THE FUTURE OF STEEL CONSTRUCTION

Sustainable structural steelwork

Dr Michael Sansom

BCSA

Context

- The sustainability agenda remains largely focussed on carbon
- Focus has shifted from operational to embodied carbon
- Discussion is more focused on steelmaking rather than design and execution of steel structures
- Let’s not forget that for the client/user, the product is the building not the steel beam, the brick or the concrete pile

Challenging landscape – *not just carbon!*

- US steel tariffs – currently 25%
- EU steel tariff and quota proposals – 50% tariff and 47% quota reduction
- UK Net-zero commitments – under threat?
- EU CBAM – from January 2026
- UK CBAM – from January 2027 – no transition period
- UK electricity price – 113% higher than the EU14 median for large industrial users
- Steel Industry (Special measures) Act

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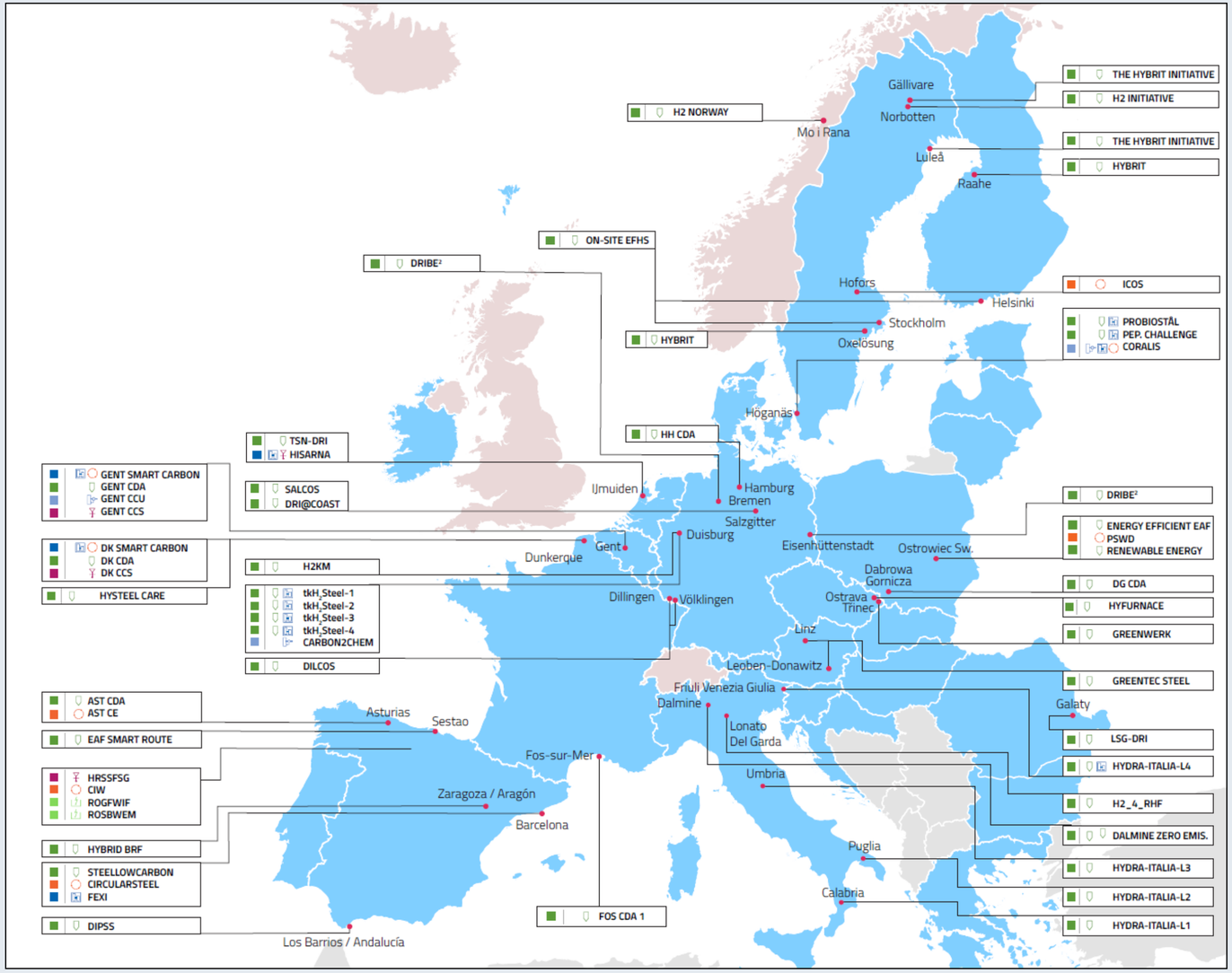
EU low-carbon steel R&D



Circular Economy (CE)

Carbon Direct Avoidance (CDA)

H_2-based metallurgy

Electricity-based metallurgy

Smart Carbon Usage (SCU)

Proces Integration

Carbon Valorisation/CCU

Carbon Capture and Storage CCS²
(not included in SCU, CDA or CE)

Eurofer, 2022

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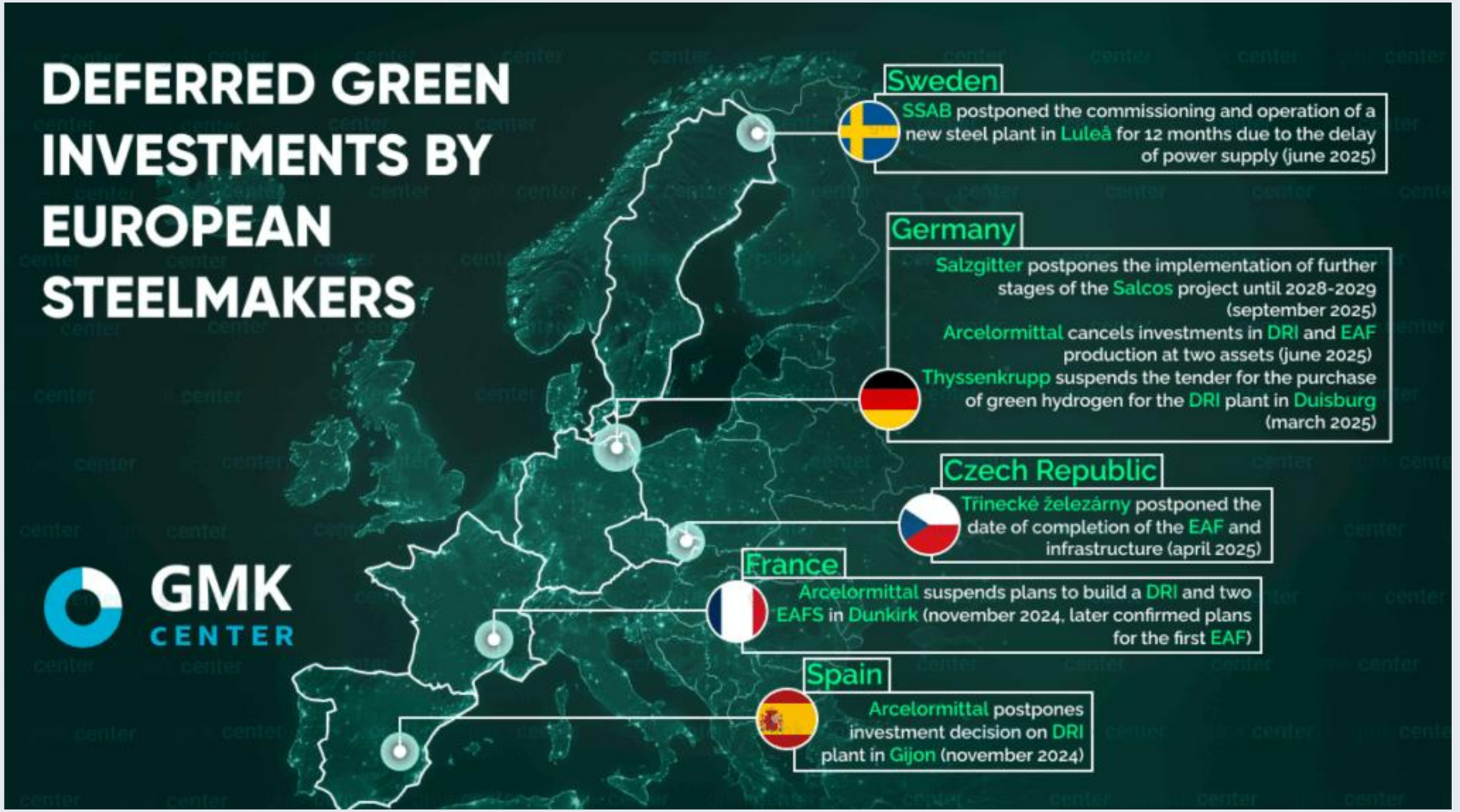
DEFERRED GREEN INVESTMENTS BY EUROPEAN STEELMAKERS
Sweden
SSAB postponed the commissioning and operation of a new steel plant in Luleå for 12 months due to the delay of power supply (june 2025)
Germany
Salzgitter postpones the implementation of further stages of the Salcos project until 2028-2029 (september 2025)
Arcelormittal cancels investments in DRI and EAF production at two assets (june 2025)
Thyssenkrupp suspends the tender for the purchase of green hydrogen for the DRI plant in Duisburg (march 2025)
Czech Republic
Třinecké železárny postponed the date of completion of the EAF and infrastructure (april 2025)
France
Arcelormittal suspends plans to build a DRI and two EAFS in Dunkirk (november 2024, later confirmed plans for the first EAF)
Spain
Arcelormittal postpones investment decision on DRI plant in Gijon (november 2024)
GMK CENTER

Delayed or cancelled EU projects

- ArcelorMittal – frozen investment decisions on several DRI projects including Ghent and Dunkirk
- Salzgitter – postponed next stages of Salcos
- Thyssenkrupp – indefinitely postponed its green hydrogen plant at Duisberg
- Acciaerie d’Italia – postponed decarbonisation plans for Taranto plant
- SSAB Hybrit – full commercial scale rollout delayed to 2030

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Reasons

- Challenging economic conditions, depressed steel market, global competition
- High capital and operational cost for low-carbon production
- Slow development of the hydrogen market
- Insufficient affordable hydrogen and electricity
- Weak regulatory and policy support
- Trade policy uncertainty and EU CBAM
- Customers unwilling to pay a low-carbon premium
- Lack of investment

UK Steel Strategy

- UK Steel Council established in January 2025
- Strategy delayed by Special Measures Act, cabinet reshuffle

Strategy elements:

- Hatch undertaking UK **demand v capacity** gap assessment
- **Electricity prices** addressed in the Industrial Strategy
- Network costs will improve with greater renewables resulting in price parity by 2030
- **Trade tariffs and quotas** – no move on US, EU negotiations continuing
- Informal EU-UK agreement on ETS alignment
- **Investment** – manifesto pledge £2.5bn investment in the UK steel industry confirmed; private investment more challenging
- **British Steel** technology transition uncertain but blast furnaces will not be shut down, unlike Tata Steel

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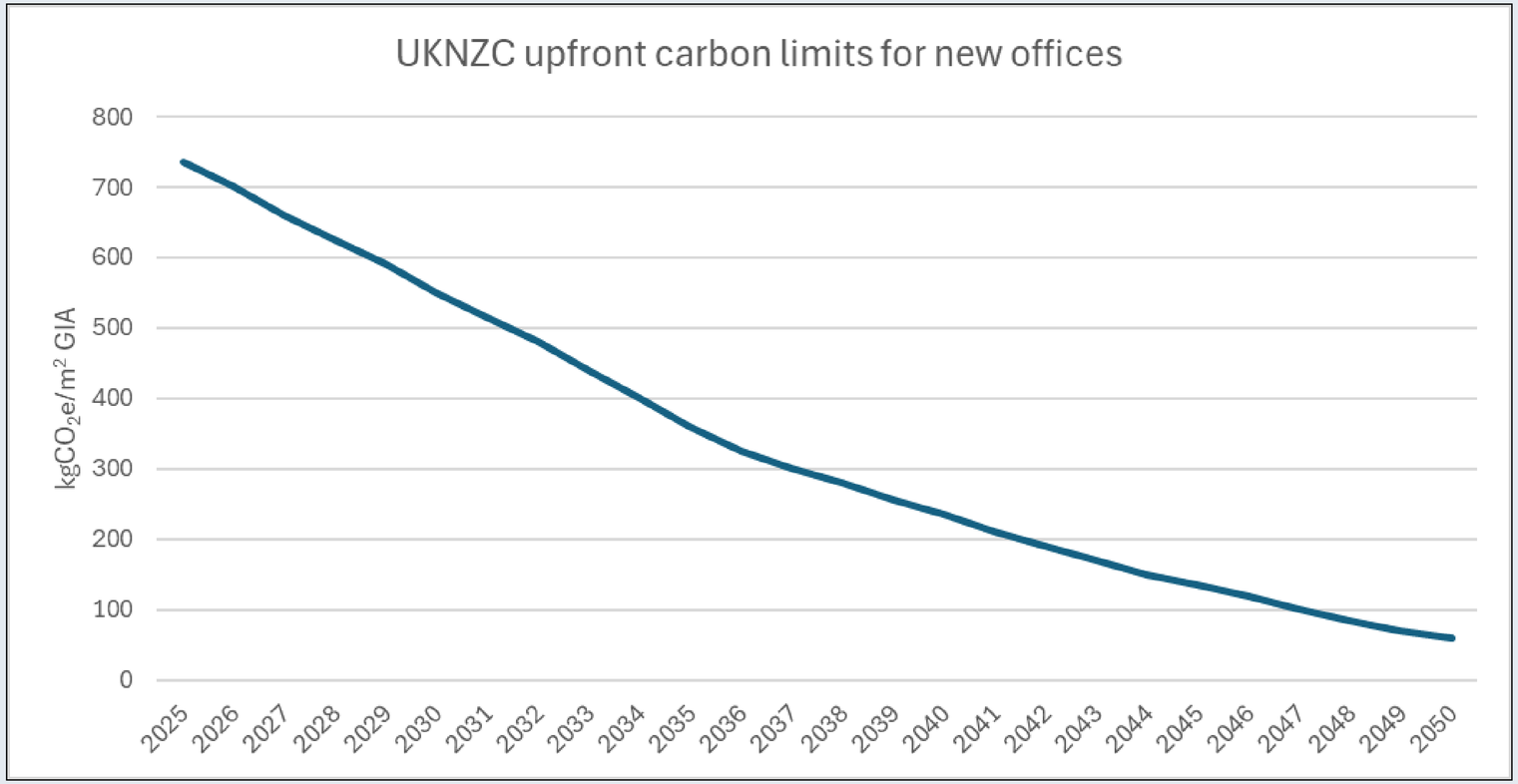
UK Government policy

- Lack of coherence; different departments have different objectives and are developing inconsistent policies

DESNZ	– Low-carbon industrial products consultation
	– Frazer Nash WLC methodologies report
DBT	– UK Industrial Strategy
	– UK Steel Strategy (expected Nov 2025?)
DESNZ/DBT	– Built environment circular economy roadmap – under NDA
BEIS	– Industrial decarbonisation strategy (2021)
	– ‘ore-based steelmaking to be net-zero by 2035’
MHCLG	– Aecom study on the practical, technical and economic impacts of measuring and reducing embodied carbon in buildings
DEFRA	– Government buying standards for new build construction
HMRC	– UK CBAM

Voluntary embodied carbon targets

- Growing calls to regulate embodied carbon, Part Z
- Growing adoption of voluntary embodied carbon targets
- UK Net zero carbon building standard superseding LETI, RIBA, Mayor of London targets



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Use of EAF steel to meet embodied carbon targets

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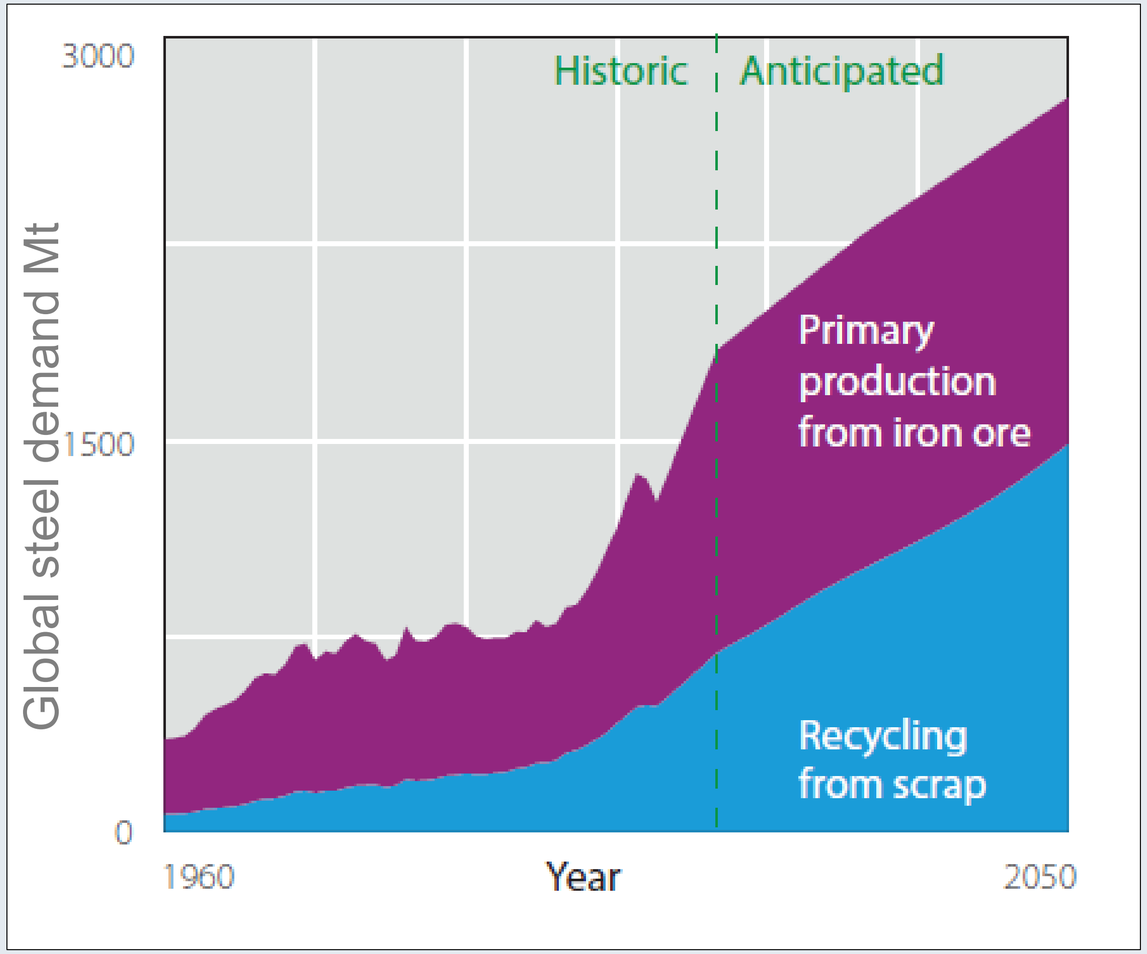
Project/Location	Client	Tonnage	Fabricator	Claimed CO_2 Saving
Worship Square, Shoreditch London	HB Reavis	≈2,400 t	BHC	≈60% reduction vs UK average (~0.64 $kgCO_2e/kg$)
Stonecutter Court, City of London	Obsidian / Deka	≈3,500 t	Severfield	≈ Two-thirds EAF route steel, embodied carbon significantly reduced
2 Finsbury Avenue (2FA), Broadgate London	British Land / GIC	≈10,000+ t	William Hare	Target ≈50–70% reduction through ~90% EAF sourcing
Barrett Steel Groveport Distribution Facility	Barrett Steel	≈450–900 t	Caunton Engineering	≈1,408 tCO_2e saving vs standard steel
Spectra Building, University of Hertfordshire	University of Hertfordshire	≈1,200 t	Severfield	Use of EAF sections to reduce A1-A3 embodied carbon (benchmarked ~40–55% lower)
Paradise Circus Phase 3, Birmingham	MEPC	≈6,000–8,000 t	Multiple (incl. Hare / Severfield / BHC)	EAF-first procurement preference to reduce A1-A3 emissions (case-by-package)

Constrained supply of ferrous scrap



Steel Arising, Uni Cambridge

- Global supply of scrap is finite but growing
- Global production split 70:30 BF-BOF:EAF
- While steel demand exceeds scrap supply, specifying EAF steel on your project has no net benefit on global carbon emissions

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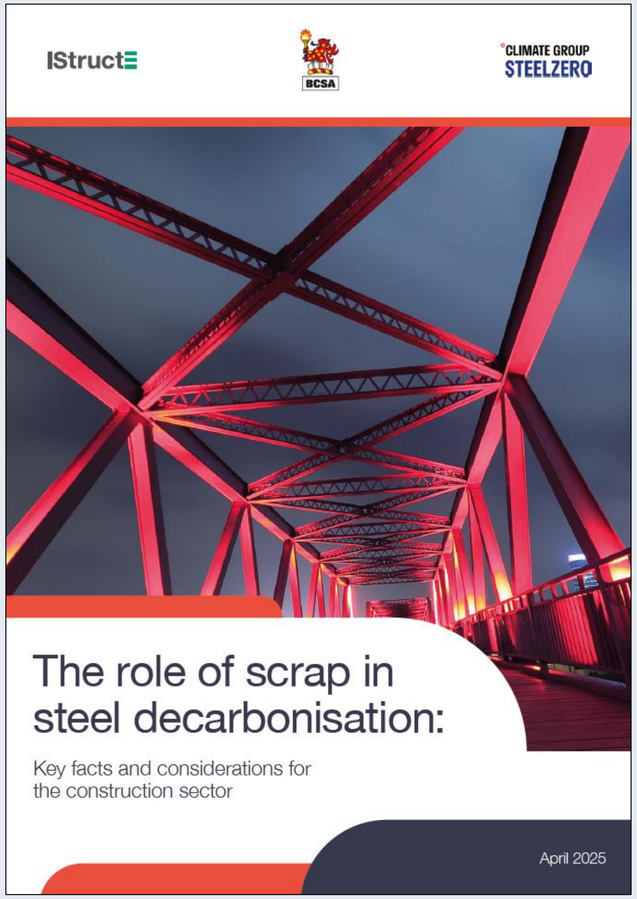
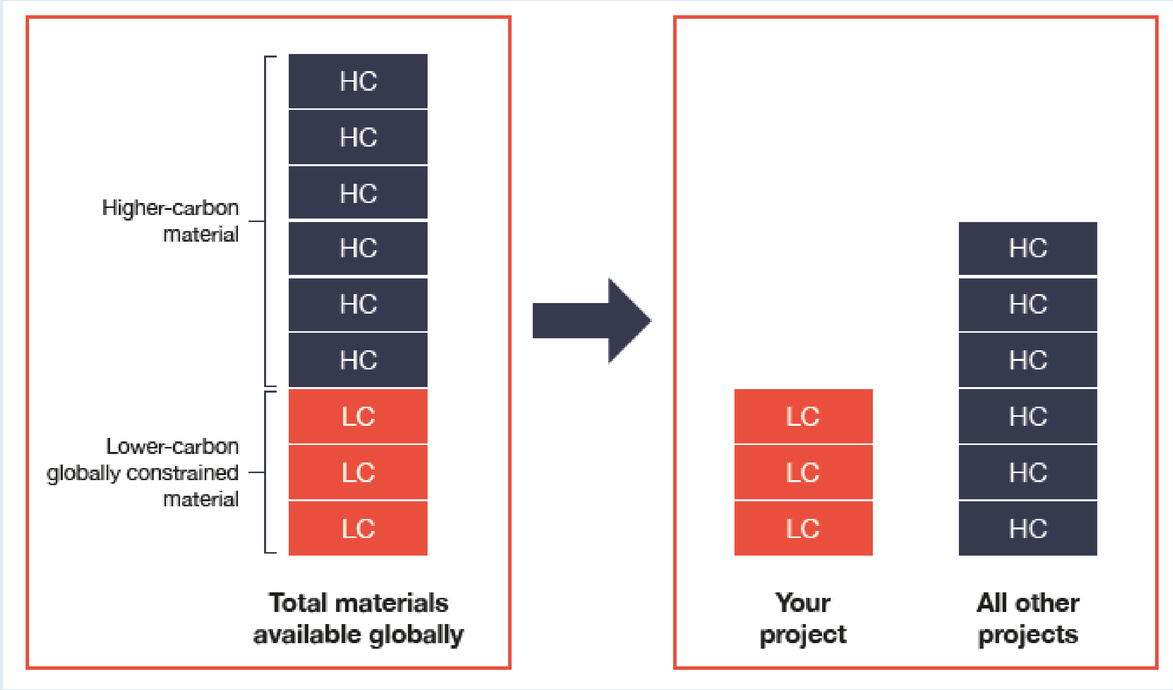
Constrained supply of ferrous scrap





'Specifying project- or national-level limits/targets that promote increased use of recycled steel is unlikely to lead to significant global reductions in greenhouse gas emissions'

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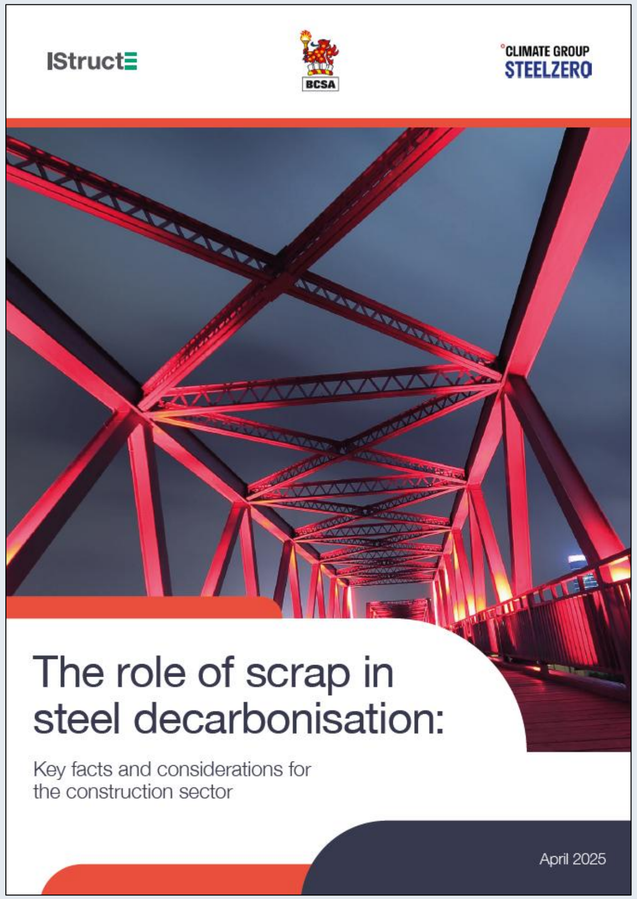
Key messages



1. Maximising the recovery and recycling of scrap is fundamental
2. Scrap is a constrained resource
3. The rate of recovery is 80-85% with limited opportunity to increase this
4. To reduce global emissions, policy, investment, and incentives must therefore focus on a dual decarbonisation approach
5. Construction industry can support decarbonisation by using steel more efficiently in design and specifying steel aligned with the dual decarbonisation approach
6. Specifying project- or national-level limits/targets that promote increased use of recycled steel is unlikely to lead to significant global reductions in greenhouse gas emissions.

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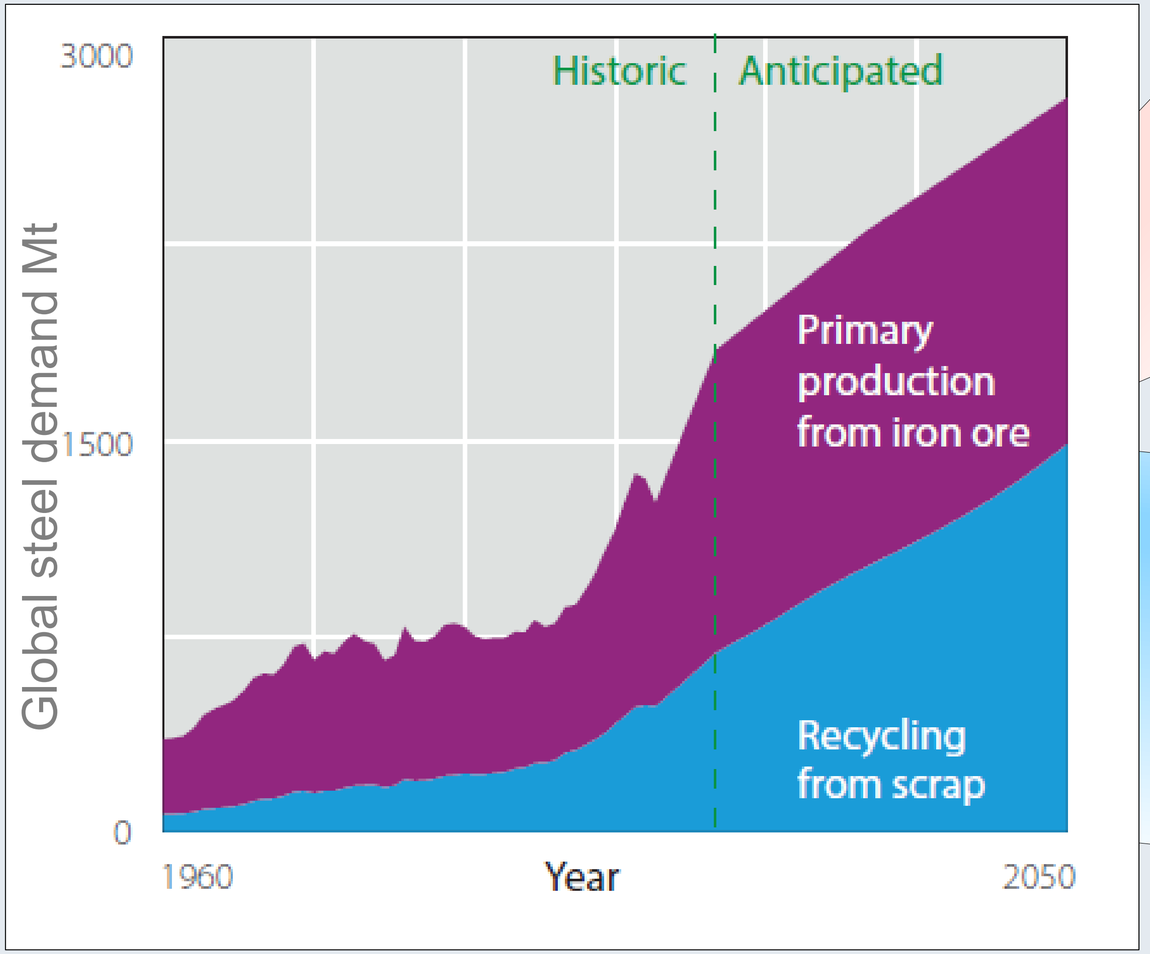
Dual-decarbonisation approach



Steel Arising, Uni Cambridge

Decarbonising primary steelmaking is the priority – 90% GHG emissions

EAF steelmaking decarbonised using low/zero carbon electricity – 10% GHG

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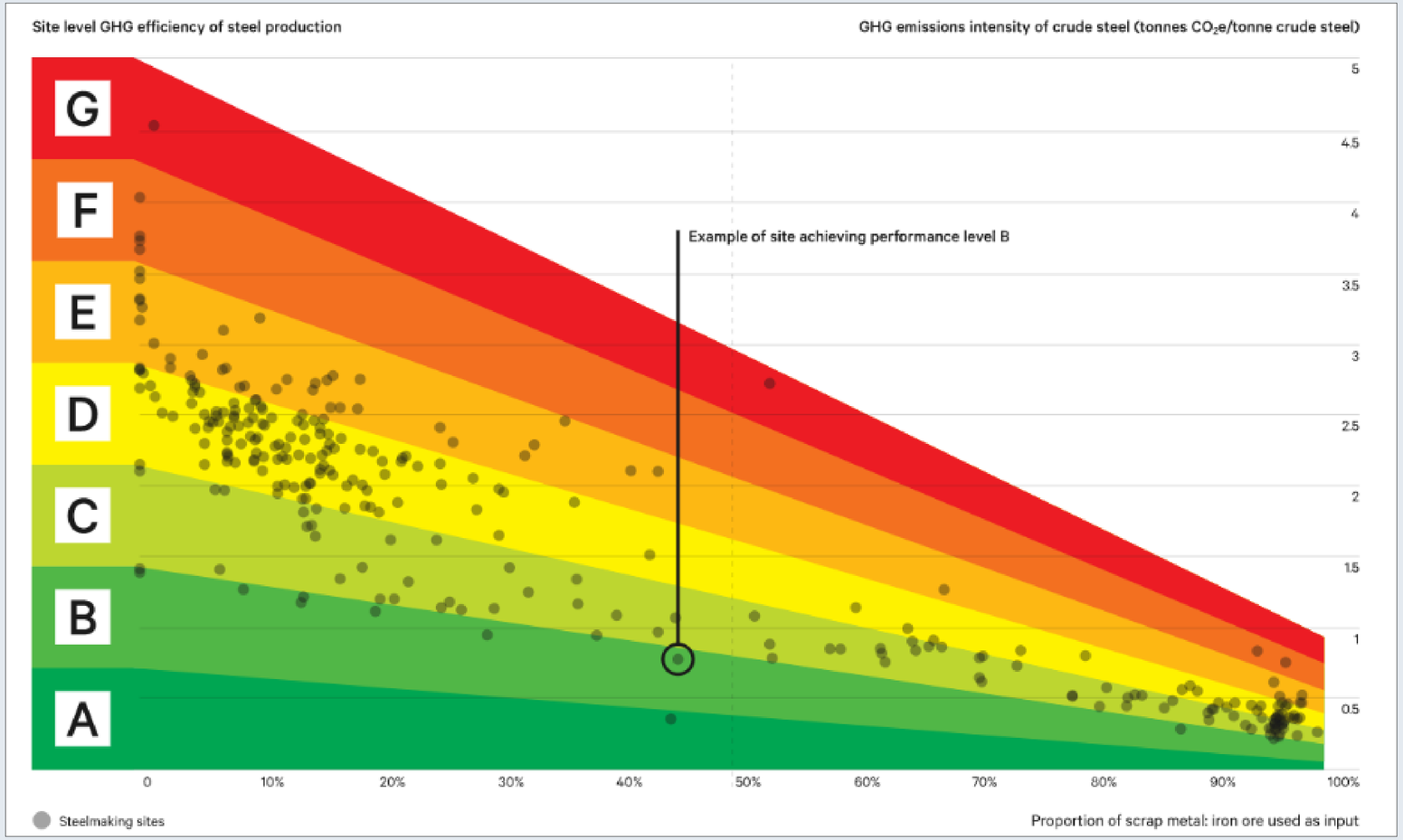
Low-carbon steel standard



CRU and Chatham House

- Reflects the fact that all steelmakers need to decarbonise
- Incentivises all steelmakers to decarbonise
- Supported by many other organisations

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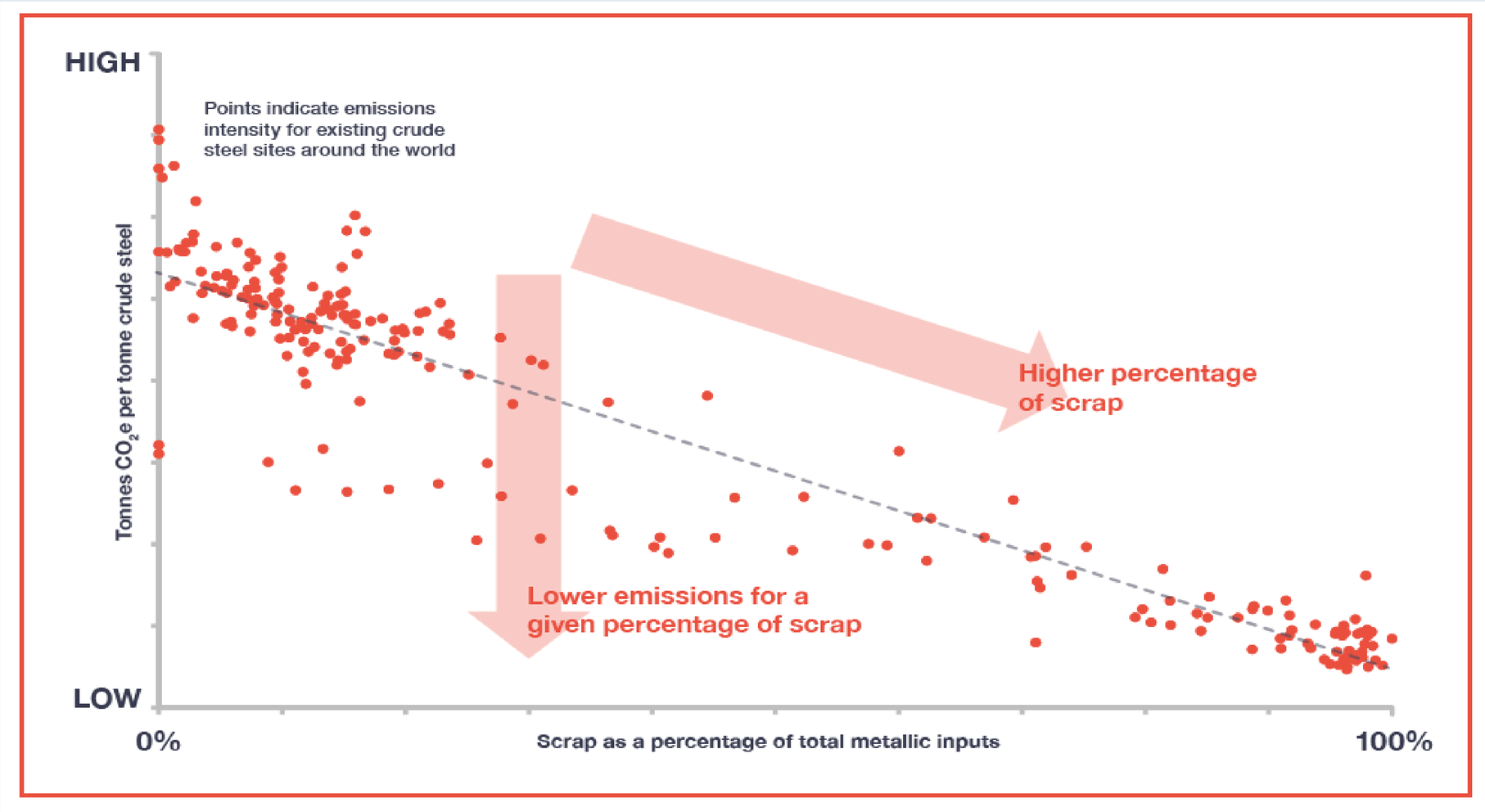
Dual-decarbonisation



The role of scrap in steel decarbonisation, IStructE

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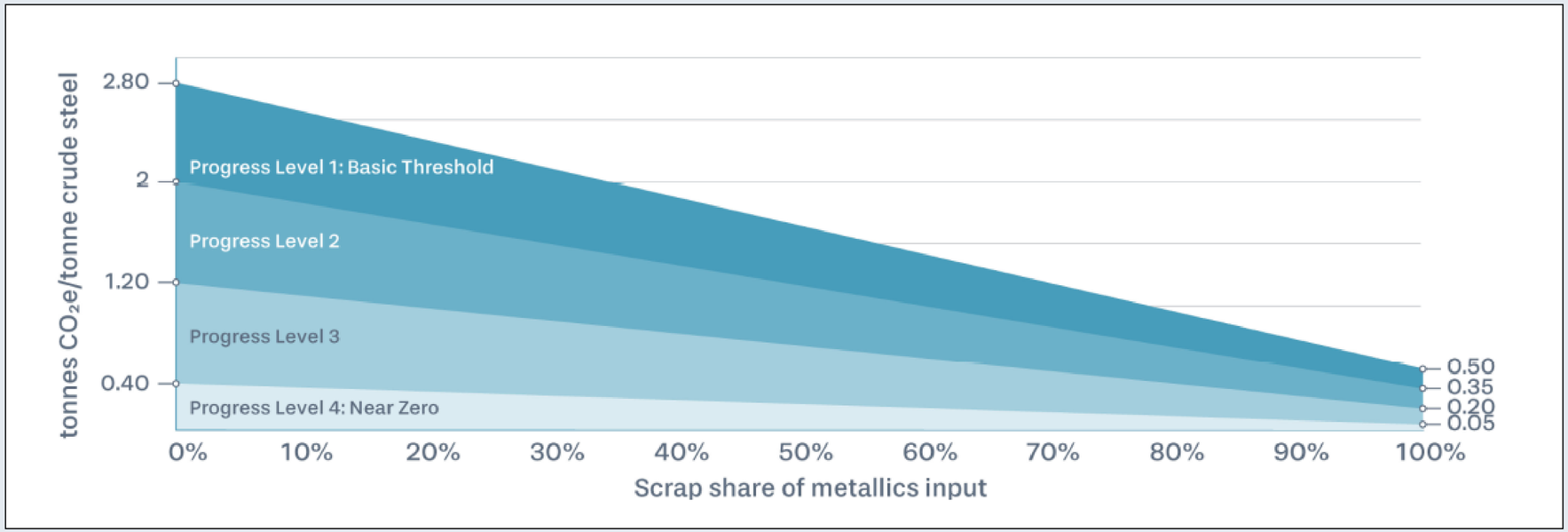
Our recommendation to Government



ResponsibleSteel criterion 10.6

- Measure carbon intensity as a function metallic scrap input

BUT:

- Progress levels to be tailored to current UK steelmaking capabilities
- Decarbonisation timescales should be aligned with UK Steel and Industrial strategies

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Other steel product classification options

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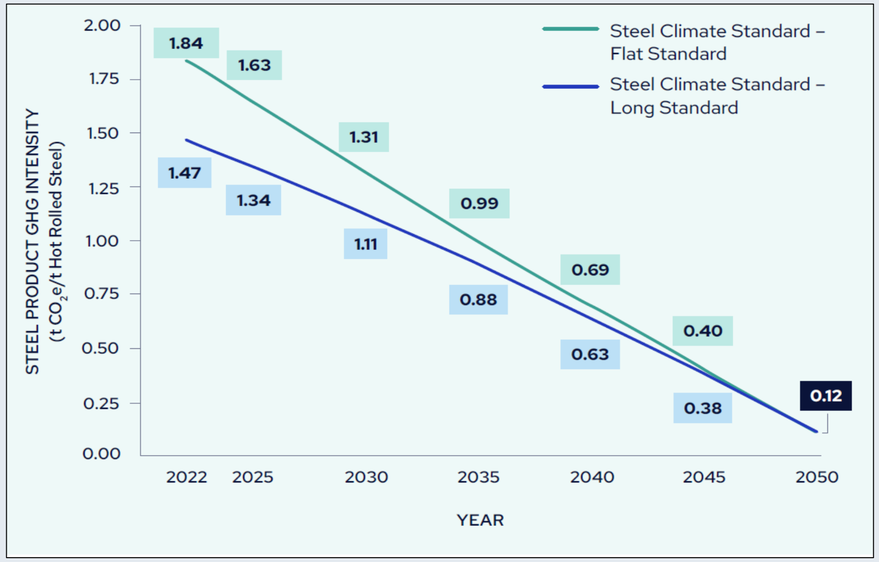
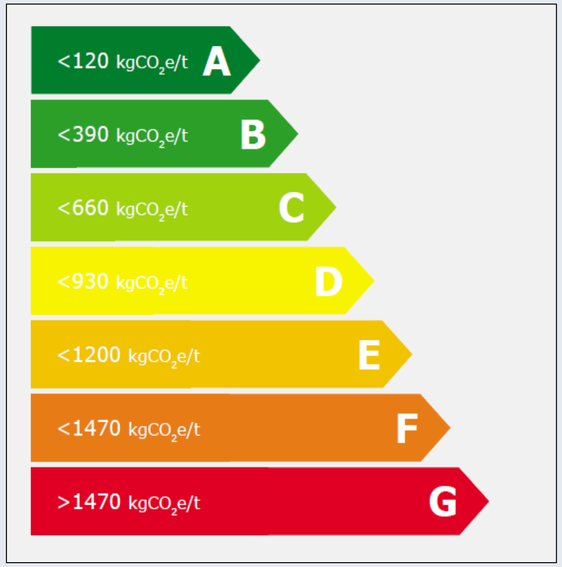
Global Steel Climate Council's (GSCC's) product standard



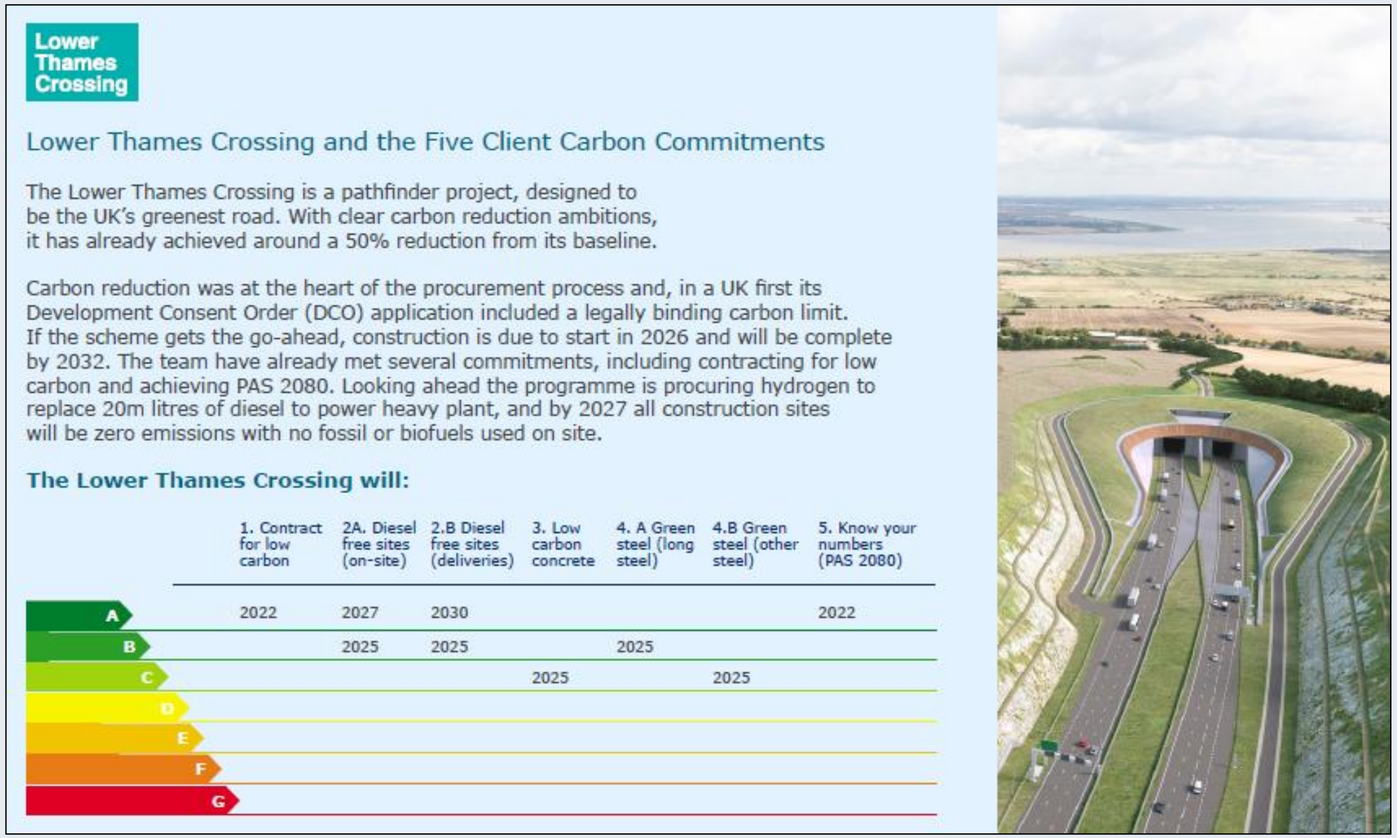
- No scrap sliding scale
- System boundary up to hot rolled steel
- Flat steel and long steel, one threshold each
- Dynamic and aligned to net zero

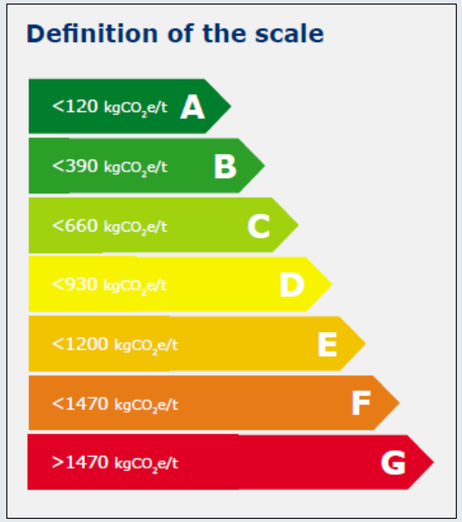
Green steel scale in the CLC's Five Client Carbon Commitments (5CCCs)



- No scrap sliding scale
- System boundary up to hot rolled steel (applies GSCC's system boundary)
- Six bands (A to F) not incl. G
- Fixed

CLC client carbon commitments





CLC commitment 4 - steel

2025 commitment to procure long products <390 $kgCO_2e/t$

This means importing steel while Government taxpayer is supporting British Steel

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Circular economy and steel reuse

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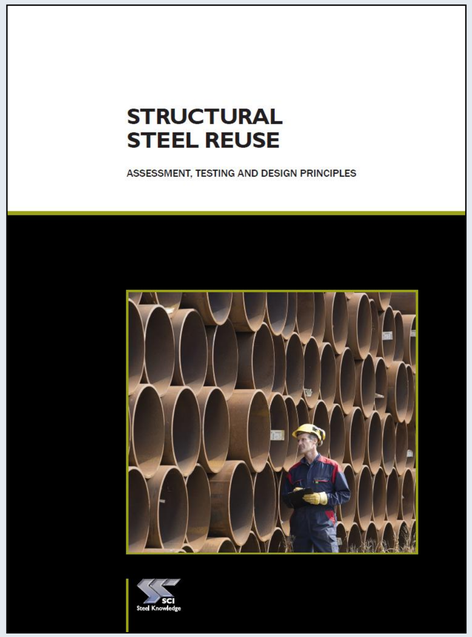
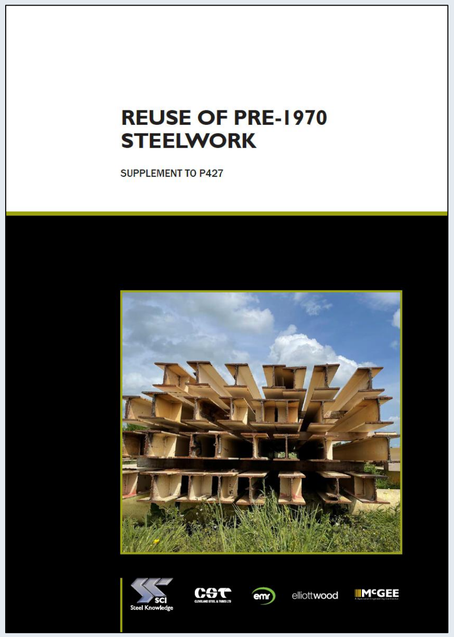
Steel reuse guidance



SCI P427



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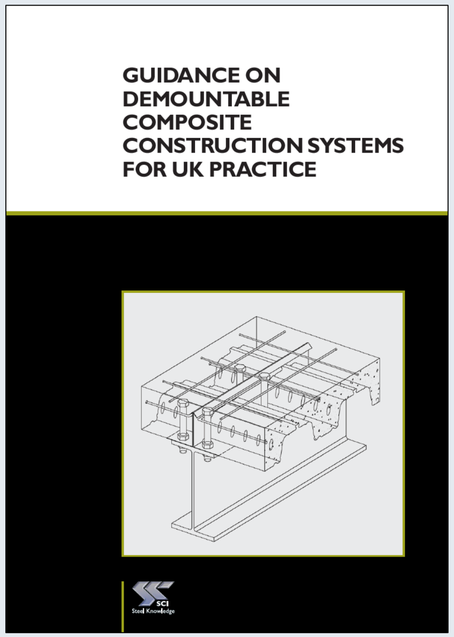

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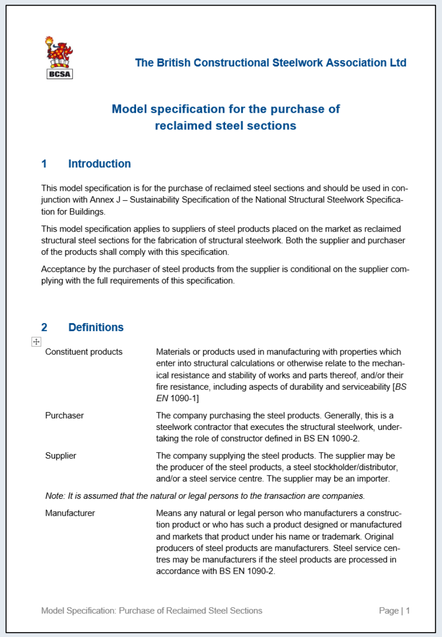

The British Constructional Steelwork Association Ltd

Model specification for the purchase of reclaimed steel sections

1 Introduction

This model specification is for the purchase of reclaimed steel sections and should be used in conjunction with Annex J – Sustainability Specification of the National Structural Steelwork Specification for Buildings.

This model specification applies to suppliers of steel products placed on the market as reclaimed structural steel sections for the fabrication of structural steelwork. Both the supplier and purchaser of the products shall comply with this specification.

Acceptance by the purchaser of steel products from the supplier is conditional on the supplier complying with the full requirements of this specification.

2 Definitions

Constituent products	Materials or products used in manufacturing with properties which enter into structural calculations or otherwise relate to the mechanical resistance and stability of works and parts thereof, and/or their fire resistance, including aspects of durability and serviceability (*BS EN* 1090-1)
Purchaser	The company purchasing the steel products. Generally, this is a steelwork contractor that executes the structural steelwork, undertaking the role of constructor defined in BS EN 1090-2.
Supplier	The company supplying the steel products. The supplier may be the producer of the steel products, a steel stockholder/distributor, and/or a steel service centre. The supplier may be an importer.

Note: It is assumed that the natural or legal persons to the transaction are companies.

Manufacturer	Means any natural or legal person who manufacturers a construction product or who has such a product designed or manufactured and markets that product under his name or trademark. Original producers of steel products are manufacturers. Steel service centres may be manufacturers if the steel products are processed in accordance with BS EN 1090-2.

Model Specification: Purchase of Reclaimed Steel Sections Page | 1

BCSA model spec for reclaimed sections

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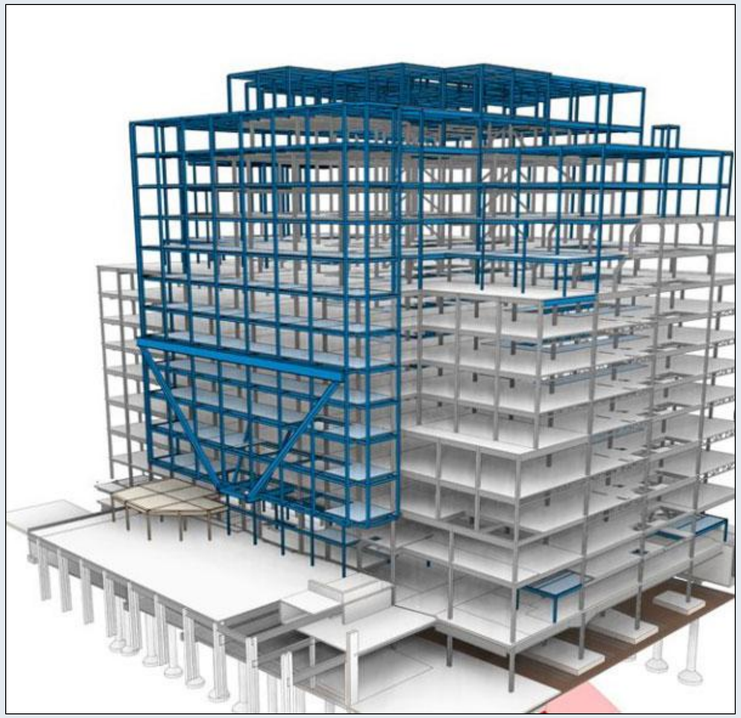
Refurb and structural extensions



One Exchange Square, Broadgate

1 Silk Street, Barbican

RetroFirst

- Growing evidence that steel-framed buildings are more suitable for adaptation and extension
- We need better circular economy metrics to quantify these benefits – Module D1 does not adequately reflect the benefits of structural steel

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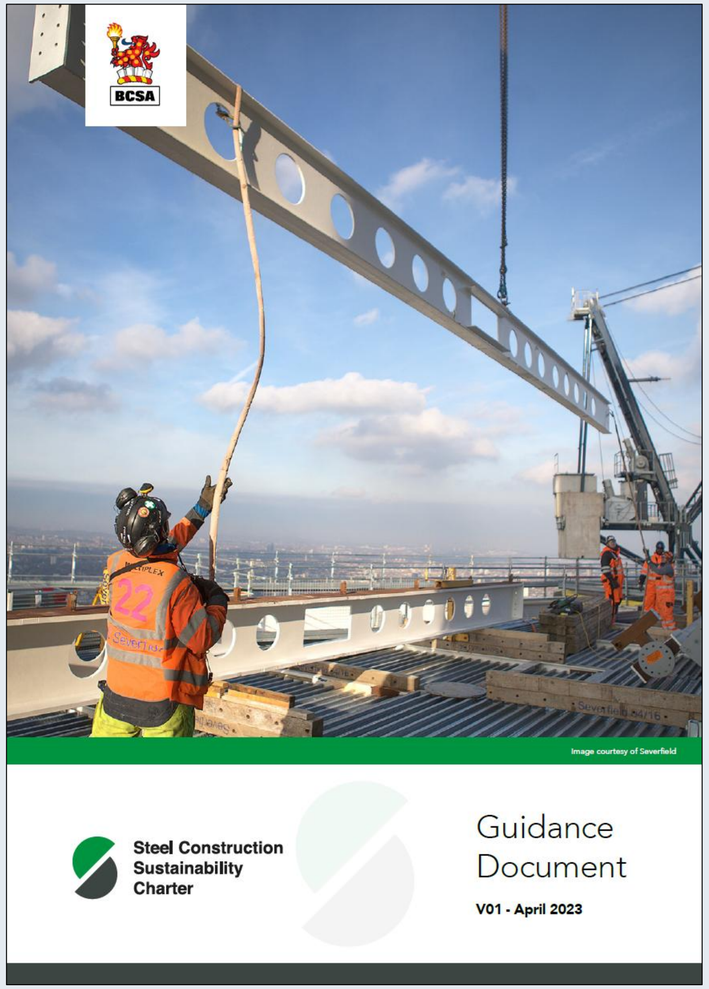
BCSA sustainability charter



- First developed in 2005
- Constantly reviewed and updated to reflect current practice and sustainability requirements
- Addresses social and economic aspects in addition to environmental responsibility
- Four levels of certification
- 15 charter requirements

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BCSA Sustainability Charter requirements

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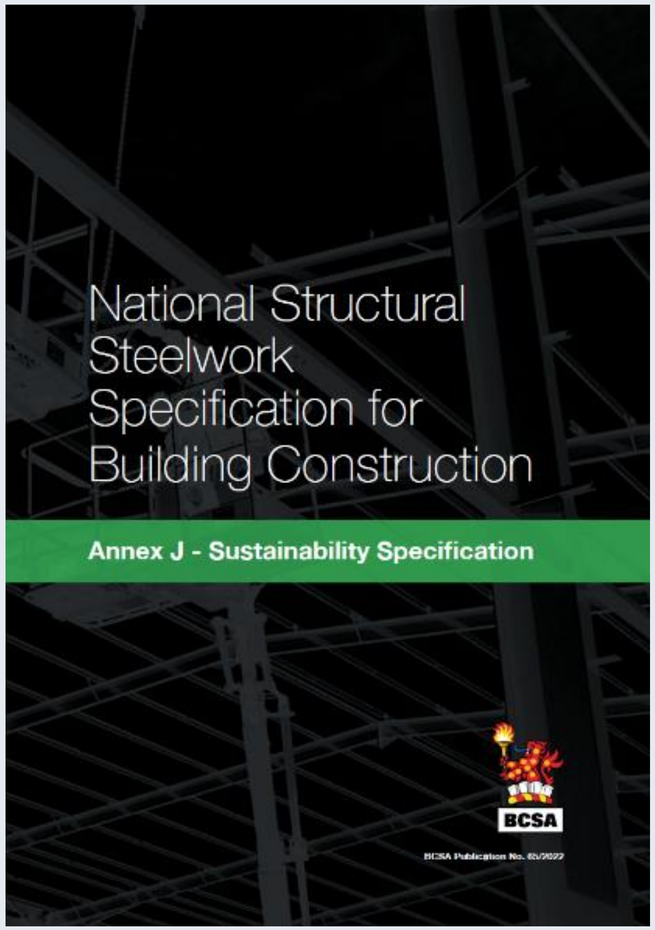
1. A published sustainability policy
2. A policy to manage Energy, Water, Waste & Travel
3. A policy to reduce the company carbon footprint
4. A valid EMS to BS EN ISO 14001
5. A programme of involvement with the community
6. A structured training and development programme
7. A published equal opportunities policy
8. A published ethical trading policy
9. A valid H&SMS to OHSAS18001/BS EN ISO 45001
10. Use of Life Cycle Assessment (LCA) techniques
11. A responsible sourcing policy
12. A valid QMS to BS EN ISO 9001
13. Procure 50% Steel from Decarbonised source
14. A commitment to optimise sustainability in design
15. Demonstration of innovation towards sustainability

NSSS Annex J



- Annex to NSSS 8th edition
- Specifies general requirements and practices for achieving sustainable steelwork construction

Includes requirements on:

- Design
- Fabrication
- Specification of new and reclaimed steel
- Quality management
- Provision of information

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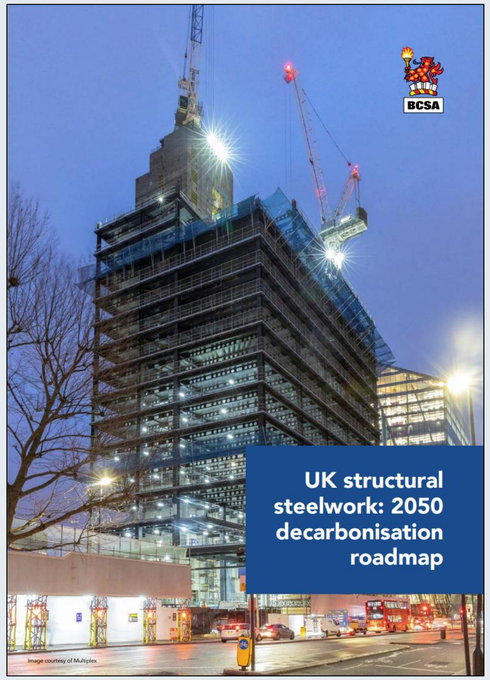
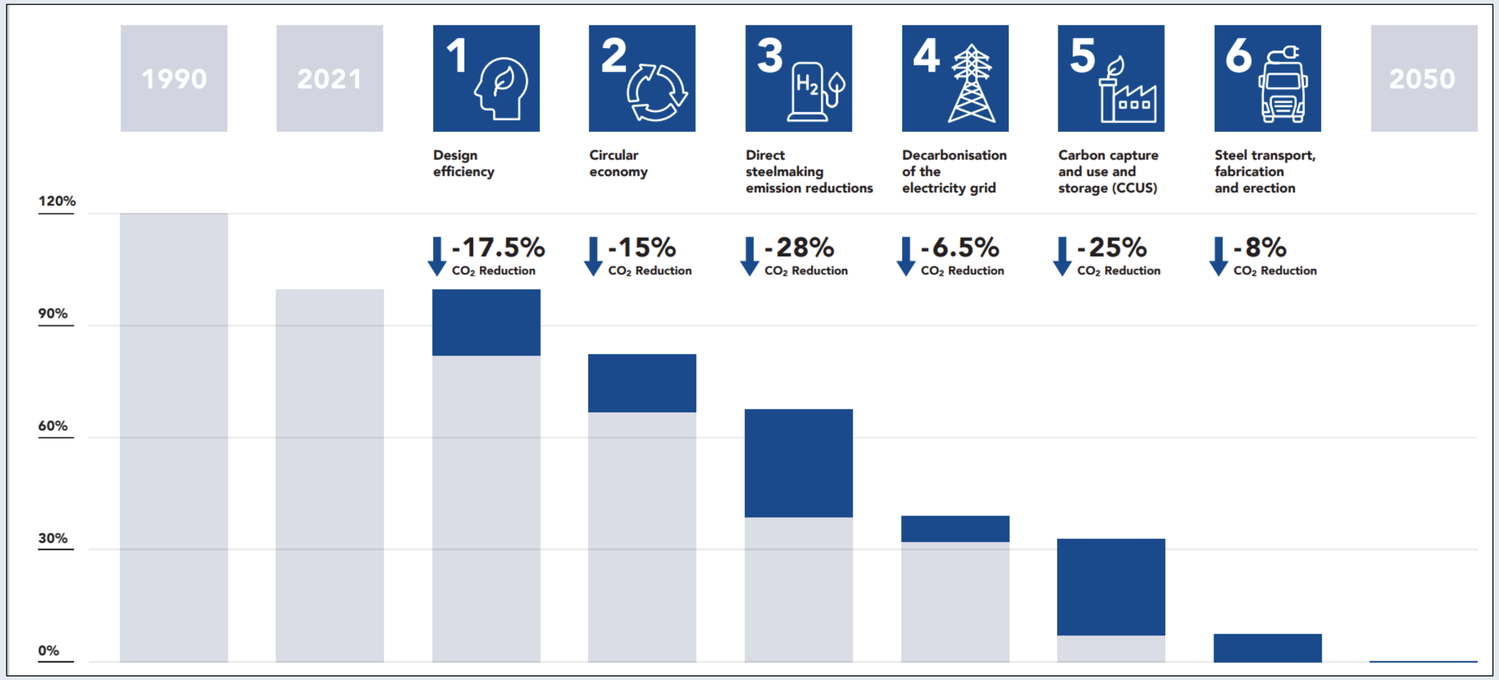
2050 Decarbonisation roadmap





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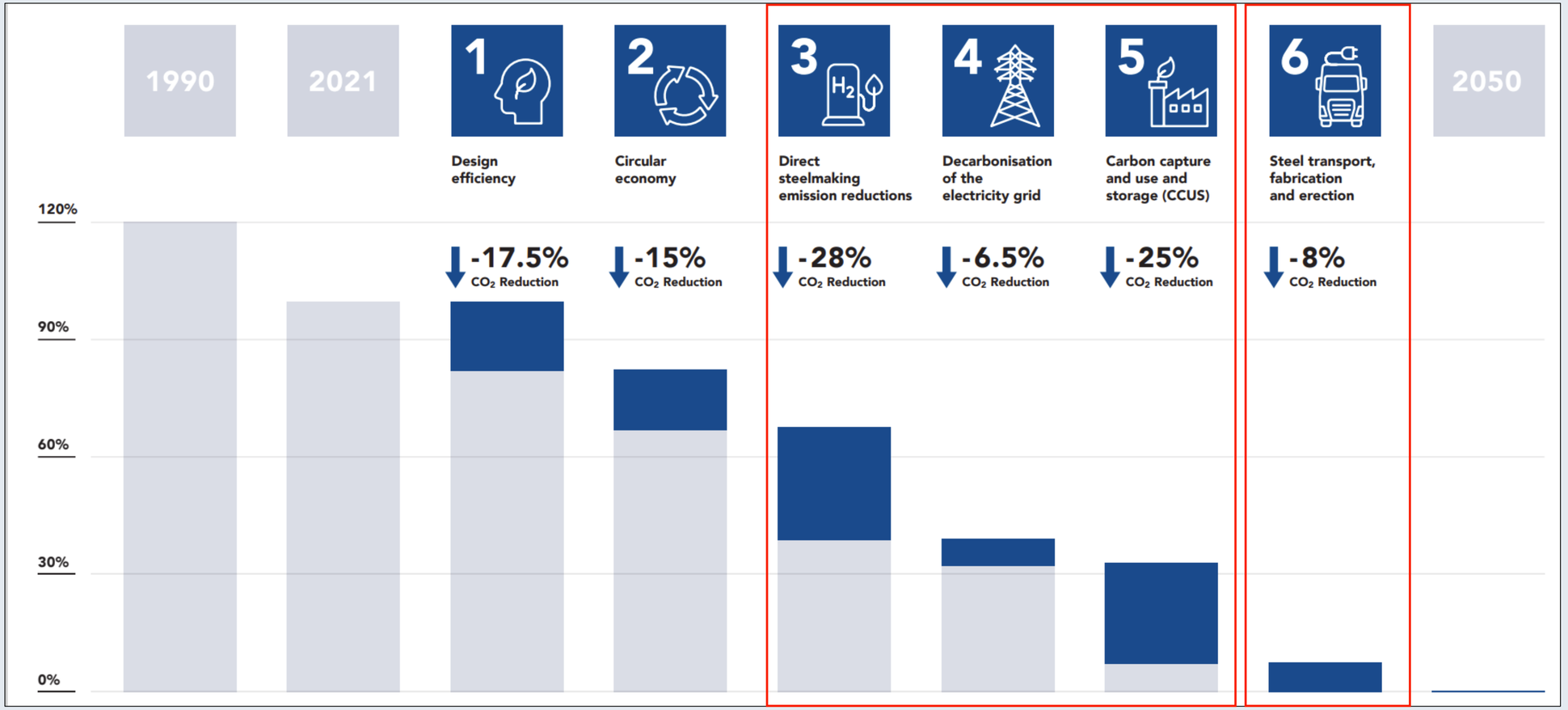
Decarbonisation roadmap



Supply side

BCSA

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Severfield are committed to science-based targets

Severfield has committed to set science-based emissions reduction targets — across the entire value chain — that are consistent with keeping global warming to 1.5°C above pre-industrial levels. Severfield has also committed to a long-term target to reach net-zero emissions by no later than 2050.

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Proud to be recognised for significent carbon reductions since 2010

2025 Achilles CarbonReduce powered by TOITŪ 15 years Certified ISO-14064-1

HARE

CLIMATE GROUP STEELZERO

C2nstructZERO

The Construction Industry's Zero carbon change programme

BES 6001

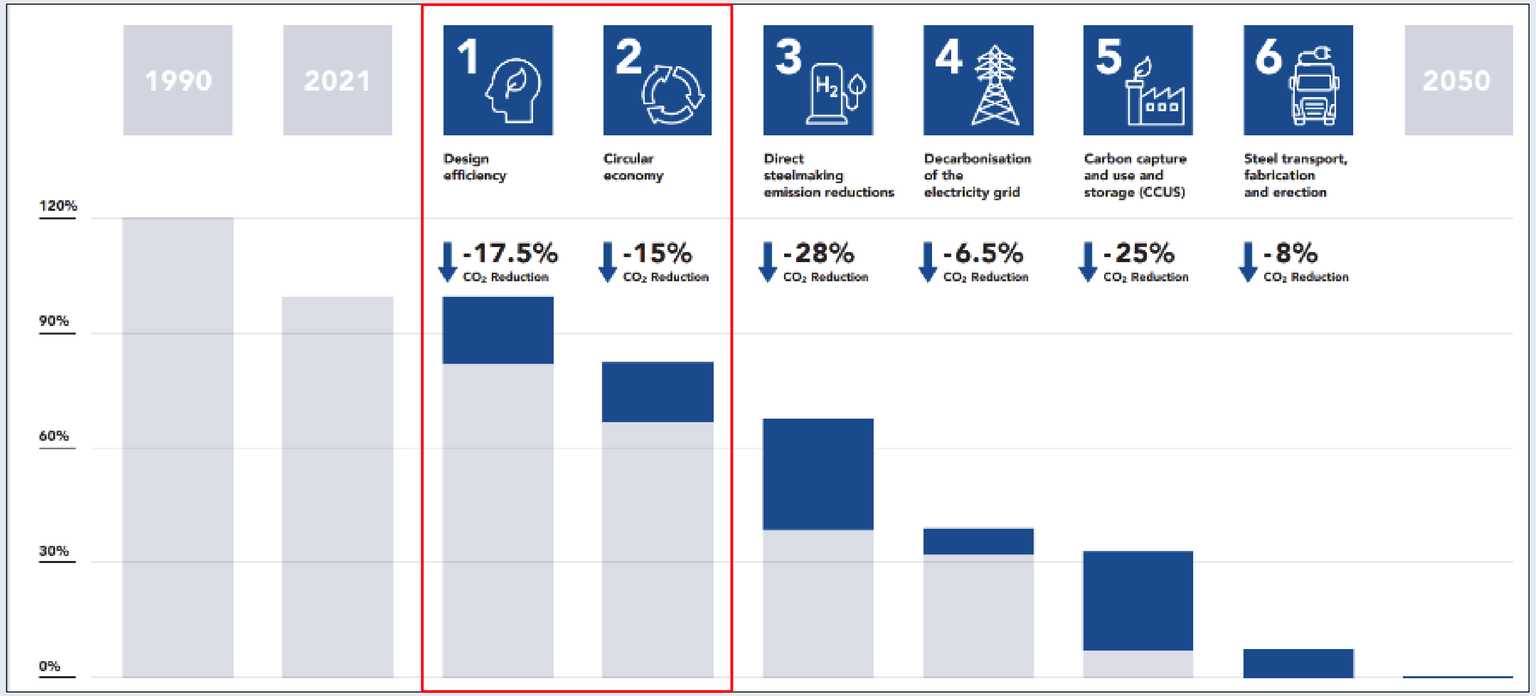
Responsible Sourcing

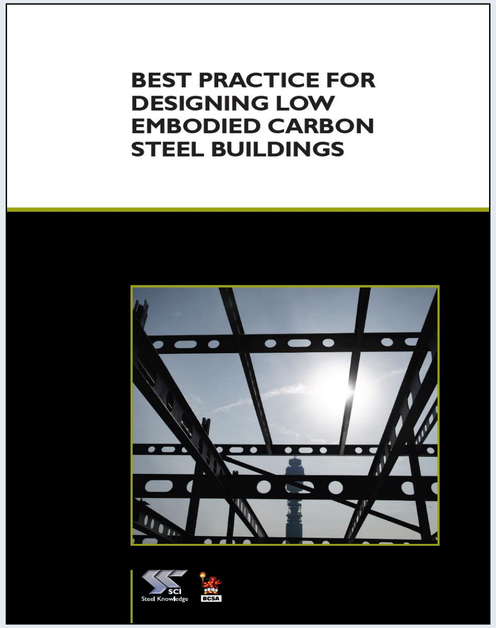
www.greenbooklive.com

GOLD

SUPPLY CHAIN SUSTAINABILITY SCHOOL

Demand side measures





SCI P449

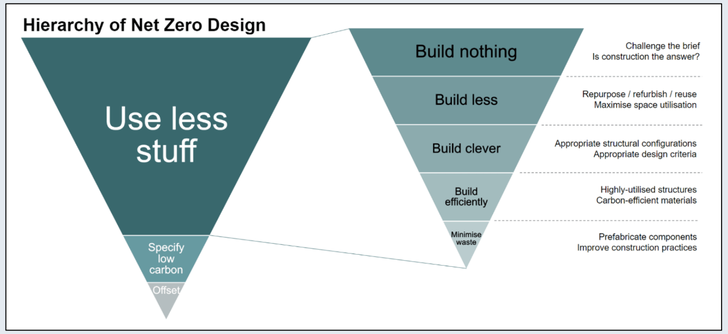
Steel Construction .info

SteelConstruction.info

The free encyclopedia for UK steel construction information

SCI Steel Knowledge

SCI Steelbiz



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Conclusions

- Low-carbon steel is technically viable but will take time and money
- If Government wants a viable UK steelmaking industry, we need coherent policies
- Educate your clients about the net global impacts of specifying EAF steel on your projects
- **BUT** steelwork contractors will use EAF steel if this is the only way to compete with alternative structural solutions

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THE FUTURE OF STEEL CONSTRUCTION

Low embodied carbon steel buildings: Design recommendations

David Brown

Steel Construction Institute

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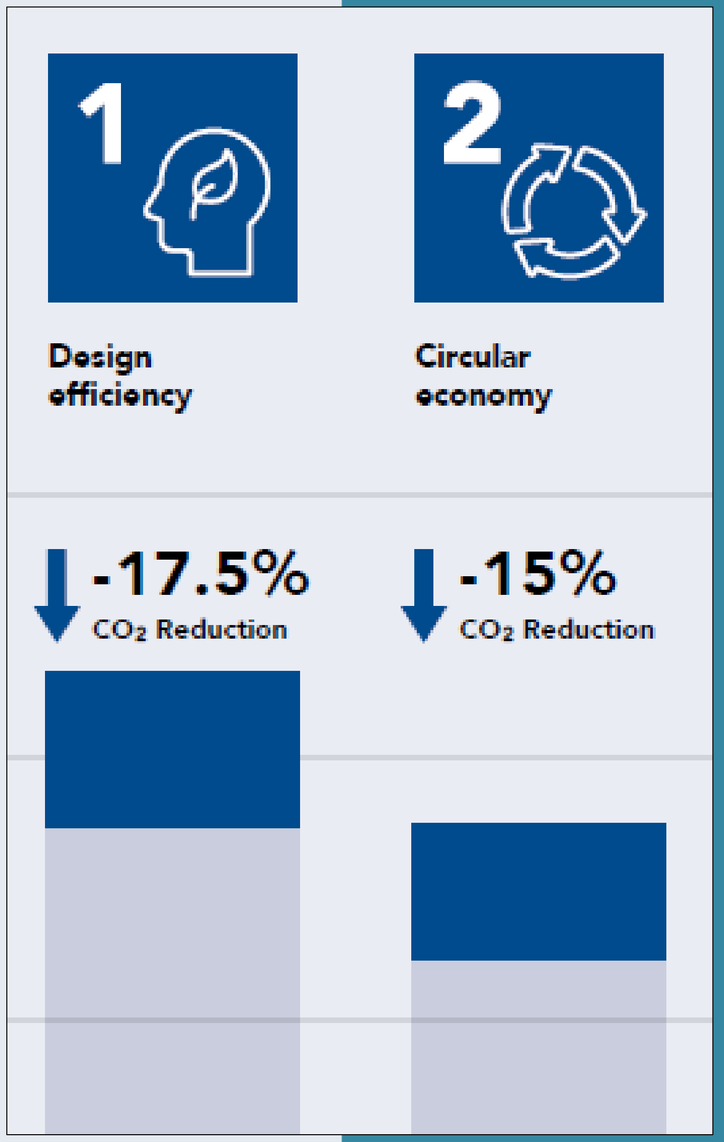
Design responsibility

- 17.5% reduction from design
- 15% reduction from circular economy
  - Including reuse



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What is the problem?

- Inefficient design
  - Allowing for the (uncertain) future: “don’t do it, strengthen later”
  - Allowing for ‘inevitable’ design development
  - Avoiding the time and cost of redesign, not covered by competitive fees
- The “sleep at night” factor
  - “risk mitigation”
- No penalty for inefficient design

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Evidence of an opportunity

Utilization of structural steel in buildings

Muiris C. Moynihan and Julian M. Allwood

Department of Engineering, University of Cambridge,

- Of 10,000 beams, average utilization is < 50%

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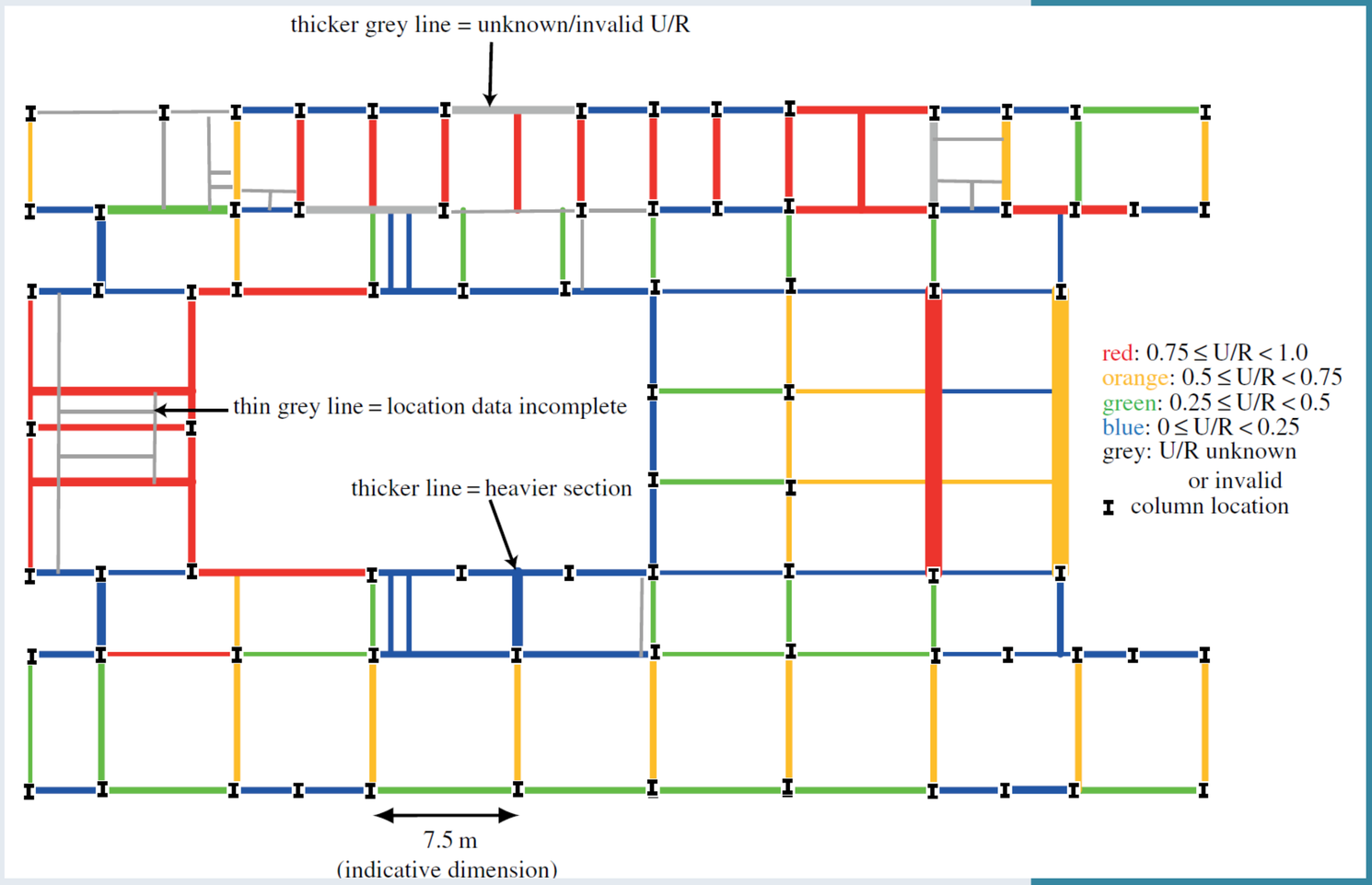
Evidence of an opportunity

- 0.75 < UR < 1 ☺
- 0.5 < UR < 0.75
- 0.25 < UR < 0.5
- 0 < UR < 0.25 ☹



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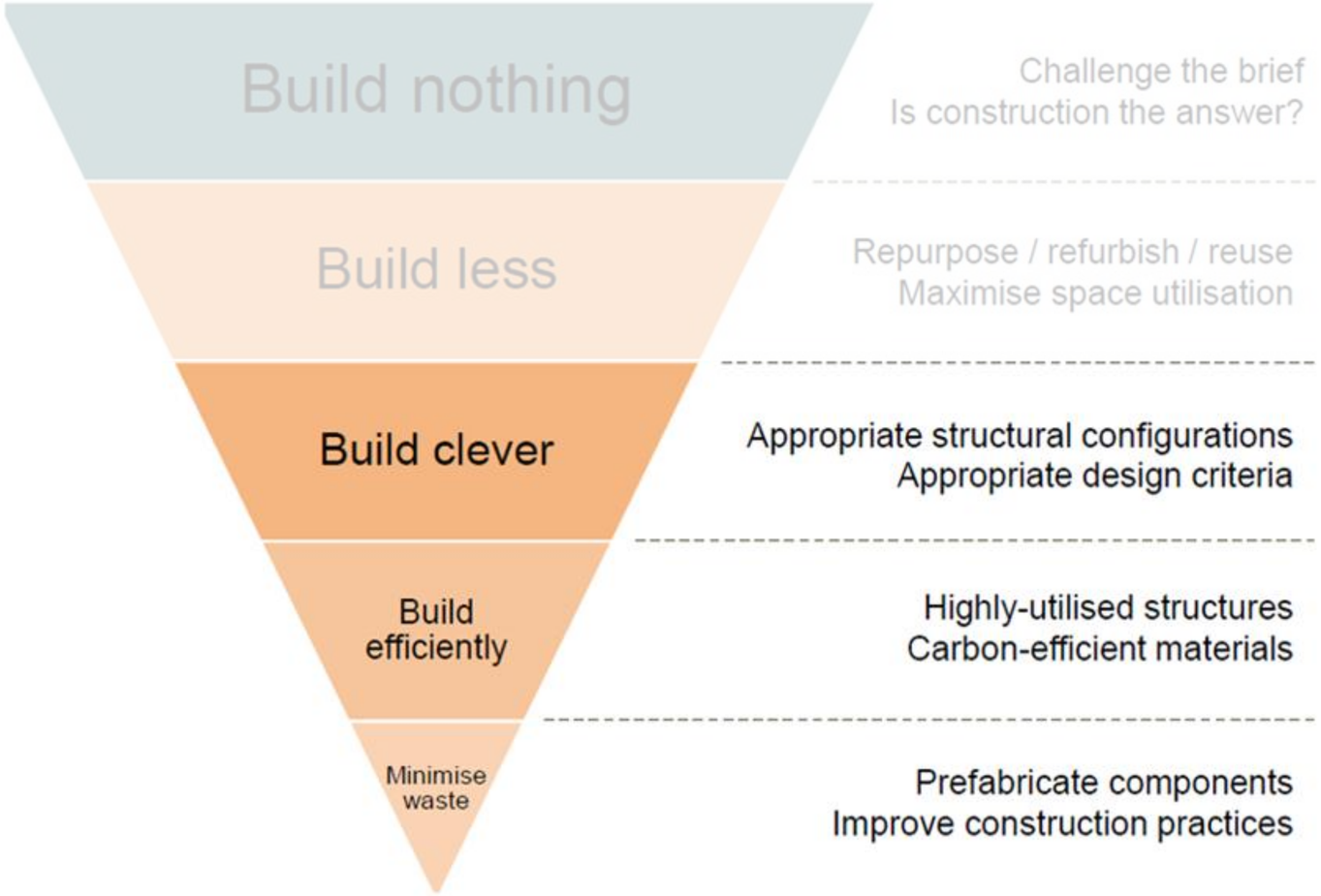
Decision Hierarchy



- *If* we are to build, there are opportunities to do better

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Efficient design

- General arrangements
- Systems
- Members

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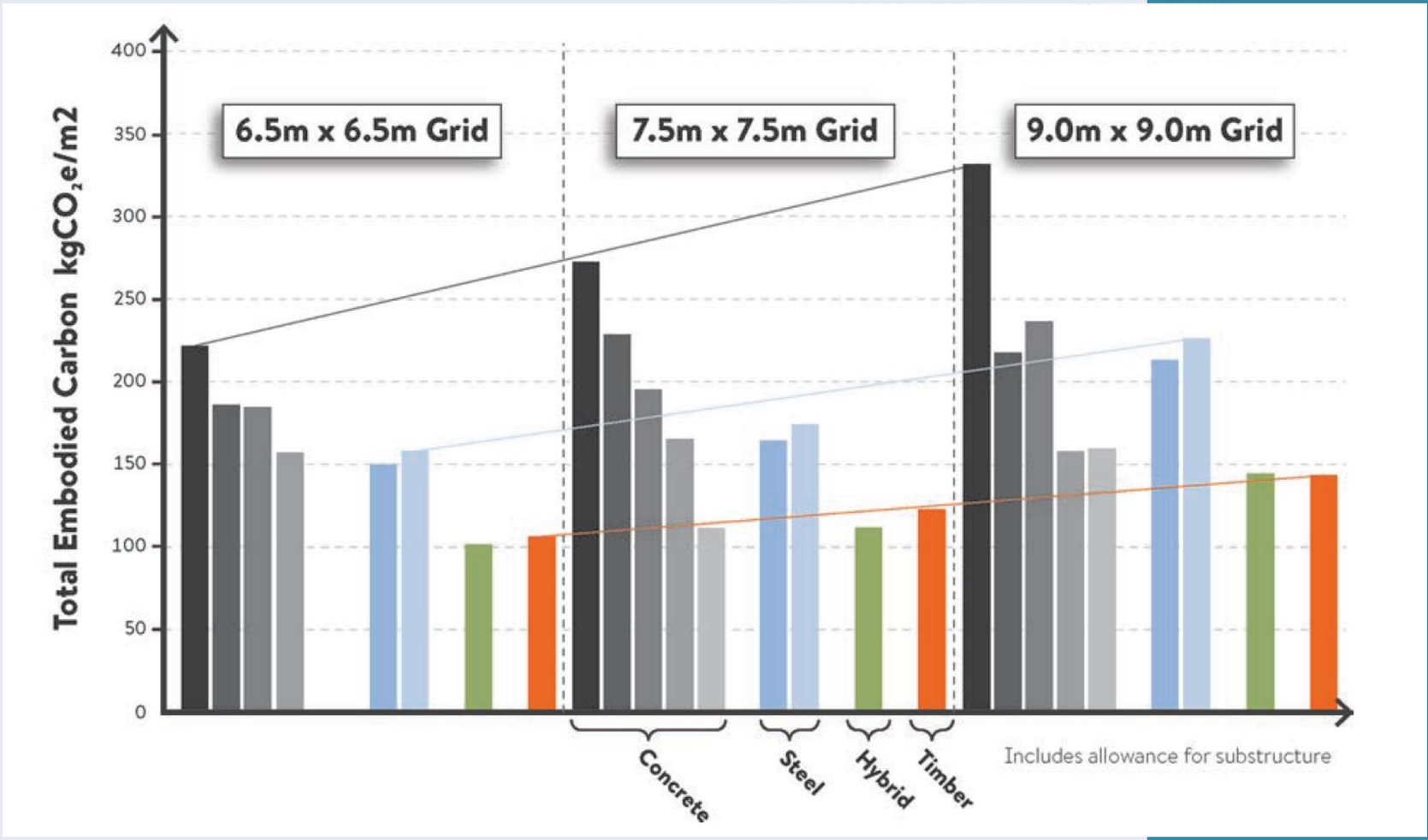
General arragements

- More carbon with longer spans



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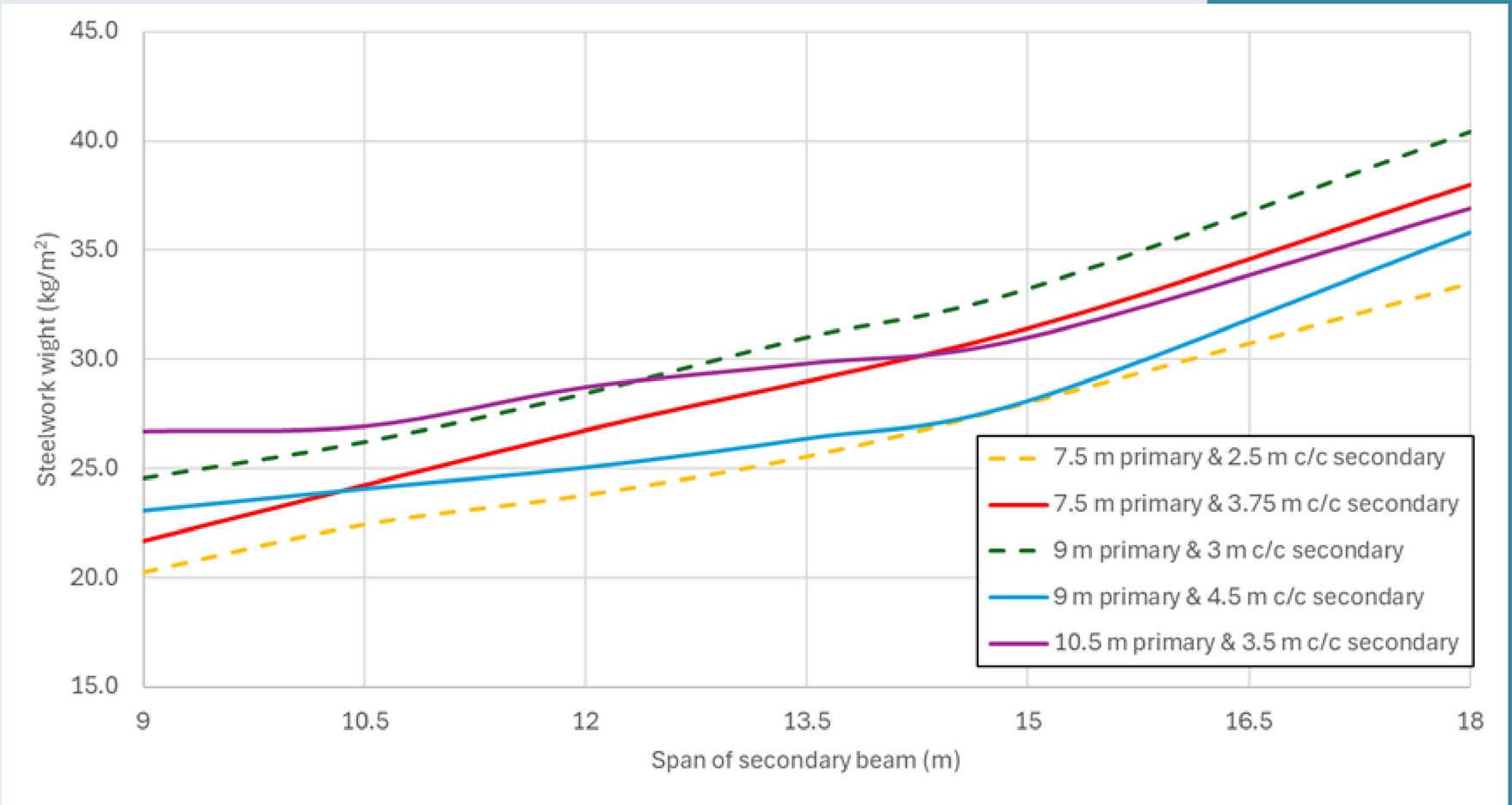
Longer spans

- Fact is longer spans = more carbon
- But “not much more?” compared to:
  - Useable space
  - Flexibility
  - Premature redundancy

THE FUTURE OF STEEL CONSTRUCTION

Longer spans

- With web openings



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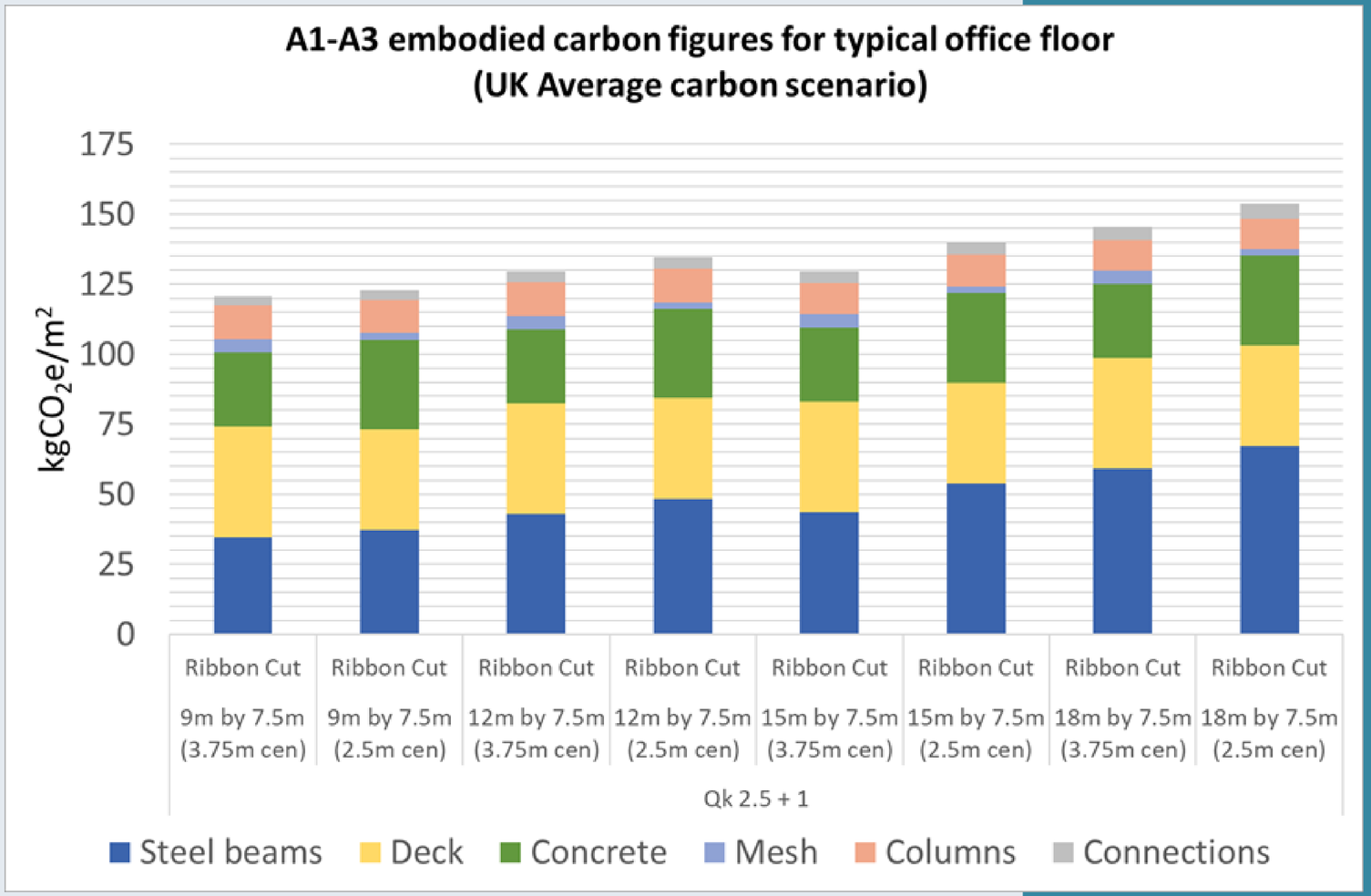
Longer spans

- Floor slab does not change
- Less beams (longer slab spans) is lower carbon)



Design criteria: Imposed floor loads

- Don’t overspecify – loading
  - Do we *really* need 5 kN/m^2?
  - Surplus capacity – for an unpredictable future – don’t do it!

- For offices, 2.5 kN/m^2 is specified in the UK NA and recommended by BCO
- *Probably* endorsed in the UK NA for Gen2

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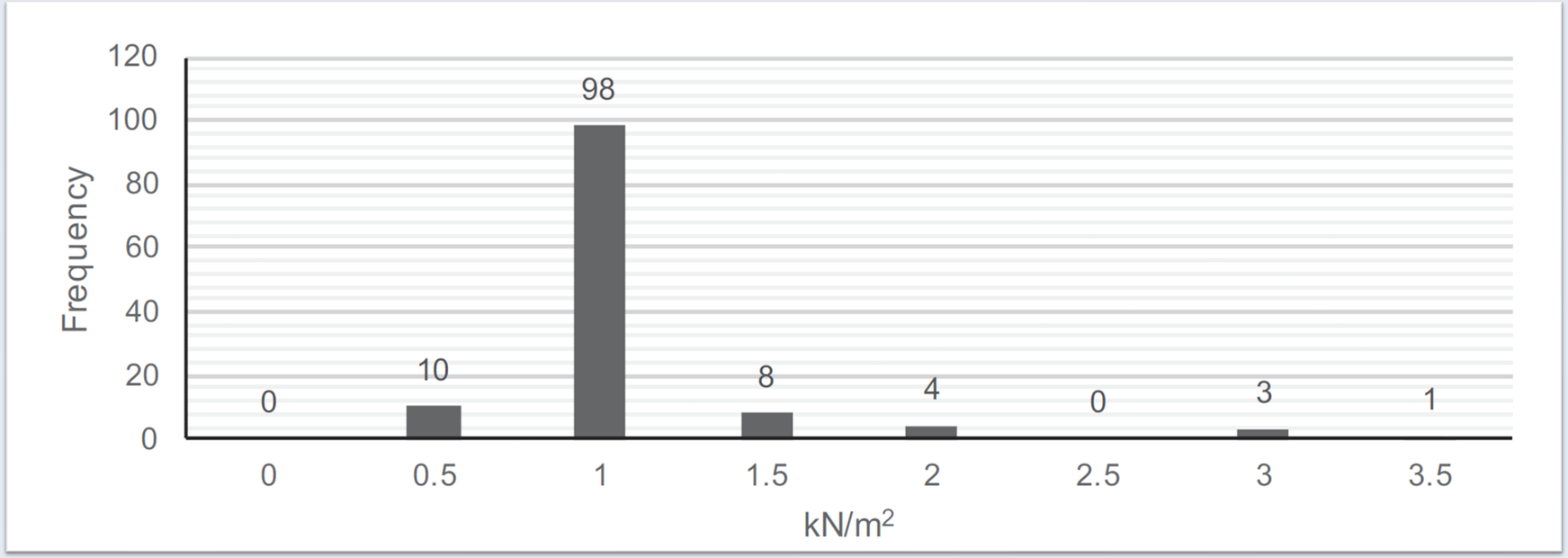
Allowance for partitions

- And the survey says:



- Almost everyone uses 1 kN/m^2

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Allowance for partitions… since 2005

- EN 1991-1-1 clause 6.3.1.2 (8)

Self weight of partition (kN/m)	Allowance (kN/m^2)
Less than 1	0.5
Between 1 and 2	0.8
Between 2 and 3	1.2

- UK NA will *probably* endorse 0.5 kN/m^2

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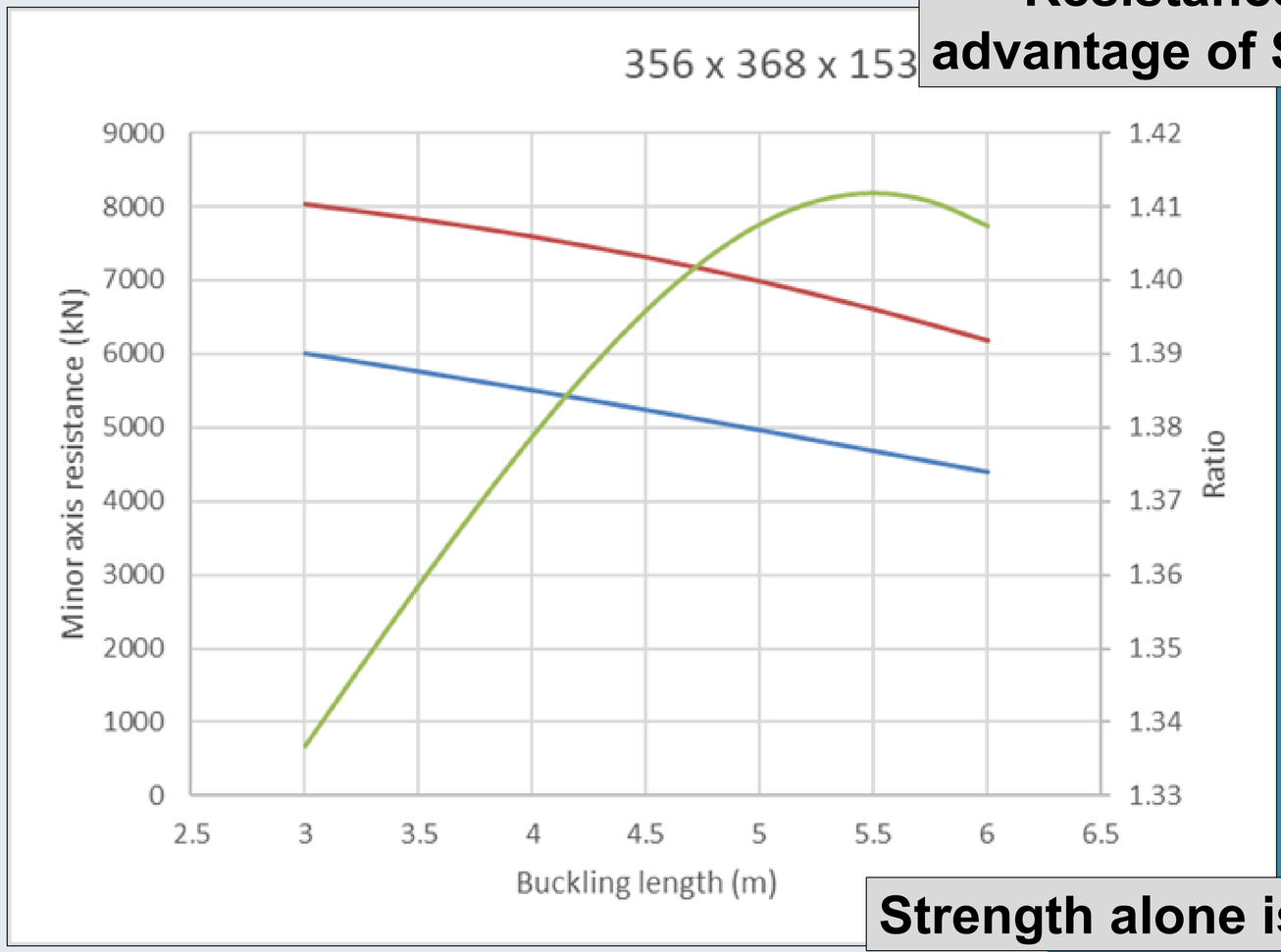
S460 – for columns

- UC in S460
  - Structurally advantageous – beneficial buckling curve
  - Lighter weight – overall cheaper
  - Lighter weight – less carbon
  - Lighter weight – smaller

- This should be the solution for columns in multi-storey buildings

S460 – for columns

- Taking all into account:
- (but in Gen2, the advantage is reduced)



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Design combinations of actions

- EN 1990 6.10, or the more onerous of 6.10a and 6.10b?

- Always use (6.10a and 6.10b)
- Almost always, 6.10b will be critical
  - In an office, 6.10b is critical until $g_k > 4.5q_k$ (a very strange building!)

Design combinations of actions

- EN 1990; 6.10

  $1.35 \times 3.5 + 1.5 \times (2.5 + 0.5) = 9.23\ kN/m^2$

- EN 1990; 6.10b

  $0.925 \times 1.35 \times 3.5 + 1.5 \times (2.5 + 0.5) = 8.87\ kN/m^2$

- 4% saving – throughout the project

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Design methods

- Predominantly “simple” construction
  - *Nominally* pinned joints
  - Stabilised frames (commonly, cores, or braced)

- Semi-continuous design is an easy option
  - A little extra effort

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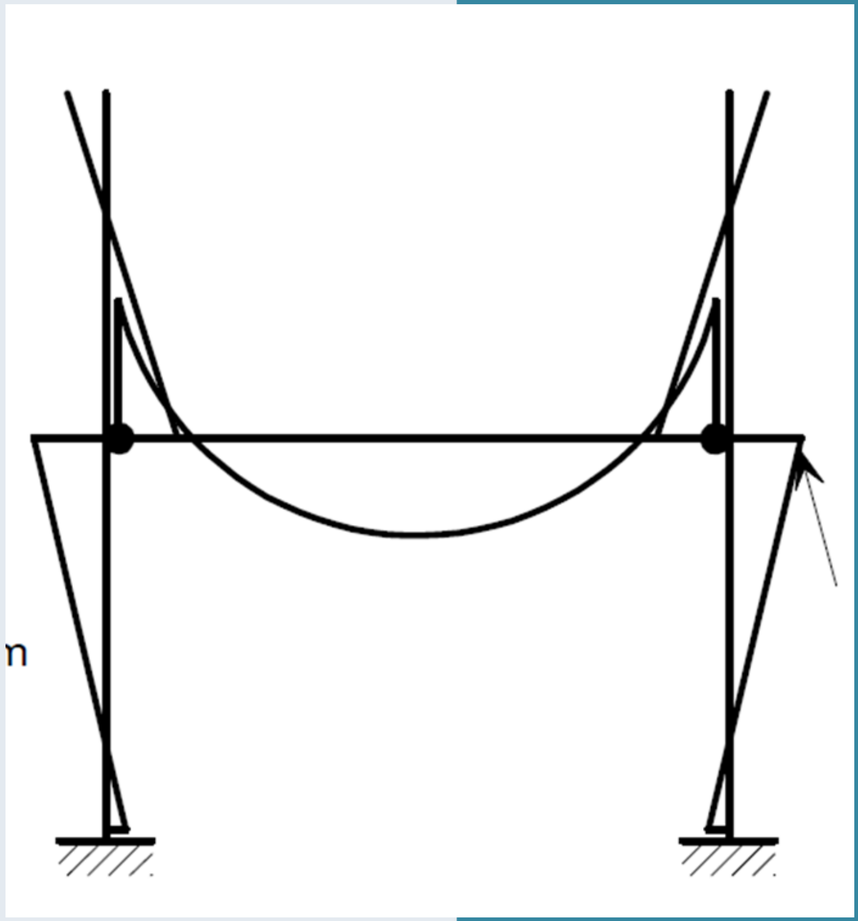
Semi-continuous design

- “lift” the BMD, by recognising the resistance of “straightforward” joints
- Control the moment into the columns, by using joints that are partial strength and behave plastically
- Reduce the beam deflections by recognising the known stiffness of standardised joints



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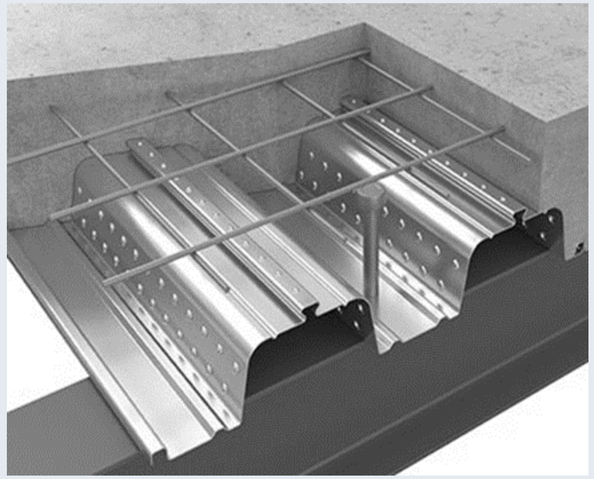
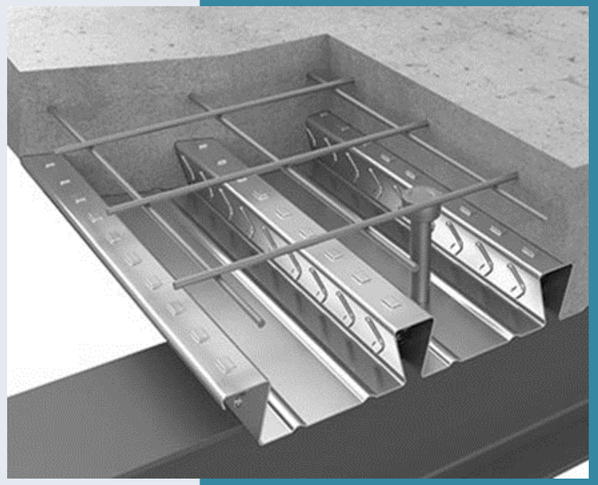
Where to focus attention:

- Steel in floors is 3 × steel in columns
  - So put effort into the floor systems
  - Aim for highly utilised floor members, especially if repeated
  - Not over-rationalised

- Floor slab should be considered
  - Don’t adopt the standard solution (150 mm concrete?) without thought

Floor slabs





If CLT is too radical…….

- Maximise the deck span
- Double spanning deck sheets
- Trapezoidal profiles, (unless acoustics or vibration critical)
- Consider propping
- Use low carbon concrete
- Use the minimum slab depth, not “business as usual”

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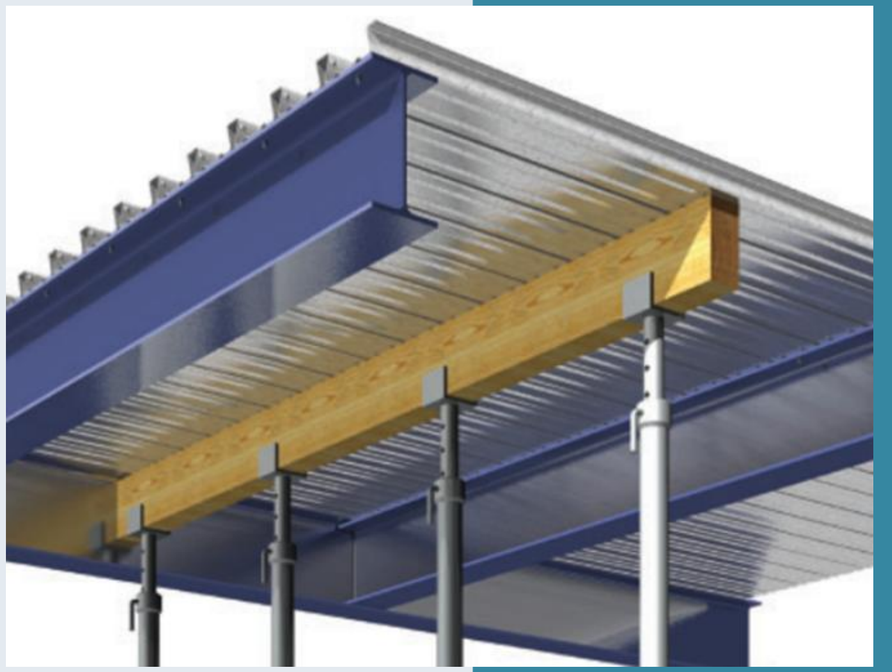
Propping?

- “Surely not” – it impacts the construction programme
- But it is effective in carbon reduction



Steel members

- Uniform resistance (UB, UC) but non-uniform effects?

- Welded members
  - Asymmetric members
  - Plate girders, perforated as required?

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Asymmetric sections

- Common – from plate or UB, in composite
- In the composite section, the compression flange does little

- Asymmetric cellular member are very common

(not so) radical? – Mass timber floors

- More costly?
- Huge eco benefits
- Shorter programme

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Mass timber solutions

- Cross laminated timber (CLT) favoured in UK
  - At least three layers
  - 80-300 mm thick
  - Up to 16.5 m long
  - Machined precisely
- Competition for concrete
- Design rules becoming available

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Fire resistance

- The correct solution demands information from the designer – the critical temperature.

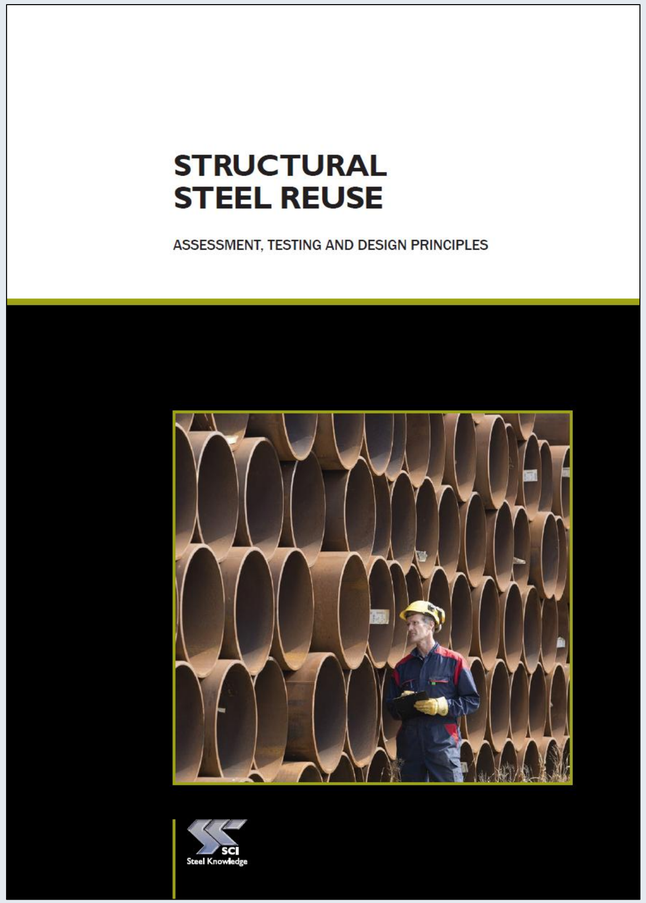
- Else with default values (some of which are wrong!):
  - Time consuming (extra coats)
  - Expensive
  - Carbon

Data needed for a proper design

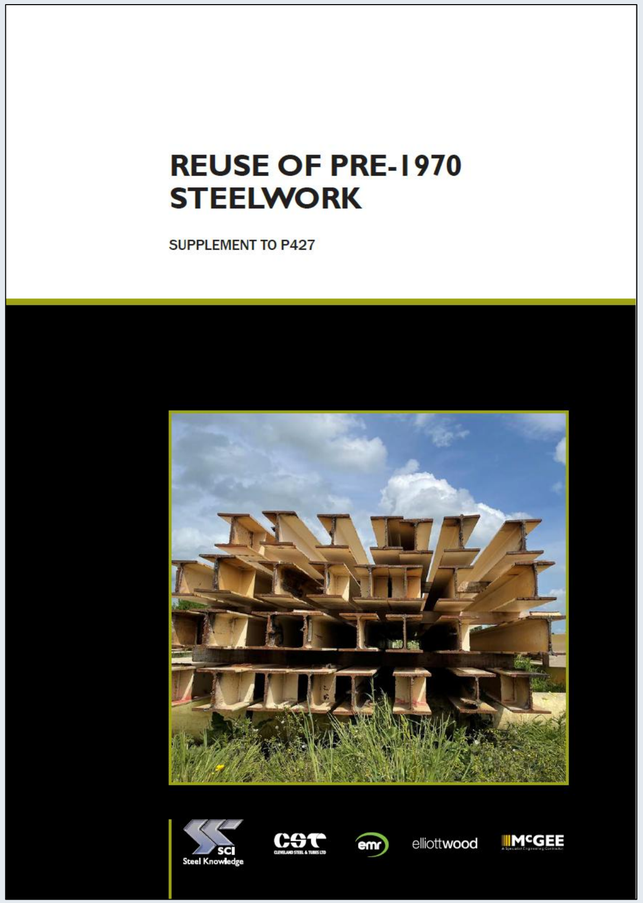
- The critical temperature demands:
- The proportions of g_k and q_k
  - So the load reduction can be determined
- The original utilisation
  - So any spare resistance can be used

- Sometimes, careful choice of member
  - High A/V (thin wall hollow sections) almost impossible to protect

Reuse resources



P427,
second edition 2024



P440, 2023

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Why reuse?

- Blast furnace: 2400 kg CO_{2e}/t
- Electric arc: 500 kg CO_{2e}/t
- UK average: 1740 kg CO_{2e}/t
- Reused steel: 50 kg CO_{2e}/t

Yes, you can CE Mark

- BS EN 1090-2 is the technical requirements
- Clause 5.1:
  If constituent products that are not covered by the standards listed (in BS EN 1090-2) are to be used, ***their properties are to be specified****.”*
  - Demonstrated by test

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Steel properties

- The key properties
  - Strength: yield and tensile (ultimate)
  - Elongation
  - Tolerances
  - Impact strength (optional)
  - Carbon equivalent (optional)
- To be declared by the stockist
- Other characteristics, not mandatory to declare

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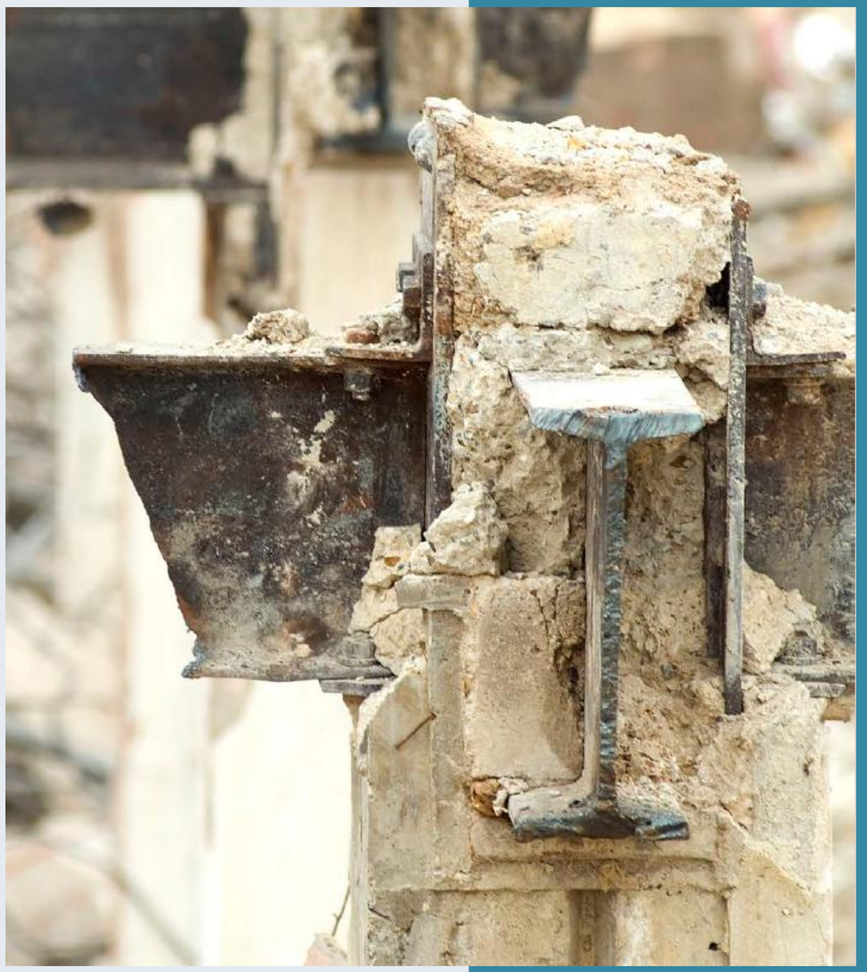
Damage and defects

- Of course its not perfect!
  - It may have been burnt through
  - It may have been dropped
  - It is likely to have damage

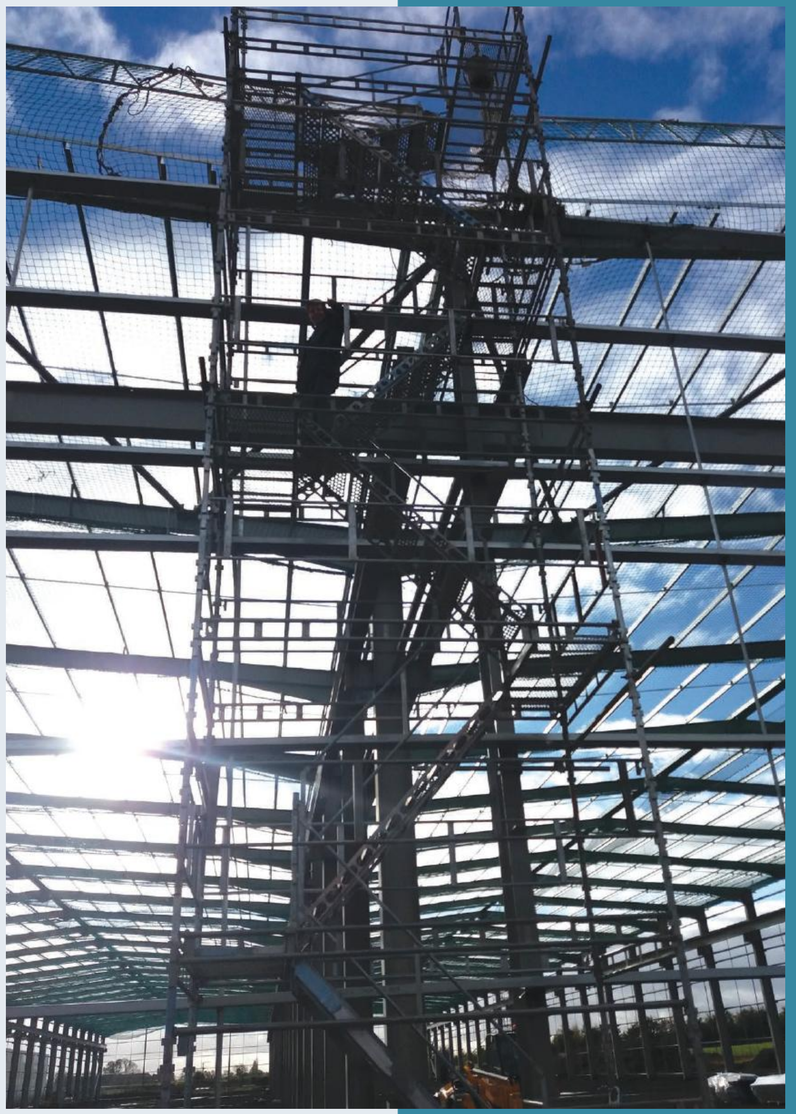
- But when do we care?

  ….it depends on the circumstance



Design issues

- The steel has not lost its strength!
- No change to cross sectional resistance calculations
  - $\gamma_{M0} = 1.0$
  - Full resistance for restrained beams



Buckling resistance

- Post 1970 steel (P427)
- Increase γ_{M1} by 15%

- Pre 1970 steel (P440)
  - Increase γ_{M1} by 15%
  - Conservative buckling curves, as BS 449
  - Advice on welding
  - Advice on brittle fracture

Flexibility – the steel is not likely to be perfect

- Identify:
  - Concealed steelwork?
  - An envelope of sizes, if there are constraints?
  - Identify likely candidates – secondary beams?

  - Additional design input – but reduced carbon

Lower embodied carbon – good practice

- Appropriate design loads
  - For now, not for the (uncertain) future
- Fully utilising steel (including S460)
- Assessing efficient options (high strength, trapezoidal profiles, cellular, etc)

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Lower embodied carbon – good practice

- Encouraging appropriate reuse, at the right time
- Focus on floors – large proportion of CO_2e
  - Consider low carbon concrete, CLT
  - Prioritise the repeating elements

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Resources

- The BCSA / SCI guide P449……