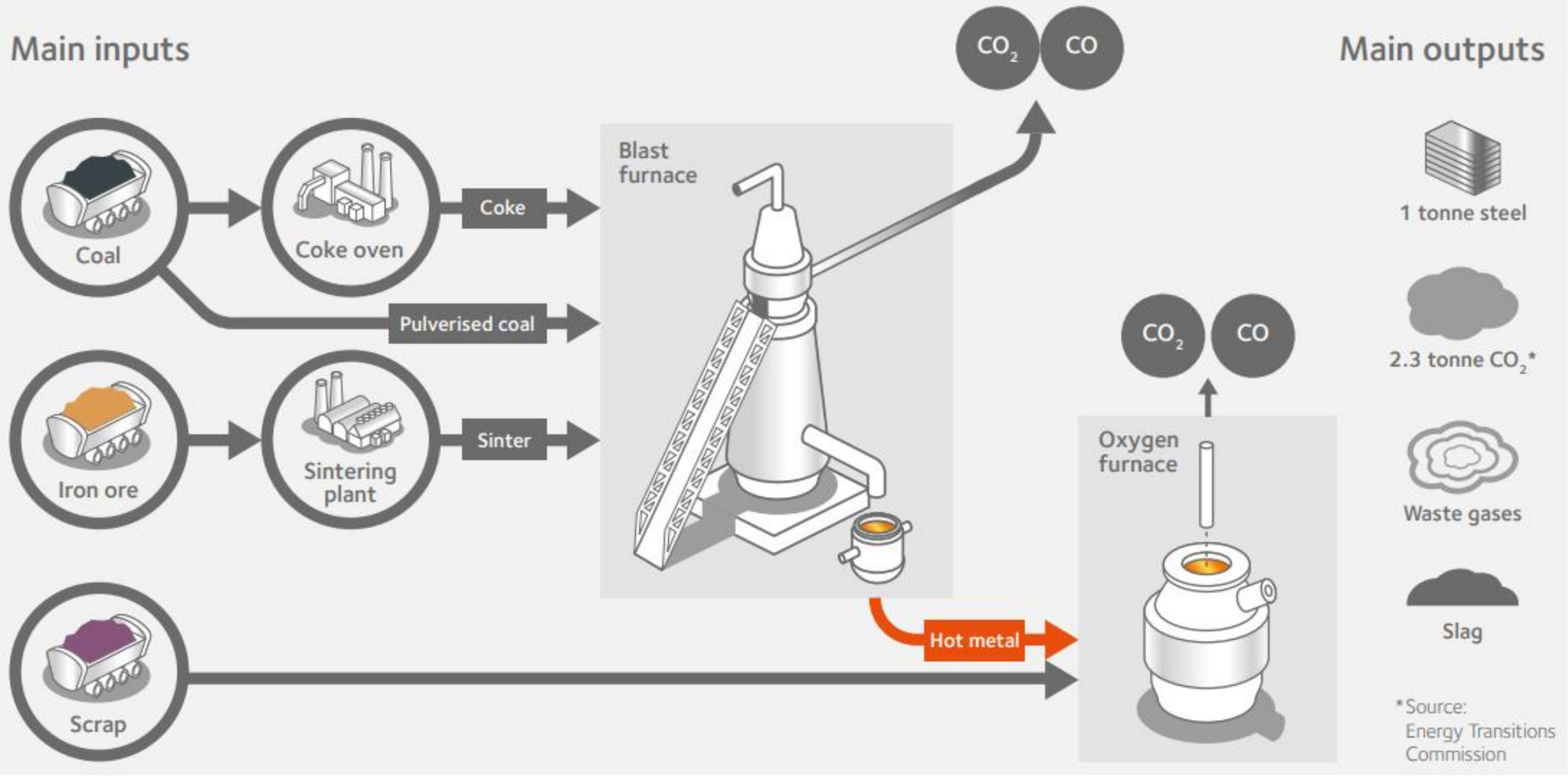
Graphic representation of Industrial Symbiosis [4, 5].

Steel Demand Outlook to 2050



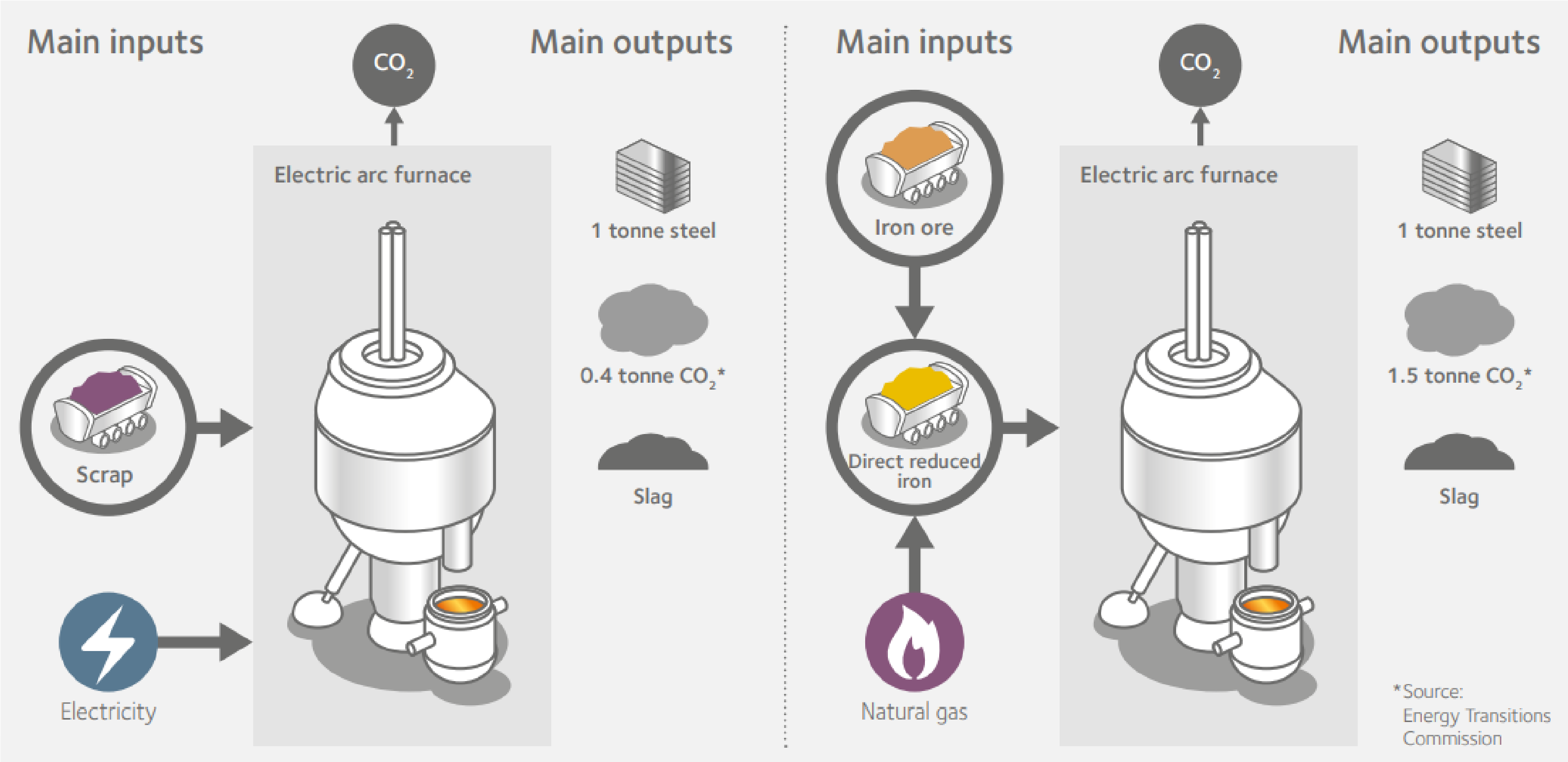
Global steel demand outlook [7].

Primary Steelmaking - Industrial Symbiosis



Process Flow Diagram of the primary steel making route.

Secondary Steelmaking - Industrial Symbiosis



Process Flow Diagram of the secondary steel making route [6].

Materials Processing Institute

Iron and steelmaking slags

Source	Processing	Application
Blast Furnace	Slow cooling (air cooled), crushing, sieving	Concrete and road aggregate
	Rapid cooling (water cooled), gridding	Cement, concrete addition
Basic Oxygen Furnace	Slow cooling, crushing, sieving	Concrete and road aggregate
Electric Arc Furnace	Slow cooling, crushing, sieving	Cement addition and concrete
	Slow cooling, moistened, crushing, sieving	Concrete and road aggregate
Ladle Furnace	Slow cooling, moistened, crushing, sieving	pH stabiliser, roads, cement

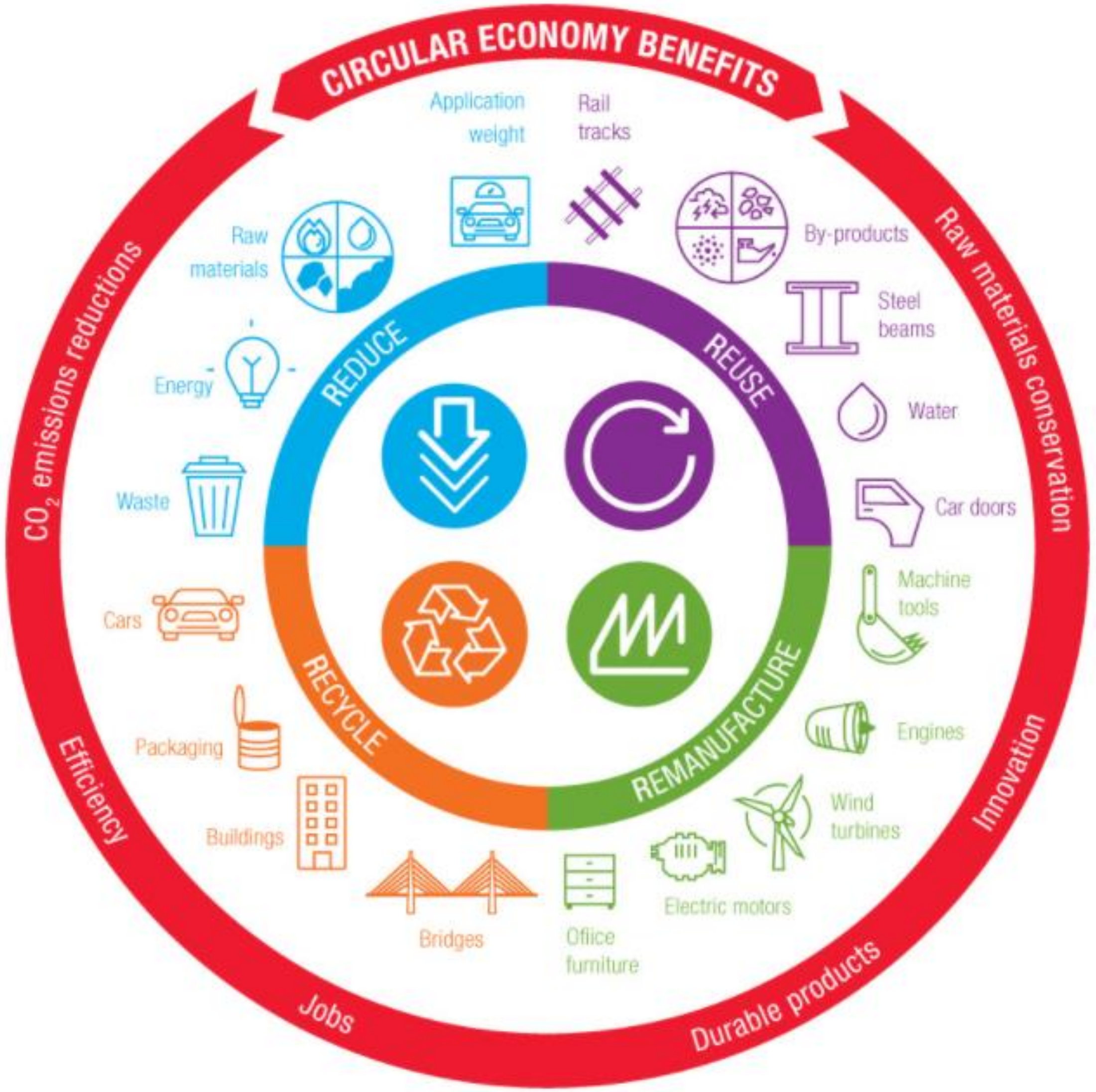
Source, processing, and applications of iron and steelmaking slags [7].

Geopolymers and Geopolymer Cement

- Inorganic materials with a polymeric structure
- High strength among other valuable properties
- Chemically inert to a range of aggressive structures
- >80% reduction in CO_2 emissions when compared to industry standard materials
- Potentially sourced from legacy industrial sites

Materials Processing Institute

Worldsteel

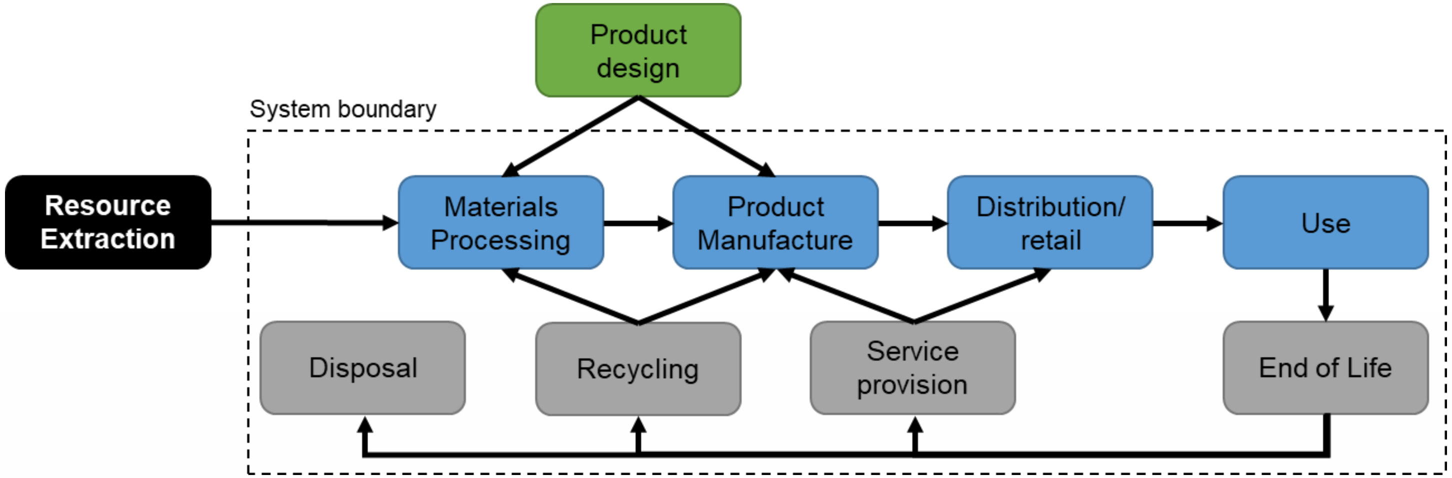


Worldsteel Circular Economy Strategy; “The 4Rs”.

Tools for understanding and maintaining value; LCA and MSA

Lifecycle Assessment

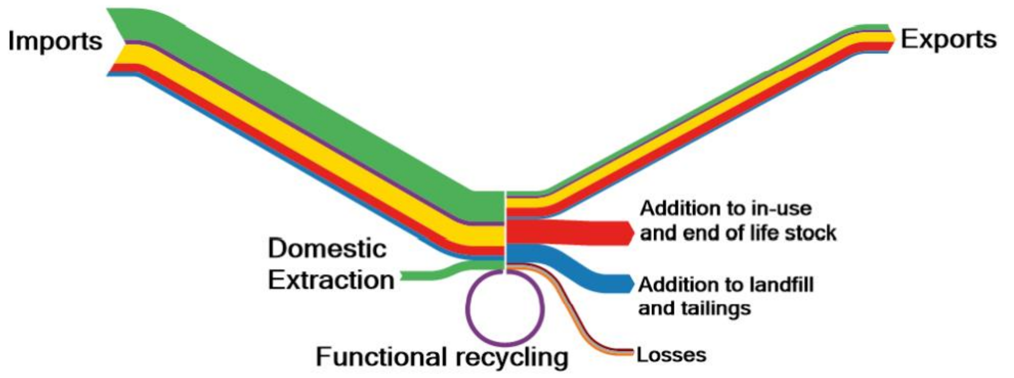
- Structured framework that enables selected impacts or benefits to be quantified throughout the life cycle of a material, product or service.
- Useful for:
  - Identifying critical points in the life of the system
  - Comparing different approaches/technologies
  - Setting benchmarks
  - Full life optimisation



Materials Processing Institute

Material System Analysis (MSA)

- A tool that maps the flow of a material through its entire lifecycle from exploration and extraction, through processing, manufacturing and use and on to the end of life either through recovery or disposal
- Highly effective for identifying pinch points in the material value chain allowing mitigation strategies to be built-in and resilience to be built



Material System Analysis of Nine Raw Materials; C. T. Matos et al; JRC of the EC; 2021

Materials Processing Institute

Key points

- Circular Economy is not solely about end of pipe treatments and waste management
- Resource optimisation throughout useful life and beyond
- Challenges to convert from a linear to a circular model…
- …but also opportunities
- Established tools support value chain quantification
- Extensive opportunity for research and commercialisation on new processes and technologies

Materials Processing Institute

References

[1] "The 17 Goals", https://sdgs.un.org/goals, accessed 16/11/2021.

[2] Adapted from: https://www.government.nl/topics/circular-economy/from-a-linear-to-a-circular-economy, accessed 15/11/2021 .

[3] Adapted from: R. Lombardi. "Introducing the proposed industrial symbiosis workshop", International Synergies, https://www.sist.si/image/catalog/DOWNLOAD/STANDARDIZACIJA/2018Feb%20CWA%20IndSym%20RLombardi%20SHAREBOX.PDF, accessed 16/11/02021.

[4] https://ec.europa.eu/environment/europeangreencapital/wp-content/uploads/2018/05/Industrial_Symbiosis.pdf, accessed 16/11/2021.

[5] Arcelor Mittal, "Climate Action Report 1, May 2019, https://storagearcelormittaluat.blob.core.windows.net/media/3lqlqwoo/climate-action-report-2019.pdf, accessed 16/11/2021.

[6] Arcelor Mittal, "Climate Change", https://corporate.arcelormittal.com/sustainability/approach/climate-change, accessed 24/05/2021.

[7] C. Thomas, J. Rosales, J. A. Polanco and F Agrela, 7 – "Steel slags", Editor(s): J. de Brito, F. Agrela, In: Civil and Structural Engineering, New Trends in Eco-efficient and Recycled Concrete, Woodhead Publishing, 2019, 169-190.

[8] D. Stewart, "The Single-Stage Production of Low Zinc Pig Iron Nuggets from Basic Oxygen Furnace dust, using Blast Furnace Dust as a reductant", 2019.

[9] N. Rodriguez Rodriguez, L. Gijsemans, J. Bussé, J. Roosen, M. A. Recai Önal, V. Masaguer Torres, Á. Manjón Fernández, P. T. Jones, K. Binnemans, "Selective Removal of Zinc from BOF Sludge by Leaching with Mixtures of Ammonia and Ammonium Carbonate," Journal of Sustainable Metallurgy, 2020.

[10] Hephaestus Metals, "Innovation for Circular Economy and Environmentally Friendly Processes," received 2020.

[11] F. Malaret, J. Hallett, K. Sedransk Campbell, "Oxidative ionothermal synthesis for micro and macro Zn-based materials," Materials Advances, vol. 1, pp. 3597-3604, 2020.

Materials Processing Institute

Thank You

Materials Processing Institute
Eston Road
Middlesbrough
TS6 6US
United Kingdom

+44 (0)1642 382000
enquiries@mpiuk.com

www.mpiuk.com

elliottwood

Engineering a better society

FULL CIRCLE TO RE-USE

Education **E** | Technology **T** | Health **H** | Infrastructure **I** | Culture **C** | Sustainability **S**

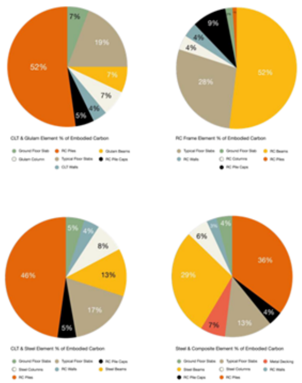
elliottwood | engineering a better **society**

Our Values

These are the values we all take into our day-to-day work

Certified B Corporation PENDING

Carbon Tools Output



The **Building** Society

Be Brilliant

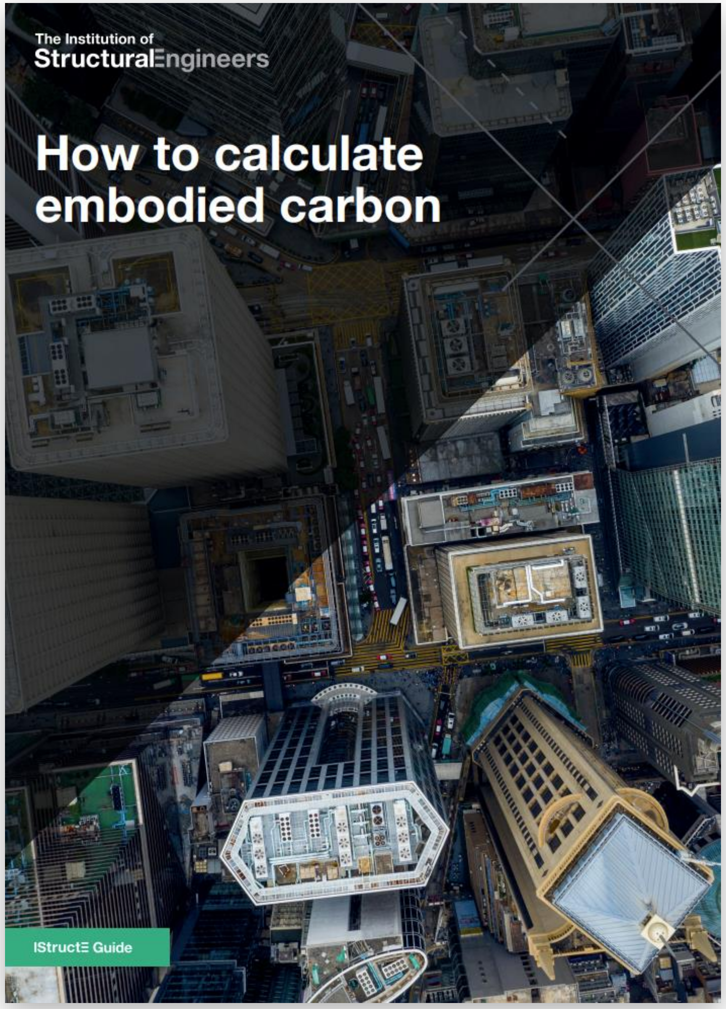
—To go above and beyond
—To show outstanding ability no matter the task
—To offer unrivalled service
—To achieve your full potential

Flip It

—To disrupt routine
—To consider other perspectives
—To cultivate curiosity
—To realise unexpected benefits

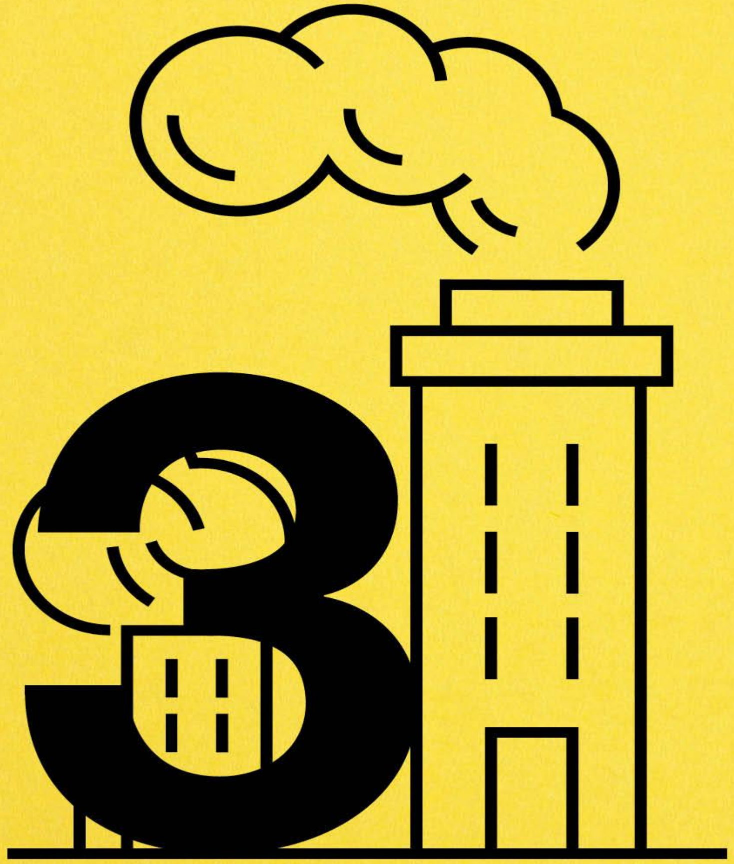
Step Forward

—To inspire everyone for a better future
—To embrace diversity and inclusion
—To safeguard the wellbeing of yourself and others
—To choose well, leaving a positive footprint on our shared world



The Structural Carbon Tool

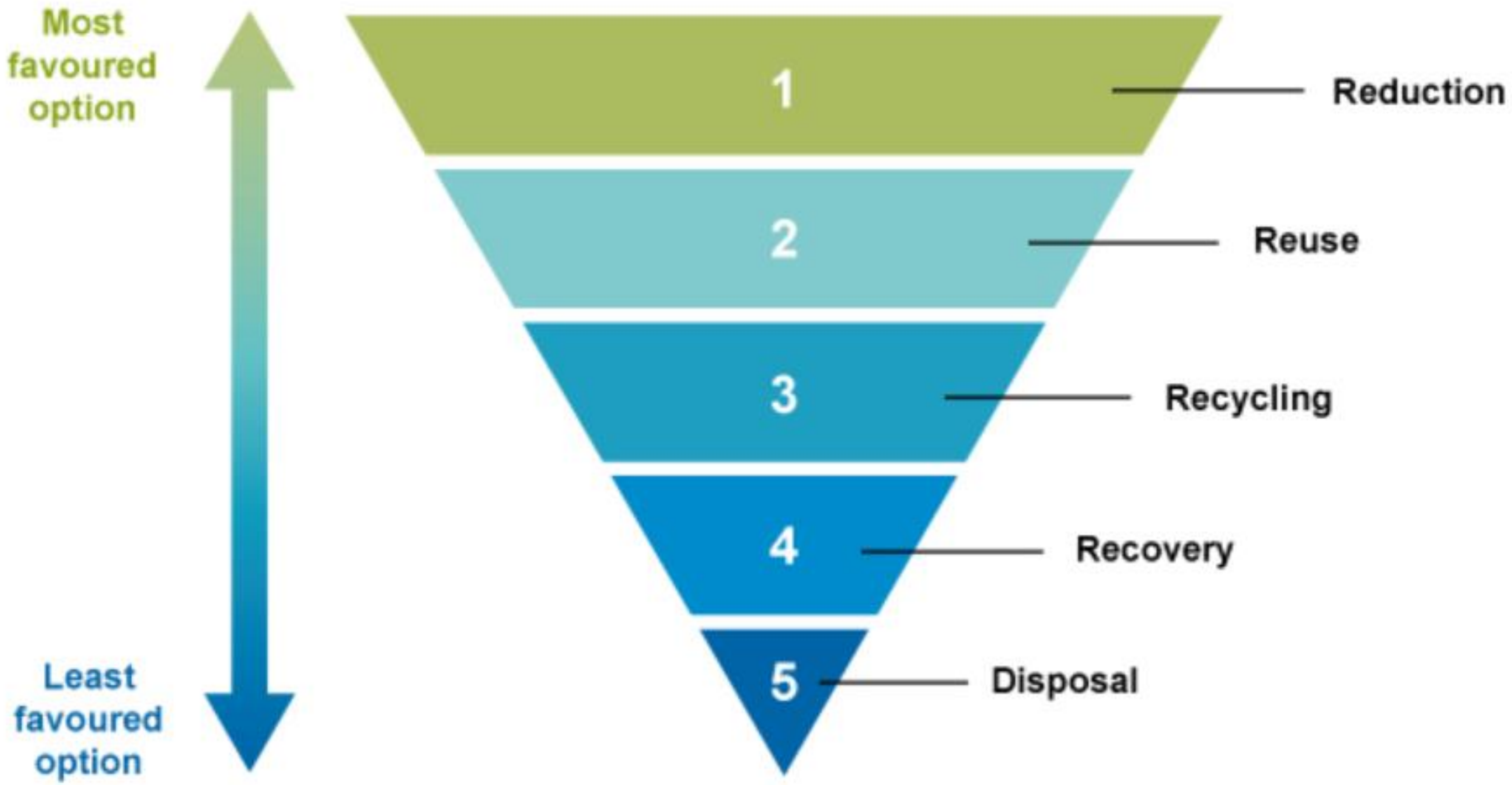
Of the 33.1 billion tonnes of man-made CO_2 created worldwide, 40% is attributable to the construction industry.



The demolition, and excavation debris from the construction industry represents 63% of total annual UK waste.

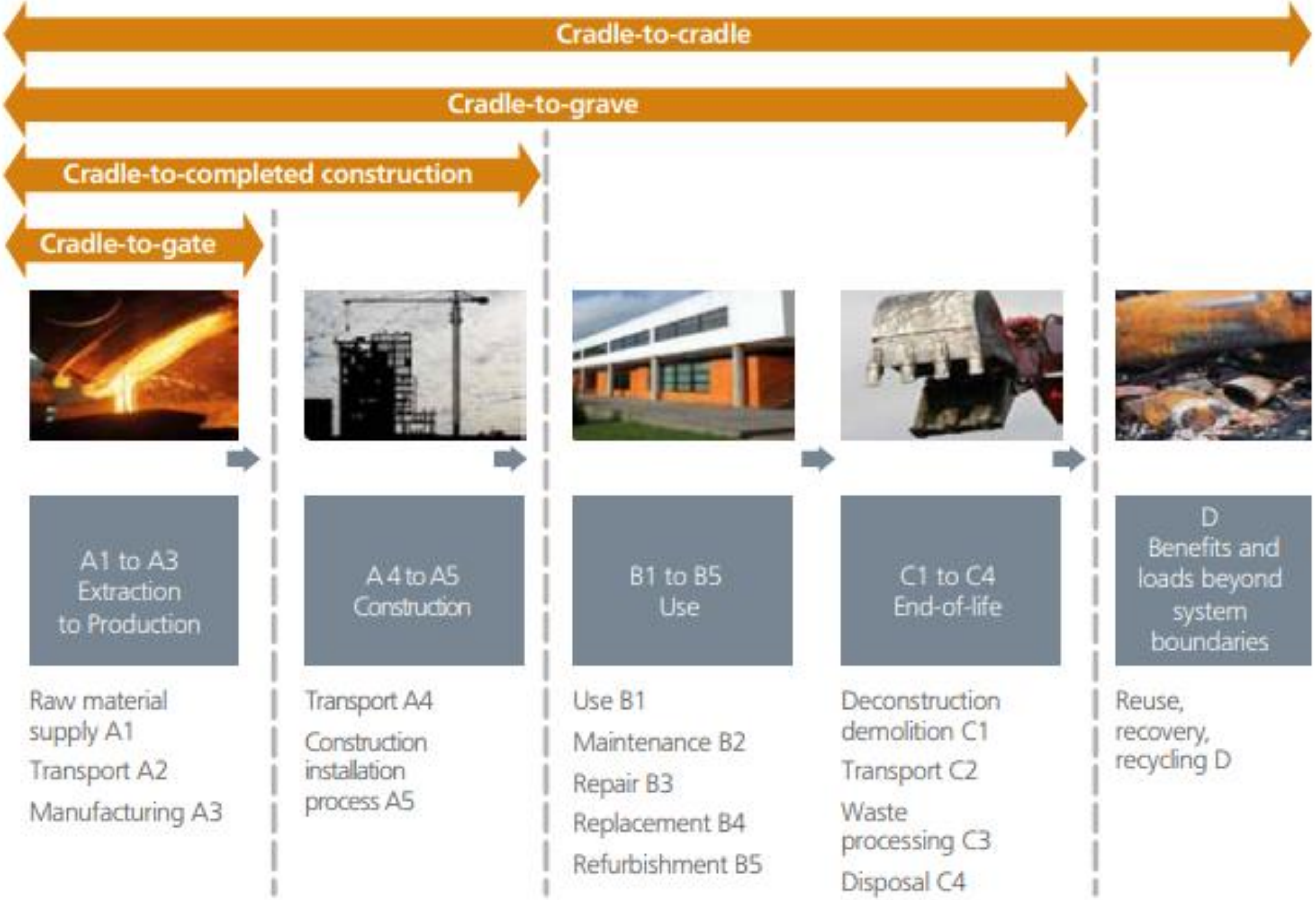
An estimated 80% of a product's environmental impact is determined at the design stage.

Re-use vs Re-cycle




Understanding Carbon
CO2
CO2
CO2
CO2
Embodied Carbon
Manufacture, transport and
installation of construction materials
Operational Carbon
Building energy consumption

Lifecycle embodied carbon

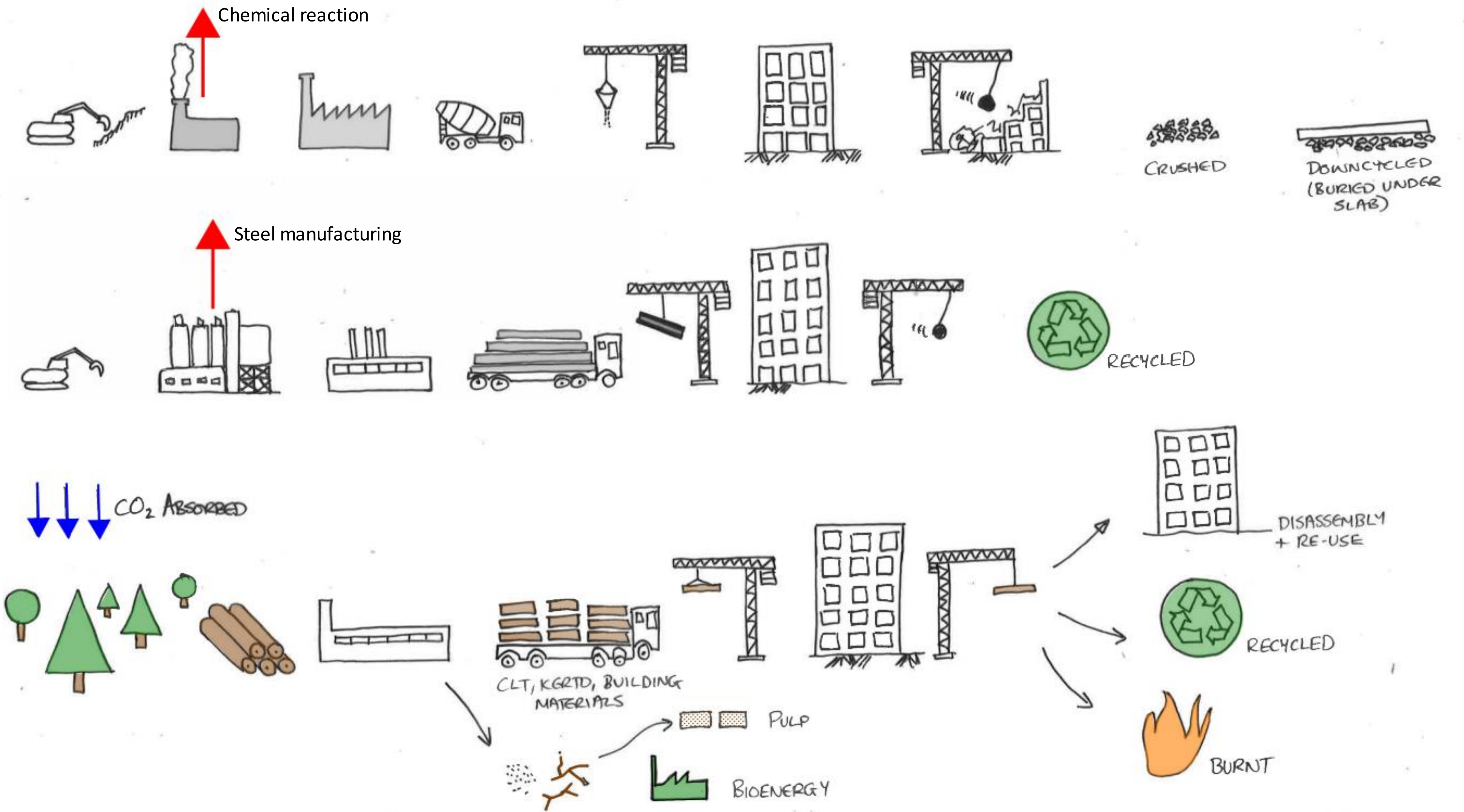


Concrete, steel & timber – where is the embodied carbon?

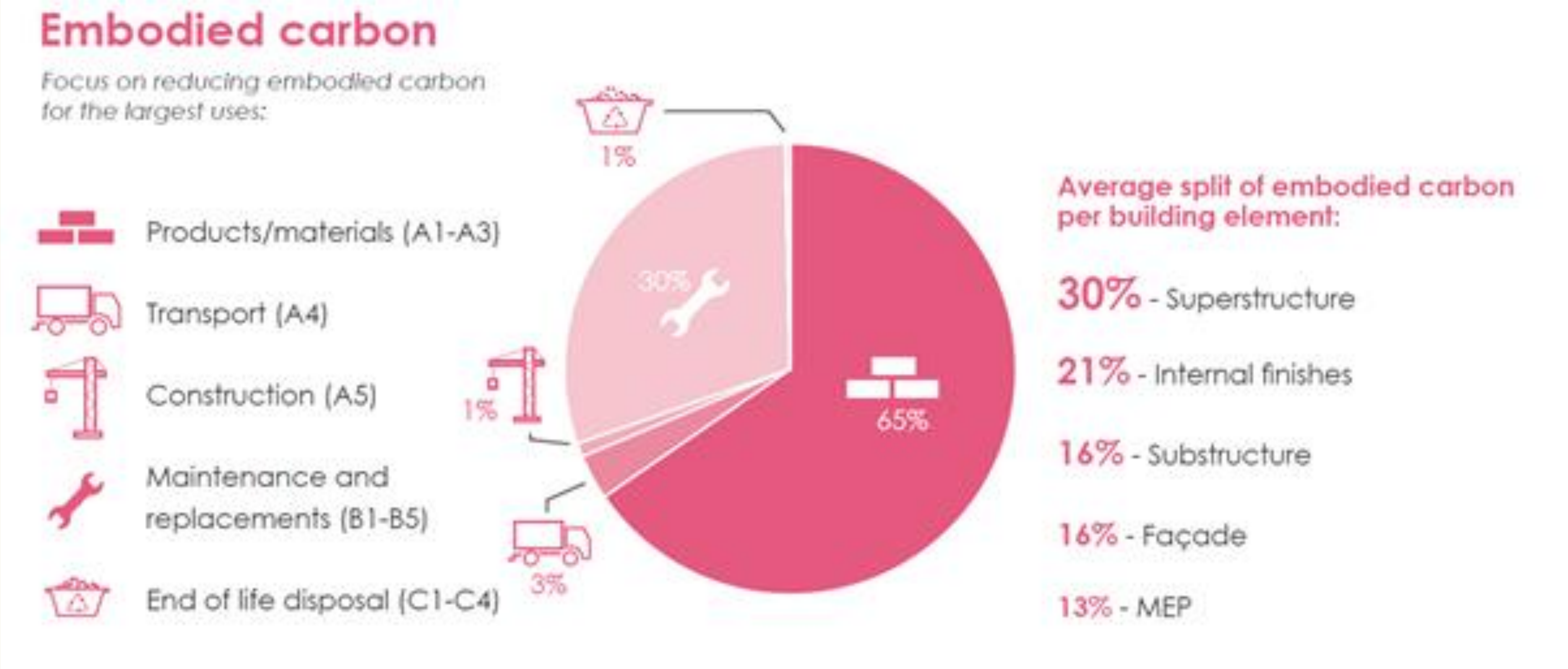
Concrete

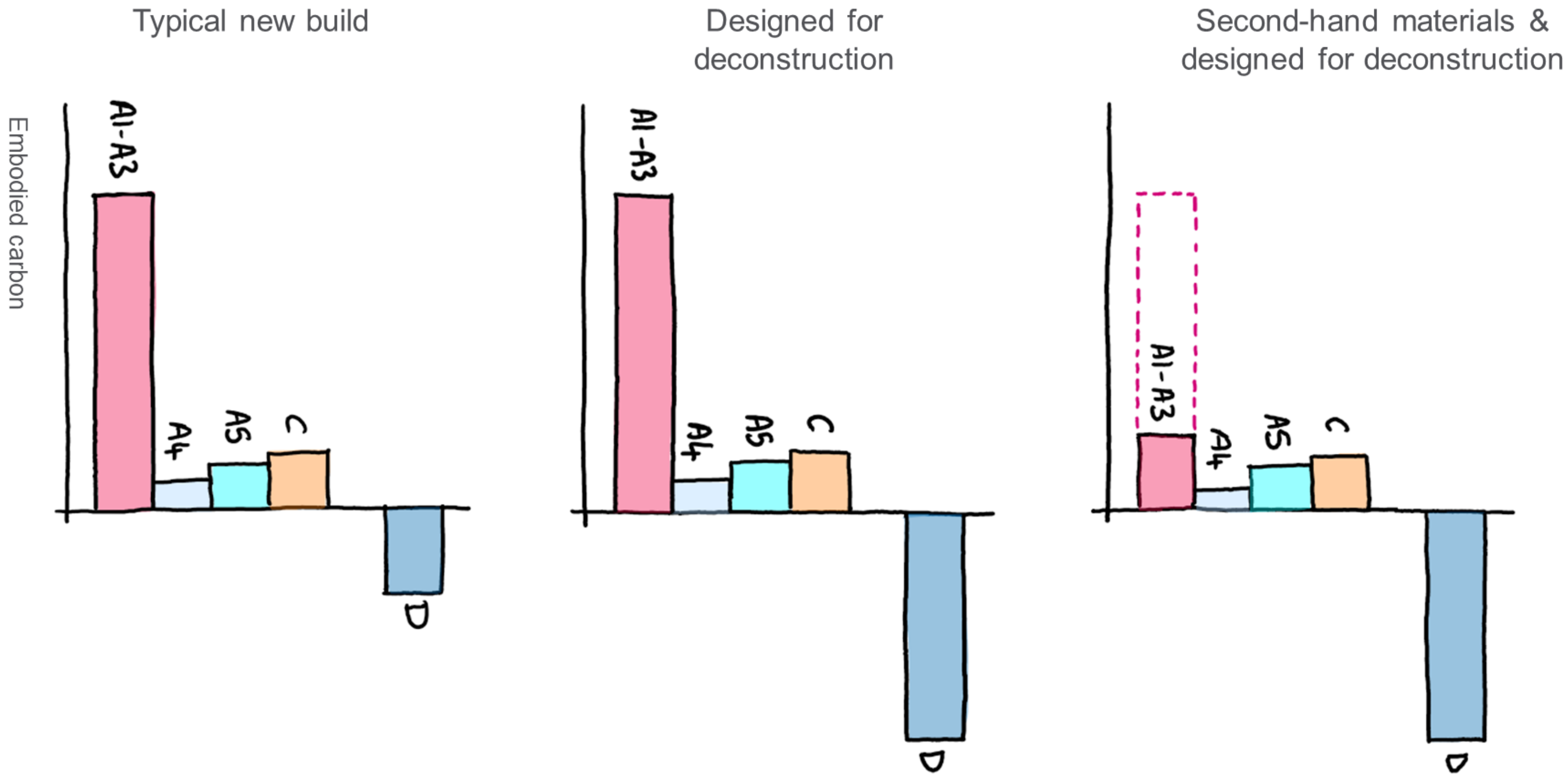
Stee
l

Timber



Impact of Material Production (LETI)

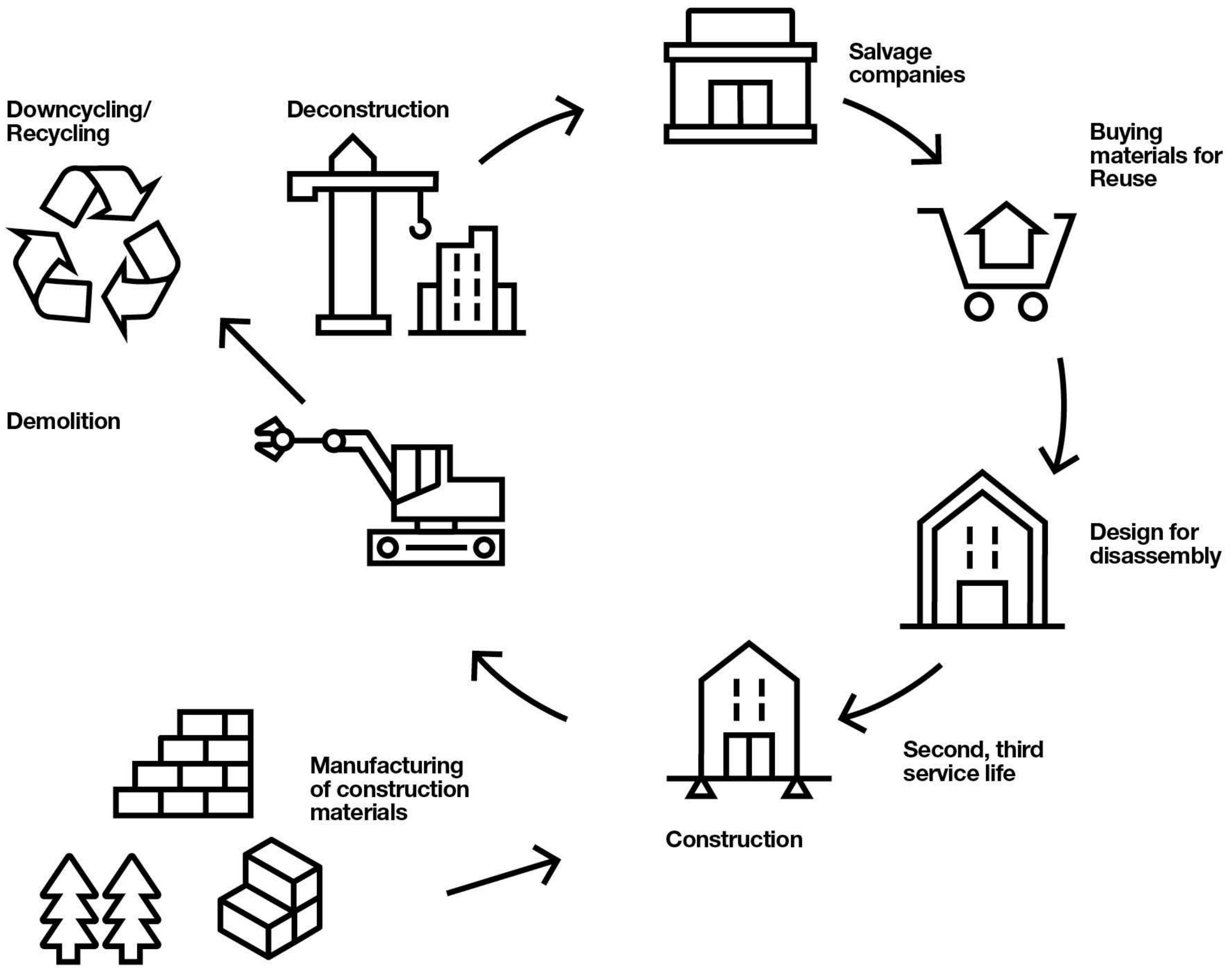



Typical new build
Designed for deconstruction
Second-hand materials & designed for deconstruction
Embodied carbon
A1-A3
A4
A5
C
D

To turn full circle

"We cannot build our way out of the climate emergency. Building anything costs embodied carbon – emissions the planet cannot afford. We must work with what we've already got by repurposing existing buildings and reusing the materials contained within them. And it needs to happen now."

Penny Gowler, Elliott Wood



elliottwood

Circular Economy

Definition

A circular economy (CE) is an alternative to a traditional linear economy (make, use, dispose) in which we keep resources in use for as long as possible, extract the maximum value from them while in use, then recover and regenerate products and materials at the end of each service life.

Primary actions to transition to a CE

Optimise existing resources by:

- Reusing buildings, systems, components & materials rather than recycling
- Deconstructing not demolishing
- Using biogenic materials

Designing new buildings for:

- Maintainability & upgrading e.g. designing in layers
- Flexibility & adaptation but not overdesigning
- Deconstruction to facilitate reuse in future

Current Material Shortages

Builders' recovery hit by material shortages, says FMB

Fastest rise in construction activity since 1997 risks being undermined by price increas

Press release | 6 July 2021

You're here: Homepage → News and campaigns → Resource library search → Builders' recovery hit by materi

The fastest rise in construction activity since 1997 risks being undermined by price increases and a shortage of building materials, warns the Federation of Master Builders (FMB), in response to today's Construction PMI data.

Brian Berry, Chief Executive of the FMB said: "The building materials shortage is disproportionately affecting small builders and threatening their recovery from the pandemic despite strong growth in the construction sector. The materials shortage is proving a serious detriment to both businesses throughout the supply chain and consumers. As the country reopens for business, it's imperative that building firms have better access to the materials they need to build."

Berry concluded: "It's very encouraging that activity in the construction sector is increasing at its fastest rate in over twenty years, but given that confidence is rapidly dropping away, the lack of materials needs addressing before jobs and business continuity start to be compromised. Small firms form over 90% of the construction industry, and they are experiencing the most difficulties as a result of these shortages."

Notes to editors

The Federation of Master Builders (FMB) is the largest trade association in the UK construction industry representing thousands of firms in England, Scotland, Wales and Northern Ireland. Established in 1941 to protect the interests of small and medium-sized (SME) construction firms, the FMB is independent and non-profit making, lobbying for members' interests at both the national and local level.

The FMB is a source of knowledge, professional advice and support for its members, providing a range of modern and relevant business building services to help them succeed. The FMB is committed to raising quality in the construction industry and offers a free Find a Builder service to consumers.

CN Construction News

NEWS

Materials shortage update: cement supplies 'particularly hard hit'

21 JUL 2021 | BY TIYA THOMAS-ALEXANDER

Bagged cement supplies for a house under construction

Supplies of bagged cement have been "particularly hard hit" according to the Construction Leadership Council's latest update on material shortages.

Bulk cement supplies are also constrained, despite kilns at UK cement suppliers all being operational. The CLC warned it would take time for stock levels to return to normal and, due to increased demand, they forecast longer lead times for deliveries until the end of the year at least.

The latest update from Builders Merchants Federation CEO John Newcomb and CPA boss Peter Caplehorn, who are also the co-chairs of the Construction Leadership Council's Product Availability working group, said shortages across a range of products seen in the first half of the year were continuing, due to ongoing excess demand, steep inflation and delivery delays.

News | Opinion | Sport | Culture | Lifestyle | More

Business ▸ Economics | Banking | Money | Markets | Project Syndicate | B2B | Retail

Construction industry

Supply shortages hit Britain's booming building industry

Strongest growth in sector for more than 20 years but firms facing longer lead times and higher prices for components

Larry Elliott

Tue 6 Jul 2021 11.27 BST

▲ The monthly survey by IHS Markit/CIPS reported a surge in house building and a pick up in construction activity generally. Photograph: Joe Giddens/PA

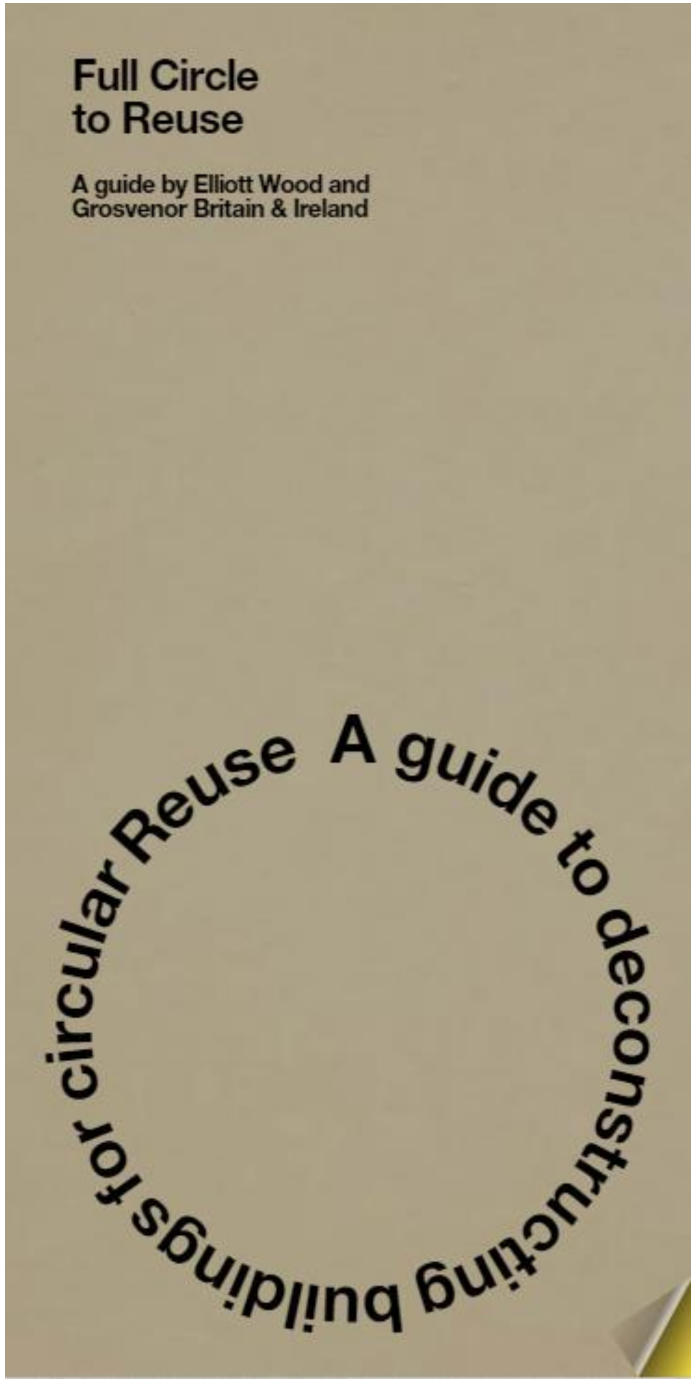
Britain's booming construction sector is suffering from severe supply chain bottlenecks as it experiences the strongest growth in almost a quarter of a century, the latest snapshot of the industry has shown.

The monthly survey by IHS Markit/Cips reported a surge in housebuilding and a pick up in construction activity generally as the economy emerged from Covid-19 lockdown.

But the rise in the construction purchasing managers' index to its highest level since June 1997 was accompanied by mounting price pressures and delays caused by a shortage of materials and finished goods.

The IHS/Markit CIPS report stood at 66.3 in June, up from 64.2 in May, the 11th consecutive month of expansion and well above the 50 cut-off point that denotes whether the sector is growing or contracting.

Rapid growth boosted employment in the construction sector - which accounts for about 6% of the economy - but 77% of firms reported longer lead times from suppliers, while prices for products and raw materials rose at their fastest rate since the survey was launched.

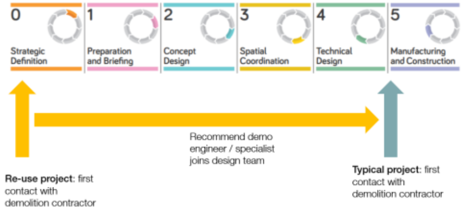


12 Steps to Reuse

01 Mapping by RIBA Stages
02 Assessing Potential
03 Surveys
04 Structural Investigations
05 Inventory + Structural Sketches
06 Practical Deconstruction

07 Reuse Feasibility
08 Reuse Evaluation Building Materials + Products
09 Reuse Evaluation Steel + Concrete
10 Reuse Evaluation Timber
11 Reuse Evaluation Masonry
12 Reuse Alternatives

Five point plan: 1. Early involvement of demolition contractors



01

Mapping by RIBA Stages

This chart outlines the process for the Reuse assessment of materials in existing buildings.

Crucially, it's mapped against the different stages of the RIBA plan of work 2020, to show where they can be incorporated into a project.

Key to delivery is ensuring the gathering of information, through investigations and surveys, is undertaken at the very earliest opportunity – even before a project has been officially started.

In parallel with this, A demolition consultant should be involved from the start and appointed as a part-time consultant within the design team.

	Pre-Design Stage (At any time)	0 Strategic Definition	1 Preparation & Briefing	2 Concept Design	3 Spatial Co-ordination	4 Technical Design	5 Manufacturing & Construction
Assessment of Reuse potential – Reuse in-situ	Intrusive structural investigations, limited to where non-intrusive investigations don't work; Desk study; Dimensional Survey; Reclamation advice on visible materials; Non intrusive structural investigations; Revit model & material passports; Inventory & Structural Sketches; Site visit			Targeted structural investigations; Conceptual design using available materials	Targeted structural investigations; Source second-hand materials	Targeted structural investigations; Procure second-hand materials	Revit model & material passports
Assessment of Reuse potential – Reclamation	Intrusive structural investigations, limited to where non-intrusive investigations don't work; Desk study; Dimensional Survey; Reclamation advice on visible materials; Stage 0 with full existing building model; Non intrusive structural investigations; Revit model & material passports; Inventory & Structural Sketches; Demolition consultant input; Site visit	Demolition consultant input	Demolition consultant input	Conceptual design using available materials; Material testing & grading certification; Demolition consultant input	Source second-hand materials; Markets for reclaimed materials; Demolition consultant input	Procure second-hand materials; Demolition consultant input	Revit model & material passports (if only part of the building is deconstructed).; Demolition contractor; Material testing & grading certification
Business as usual – Knock-down & Rebuild							Demolition Contractor
Business as usual – Refurbishment		Architect develops brief with client	Desk study; Dimensional Survey	Archt. options drive structural investigations	Structural scheme (assumptions); Targeted structural investigations		Demolition Contractor

Key
- Demolition input
- 3rd party (established)
- 3rd party (developing)
- Structural engineer
- Design team

What's behind the finishes? Non-destructive structural investigations

Different non-destructive techniques (NDT) can be used to investigate the structure hidden behind the finishes or the reinforcement within structural elements (e.g. concrete encased steel beam, reinforcement in slabs, wall thickness, web thickness, spans directions, etc.). For the MSB project, the following equipment was used: impulse radar or GPR system (GSSI structure scan), cover meter (proceq), metal detector, ultrasonic material thickness gauge (PCE-TG 50), thermal camera, hand-held laser distometer, measuring tape, Vernier callipers and camera.

The table below indicates the non-destructive techniques that could be used to investigate different structural elements and the type of information that can be obtained. An initial site visit by the investigation contractor is important to identify where finishes could be easily removed for access and to generally advise on likely success of such investigations. Several techniques could be employed for a single material or component.

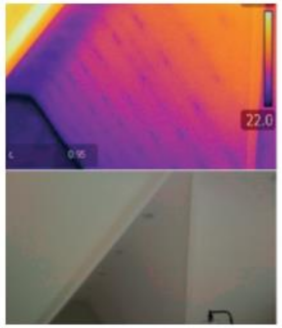
Depending on the type of material, the best method to investigate the structure might need to be selected on site. Some of the limitations of NDTs are related to the direct access to the surface material to be scanned. For example, the structure behind metal finishing panels cannot be detected; insulation between the structure and the scanned surface may affect the resolution of the measurements; and voids may prevent the recording of useful information.

Overall, there is a significant amount of data that could be measured using non-destructive methods without the need to strip out, drill or remove material. These provide a rapid means to obtain structural information about the buildings in real-time. The only extra time needed on site is to set up the equipment (settings and calibration) and the access to the building components being inspected – through the removal of ceiling tiles, positioning of stairs, etc. On average, one day per building was enough to investigate the buildings on the MSB project.

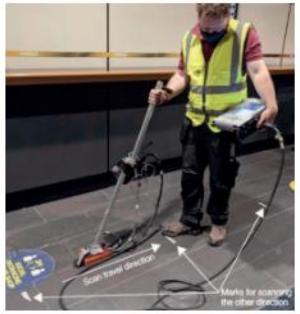
Structural Element	Material	Non-destructive technique	Output
Floors	Concrete	Impulse radar (High/ Low freq 0.5/1.0m dp)	Arragement of reinforcement & spacing, filler joist locations & centres. Not suitable for determining reinforcement bar sizes.
		Cover meter	Map the arrangement of reinforcement & provide spacing dimensions (filler joist locations & centres), rebar dims & local depth of cover.
	Hollow clay pots	Thermal imaging camera	Immediately identifies material boundaries based on temperature differences. Allows spacing & locations to be determined. Laser pointer integrated within camera can also be used to mark & measure dims.
	Timber	Impulse radar (High frequency)	Map joist locations & centres but not sizes.
		Lifting floorboards / drill small holes	Cross sectional dimensions.
Walls	Masonry	Impulse radar (Low freq)	Wall thickness & material type. Low frequency best for finding the back of the wall. Calibration based on wall with access both sides.
Roof	Timber	Thermal imaging	Rafters / joists located and centres estimated.
Beams & columns	Concrete encased	Metal detector (small / med / large heads)	Sound indicates presence of metal. Small head has smallest range but is most sensitive.
	Steel	Ultrasonic	Web & flange thickness particularly when web accessible one side only
		Vernier	Flange thickness, manual measurement.


24 North Audley Street. Extensive finishes present within 24 AS. Beam down-stands obscured by ventilation boxing out.

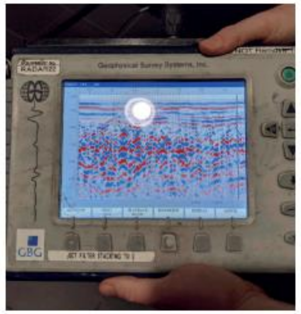

34 North Row. The structure is generally exposed. The semi-exposed first floor visible from ground floor.



31-33 North Row. The structure is generally hidden behind the finishes. Thermal camera identified the rafter locations & spacing.



High-frequency impulse radar (up to 0.50m depth) to scan reinforcement in concrete slab of 32 NR.



Impulse radar real-time output data showing location of reinforcement.


Scanning first floor of 34 NR using a cover meter.


Using a metal detector to scan a concrete encased steel column at ground floor of 34 NR.


Example of measuring the thickness of a metal object using the ultrasonic thickness gauge.


Digital image output from thermal camera identifying the hollow pot slabs of first floor 34 NR.

05

Inventory + Structural Sketches

Once a basic measured survey is available and archive information has been sourced following the desk study and non-intrusive investigations, an inventory of materials and elements can be created.

Supplied as a simple Excel spreadsheet, with yellow highlighted columns indicating the data, included in the material passports template.

This is accompanied by structural sketches indicating locations of the structural elements with any IDs referenced in the inventory.

The inventory is used to:

1.
Measure material quantities and establish the type of structural elements available for Reuse.

2.
Help select reclamation markets to target (based on aggregated inventory data).

3.
Feed into the BIM model of the existing building and material passports for individual elements.

EW ID	ID	Material	Element Type	Element	Section	Mass/Metre	Width (mm)	Depth (mm)	Length (mm)	Area (m2)	Volume (m3)	Weight (kg)	Tensile Strength (N/mm2)	Steel Grade	Structural Load-bearing	Structural Stability	Others	Existing Method of Fixing	Data Source	Comments
34NR-GF-SB-001	SB-X-00001	Steel	Beam	Steel Beam	305x165x40 UB	40.3			3900			157	265	S275	Y	N		Bolted	Estimated (visual inspection)	
34NR-GF-SB-002	SB-X-00002	Steel	Beam	Steel Beam	305x165x40 UB	40.3			3700			149	206	S275	Y	N		Welded	Estimated (visual inspection)	
34NR-GF-SB-003	SB-X-00003	Steel	Beam	Steel Beam	305x165x40 UB	40.3			3600			145	341	S355	Y	N		Bolted	Estimated (visual inspection)	
34NR-GF-SB-004	SB-X-00004	Steel	Beam	Steel Beam	356x171x45 UB	45			1600			72	271	S275	Y	N		Bolted	Estimated (visual inspection)	

06

Practical Deconstruction

Conversations with various demolition contractors have identified a series of issues within the current demolition industry that act as barriers to making deconstruction and material Reuse the norm.

A five-point plan to address these barriers is outlined here:

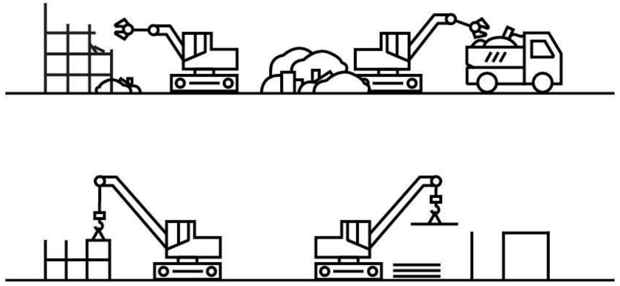
1.
Early involvement of demolition specialists.

2.
Better specification of client objectives with respect to material Reuse.

3.
Rewrite demolition contracts to incentivise demolition contractors.

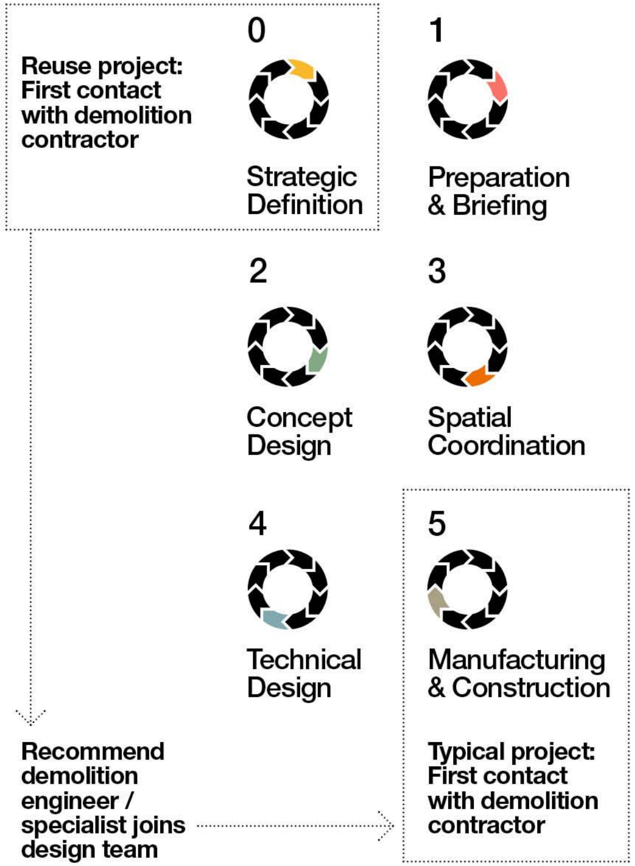
4.
Improve recertification of and warranties for reclaimed materials.

5.
Legislation to disincentivise cheap material imports.



1

Early involvement of demolition specialists

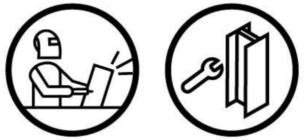


2

Better specification of client objectives with respect to material Reuse

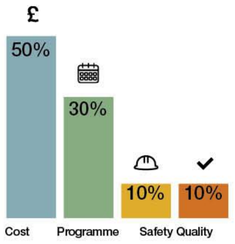
“Is there any reason why you can’t unbolt a steel frame rather than cut it ?”

“No technical reason, it’s just we’re never asked to”

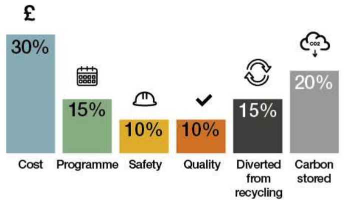


3

Rewrite demolition contracts to incentivise deconstruction



Current Situation



Tender breakdown to incentivise contractors

4

Improve re-certification and warranties for reclaimed materials

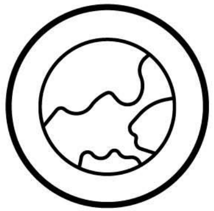
- Currently re-certification of reclaimed materials is rare.
- Re-certification and warranty is needed to improve uptake of second-hand materials.

Options
- Salvage merchants undertake role.
- Engage with investigation companies willing to enter into collateral warranties based on testing.
- Incentivise manufacturers to take responsibility for repair and refurbishing. Difficult for commoditised materials.

5

Legislation to reduce the impact of cheap material imports

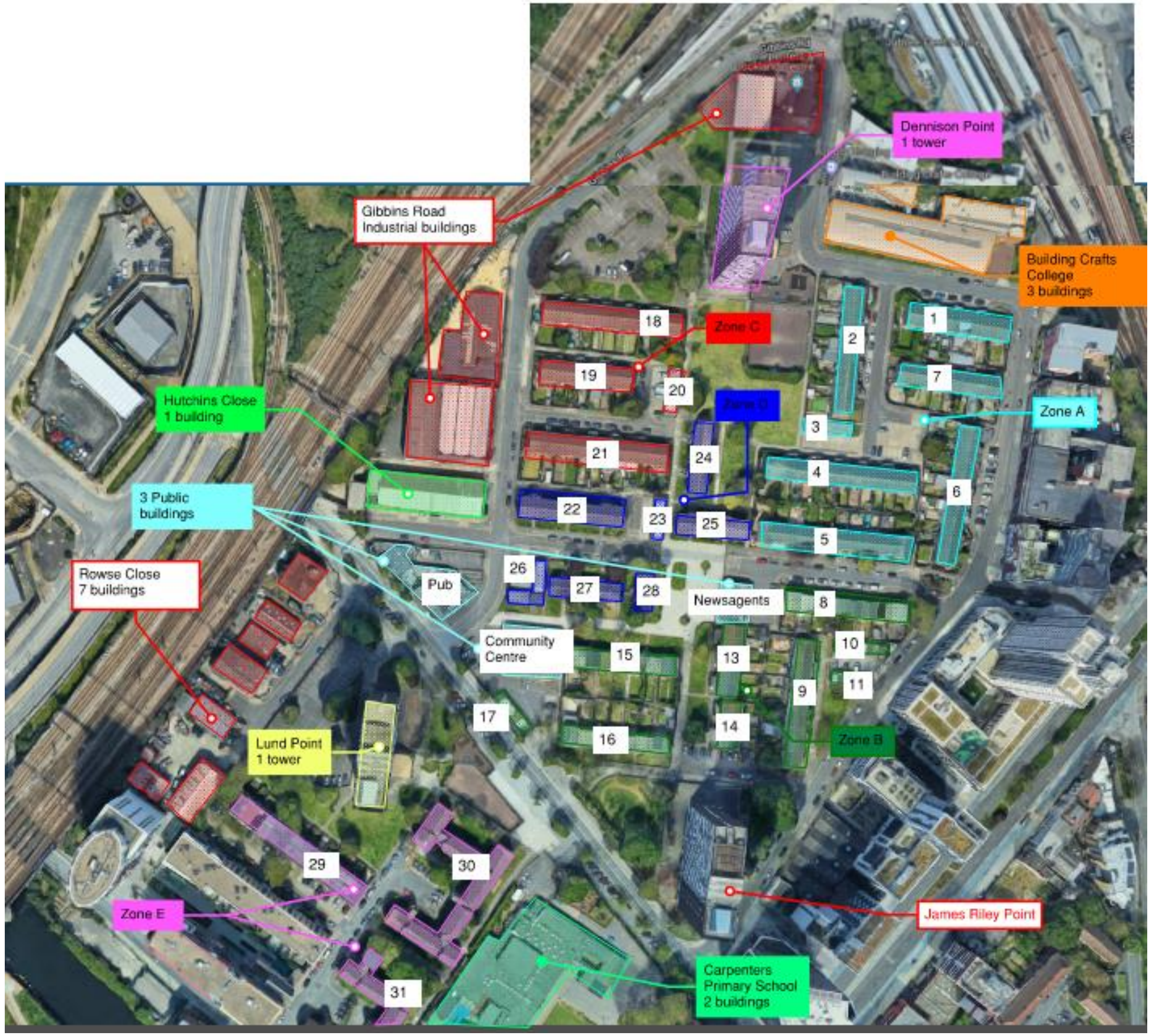
- Imbalance in labour costs between UK and global markets.
- Cheaper to buy new than salvage materials.
- Unsustainable for a single client to bear the cost.
- UK legislation required to incentivise second-hand markets.



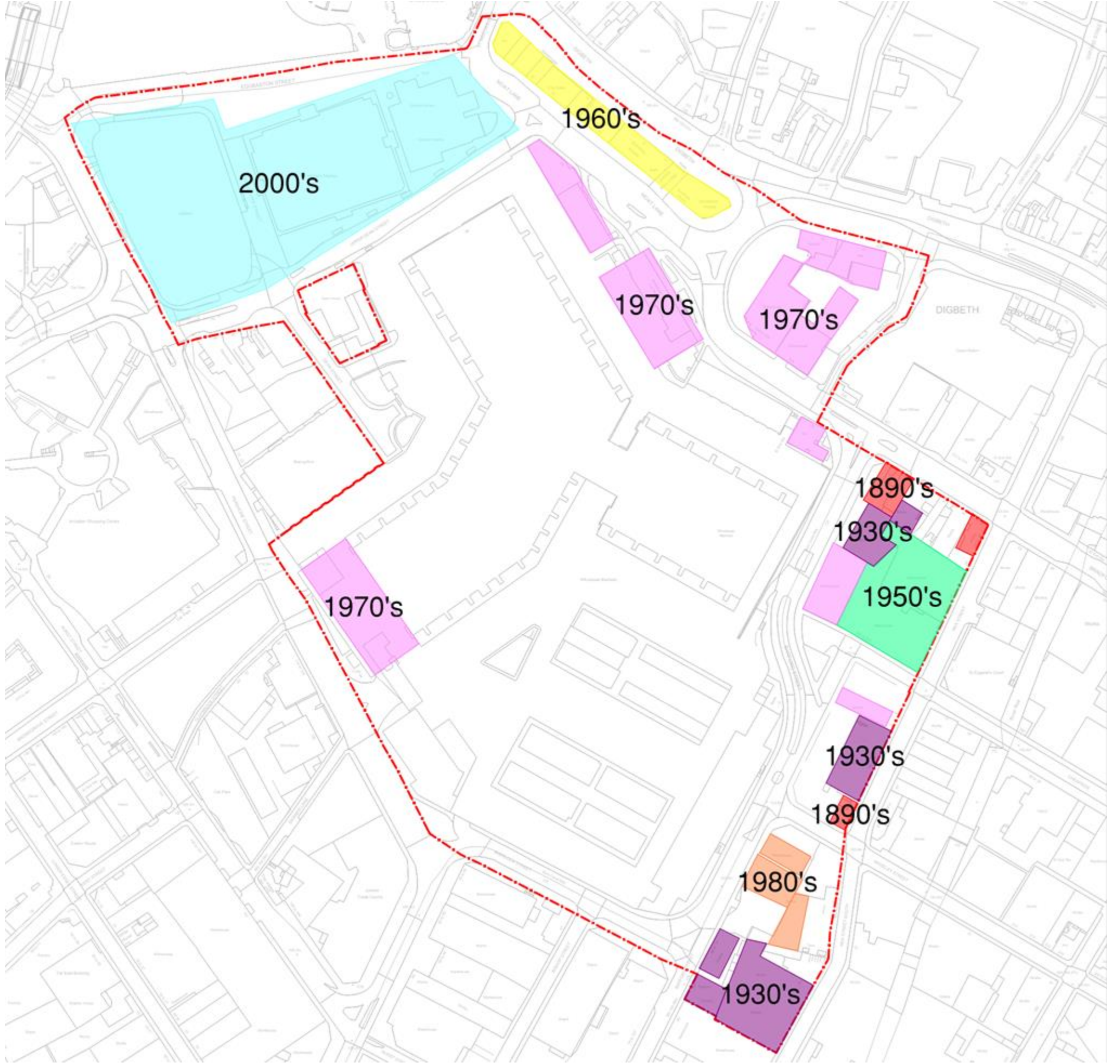
Application of reuse potential audits

Example application: masterplans - Carpenters Estate, Stratford

© Elliott Wood



Example application: masterplans - Smithfield, Birmingham



© Elliott Wood

elliottwood

Reuse of steel

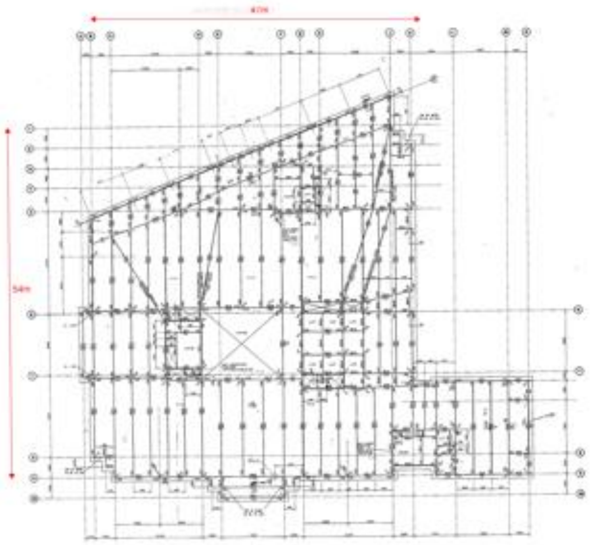
elliottwood

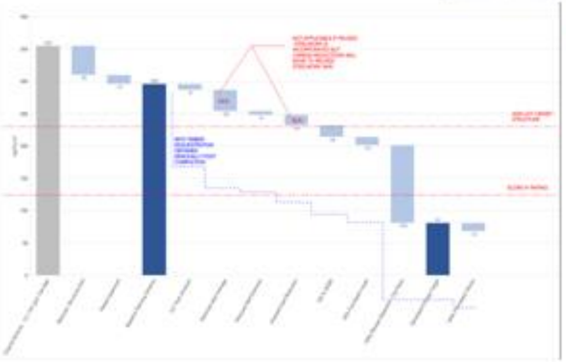
1990s steel frame donor building

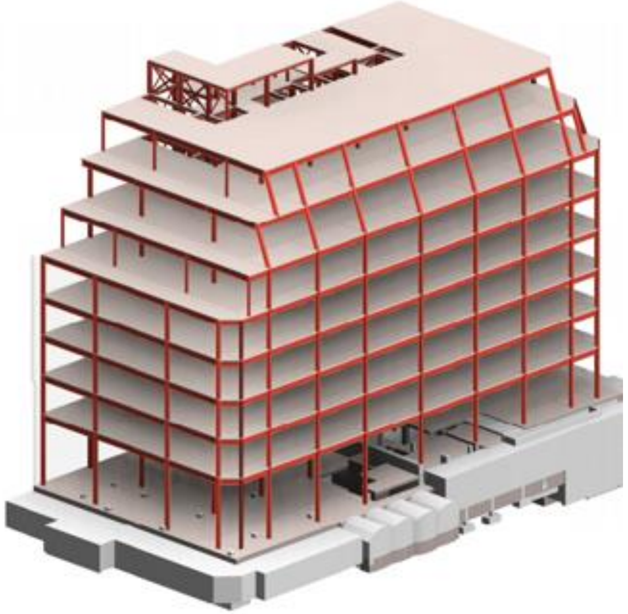
120 $kgCO2_e/m^2$ saving

Largest steel reuse project in UK

Improved grid

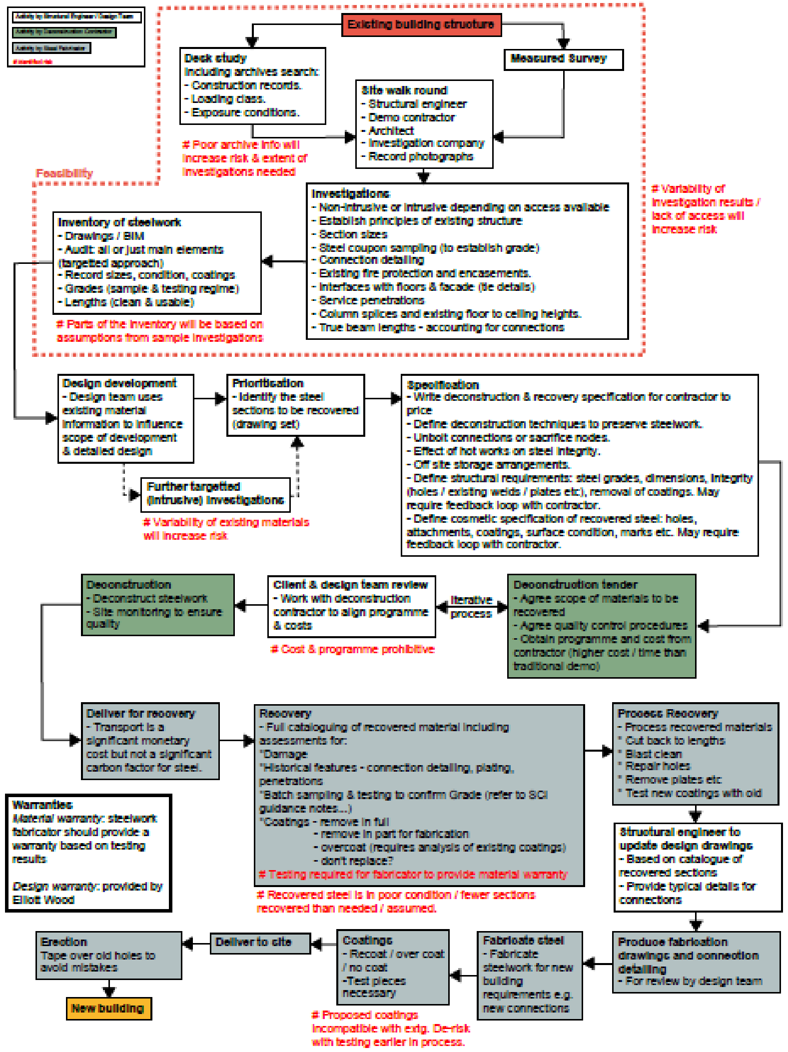




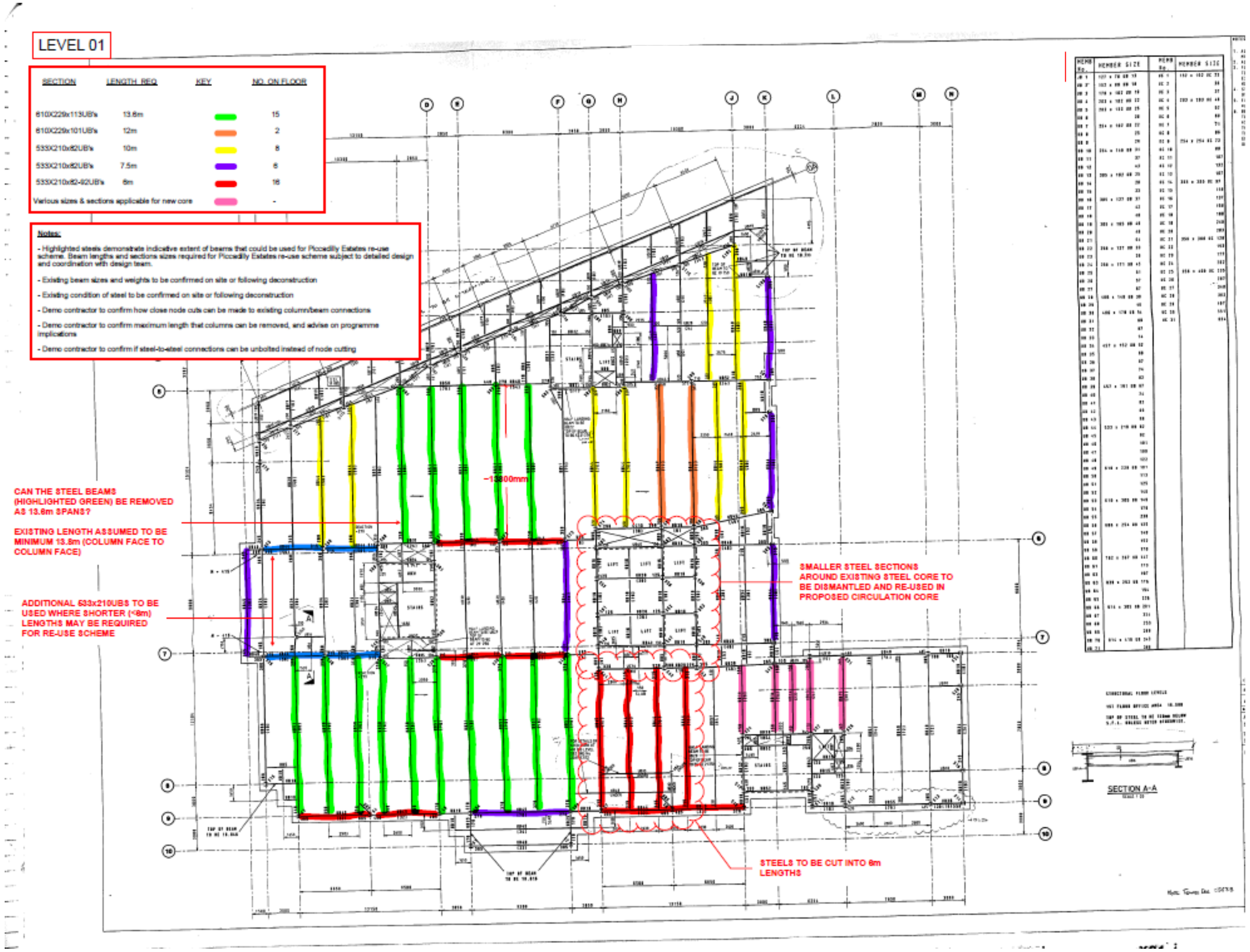


Re-use of structural steelwork process

elliottwood



Donor Structure

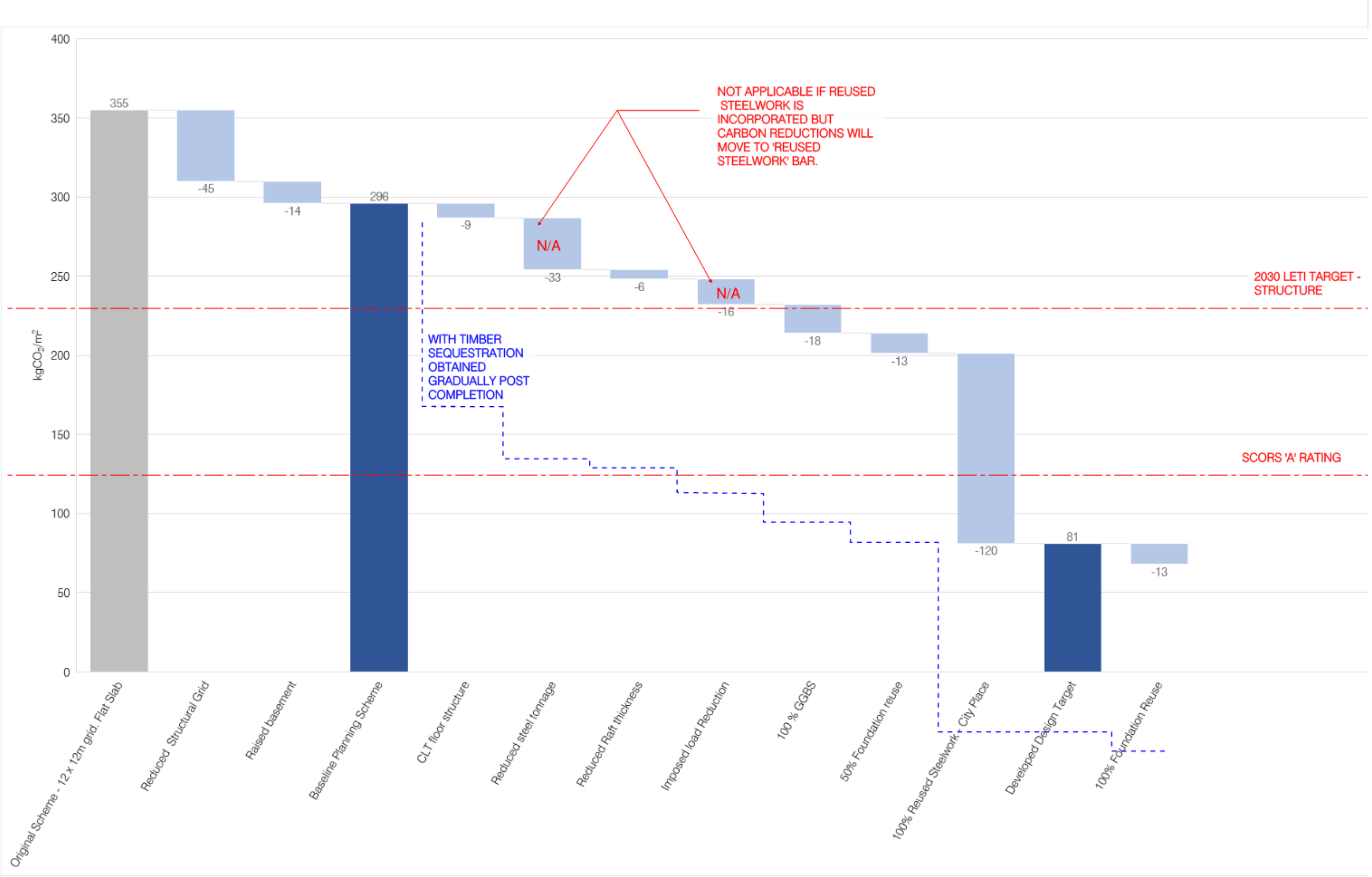



FIRE EXIT

Receiving Structure

Carbon Waterfall

elliottwood | engineering a better society



GENERAL

All concrete and metal deck to be fully removed. Shear studs to be removed off site (Top section of the stud can be removed on site, if required to assist with transportation).

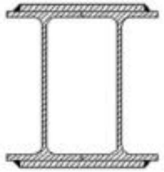
REJECT


Excessive corrosion


Fire exposure

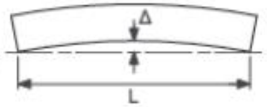
Plastic deformation and Excessive deformation


Cracked steelwork


Built-up members

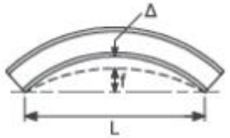
ACCEPTABLE IMPERFECTIONS ANYWHERE ALONG THE BEAM

Straightness on both axes:



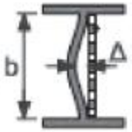
Δ = ± L/750

Curve or camber:



Δ = ± L/500 or 6mm whichever is greater

Web distortion:



Δ = b/200

Flange distortion:

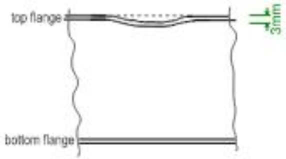
Δ = b/150

ACCEPTABLE DINGS

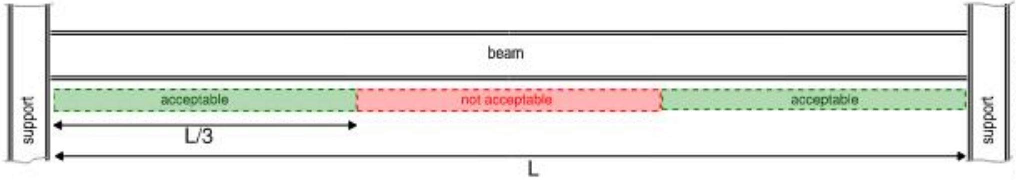
Dings up to 3mm will typically be within CE grading standards

Greater dings will require specific assessment of their effect on the structural capacity of the beam

Dings greater than 25mm or at middle third of the beam, are not not acceptable



example of acceptable ding



different beam areas along the span

ACCEPTABLE DAMAGE

Damaged coating or finishes:

Twisted or damaged shear studs:

NOTES:

1- Take appropriate H&S measures if toxic coatings or elements are identified on site (e.g. lead primer paints, asbestos, galvanised steels, etc.)
2- Notify structural engineer of any unexpected welded attachements or holes in steel members.

rev	date	by	chk	description
P1	10/02/22	ASP	JG	Information

Drawing title
Steel Reuse - Site Guidance

Scale	Date	Drawn
NTS	10.02.2022	ASP

elliottwood engineering a better society

Elliott Wood Partnership Ltd
Central London • Wimbledon • Nottingham
Consulting Structural and Civil Engineers
(020) 7499 5888 • elliottwood.co.uk

Project

Drawing status	Status	Revision
Information	-	P1

Project no. Originator Zone Level Type Role drg no.
2180000 - EWP - ZZ - XX - SK - S - 0002

elliottwood

Projects

elliottwood

Orford Mews – Circular low carbon project

Zero waste

Embodied carbon is 36% of the RIBA benchmark

Designed for disassembly

elliottwood

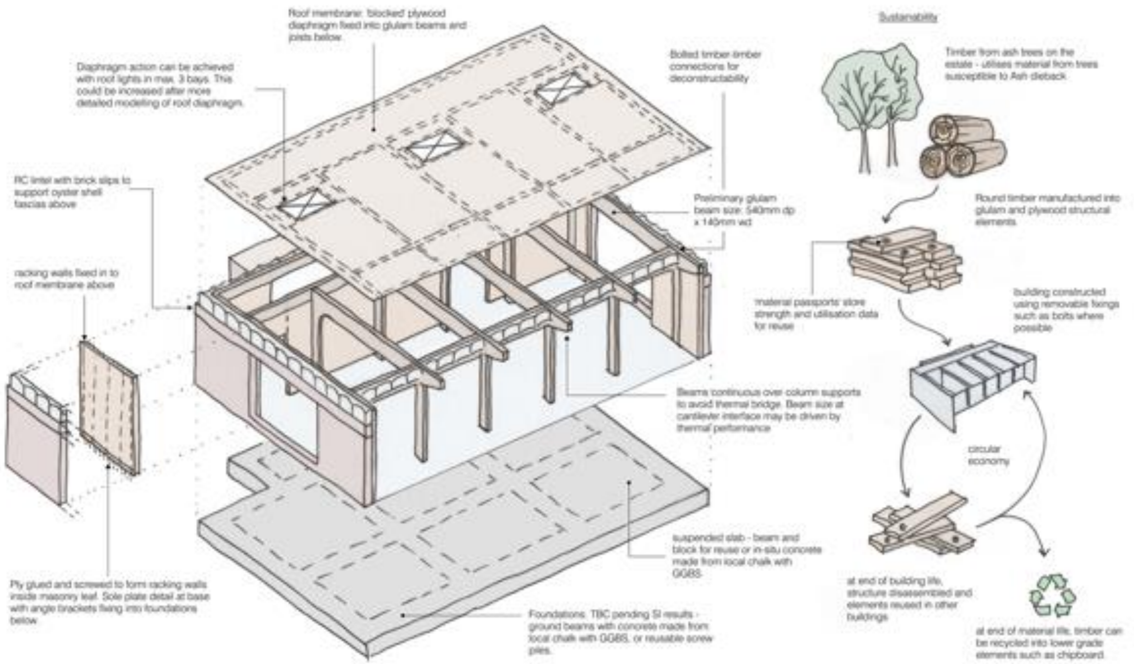
Glyndebourne Pavilion – Circular low carbon, local materials

Local materials

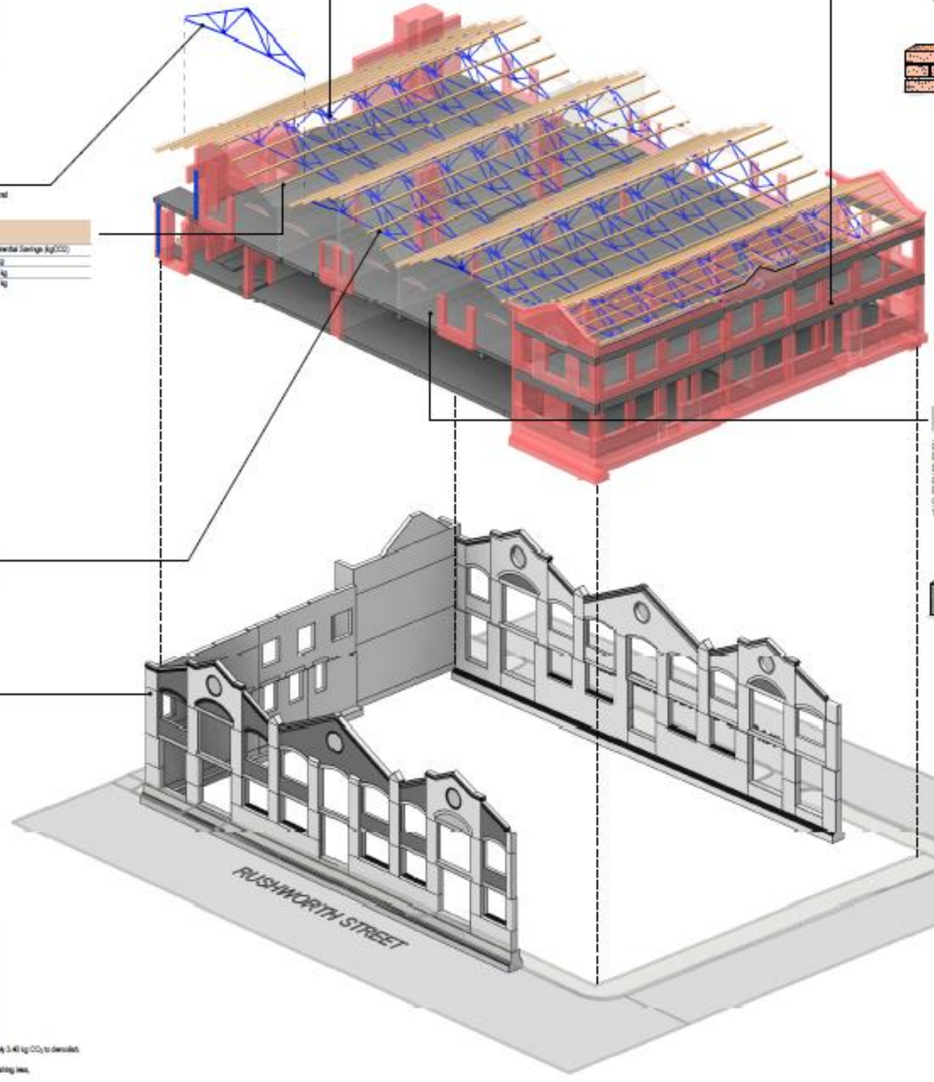
Materials from waste

Designed for deconstruction

Material passports



DEMOLISHED STRUCTURE



Removed Steel

Element	Volume (m3)	Mass (7850 kg/m³)	Potential Savings (kgCO2)
EXG Truss1	0.20 m³	1563.07 kg	156.31 kg
EXG Truss2	0.28 m³	2237.14 kg	223.71 kg
EXG Truss3	0.28 m³	2223.60 kg	222.36 kg
EXG Truss4	0.28 m³	2200.70 kg	220.07 kg
UB203x133x30	0.03 m³	212.17 kg	21.22 kg
Totals	1.07 m³	8436.74 kg	843.67 kg

STEEL RE-USE POTENTIAL

Most of the steelwork will end up being recycled to new steel beams. However this is still a high energy consuming process where steel needs to be melted to create new steel profiles.

By directly re-using steel beams and columns, and using them for a new structure, we can prevent these activities to take place. We can approximately save 0.1 kgCO₂e/kg of steel

Steel can be re-used as:
- New structural framing.
- Temporary works and form work.
- Non loadbearing formwork.
- Art and other decorative functions.
- Lightweight agricultural buildings.

Existing truss formed of bolted together angles
On this site it has been identified that the existing steel trusses could be dismounted with ease and re-used in a number of ways.

Removed Timber

Element	Volume (m3)	Mass (Assumed 450 kg/m³)	Potential Savings (kgCO2)
EXG 100x50 TIMBER JOIST	2.33 m³	1050.94 kg	1585.75 kg
EXG 200x100 TIMBER JOIST	15.05 m³	6774.21 kg	10161.31 kg
Grand total	17.38 m³	7806.04 kg	11712.07 kg

TIMBER RE-USE POTENTIAL

Typically 25% of timber ends up on the landfill while 75% goes to the incinerator. These disposal processes causes the material to increase its footprint beyond the carbon that initially sequestered by growing into a tree!

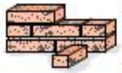
By re-using timber we keep carbon sequestered in the timber and the potential savings are approximately 1.50 kgCO₂e/kg of timber

Timber beams can be re-used
- New structural framing as second hand timber joists
- Temporary works and form work
- Non loadbearing formwork
- Landscaping / furniture

Removed Masonry

Material	Volume (m3)	Mass (2000 kg/m³)	Potential Savings (kgCO2)
Exg Masonry - Brick	302.90 m³	605802.32 kg	60580.23 kg
Exg Masonry - Concrete Block	124.09 m³	248182.87 kg	24818.29 kg
Exg Masonry - Render	3.25 m³	6506.80 kg	650.68 kg
Exg Masonry - Single Brick Block	0.04 m³	87.89 kg	8.79 kg
Exg Red Masonry - Brick	0.30 m³	605.75 kg	60.58 kg
Totals	430.59 m³	861185.63 kg	86118.56 kg

MASONRY RE-USE POTENTIAL



If demolished without care, brick- and blockwork can end up in landfill or crushed up as aggregate. If the brickwork is demolished carefully the bricks can be salvaged, cleaned and re-used. Else, sections of the wall can be cut out and used as brick slip systems on walls.

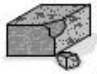
The potential savings are approximately 0.1 kgCO₂e/kg of directly re-used masonry

Masonry can be re-used as such:
- Re-used in the the new building.
- Make-good of existing walls.
- Aggregate in new concrete mixes (processed on site).
- Landscaping.
- Brought to specialized processing facilities for re-used of blockwork.

Removed Concrete

Material	Volume (m3)	Mass (2000 kg/m³)	Potential Savings (kgCO2)
Exg Concrete - Grout	0.05 m³	118.38 kg	11.84 kg
Exg Concrete - Mass Concrete	1.83 m³	3662.90 kg	366.29 kg
Exg Concrete - Reinforced Concrete	745.12 m³	1788260.06 kg	178826.01 kg
Exg Masonry - Concrete Block	124.09 m³	297819.45 kg	29781.94 kg
Exg Rendered Concrete - Reinforced Concrete	0.00 m³	0.00 kg	0.00 kg
Totals	870.89 m³	2090132.79 kg	209013.28 kg

CONCRETE RE-USE POTENTIAL



Concrete can end up on landfill or can be used as aggregate in new a concrete mix. If aggregates are used on a site consider using the concrete from site. This prevents the transportation and processing of these materials.

The potential savings are approximately 0.1 kgCO₂e/kg of re-used concrete

Concrete can be re-used as such:
- Aggregate in new concrete mixes (processed on site). Early dialogue with contractor required.
- Hardcore as sub-base under the new foundation.
- Landscaping.

Removed Other

Element	Material	Volume (m3)
Generic - 125mm	Exg Generic	184.27 m³
Totals		184.27 m³

Other elements that will be removed are listed above table.

In this project this captures the existing roof that will be removed. The design team is to review the buildup and find potential ways to re-use these elements.

Retained Structure

Material	Volume
Exg Concrete - Grout	0.04 m³
Exg Concrete - Mass Concrete	4.39 m³
Exg Concrete - Reinforced Concrete	23.88 m³
Exg Masonry - Brick	280.76 m³
Exg Masonry - Render	3.82 m³
Exg Masonry - Single Brick	0.76 m³
Exg Masonry - Single Brick Block	3.48 m³
Exg Red Masonry - Brick	0.00 m³
Exg Rendered Concrete - Reinforced Concrete	0.57 m³
Totals	318.32 m³

The above listed values show the volume of retained structure.
The more retained structure the smaller the embodied carbon of the project will be.

DEMOLISHED FLOORS

Element	Area (m²)	Carbon Cost for Demo
EXG 170mm THK RC SLAB	134 m²	456.46 kg
EXG 180mm THK RC SLAB	74 m²	251.60 kg
EXG 200mm THK RC SLAB	92 m²	313.17 kg
EXG 300mm THK RC SLAB	961 m²	3266.89 kg
EXG 400mm THK RC SLAB	223 m²	758.09 kg
EXG 420mm THK RC SLAB	213 m²	725.29 kg
EXG RC SLAB THICKNESS TBC	481 m²	1634.32 kg
Totals	2149 m²	7306.15 kg

What?
Demolishing structure can be a carbon intensive activity, each square meter costs approximately 3.40 kg CO_2 to demolish.
What to do?
For large structures these values can add up to a large environmental impact. Consider demolishing less, and re-using parts of the existing structure to reduce these carbon costs.
If the floor allows it, the slab could be cut into square sections and used as pad foundations for lightweight buildings.

RETAINED STRUCTURE

Hierarchy of Re-use

The following materials have been identified on site as being demolished and have been ranked by re-usability savings and feasibility

Element	kgCO₂e	Feasibility
1. Steelwork	840	B
2. Timber	11 500	A
3. Masonry	86 000	C
4. Concrete	210 000	D

Feasibility legend:
A. Material ready for re-use
B. Requires some coordination
C. Requires more coordination
D. Requires substantial coordination

This drawing is to be read in conjunction with all relevant architects, engineers and specialists drawings and specifications.

Do not scale from this drawing.

Readme: Sustainability point of importance for this project

Notes

This drawing has been prepared using survey and site observations and does not portray an accurate account of exact quantities of materials in the building.
If more detailed values are required a full demolition audit will be required.

NOT FOR CONSTRUCTION

P1	S4	[illegible]	[illegible]	[illegible]	Stage 3 Issue
rev	sc	date	by	chk	description

elliottwood | engineering a better society

Elliott Wood Partnership Ltd
Central London - Wimbledon - Nottingham
Consulting Structural and Civil Engineers
[illegible]

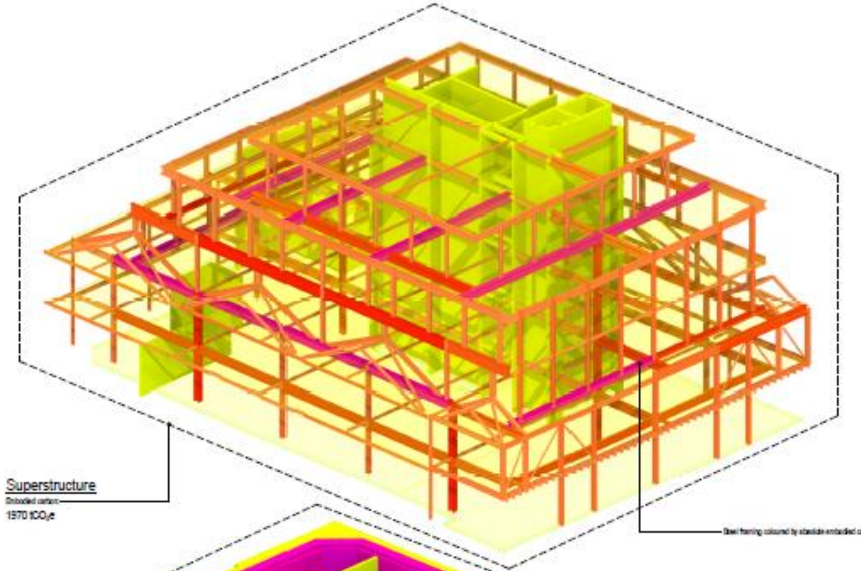
Project
33-38 Rushworth Street

Drawing title
Environmental Impact Drawing

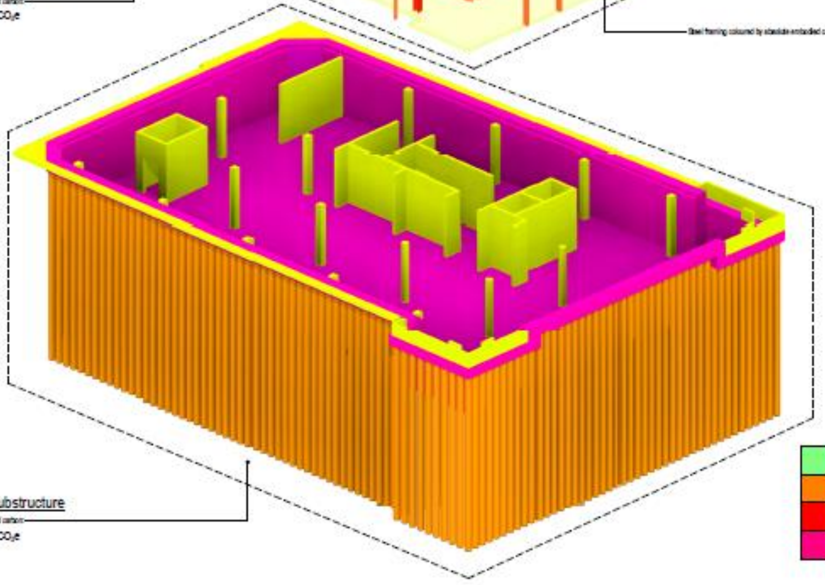
Scale (s)	Date	Drawn
N.T.S.@ A1	Sept / 2021	[illegible]

Drawing status	Status	Revision
Stage 3	S4	P1

Project no. / Originator / Zone / Level / Type / Role / dwg no.
2170073-EWP-ZZ-XX-DR-S-0070



Superstructure
Embodied carbon:
1970 tCO_2e

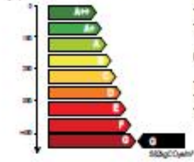


Substructure
Embodied carbon:
1113 tCO_2e

EMBODIED CARBON SCHEDULE

Category	Material	tCO2
Concrete - Mass Concrete (Piles)		
Structural Foundations	Concrete - Mass Concrete (Piles)	274.8
		274.8
Concrete - Precast Concrete (C45/55)		
Floors	Concrete - Precast Concrete (C45/55)	976.1
		976.1
Concrete - Reinforced Concrete		
Floors	Concrete - Reinforced Concrete	52.9
Structural Columns	Concrete - Reinforced Concrete	3.5
Structural Foundations	Concrete - Reinforced Concrete	12.5
Structural Framing	Concrete - Reinforced Concrete	1.1
Walls	Concrete - Reinforced Concrete	78.5
		158.4
Concrete - Reinforced Concrete (Piles)		
Structural Foundations	Concrete - Reinforced Concrete (Piles)	31.9
		31.9
Concrete - Water Resistant Concrete (C32/40)		
Structural Foundations	Concrete - Water Resistant Concrete (C32/40)	410.6
Walls	Concrete - Water Resistant Concrete (C32/40)	92.1
		502.7
Masonry - Brick		
Walls	Masonry - Brick	14.7
		14.7
Metal - Steel S355		
Structural Columns	Metal - Steel S355	141.9
Structural Framing	Metal - Steel S355	510.0
		651.9

SCC$_i$RS
Structural Embodied carbon
A1-A5 $kgCO_2e/m^2$ GIA

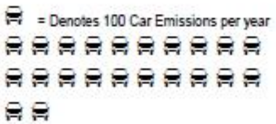


Total Embodied Carbon: 3083.8 tCO_2e

Total CO_2e = Total materials + A5 Global + C1 Global
Total CO_2e = 3072.24 + 0 + 11.56
Total CO_2e = 3083.8 tCO_2e (Metric tons of carbon dioxide equivalent)

0.582 tCO_2e/m^2 (Metric tons of carbon dioxide equivalent per square meter)

This equals to: 2202.71 average car emission per year (1.40 tCO_2/car). (UK)
This requires 76067 Trees (Spruce or Fir) to grow for at least 30 years
The Social Carbon Costs are: 308380 £ total



EMBODIED CARBON INTENSITY LEGEND ($kgCO_2e/kg$)	EXAMPLE
LOW	TIMBER & RE-USED MATERIALS
MEDIUM EMBODIED CARBON	NON-REUSABLE TIMBER AND CONCRETE
HIGH EMBODIED CARBON	CONCRETE
VERY HIGH EMBODIED CARBON	WATER PROOF CONCRETE AND STEEL

CONCRETE POTENTIAL

Concrete is one of the biggest contributors to the embodied carbon of a building. The production of cement and the requirement of reinforcement the use of concrete will make it almost impossible to make a sustainable building using this material.

The average carbon intensity of concrete is approx.: 0.200 $kgCO_2e/kg$ C30/37 Concrete

The carbon footprint of concrete can be reduced by considering the following:
- Add min 50% of GGBS to replace the CEM cement, and allowing for longer curing times in the construction program.
- Make precast concrete easily deconstructable, making it possible to re-use precast planks for future buildings.
- Use full CEM replacement such as CEM-FREE concrete
- Consider different more sustainable construction materials where required.

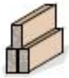
STEEL POTENTIAL

The production of steel is one of the most carbon intensive process there is. Even thou new steel sections are largely made from recycled steel, it still requires alot of energy to melt, process and form steel sections.

The average carbon intensity of steel is aprox: 2.50 $kgCO_2e/kg$ S355 Steel

The carbon footprint of steel can be reduced by considering the following:
- Consider using timber for lightweight framing where required.
- Source steel beams from demolished sites and re-use.
- Processes that use Hydrogen rather than coal to form steel are in an early stage, consider ordering from producers who try to reduce their carbon footprint.

TIMBER POTENTIAL



Timber is often considered a "sustainable" product; the benefits can be made undone if at the end of life the elements are thrown on the landfill or incinerated. When using timber it the for beneficial to consider their re-use potential by making the elements easily demountable, and clearly cataloging their strength and material classes.

The average carbon intensity of timber is aprox.: 0.300 $kgCO_2e/kg$ C24 Timber

The carbon footprint of timber, Glulam, CLT or Plywood, can be reduced by considering the following:
- Allow for disassembly in the detailing.
- Log the material classes and strength so re-use in the future will be easier.
- Cut, and use general dimensions and trim as little as possible
- Use standard length where possible to reduce waste.

This drawing is to be read in conjunction with all relevant architects, engineers and specialists drawings and specifications.

Do not scale from this drawing.

Work In Progress
Date / Time Printed - 05/10/2021 10:51:28
This is not a formal drawing issue and as such may contain un-coordinated or incomplete information.

NOT FOR CONSTRUCTION

P1	[illegible]	[illegible]	[illegible]	[illegible]	Stage 3 issue
rev	no	date	by	chk	description

elliottwood | engineering a better society

Elliott Wood Partnership Ltd
Central London - Wimbledon - Nottingham
Consulting Structural and Civil Engineers
[illegible]

Project
33-38 Rushworth Street
London SE1 0RB

Drawing title
Environmental Impact Drawing

Scale (s)	Date	Drawn
N.T.S@ N.T.S	September 2021	[illegible]

Drawing status	Status	Revision
Stage 3	S4	P1

Project no. Originator Zone Level Type Role dwg no.
2170073-EWP-RS-XX-DR-S-0071

elliottwood

How can we all help?

“We believe that the Reuse of second-hand construction materials is the only way forward. The industry has to establish a viable second-hand market which deals with storage, cataloguing and recertification. This is only in its infancy but with the right investment and government support will, we believe, become the norm.”

Gary Elliott, Elliott Wood (December 2020)

- Raise the issue of reuse with your clients, contractors, design teams
- Don't just let demolition happen without questioning it
- Get engineers involved sooner
- Look to source second-hand materials for your new build projects
- Talk to other clients, contractors, design teams
- Share knowledge, collaborate
- Read industry papers and attend webinars

Non-structural re-use potential audits

Organisations include:

- Rotor Deconstruction
- Community Wood Recycling
- Opalis
- Salvoweb
- Building Deconstruction Institute
- ReLondon / CirCUIT

What Next?

This is just the beginning of a process, a practical guide created by Engineers and clients who manage commission and build.

But how can we take this even further into the day-to-day until it becomes the norm?

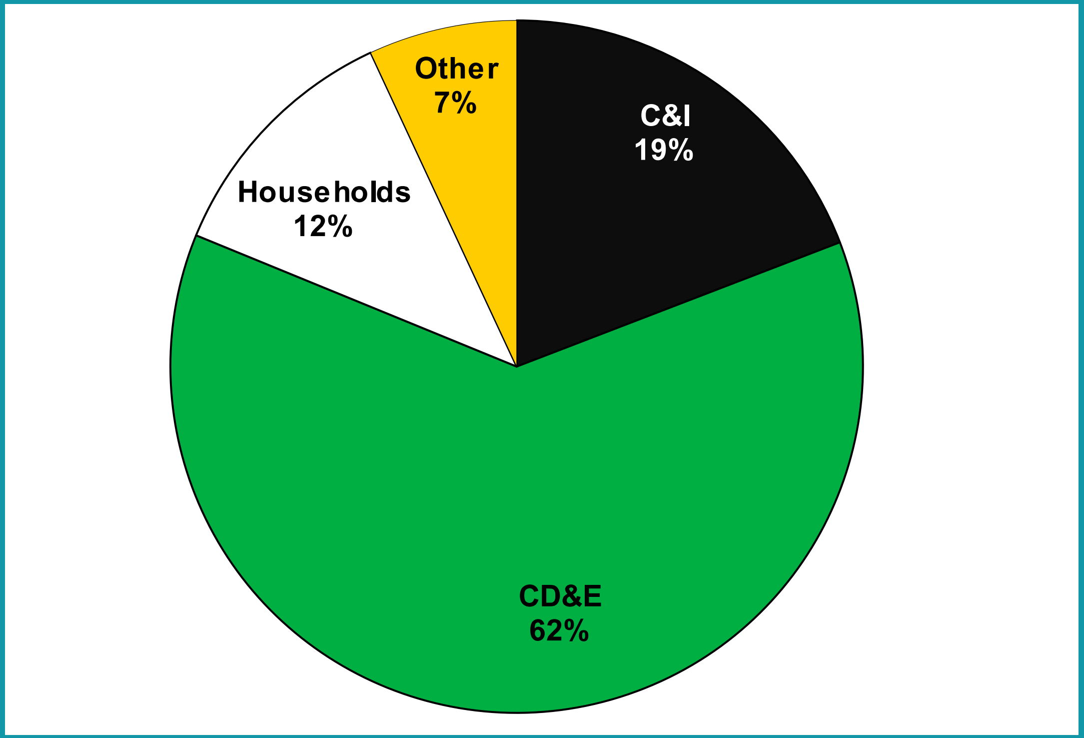
Gary Elliott
g.elliott@elliottwood.co.uk

Penny Gowler
p.gowler@elliottwood.co.uk

Can we remove waste from the construction industry?

Dr Teresa Domenech, UCL

What is construction waste?



Construction, demolition and excavation was makes over 62% of the total waste generated in the UK. The largest two waste categories are ‘mineral wastes’ (80.4 MT) and ‘soils’ (58.5MT).

What is the destination of construction waste?

million tonnes and % rate

	UK			England		
	Generation	**Recovery**	**Recovery rate**	**Generation**	**Recovery**	**Recovery rate**
	M tonnes	**M tonnes**	**%**	**M tonnes**	**M tonnes**	**%**
2010	59.2	53.1	89.7%	53.6	49.4	92.2%
2011	60.2	55.0	91.4%	54.9	50.8	92.5%
2012	55.8	50.8	91.1%	50.5	46.4	92.0%
2013	57.1	52.0	91.2%	51.7	47.6	92.0%
2014	61.5	56.3	91.5%	55.9	51.7	92.4%
2015	63.8	58.0	91.0%	57.7	53.3	92.3%
2016	66.2	60.0	90.7%	59.6	55.0	92.1%
2017	68.7	62.9	91.5%	62.2	57.9	93.1%
2018	67.8	62.6	92.3%	61.4	57.5	93.8%

Source: Defra Statistics

Material Streams and destinations

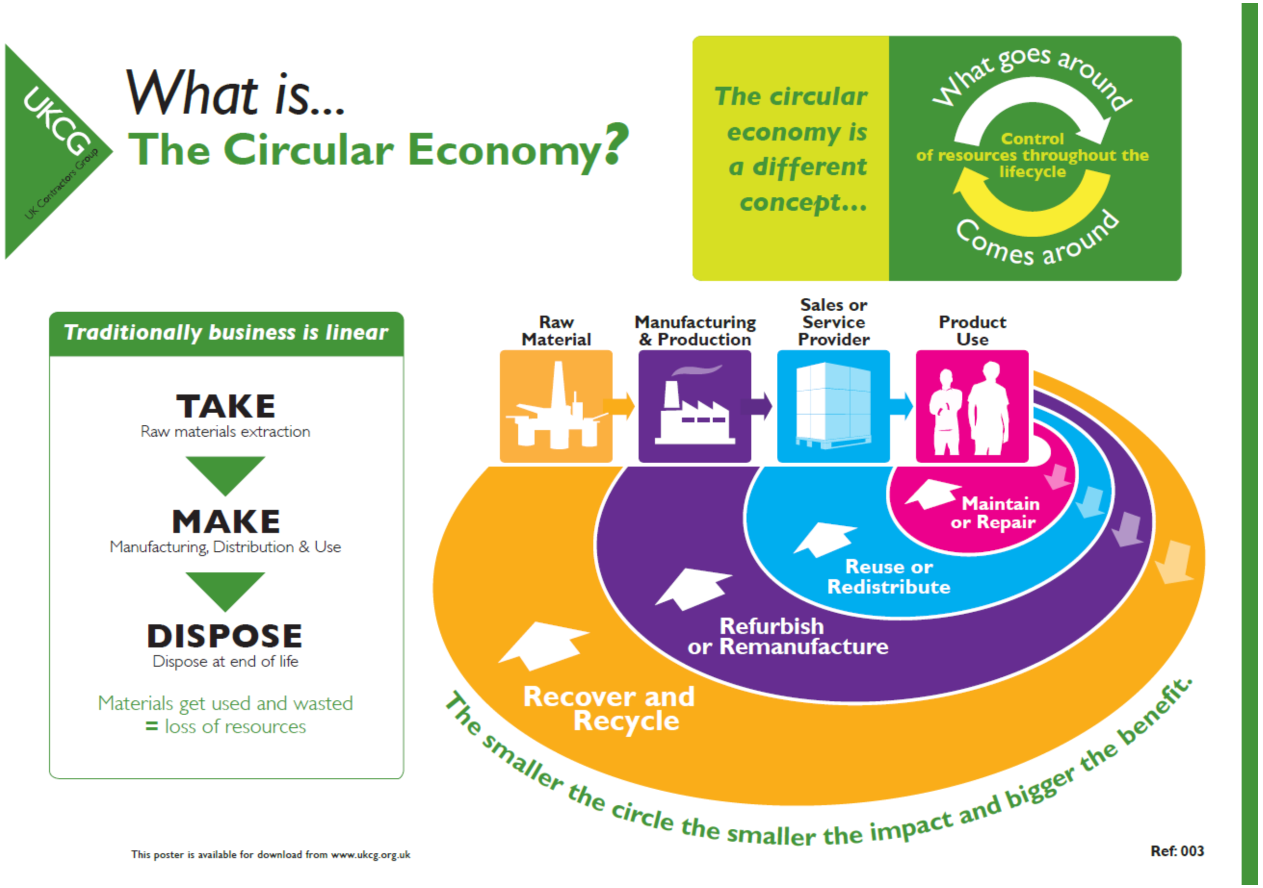
% waste material, by treatment type

Waste material	Recycling and other recovery	Incineration with Energy recovery (R1)*	Incineration (excl. R1)	Backfilling	Landfill	Land treatment and release into water bodies
Metallic wastes	15%	0%	0%	0%	0%	0%
Glass wastes	2%	0%	0%	0%	0%	0%
Paper & cardboard wastes	4%	0%	0%	0%	0%	0%
Plastic wastes	1%	0%	0%	0%	0%	0%
Wood wastes	2%	6%	27%	1%	0%	0%
Vegetal wastes	4%	0%	1%	0%	0%	0%
Household & similar wastes	1%	80%	34%	0%	10%	0%
Mineral wastes	55%	0%	0%	6%	6%	56%
Soils	12%	0%	0%	90%	58%	0%
Dredging spoils	0%	0%	0%	1%	0%	44%
Other wastes	5%	13%	37%	3%	26%	0%
All wastes	**100%**	**100%**	**100%**	**100%**	**100%**	**100%**

What does recovery of construction waste really mean?

- More than half of all waste recorded as recycled in the UK is Mineral wastes and soils, two main fractions of C&D waste
- Mineral waste is made up of bricks, stones, concrete, etc from construction which is recycled into secondary aggregates.
- The UK utilises 70 MT of recycled and secondary materials in the GB aggregates market, (28% market share)
- Highest use of secondary aggregates in Europe
- Linked to Aggregates Levy (a tax on produces of primary aggregates)

What does it mean circularity in the construction industry?



Strategies to increase circularity in the construction sector_ from waste to resource

Adaptability	Life-extension through maintenance	Build in layers	Modular design
Site Waste Management Plans	Resource Management Plans	Procurement strategies	Material and building "passports"
	Designing out waste	Designing for de-construction	

Developing the circular economy for UK construction

UKCG
UK Contractors Group

UKCG statement on the circular economy

The construction industry uses 30% of the world's raw materials. These resources are running out. Resource scarcity is already affecting business practices and is likely to dramatically change the way UKCG members operate in the future.

Changes to how products and materials are designed, procured and used will be necessary if the industry is to continue to meet the nations built environment needs in years to come.

The circular economy model demonstrates how the industry can make the most effective use of the world's resources. UKCG members have a leadership role to play to maximise opportunities for our sector.

Currently UKCG members are working towards this through the following measures:

EXISTING PRACTICES

- Sharing platforms/materials (site swap shop across projects) — C I M
- Increased recycled content of materials — I
- Materials takeback — I M
- Sharing materials across industries as feedstock for new products — I L
- Engaging and collaborating with others to develop new solutions — M

EXISTING EXAMPLES OF BEST PRACTICE AND PILOT PROGRAMMES

- Informing clients, suppliers and staff on the benefits — M
- Creating closed loop supply chains — C I
- Extending product life expectancy through correct use of robust and adaptable materials, increasing the value of durable goods — C I
- Supporting circular supply chains through procurement — C I
- Understanding value of existing assets and resources (e.g. through pre-demolition audits) — C I
- Pre-cycling — C I
- Design for deconstruction and circularity — I M
- Resource reclaim and recycling — I L
- Whole life cycle costing — L M

ASPIRATIONAL

- Using 'smart' materials — I
- Innovative revenue models — I
- Asset tracking of materials and components — C I L
- Information management and materials passports — C I
- Service/performance leasing instead of ownership — I

Enablers key:

- C Contractual
- I Innovation
- L Legal
- M Marketing and communications

Q&A

projectblueprint.eu/roadshow

Thank you for attending!

Please complete our quick feedback survey

projectblueprint.eu/roadshow

blueprint.project@essex.gov.uk