SUPPLY CHAIN SUSTAINABILITY SCHOOL

Reducing Carbon: designing out carbon

James Cadman,
Action Sustainability

House Rules


Be present in the room! Cameras on please, mics off unless talking


Get involved in our poll questions


‘Raise your hand’ or use the chatbox for questions


Please participate in our small group discussion and activity


Get the two documents ready: Word and Excel


Share your feedback at the end


Slides will be shared later


Breaks during the session

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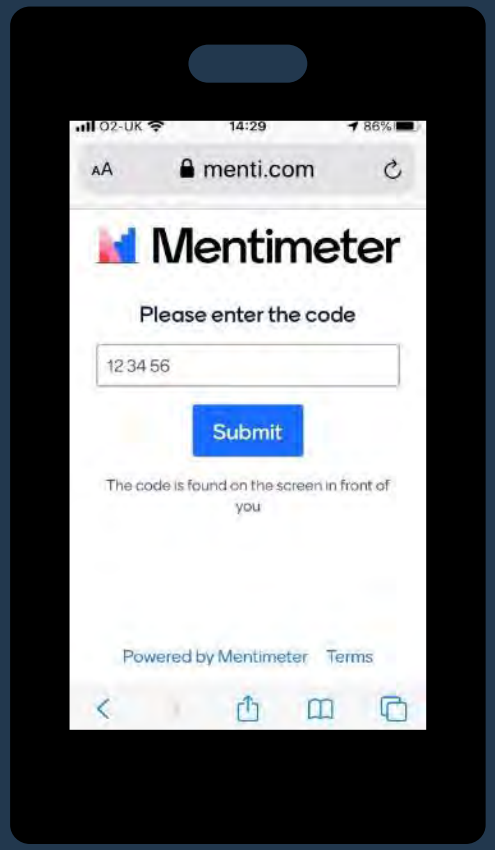
Mentimeter



Open Mentimeter

1. Go to www.menti.com in a new browser or tab on your phone or computer, *ideally Chrome or Firefox rather than Edge, or download the app.*
2. Enter the Menti code
3. Don't disconnect from the webinar, you will still need to hear us

Workshop Overview

- ✓ Overview of climate change
- ✓ Why should we design for Carbon reduction?
- ✓ How do we go about it?
- ✓ Relevant Standards and Tools
- ✓ Measuring and optioneering
- ✓ Other co-benefits

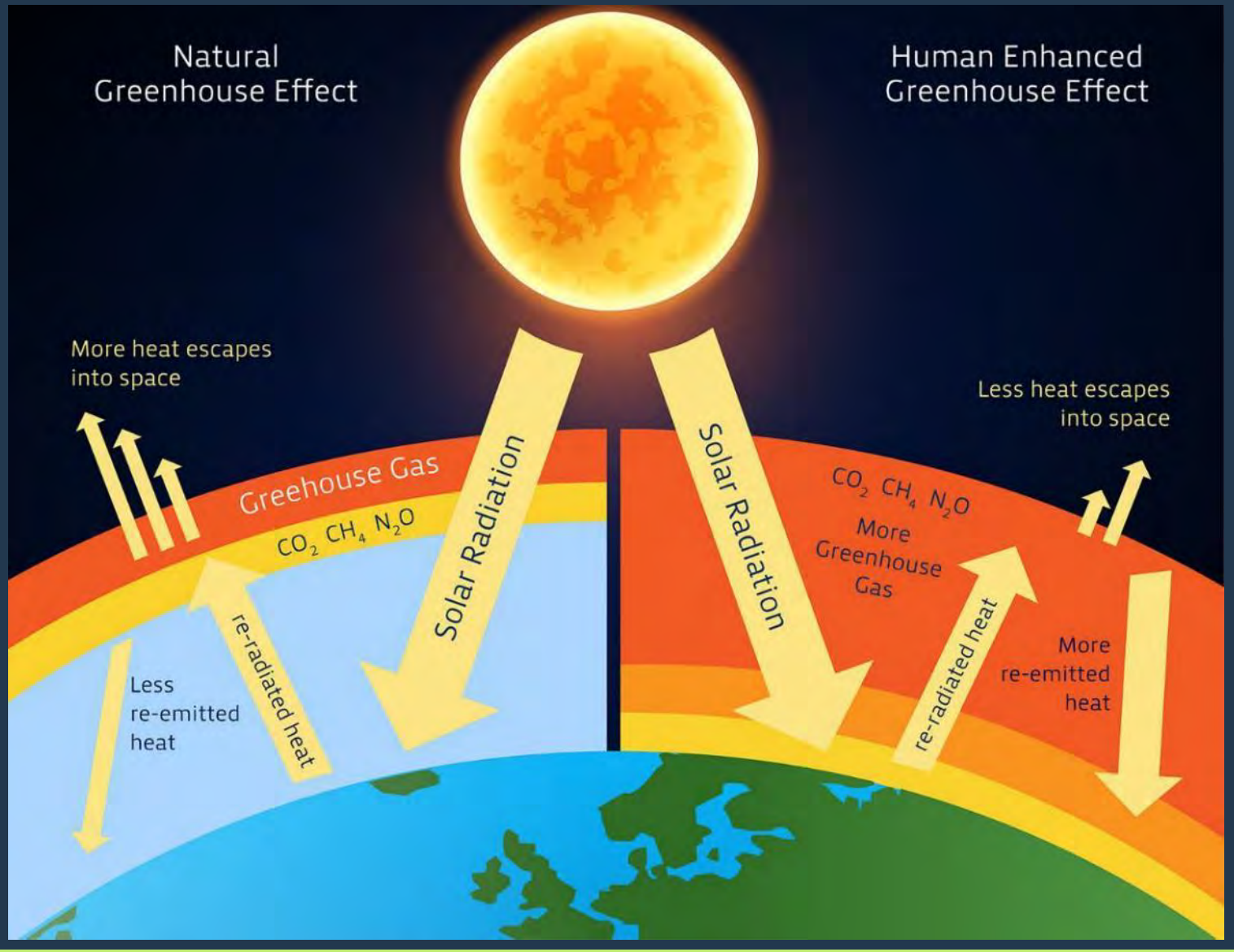
Introduction from Andrew Kidd

Director of Solutions & Outcomes
Lower Thames Crossing Programme

How much do you know about climate change?

Climate Change

Greenhouse Gas Effect



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Greenhouse Gases

Carbon dioxide – CO_2

Methane – CH_4

Nitrous oxide – N_2O

Sulphur hexafluoride – SF_6

Hydrofluorocarbons – HFCs

Perfluorocarbons – PFCs

Kyoto Protocol ‘Basket’ of 6 GHGs, the focus to limit warming to 1.5°C above pre-industrial levels

Collectively known as ‘carbon emissions’

Global Warming Potential

Not all gases are equal!!

Carbon dioxide:	1
Methane:	28
Nitrous oxide:	265
Sulphur hexafluoride:	23,500
Hydrofluorocarbons:	4 – 12,400
Perfluorocarbons:	6,630 – 11,100

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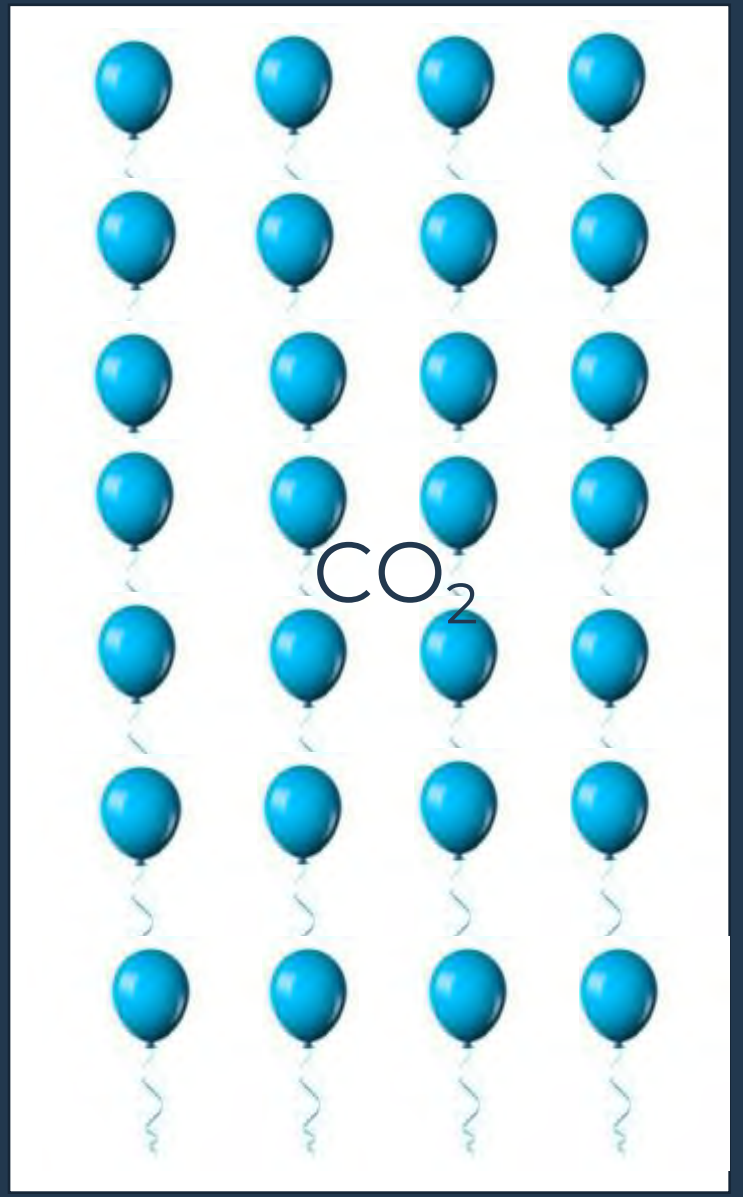
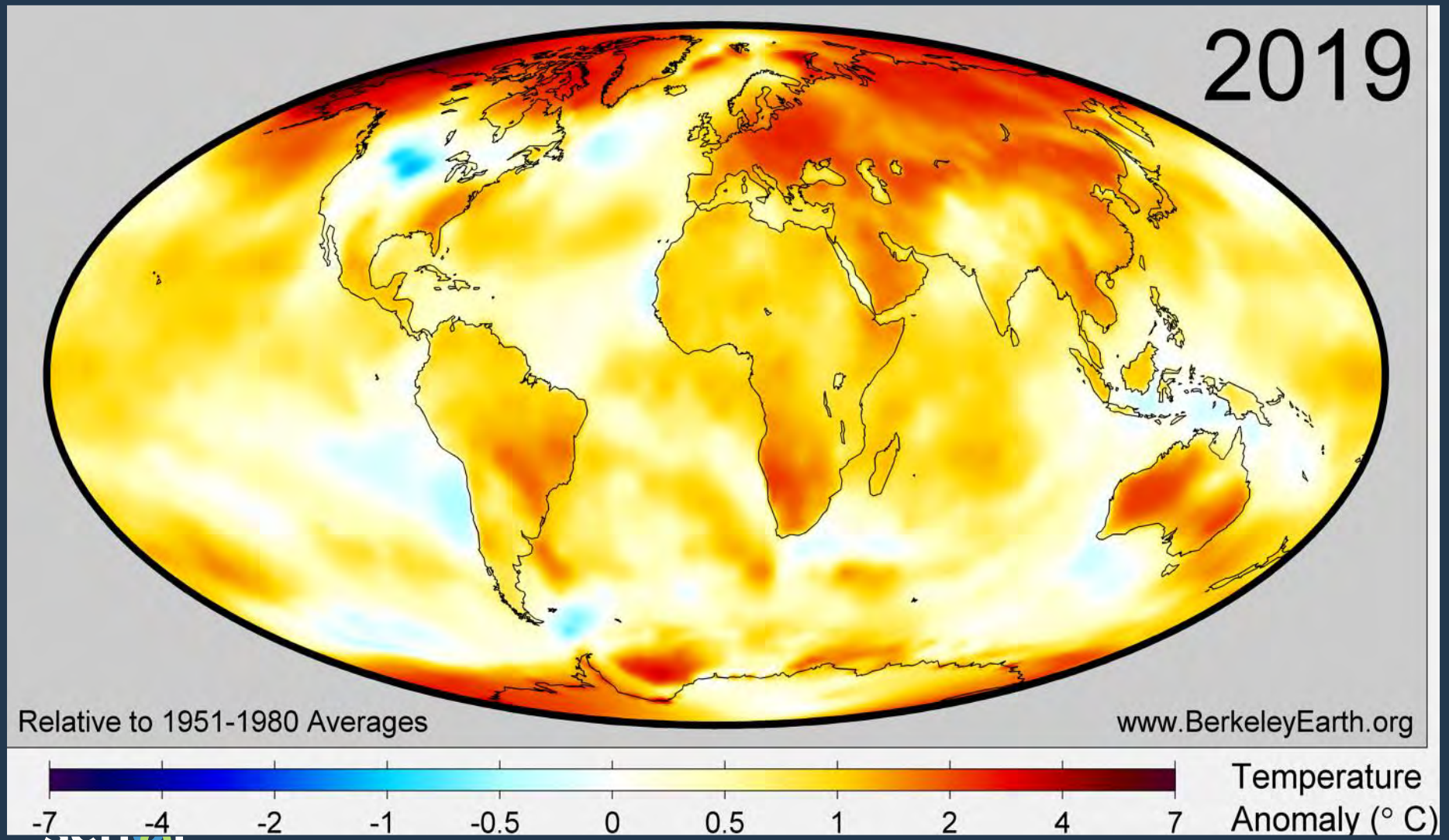


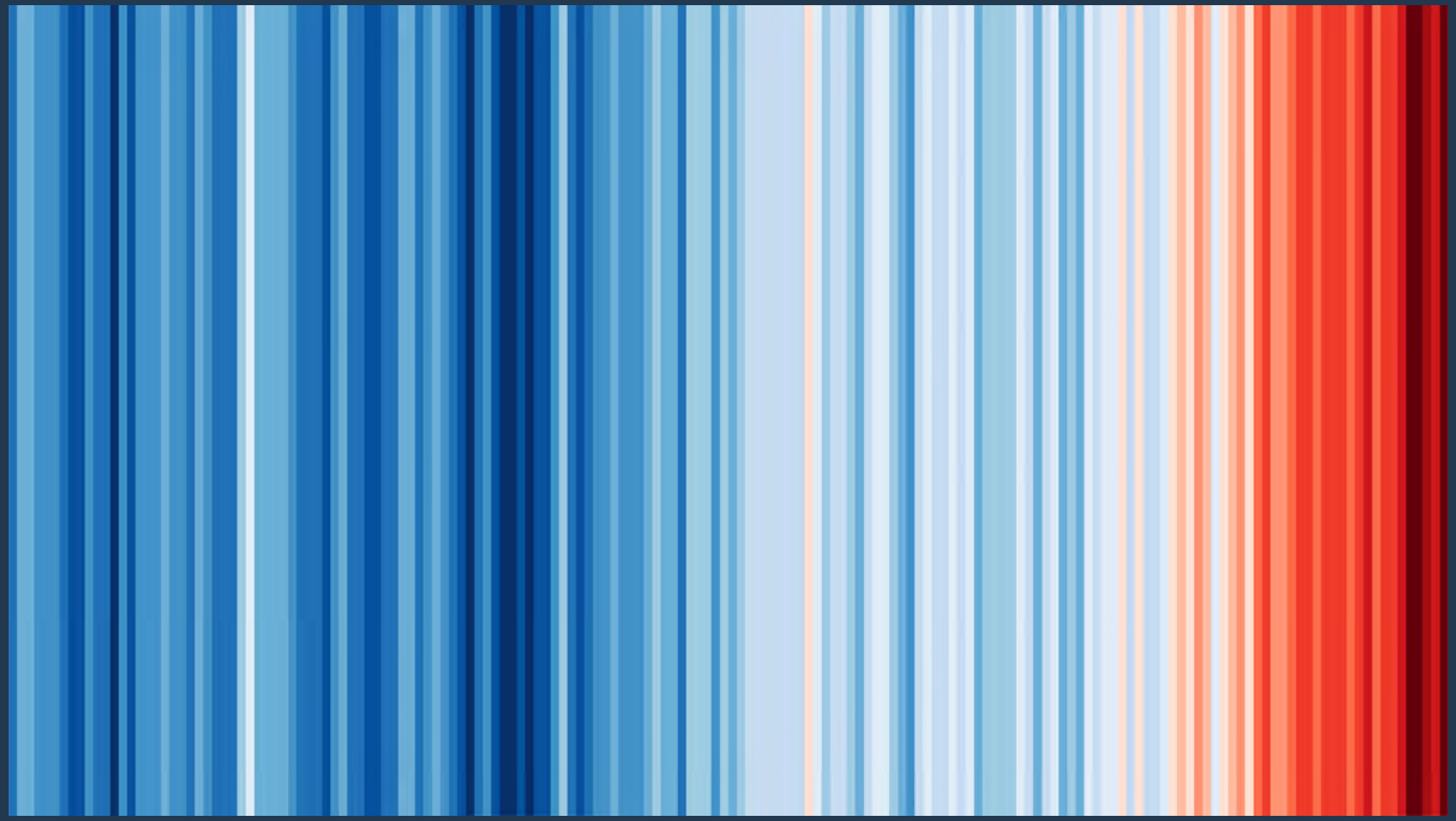
Global temperature rise



- Rise in average global surface temperature of 1.1°C since the Industrial Revolution
- But not evenly distributed over the globe
- The redder the area, the greater the change in temperatures from the baseline

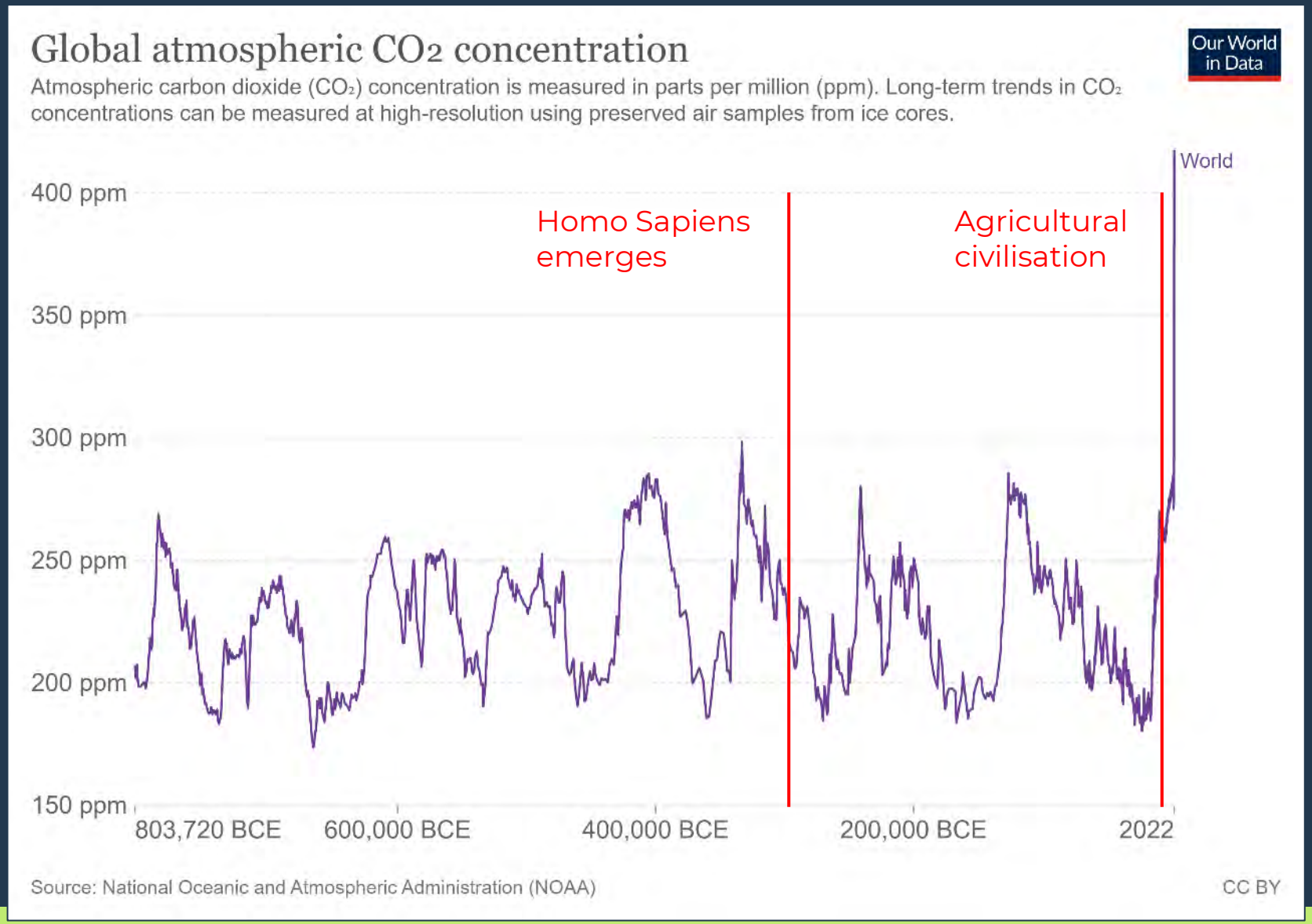
Global temperature rise

- Each stripe represents the average temperature for a single year, from 1850-2018, relative to the overall global average temperature.
- Blue for cooler-than-average years; red for years hotter than average.
- The band of deep red stripes show the rapid heating of our planet in recent decades.



The backstory to climate change…

- Atmospheric concentration of CO2 going back 800,000 years
- Shows a natural fluctuation between warmer and colder periods
- But massive increase in the recent past



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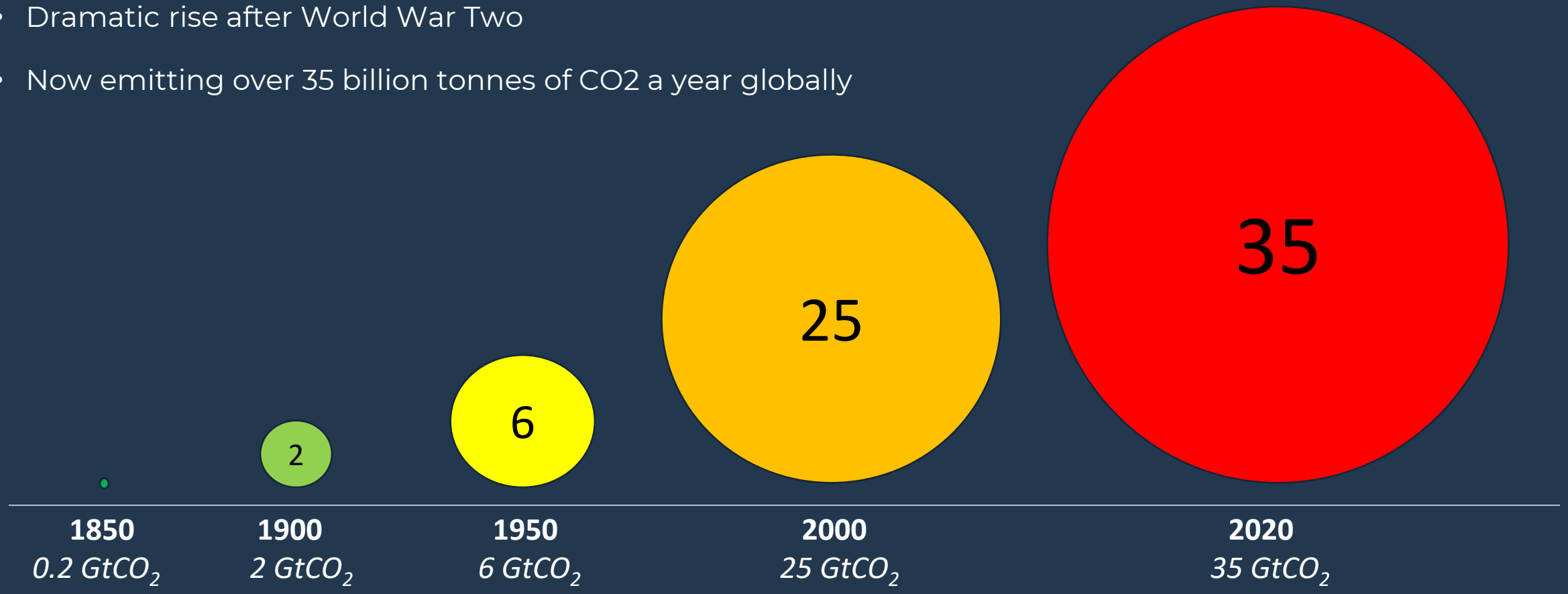
The link to carbon emissions

- Emissions start to go up after 1850 – industrial revolution kicks off
- Dramatic rise after World War Two
- Now emitting over 35 billion tonnes of CO2 a year globally



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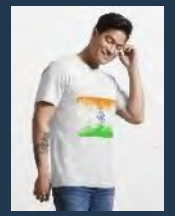
Who's doing the emitting - countries

1st China: 10.2 billion tCO2 = 28%
2nd USA: 5.3 billion tCO2 = 15%
3rd India: 2.6 billion tCO2 = 7%
4th Russia: 1.7 billion tCO2 = 5%

18th UK: 370 million tCO2 = 1%
73rd Ireland: 37 million tCO2 = 0.1%

Who's doing the emitting - people



India
1.9 tCO_2 pp

UK
5.5 tCO_2 pp

China
7.1 tCO_2 pp

Ireland
7.6 tCO_2 pp

Russia
11.5 tCO_2 pp

USA
16.0 tCO_2 pp

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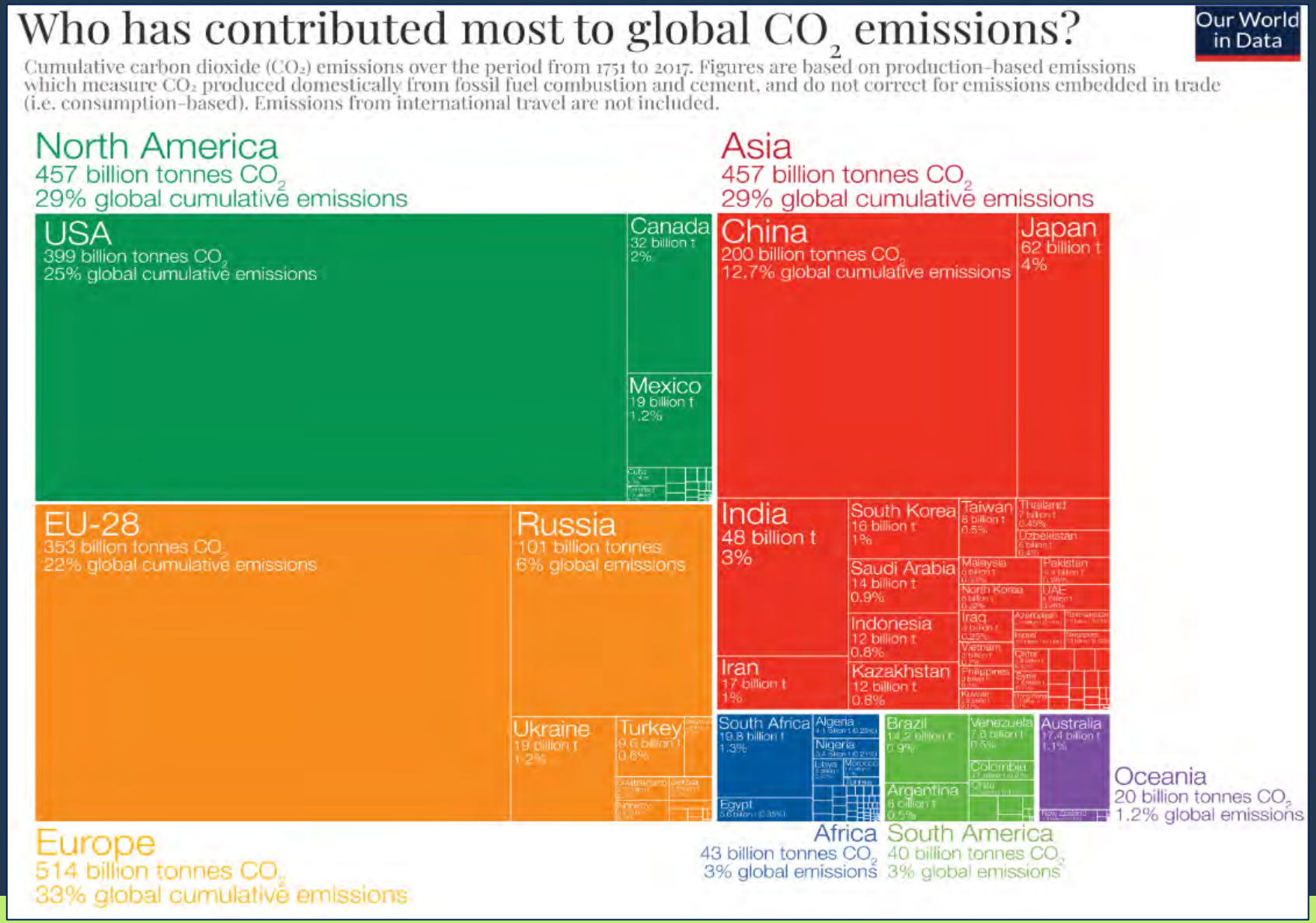
Who’s doing the emitting - people

Who's doing the emitting – everyone ever!

USA:	417 $GtCO_2$
EU-28:	370 $GtCO_2$
China:	235 $GtCO_2$
Russia:	115 $GtCO_2$
Germany:	92 $GtCO_2$
UK:	78 $GtCO_2$
Ireland:	2 $GtCO_2$



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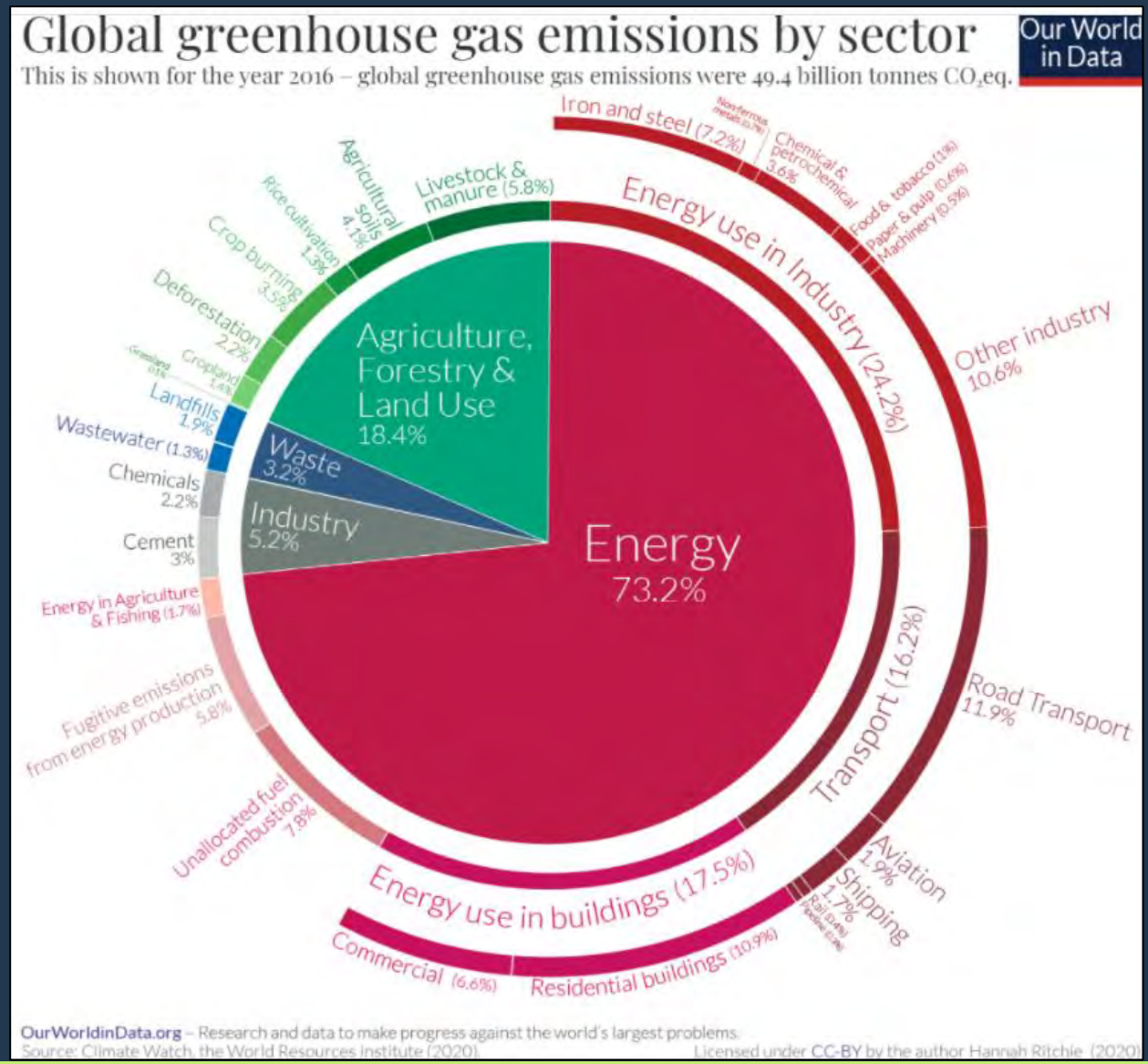
Who's doing the emitting – industry

Industry 29.4%

Agriculture & Forestry 21.1%

Buildings 17.5%

Transport 16.2%



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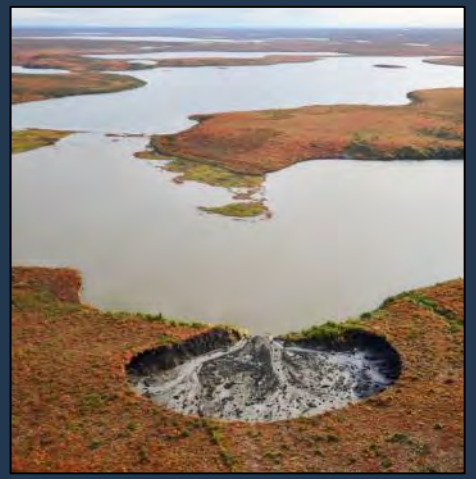
The consequences ...

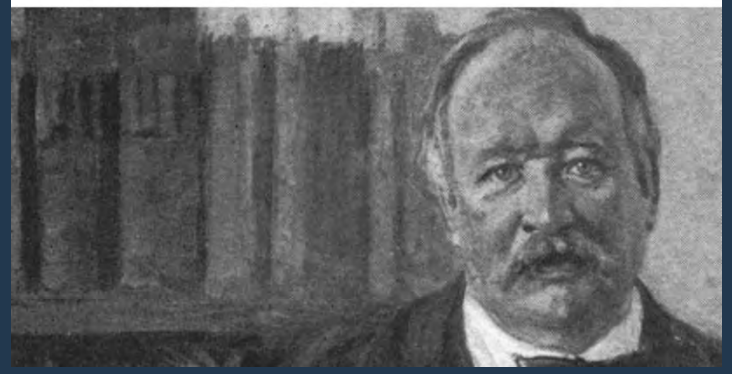


This is not a new thing!

1895

Svante Arrhenius, the Man Who Foresaw Climate Change

Climate change | Environment | History | Physics



1912

WARKWORTH, WEDNESDAY, AUGUST 14, 1912.
3d per Copy.

Science Notes and News.

COAL CONSUMPTION AFFECTING CLIMATE.

The furnaces of the world are now burning about 2,000,000,000 tons of coal a year. When this is burned, uniting with oxygen, it adds about 7,000,000,000 tons of carbon dioxide to the atmosphere yearly. This tends to make the air a more effective blanket for the earth and to raise its temperature. The effect may be considerable in a few centuries.

1938

THE ARTIFICIAL PRODUCTION OF CARBON DIOXIDE 223

551.510.4 : 551.521.3 : 551.524.34

THE ARTIFICIAL PRODUCTION OF CARBON DIOXIDE AND ITS INFLUENCE ON TEMPERATURE

By G. S. CALLENDAR

(Steam technologist to the British Electrical and Allied Industries Research Association.)

(Communicated by Dr. G. M. B. Dobson, F.R.S.)

[Manuscript received May 19, 1937—read February 16, 1938.]

SUMMARY

By fuel combustion man has added about 150,000 million tons of carbon dioxide to the air during the past half century. The author estimates from the best available data that approximately three quarters of this has remained in the atmosphere.

The radiation absorption coefficients of carbon dioxide and water vapour are used to show the effect of carbon dioxide on "sky radiation." From this the increase in mean temperature, due to the artificial production of carbon dioxide, is estimated to be at the rate of 0·003°C. per year at the present time.

The temperature observations at 200 meteorological stations are used to show that world temperatures have actually increased at an average rate of 0·005°C. per year during the past half century.

1970

"There is general scientific agreement that the most likely manner in which mankind is influencing the global climate is through carbon dioxide release from the burning of fossil fuels. . . . There are some potentially catastrophic events that must be considered. . . . Rainfall might get heavier in some regions, and other places might turn to desert. . . . [Some countries] would have their agricultural output reduced or destroyed. . . . Man has a time window of five to ten years before the need for hard decisions regarding changes in energy strategies might become critical. . . . Once the effects are measurable, they might not be reversible." James F. Black, Senior Scientist, Exxon Mobil

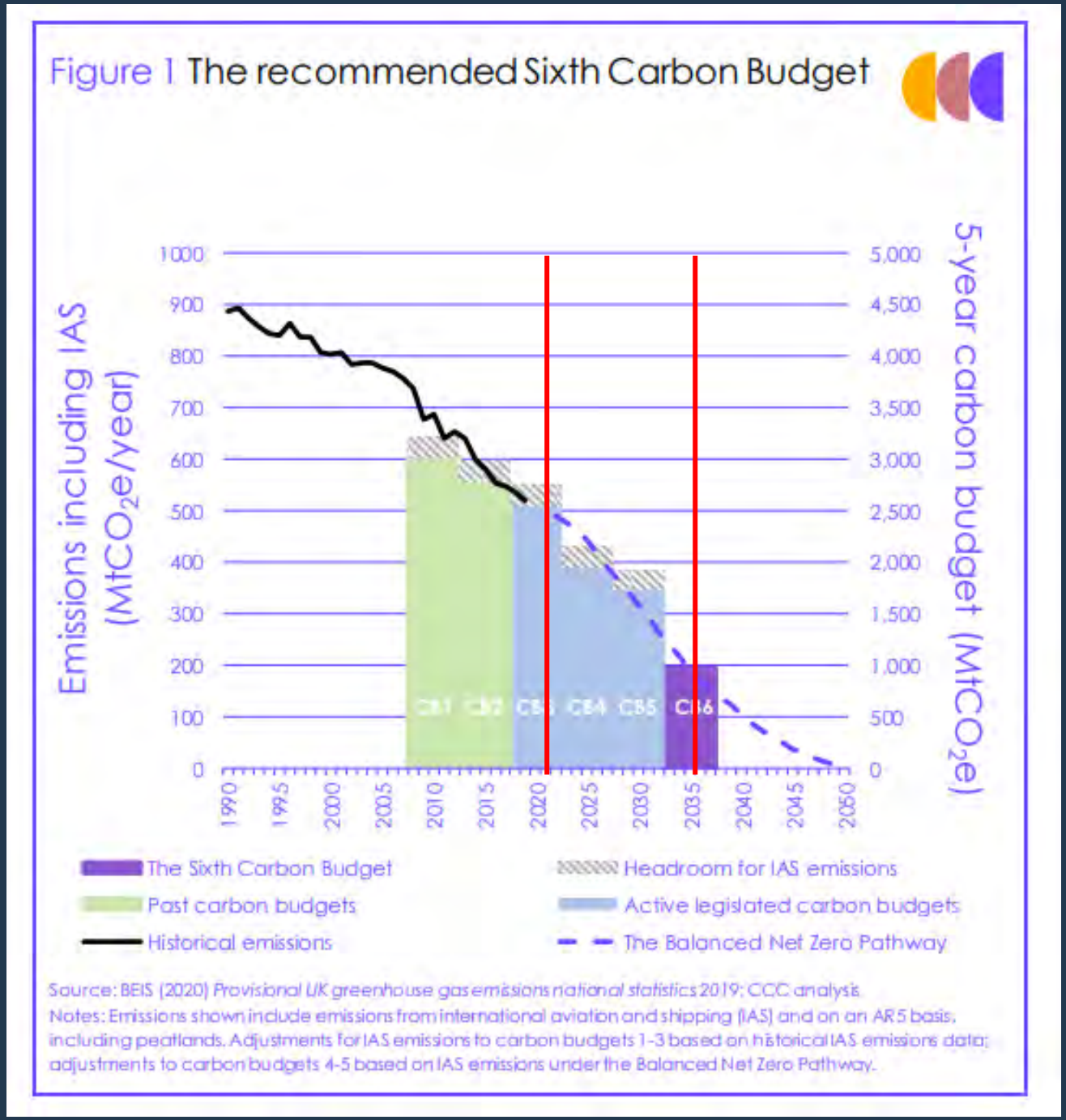
SUPPLY CHAIN SUSTAINABILITY SCHOOL

Carbon reduction

Why should we design for carbon reduction?

Well, the Law for one!

- Climate Change Act target of 100% reduction by 2050 – ‘net zero’
- Scotland has legislated to hit net-zero by 2045
- Wales’ target to reduce by 95% by 2050 but aiming for net zero
- New intermediate target of 78% by 2035 vs 1990 baseline



Drivers and Benefits

Reduce carbon reduce costs

Better reporting: SECR, ESOS, SBTi

Build-phase productivity: lean thinking

Holistic whole-life approach to efficient asset management

More efficient material use – circular economy

Building/asset lifetime extension: modularity

Reduced risk of energy security

Resource availability /scarcity

Stakeholder/ client demands & expectations

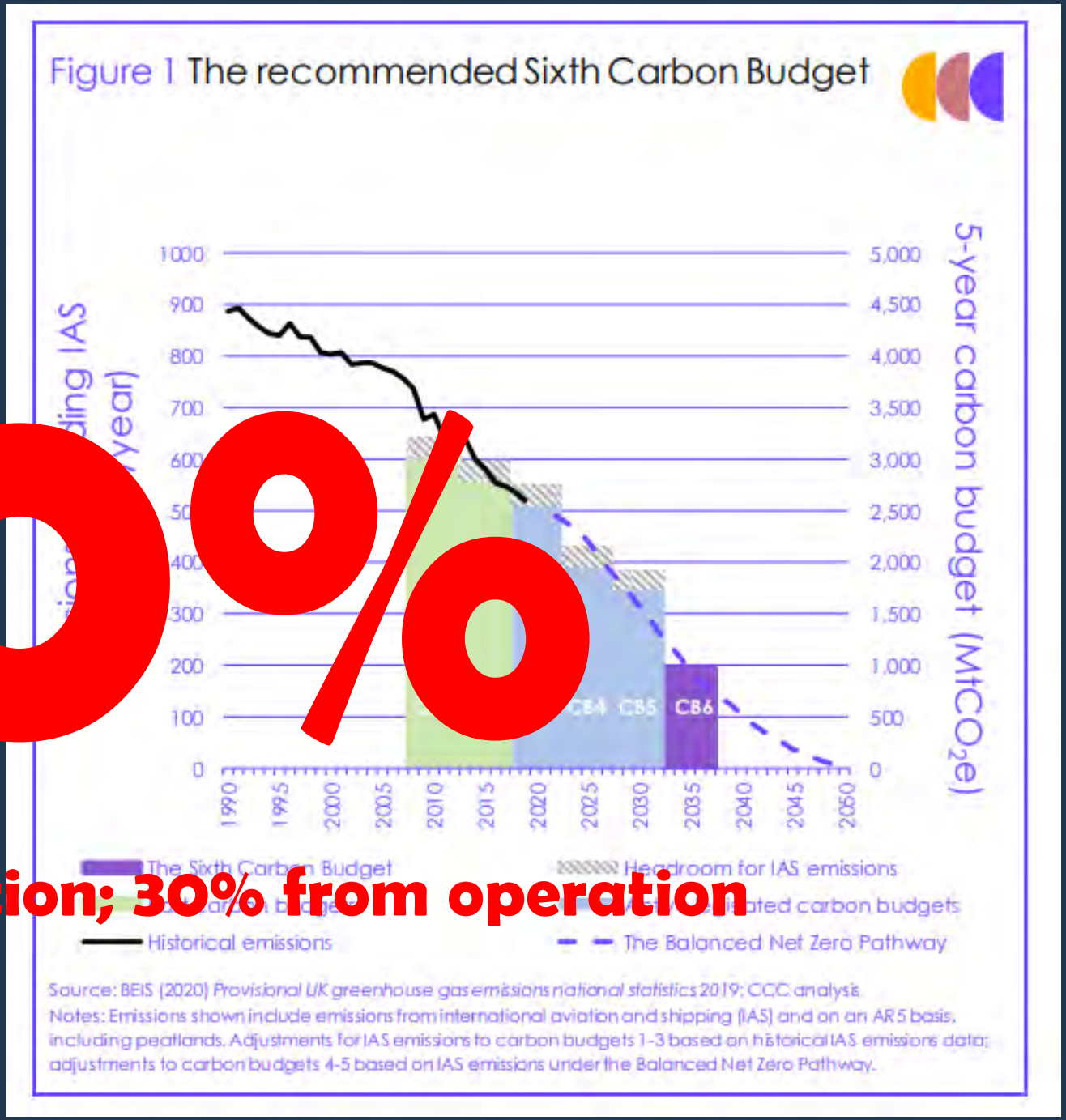
Occupancy wellbeing

Reputation and work winning

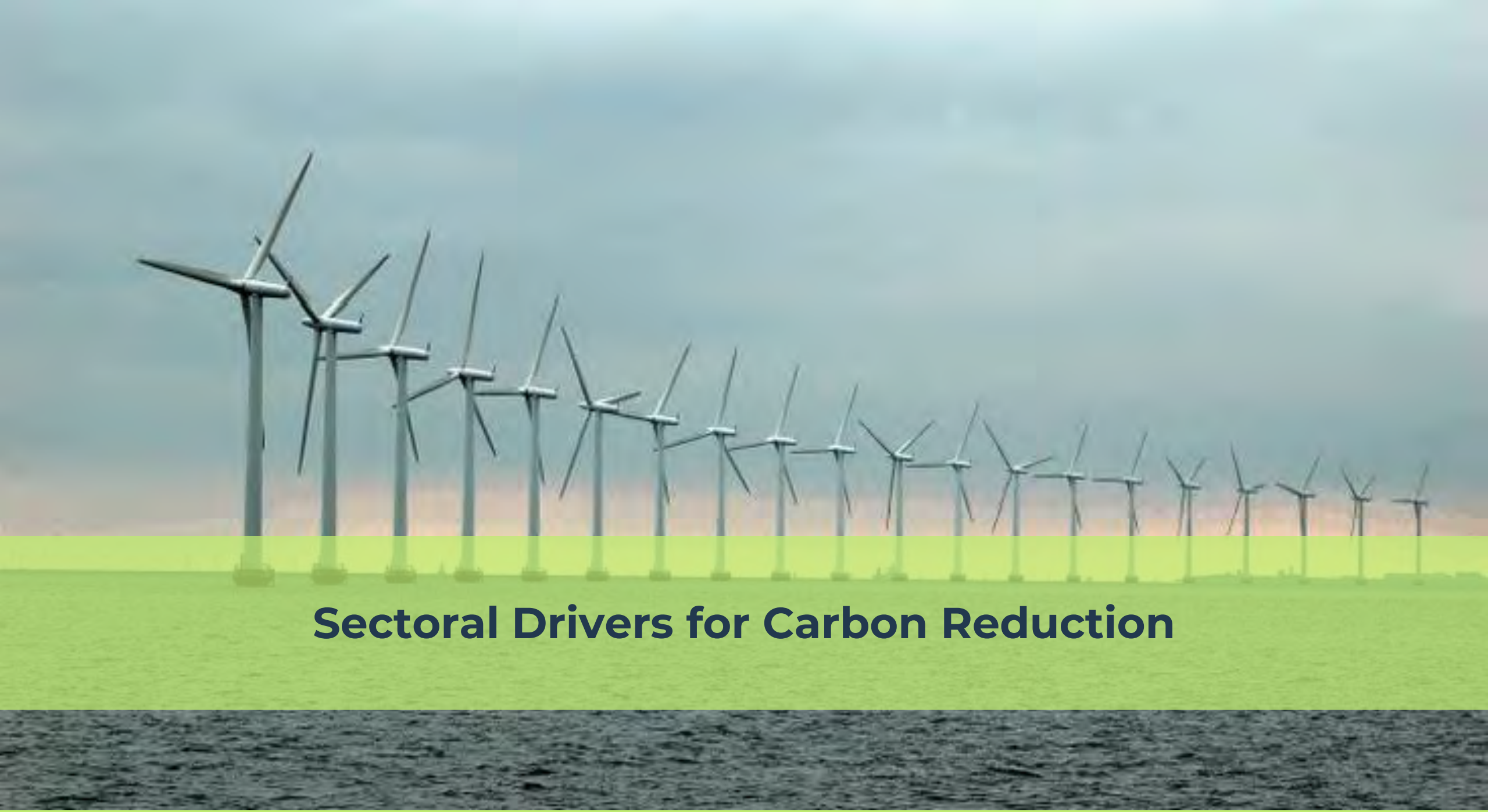
Innovation – market leader

And the Built Environment's contribution to the total…?

40%

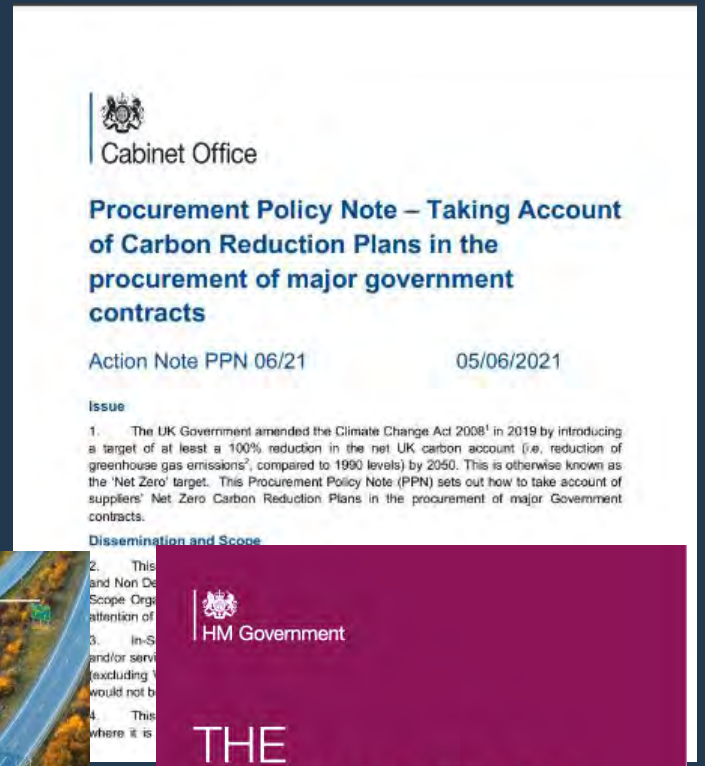


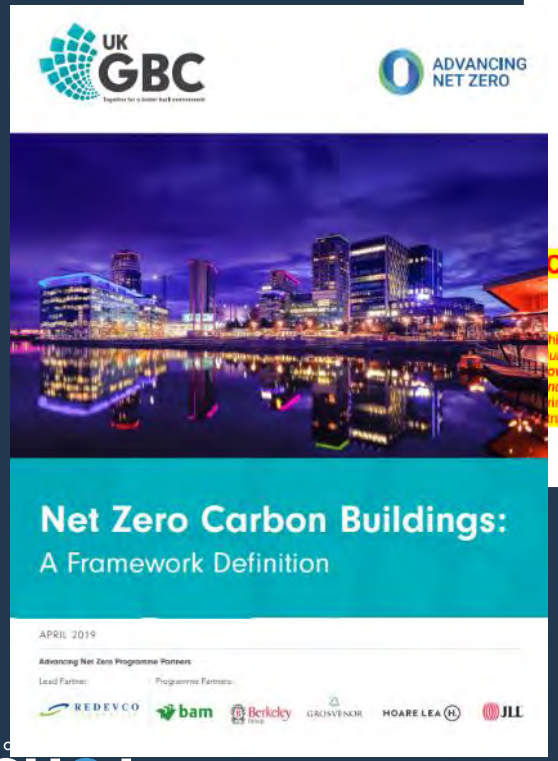
10% from construction; 30% from operation

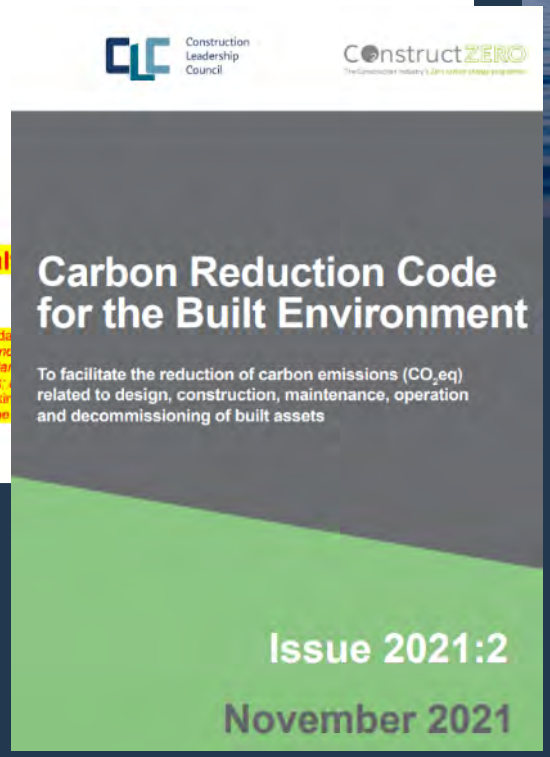


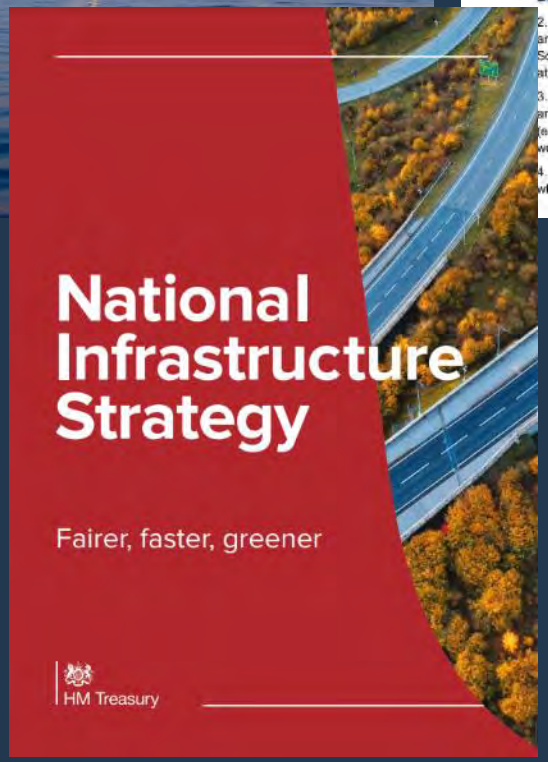
Sectoral Drivers for Carbon Reduction

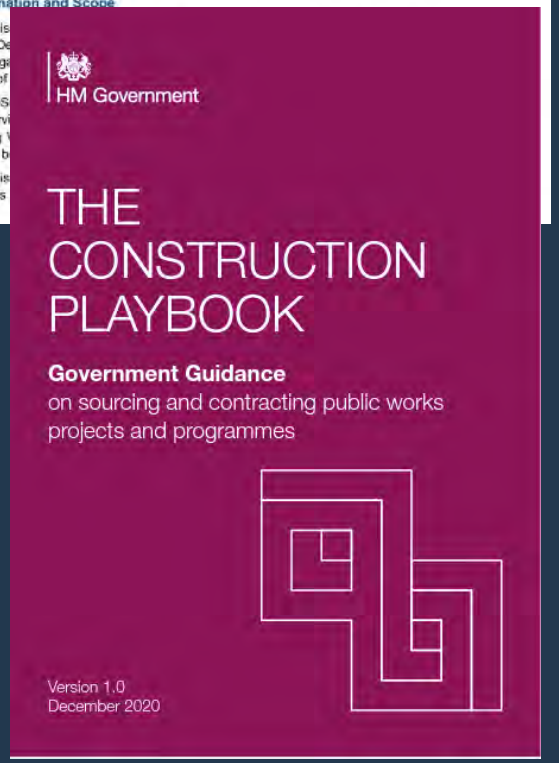
Sectoral Drivers...











SUPPLY C
SCHOOL

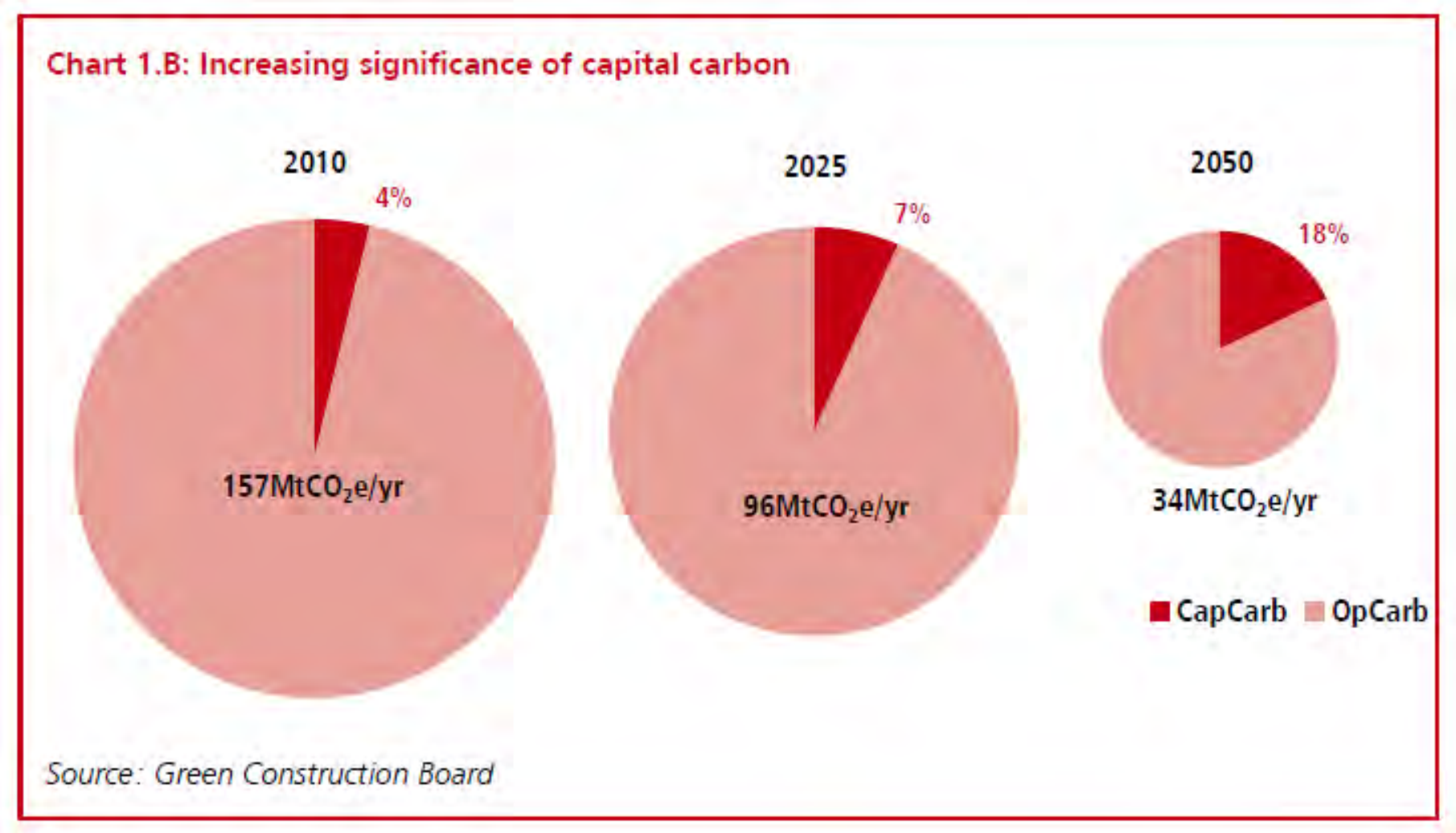
Carbon Infrastructure Review

"..... the UK is driving forward the delivery of new strategic infrastructure alongside the maintenance, modernisation and renewal of existing assets.. **We must achieve this while contributing to national reductions in carbon emissions**

The Government has no doubt that **cutting carbon is fundamentally important to long term global economic, social and environmental sustainability**.

This report makes clear that reducing carbon reduces costs. It is part and parcel of saving materials, reducing energy demand and delivering operational efficiencies."

Carbon Infrastructure Review



Construction Leadership Council – 9th March 2021

Transport

1. Zero emission vehicles and onsite plant

2. Modern methods of construction, improved logistics, reducing waste and transport

3. Connection with low carbon transport

Buildings

4. Retrofitting to improve energy efficiency of the existing housing stock

5. Low carbon heat solutions in buildings

6. Enhance the energy performance of new and existing buildings with monitoring

Construction activity

7. Carbon measurement to support quantifiable decisions to remove carbon

8. **Become world leaders in designing out carbon,** developing capability of designers and construction professionals to develop designs in line with circular economy – reducing embedded and operational carbon, shifting commercial models to incentivise and reward measurable carbon reductions.

9. Develop innovative low carbon materials (prioritising concrete and steel), as well as advancing low carbon solutions for manufacturing production processes and distribution.

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Fri March 12 2021

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News / UK / Leadership council formulates carbon reduction strategy

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Leadership council formulates carbon reduction strategy

3 days **The Construction Leadership Council has published a plan to reduce carbon across the construction sector, from manufacturing and design to construction and operation of assets.**

Construct Zero proposes a nine-point plan to reduce carbon and help the construction industry to play its part in delivering the UK government's objective of net zero for the whole economy by 2050.

The Construct Zero initiative – or CO2nstruct Zero as the organiser prefer to style it – does not set out to offers new solutions but instead brings together existing initiatives from various corners of the industry, consolidating it into collective action.

Overall UK emissions of CO_2 have been calculated at 537 million tonnes in 2018. There are three areas, collectively representing 43% of the total, that are relevant to the construction sector: transport, buildings and construction activity.

Based on these areas, the Construction Leadership Council (CLC) has used the Climate Change Committee's 6th Carbon Budget to determine nine priorities:

SUPPLY CHAIN SUSTAINABILITY SCHOOL

The Future Homes and Buildings Standards

- Ambitious changes in the energy efficiency of buildings incl. new homes
- Changes to Part L (Conservation of fuel and power) and Part F (Ventilation) of the Building Regulations 2010/2016.
- There will be a full technical consultation planned to start in 2023, building on the previous consultation in 2020, running up to finalisation in 2025
- As an interim, the Part L1A requirements for new dwellings are being tightened
- These will result in a 31% reduction in in-use CO_2 emissions for a typical semi-detached home built to the 2021 version, compared to current standards
- These come into force on 15th June 2022

The Future Homes and Buildings Standards

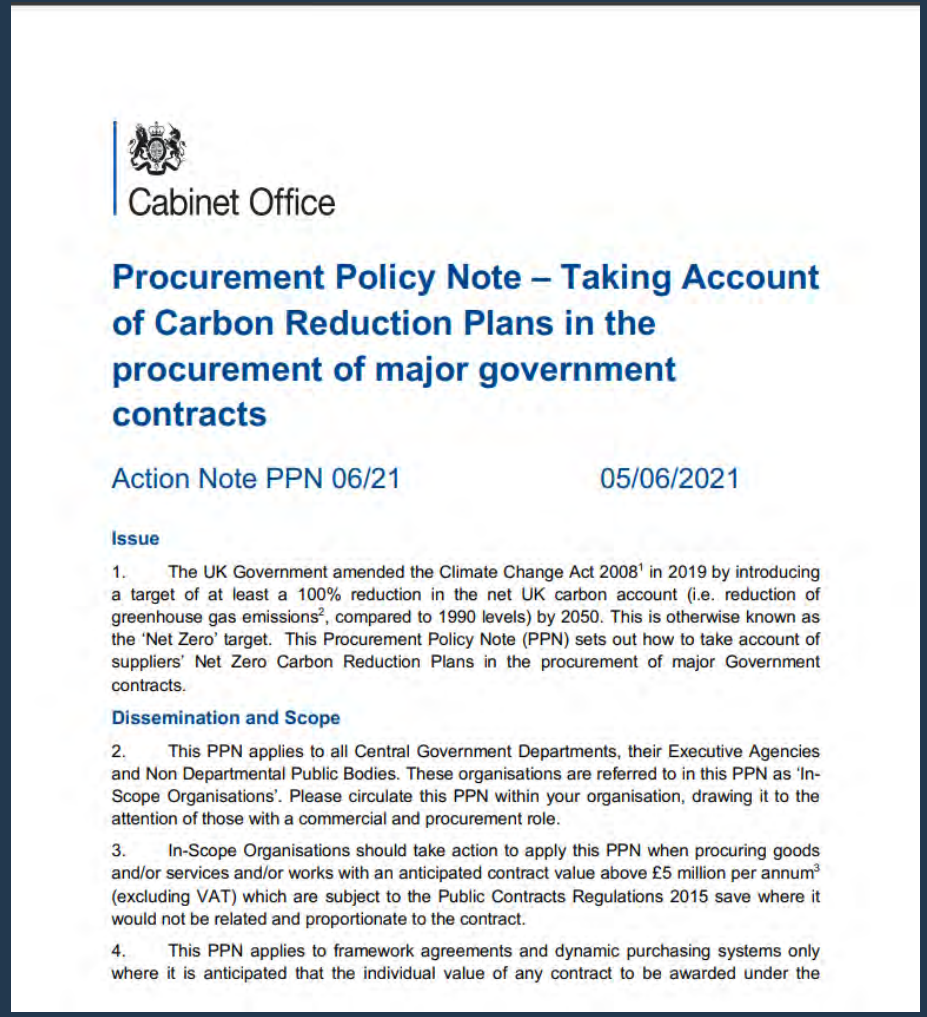
- This will be achieved via tightening the U value limits for fabric elements in new build dwellings, as shown below.

Element	2013/2016 U value, W/m²K [a]	New 2021 U value, W/m²K [b]
Roofs	0.20	0.16
Walls	0.30	0.26
Floors	0.25	0.18
Party wall	0.20	0.20
Windows	2.00	1.60
Doors	1.80	1.60

a. https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/540326/BR_PDF_AD__L1A__2013_with_2016_amendments.pdf p.15
b. https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/956100/AD_L_1.pdf p.33

UK Gov't PPN06/21: 5th June 2021 *Carbon Reduction Plans*

- Bidders for any contract over £5m ex VAT per year from Central Government, their Executive Agencies and NDPBs
- Contractors will have to provide a carbon reduction strategy confirming their commitment to achieving Net Zero by 2050 in the UK
- Covers Scope 1, 2 and certain Scope 3 (Upstream transportation & distribution, Waste generated in operations, Business travel, Employee commuting, Downstream transportation & distribution)
- From 30th September 2021
- Plans for an 'embodied carbon law': The Carbon Emissions (Buildings) Bill, and Part Z of Building Regulations



Cabinet Office

Procurement Policy Note – Taking Account of Carbon Reduction Plans in the procurement of major government contracts

Action Note PPN 06/21 05/06/2021

Issue

1. The UK Government amended the Climate Change Act 2008[1] in 2019 by introducing a target of at least a 100% reduction in the net UK carbon account (i.e. reduction of greenhouse gas emissions[2], compared to 1990 levels) by 2050. This is otherwise known as the 'Net Zero' target. This Procurement Policy Note (PPN) sets out how to take account of suppliers' Net Zero Carbon Reduction Plans in the procurement of major Government contracts.

Dissemination and Scope

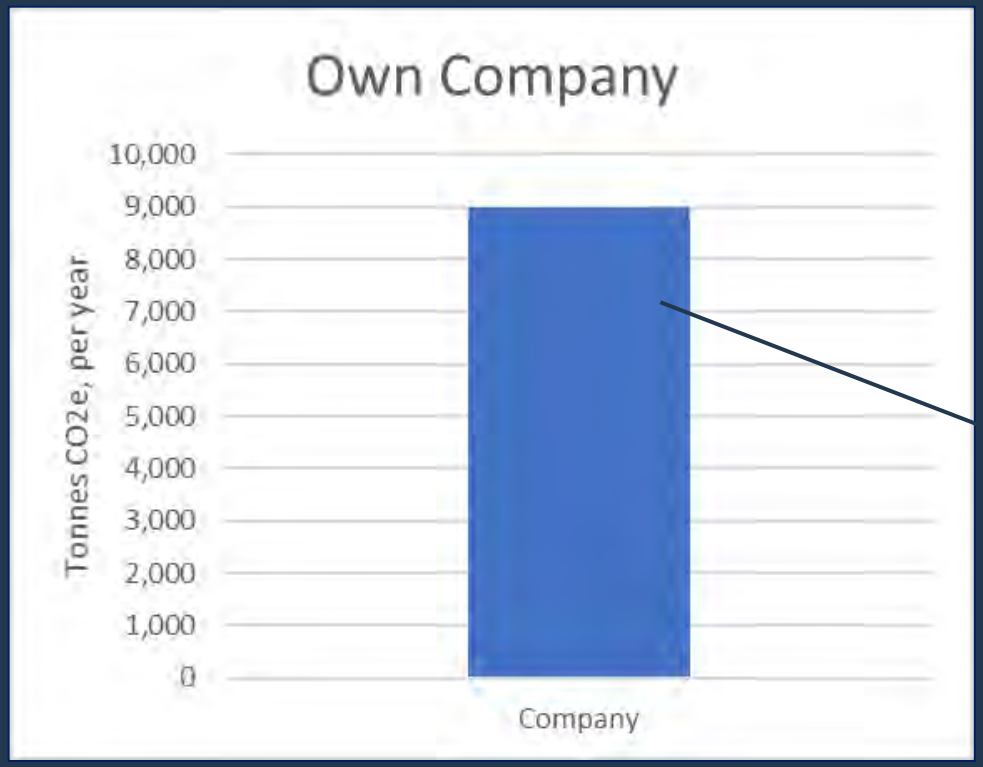
2. This PPN applies to all Central Government Departments, their Executive Agencies and Non Departmental Public Bodies. These organisations are referred to in this PPN as 'In-Scope Organisations'. Please circulate this PPN within your organisation, drawing it to the attention of those with a commercial and procurement role.

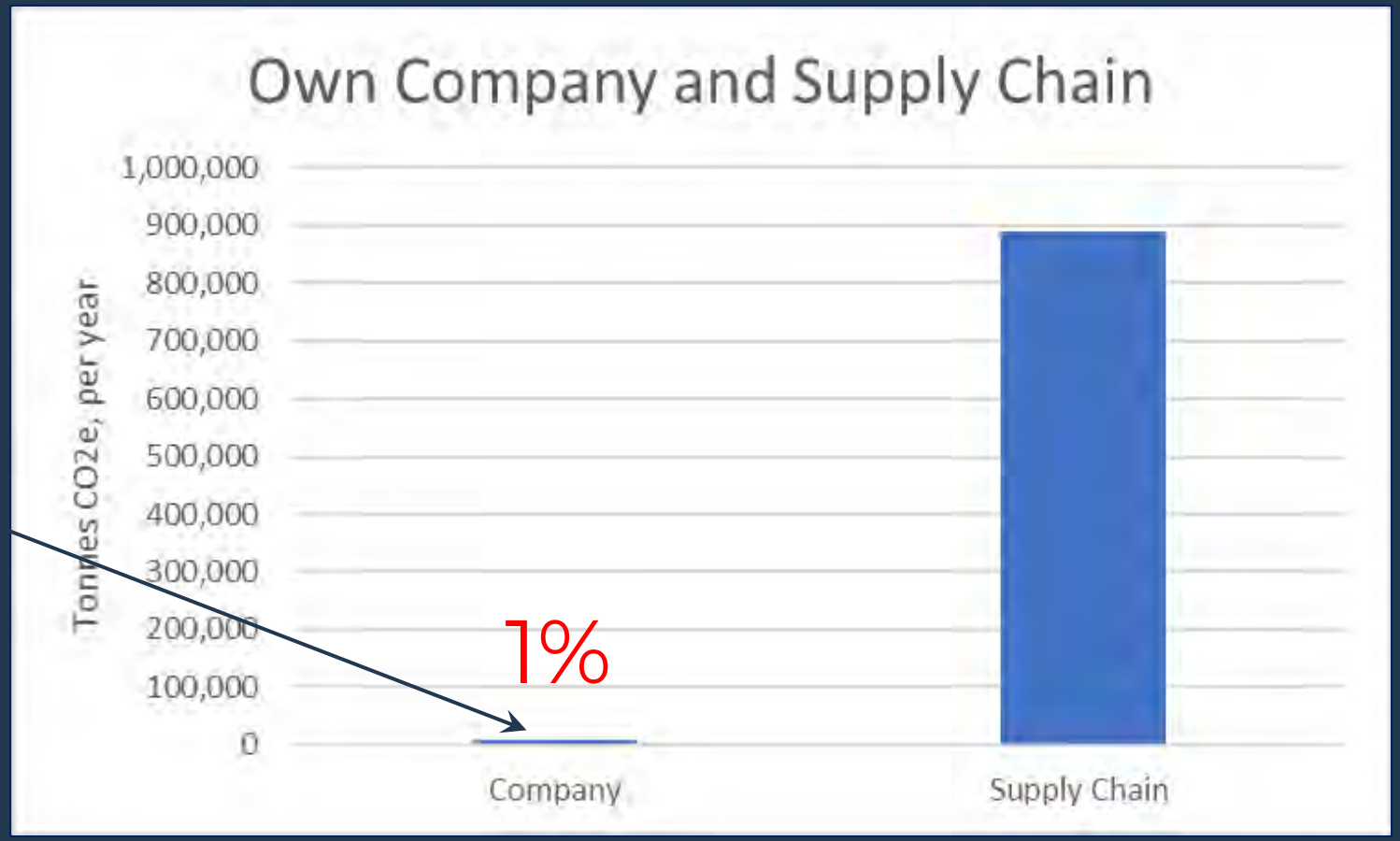
3. In-Scope Organisations should take action to apply this PPN when procuring goods and/or services and/or works with an anticipated contract value above £5 million per annum[3] (excluding VAT) which are subject to the Public Contracts Regulations 2015 save where it would not be related and proportionate to the contract.

4. This PPN applies to framework agreements and dynamic purchasing systems only where it is anticipated that the individual value of any contract to be awarded under the

The Scale of Carbon in the Supply Chain

Example of Scale: a Tier 1 Contractor





Example of Scale: Housing

1%

Materials and onsite construction
“Embodied” Carbon

The Housing Developer
“Operational” Carbon

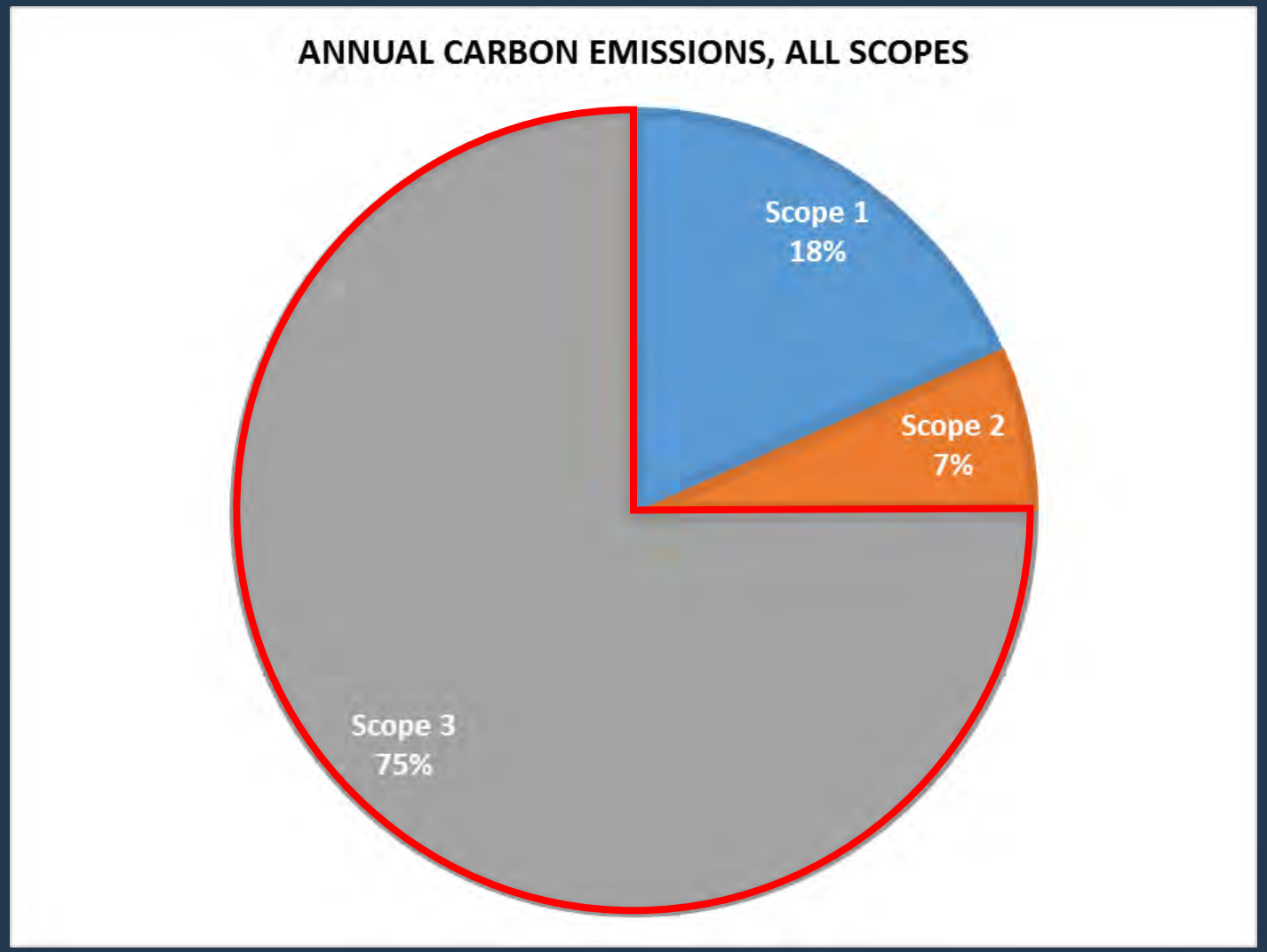
The House Owner “End User”
Carbon

Upstream

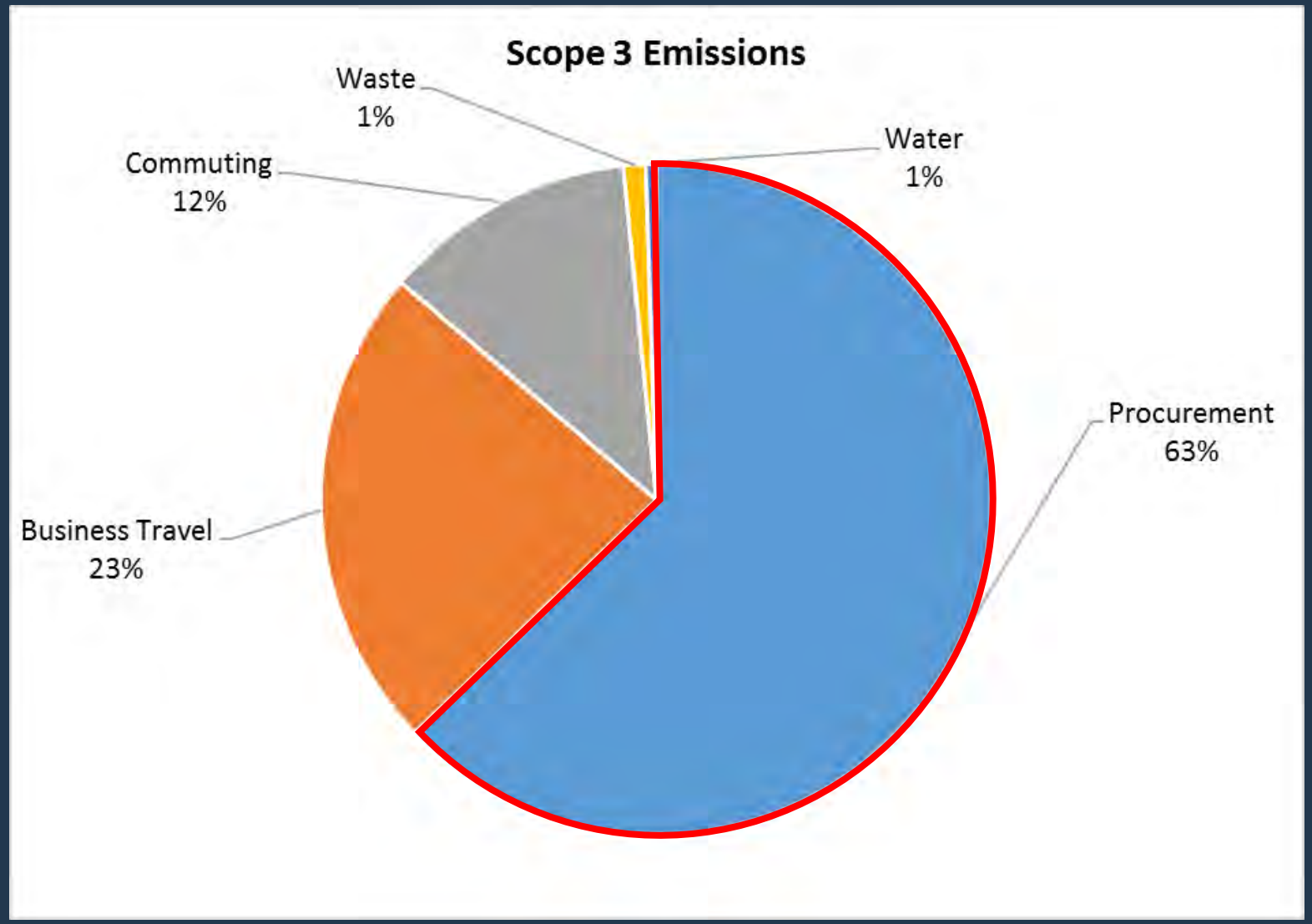
Company

Downstream

Example of Scale: an Estates Organisation



Example of Scale: an Estates Organisation



In the News

Half of UK businesses 'targeting carbon neutrality by 2030'

A survey of 502 UK businesses has found that almost half are aiming to be carbon-neutral by 2030, with 8% claiming they had already reached this milestone.

Image: EcoAct

Conducted by YouGov this summer, the survey was used to track the climate attitudes of business representatives from major sectors including education, accounting, retail, wholesaling, transport, technology services, restaurant services, construction, real estate, personal care and natural resources such as mining, forestry and oil.

Of the respondents, 93% agreed that climate change is both real and being driven, either in full or in part, by human activity.

This agreement was evident in the respondents' answers to the question: "Is your business planning to be

Where does carbon come from & how can we reduce it...?

Sources of Carbon Emissions from your Organisation

Your Suppliers

- *Materials, goods and services,*
- *Capital goods,*
- *Delivery*
- *Utilities: electricity, waste and water*
- *Business travel*

“Embodied” Carbon
“Capital” Carbon - CapCarb

Your Business

- *Fuel and energy in company facilities*
- *Vehicles and plant.*
- *Chemical / biological processes, and*
- *Fugitive emissions*

“Operational” Carbon - OpCarb

Your Client

- *In-use emissions from running the building / asset;*
- *End-of-life treatment*
- *Downstream distribution*

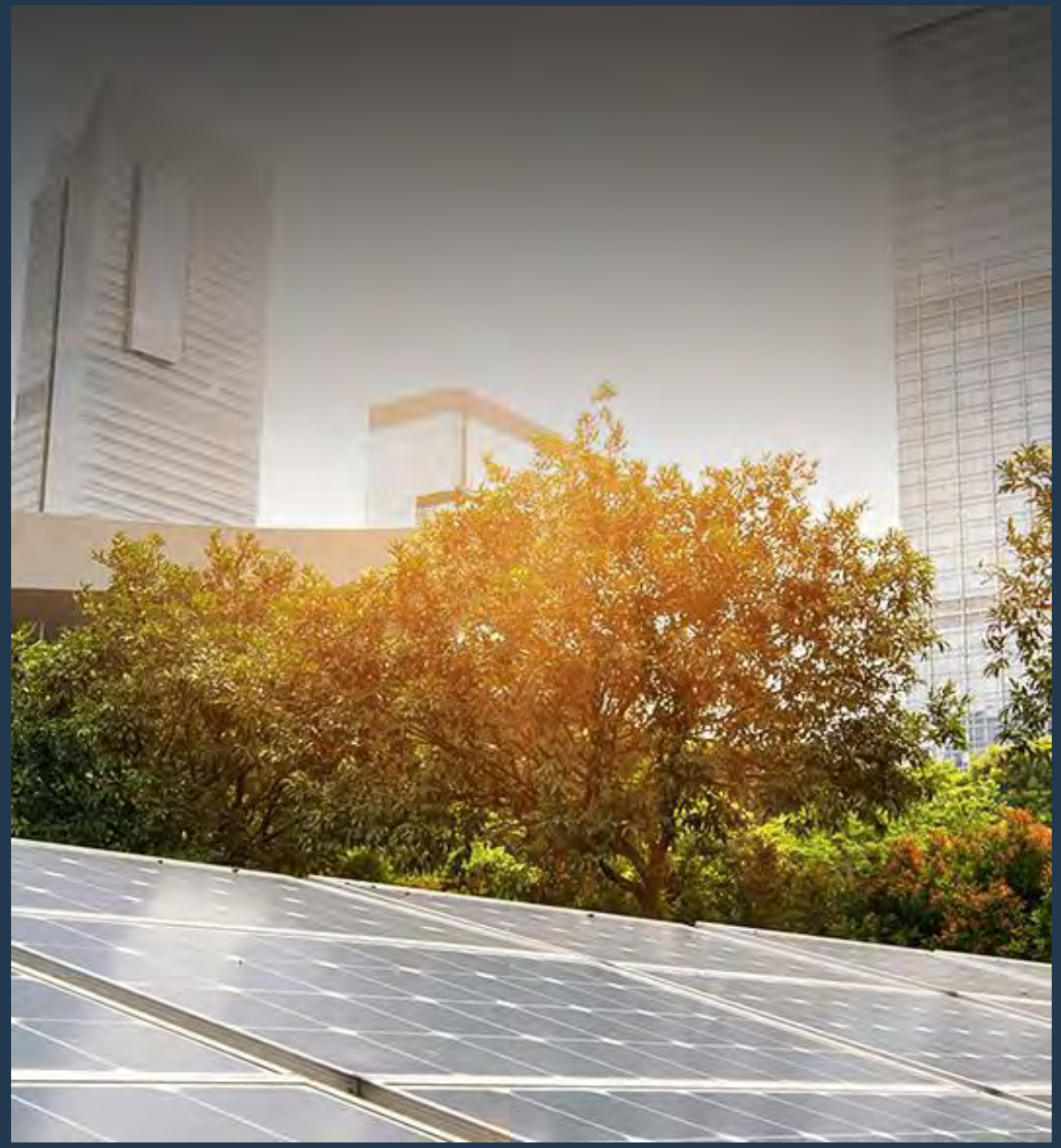
“End User” Carbon UseCarb

Upstream | Company | Downstream

SUPPLY CHAIN SUSTAINABILITY SCHOOL

How do we go about it?

- ✓ Carbon hierarchy
- ✓ Whole-life approach
- ✓ Options and actions
- ✓ Stakeholder engagement
- ✓ Skills and competences
- ✓ Measuring and optioneering



Use the Carbon & Energy Hierarchy

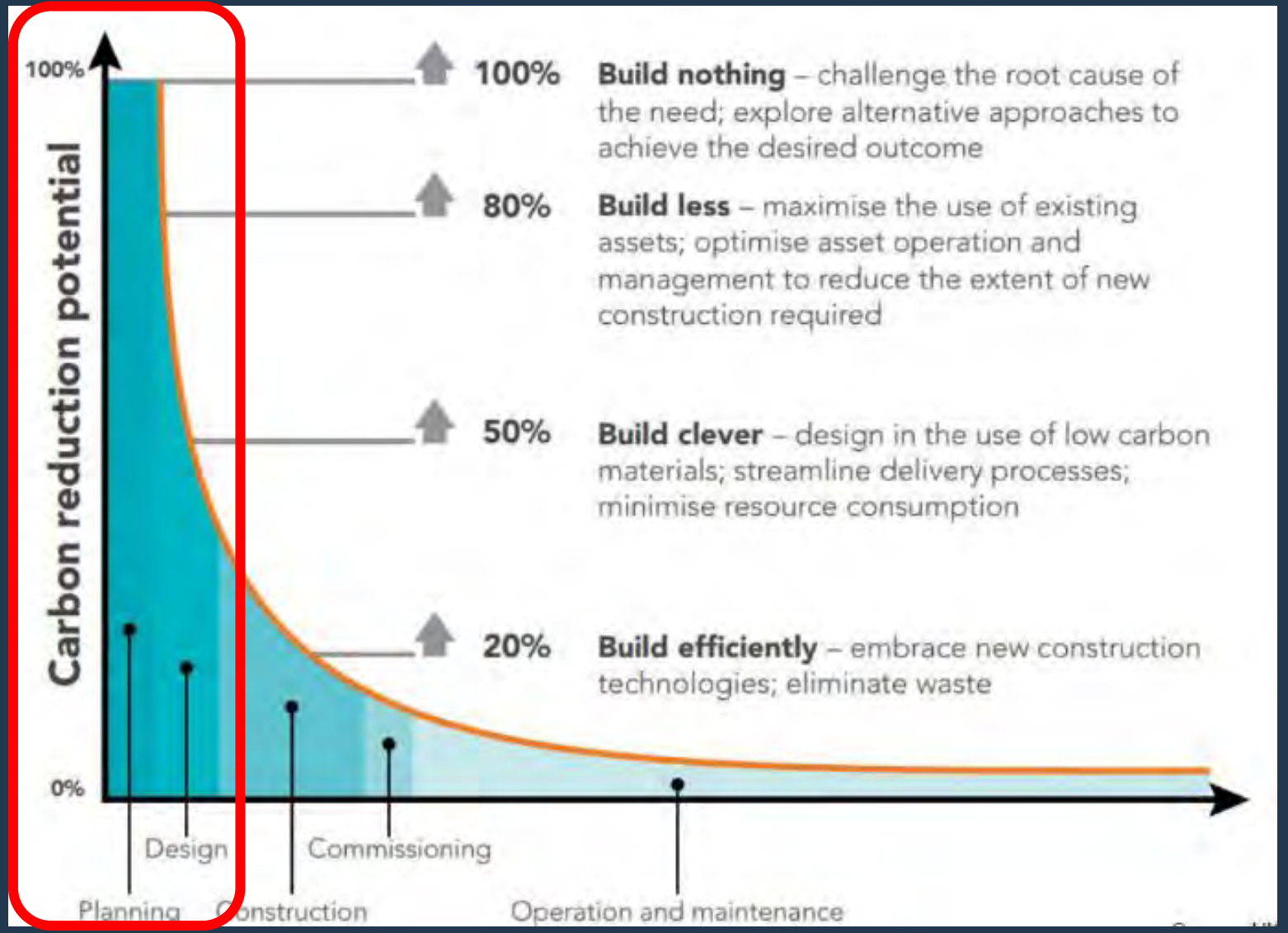
AVOID: don't use energy if you can avoid the need

REDUCE: use less by smart design, more efficient equipment, less materials, and better behaviours

SWITCH to low carbon and renewable sources of energy and materials

COMPENSATE/ REMOVE the residual remaining emissions when all other actions have been taken

Get in Early! (UKGBC)



SUPPLY CHAIN SUSTAINABILITY SCHOOL

Holistic life cycle approach

Design → Materials and Construction → In Use → Maintenance & Refurb → Circular Economy

Consider both **mitigation** and **adaptation** in your design, development and delivery

Carbon Design Options

Design, energy sources, equipment and transport

- **Passive approach** to minimise operational energy use: orientation, natural and demand-responsive systems for heating, cooling, ventilation and lighting; thermal mass for temperature regulation; green roofs
- **Energy- and water-efficient equipment**, e.g. HVAC, IT, LED, sanitaryware – spec to the right level needed
- **Renewable energy sources**: land / space for heat pumps, solar panels, CHP, etc
- **Low carbon in the build phase**: welfare cabins, plant & equipment

Carbon Design Options

Design, energy sources, equipment and transport

- **Consider infrastructure**: provision of charging points for EV, access to public transport, suitable spaces for cyclists…
- **Allow for future needs** including ease of maintenance access, as well as change of purpose
- **Servitisation** – consider if a service model is appropriate
- **Design for Adaptation to a changing climate:** SUDS, Green roofs and walls, greywater and rainwater harvesting capability

Carbon Design Options

Products, materials, maintenance and upgrade

- **Use less material in absolute terms** – work with design and procurement teams
- Switch to **materials with lower carbon impacts,** either the same material or a different material – encourage innovation
- **Increase reuse and the recycled content** of materials – engage suppliers
- **Eco-design** to enable easier maintenance, repair and upgrade later in the asset's lifetime – DfMA for 'future proofing'

Carbon Design Options

Products, materials, maintenance and upgrade

- **Reduce waste and promote circular economy** – leaner processes
- **Training** on efficient ordering, storage and use of materials
- **Pursue offsite production** where possible: lower environmental impacts as well as output efficiency, reduced safety risks
- **Lean standardisation thinking**: modularise as far as possible

Carbon Design Options

Behaviours and ease of use

- **Building (Energy) Management Systems –** ease of control and adjustment to set at right levels
- **Switches & sensors –** to automate as far as possible and avoid undesired and unintended behaviours and machine idling
- **Training** on how to use equipment efficiently
- **Metering** – half-hourly submeters to identify peak / hotspot loads to enable optimisation and reporting

What can we do about it?

Mitigation

- Sustainable transportation
- Energy conservation
- Thermal mass / sinks for temperature regulation
- Insulation and heat recovery systems
- Renewable energy
- Energy & carbon efficient materials and products
- Improve vehicle fuel efficiency
- Capture and use landfill & digester gas

- Geothermal
- Green roofs
- Solar thermal
- District heating
- Building design for natural light & ventilation
- Tree planting & care
- Water harvesting & conservation
- Local food production

Adaptation

- Infrastructure upgrades: SUDS, sewers & culverts
- Residential programs: sewer backflow & downspout disconnection
- Health programs and help for vulnerable people
- Emergency & business continuity planning
- Coastal and river bank protection and flood plain maintenance

Mitigation: the globally responsible thing to do

Actions that reduce the emissions that contribute to climate change.

Adaptation: the locally responsible thing to do

Actions that minimize or prevent the negative impacts of climate change.

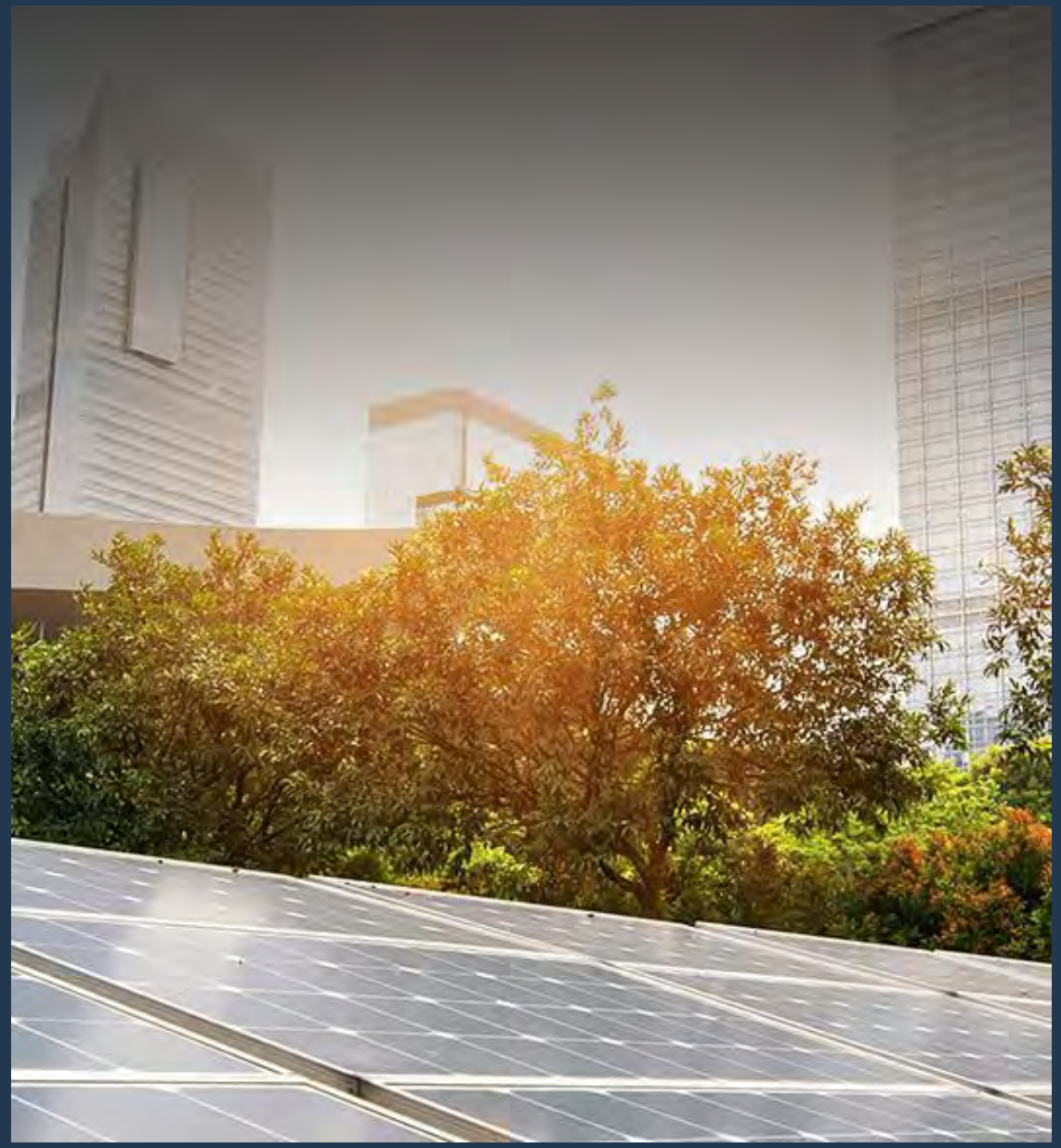
Break for Tea – back in 5 mins

Have you deployed any carbon reduction measures?

If you have, what was the reception or response to them?

Case Studies

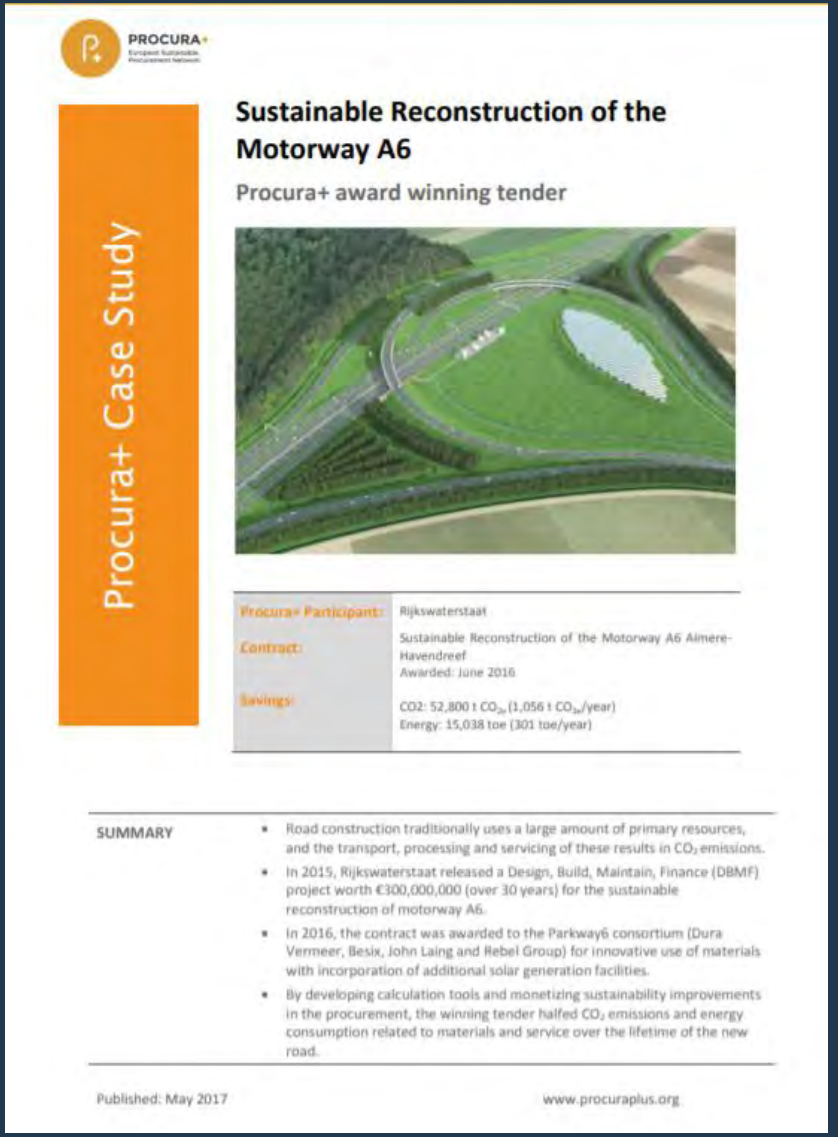
- ✓ A6 Motorway
- ✓ The Forge



Case Study – Motorway Junction

- Sustainable Reconstruction of the A6 Motorway, Netherlands
- Rijkswaterstaat released a Design, Build, Maintain, Finance (DBMF) project worth €300m (over 30 years) for the sustainable reconstruction of a stretch of the A6 motorway.
- Context: the Netherlands aims to achieve a 20% reduction in CO_2 emissions by 2020, compared to 1990 levels.
- What did the winning consortium do?
  - A design with innovative use of materials, halving CO_2 emissions and energy consumption over the lifetime of the new motorway
  - Incorporation of additional solar generation facilities
  - Development of calculation tools and monetisation of sustainability improvements

- **Award criteria: reduced CO_2 emissions, LCA on design options and Environmental Cost Indicator (ECI)**
- **Contact clauses: assessment of actual LCA and ECI during and after contract**
- **Outcome: saved 52,800 tCO_2e over 50 year lifetime through smarter transport and material use: more efficient and higher recycled content**



PROCURA+

Procura+ Case Study

Sustainable Reconstruction of the Motorway A6

Procura+ award winning tender

Procura+ Participant:	Rijkswaterstaat
Contract:	Sustainable Reconstruction of the Motorway A6 Almere-Havendreef Awarded: June 2016
Savings:	CO2: 52,800 t CO_{2e} (1,056 t CO_{2e}/year) Energy: 15,038 toe (301 toe/year)

SUMMARY

- Road construction traditionally uses a large amount of primary resources, and the transport, processing and servicing of these results in CO_2 emissions.
- In 2015, Rijkswaterstaat released a Design, Build, Maintain, Finance (DBMF) project worth €300,000,000 (over 30 years) for the sustainable reconstruction of motorway A6.
- In 2016, the contract was awarded to the Parkway6 consortium (Dura Vermeer, Besix, John Laing and Rebel Group) for innovative use of materials with incorporation of additional solar generation facilities.
- By developing calculation tools and monetizing sustainability improvements in the procurement, the winning tender halfed CO_2 emissions and energy consumption related to materials and service over the lifetime of the new road.

Published: May 2017

www.procuraplus.org

Case Study – The Forge (105 Sumner St): Landsec

- 139,000 sq ft office development in Southwark
  - Aims to be first commercial building constructed and operated in line with UKGBC's net zero carbon buildings framework
  - Work on both supply chain scope 3 emissions, and operational use
  - Using a platform-led approach to design & construction: P-DfMA, consists of a set of components that can be combined to produce highly customised structures

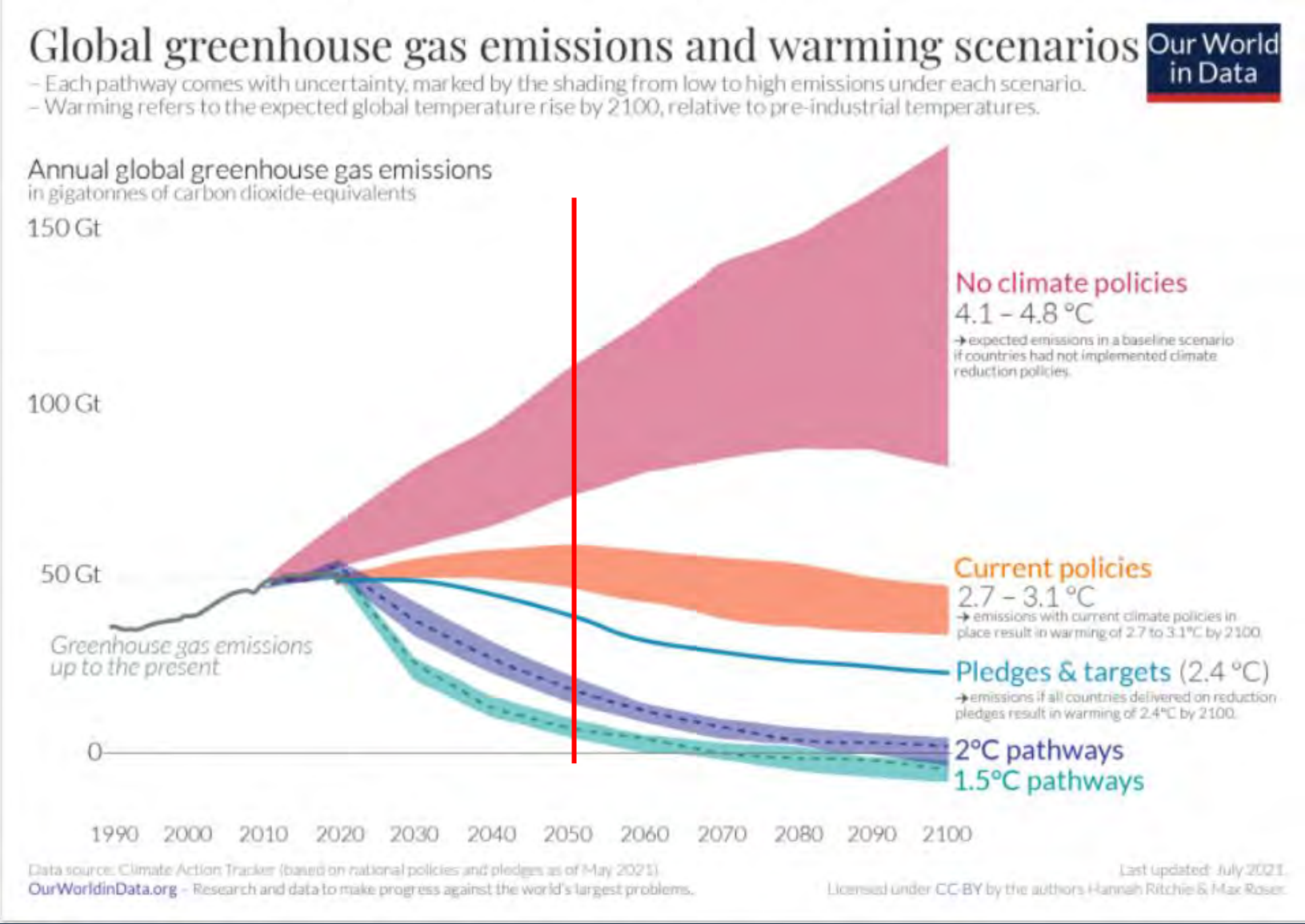
- The trial had positive results compared to a traditional construction site and techniques:
  - Construction productivity improved by 55%; Installation time 30% less; the final build achieved 33% cost savings
  - Final structure uses less material and less waste, and has an almost 20% reduction in embodied carbon
  - Further savings made in specifications, including high levels of recycled content and cement replacement in the main building materials.
  - Passive design techniques to reduce the energy demand, air source heat pumps for heating and cooling, and solar PV for electricity. Once in operation, these will be run on a 100% renewable electricity tariff.

https://www.futureoflondon.org.uk/2020/11/23/achieving-net-zero-case-study-zero-carbon-commercial-development/

https://www.youtube.com/watch?v=NQjcvSFU8Wk

Net zero carbon

The science-based route to a lower carbon world

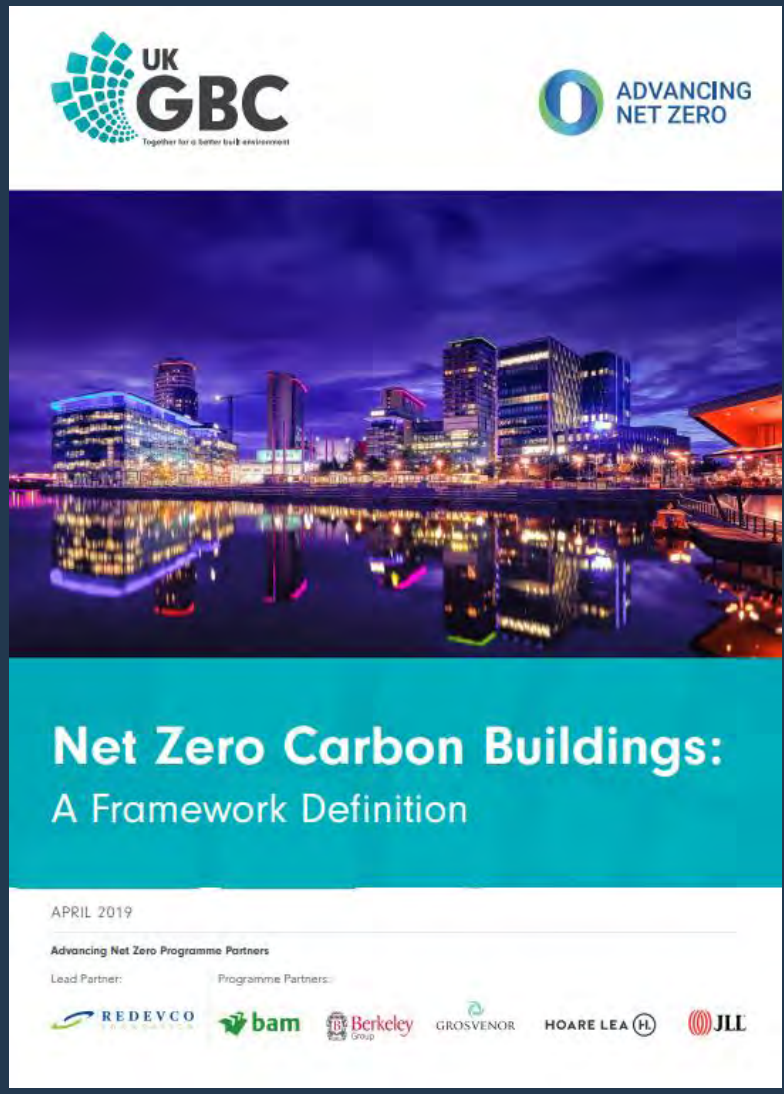


SUPPLY CHAIN SUSTAINABILITY SCHOOL

UKGBC Framework Definition of a Net Zero Carbon Building

Net zero carbon – construction: *"When the amount of carbon emissions associated with a building's product and construction stages up to practical completion is zero or negative, through the use of offsets or the net export of on-site renewable energy."*

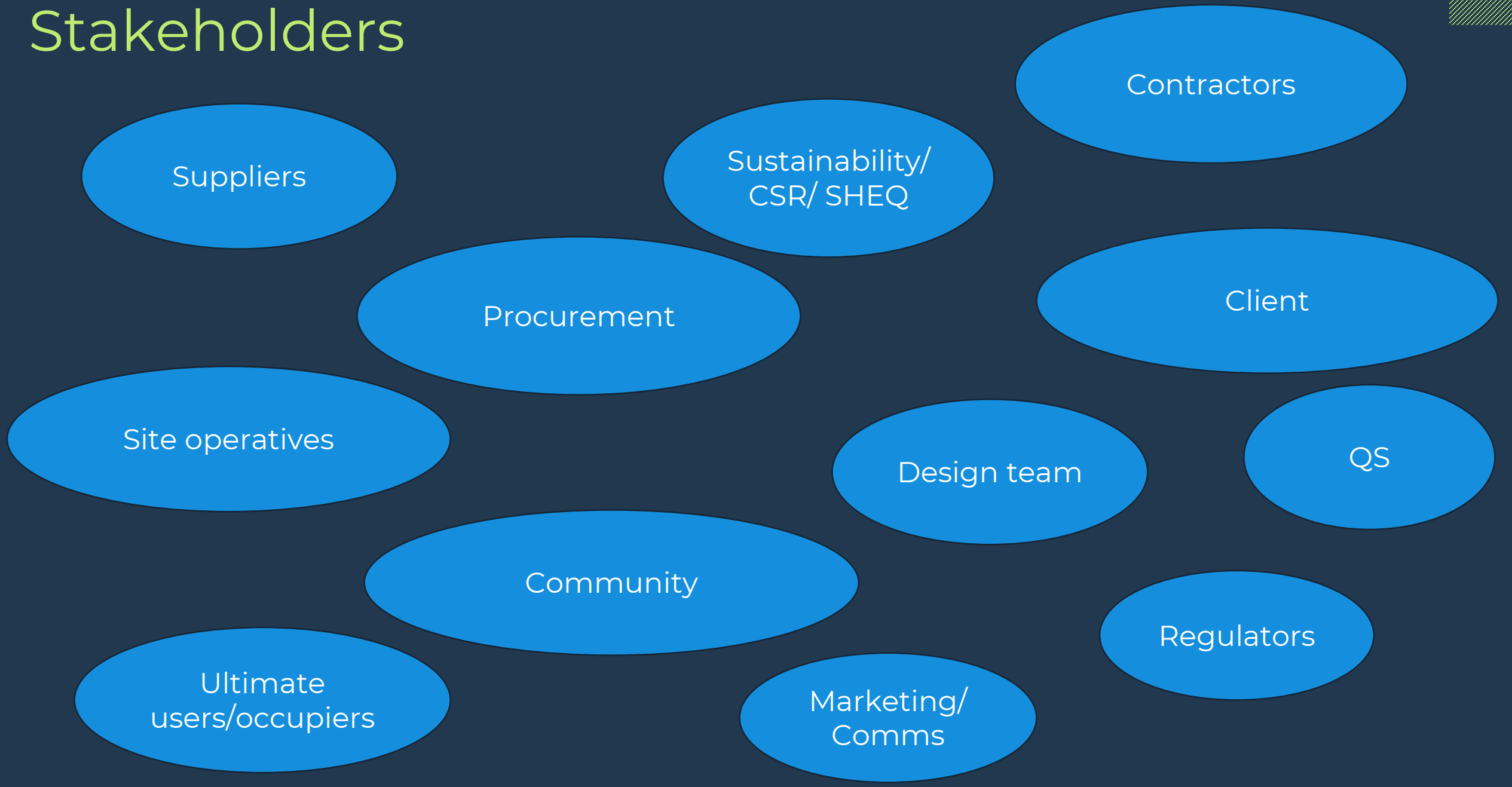
Net zero carbon – operational energy: *"When the amount of carbon emissions associated with the building's operational energy on an annual basis is zero or negative. A net zero carbon building is highly energy efficient and powered from on-site and/or off-site renewable energy sources, with any remaining carbon balance offset."*



Stakeholders

Who needs to be involved in reducing carbon?

Stakeholders




data

How do you compare?...

Activity: Better or Worse Bingo!

Which is better for carbon: reusable or disposable cups?

Vs

How many times do you need to use a reusable cup before carbon use is less than a disposable cup?

24 times. Easy!

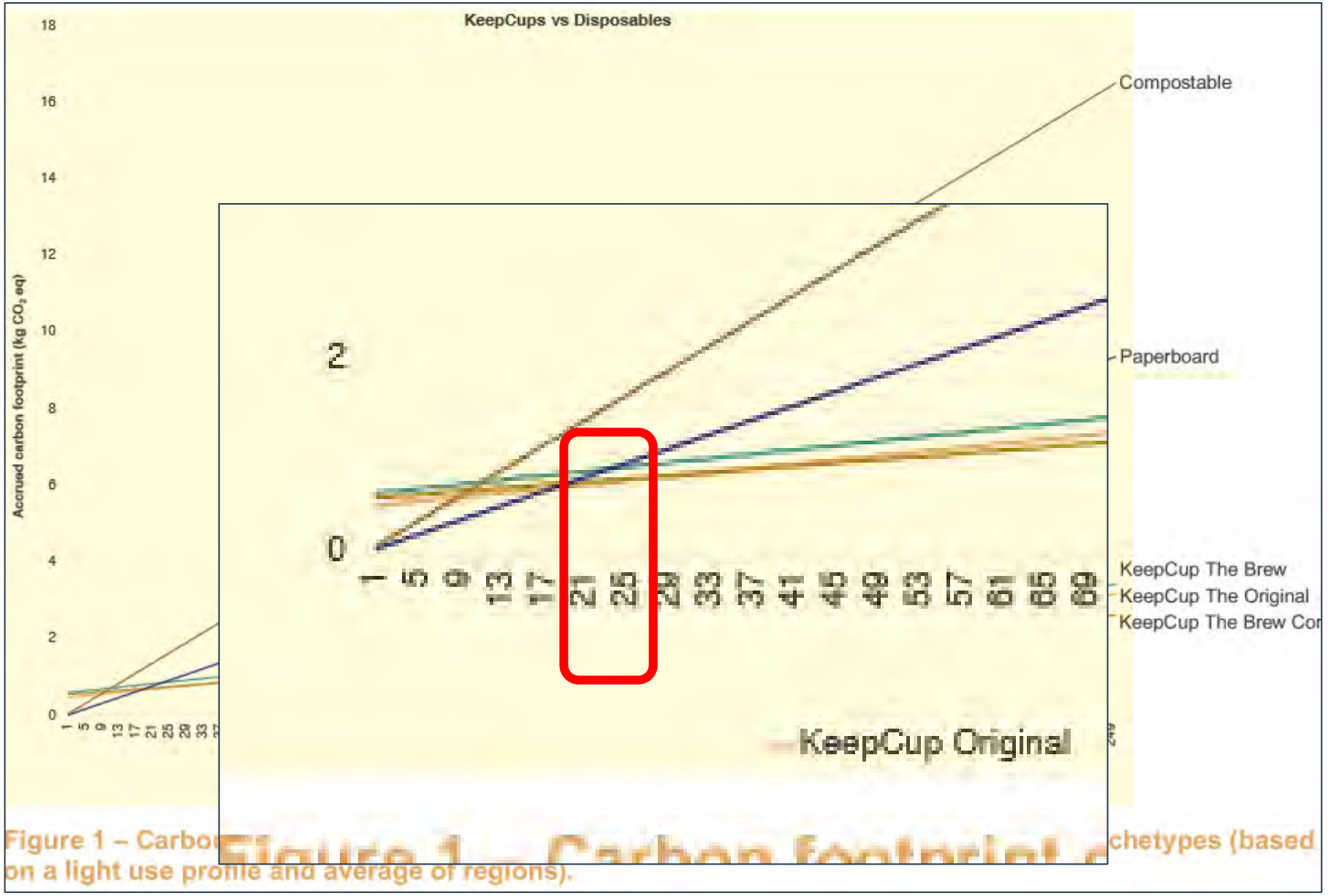


Figure 1 – Carbo chetypes (based on a light use profile and average of regions).

Getting data for designing out Carbon

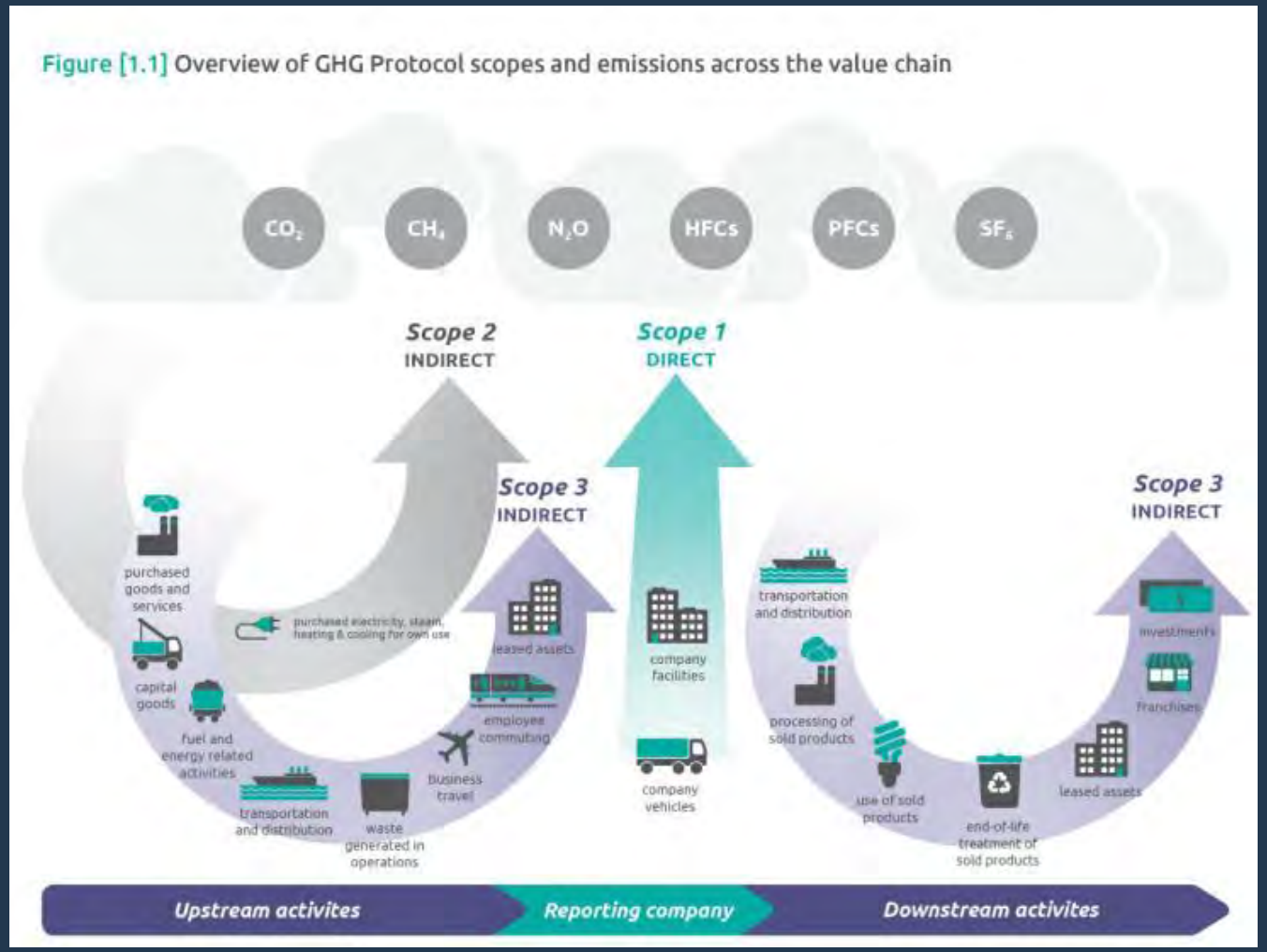
What is Carbon Footprinting?

"Commonly used to describe the total amount of CO_2 and other greenhouse gas (GHG) emissions attributable to an organisation, project or product."

Carbon reduction workshop: undertaking a footprint

1. Set the Goal
2. Set the Scope and Boundaries
3. Gather Data
4. Analyse
5. Report against KPIs
6. PDCA

Operational Boundaries – Scopes



- **Direct emissions** are emissions from sources that are owned or controlled by the reporting company
- **Indirect emissions** are emissions that are a consequence of the activities of the company but occur at sources owned or controlled by another company

Set your Boundaries for your Organisation

Your Suppliers

- *Materials, goods and services,*
- *Capital goods,*
- *Delivery*
- *Utilities: electricity, waste and water*
- *Business travel*

Your Business

- *Fuel and energy in company facilities*
- *Vehicles and plant.*
- *Chemical / biological processes, and*
- *Fugitive emissions*

Your Client

- *In-use emissions from running the building / asset;*
- *End-of-life treatment*
- *Downstream distribution*

"Embodied" Carbon
"Capital" Carbon - CapCarb

"Operational" Carbon - OpCarb

"End User" Carbon UseCarb

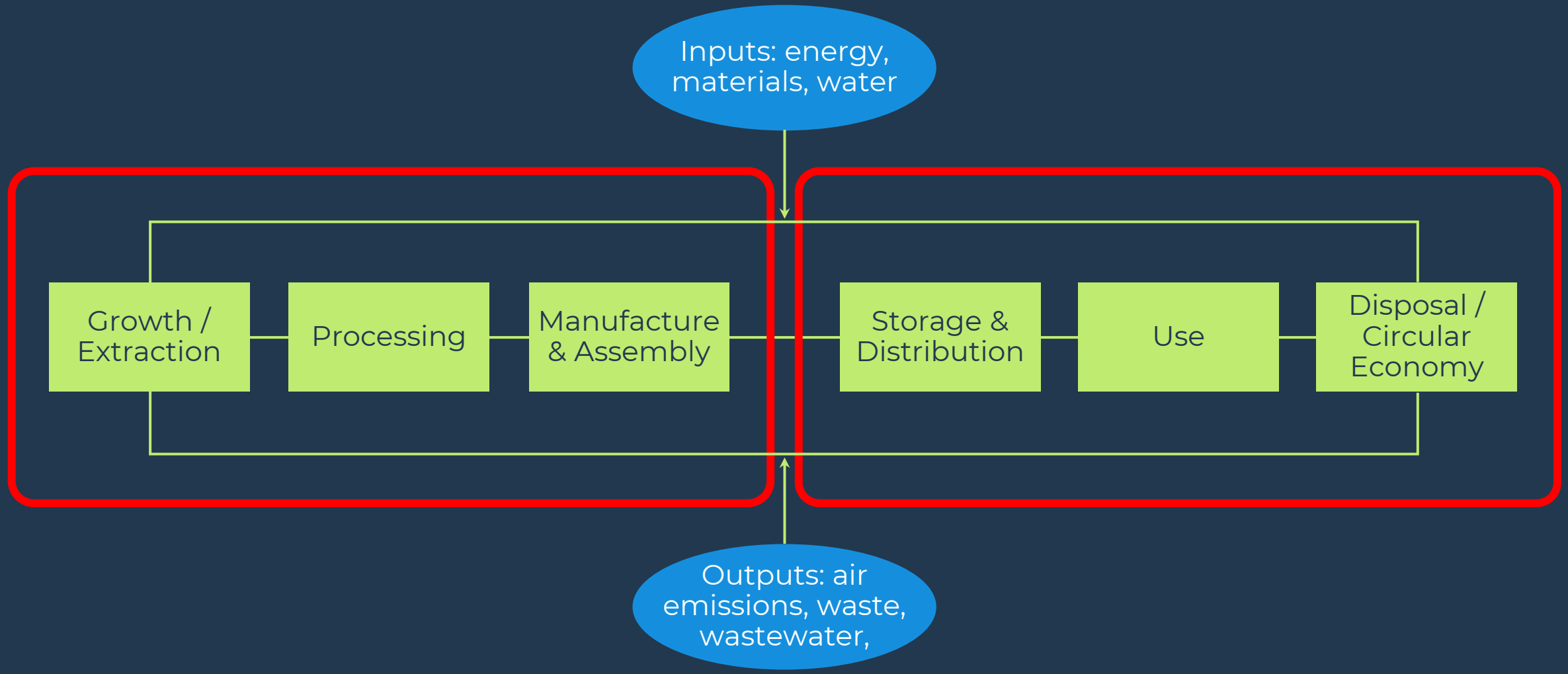
"Upstream Scopes 2 & 3 (Indirect)

Company's Scope 1 (Direct)

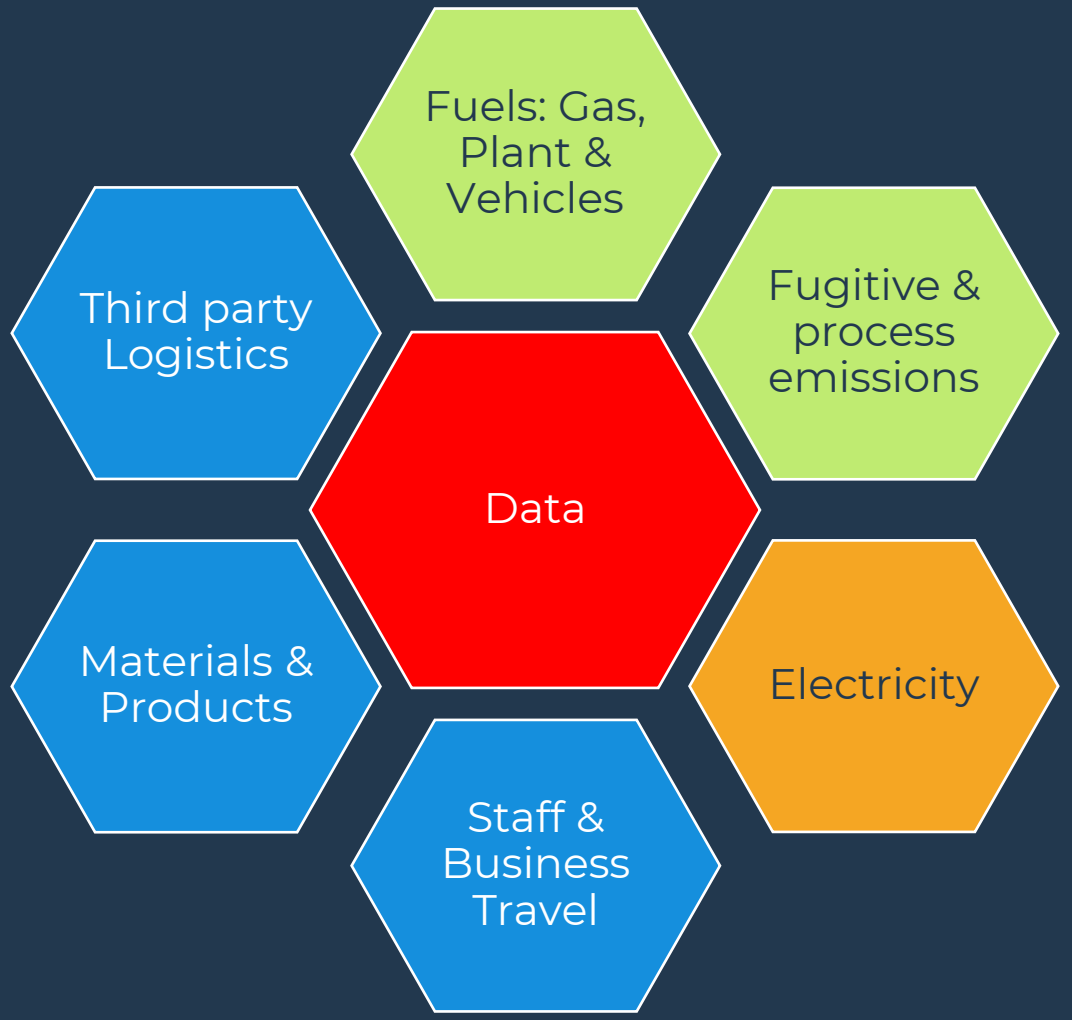
Downstream Scope 3 (Indirect)

SUPPLY CHAIN SUSTAINABILITY SCHOOL

Product Boundaries



Where does Activity Data come from



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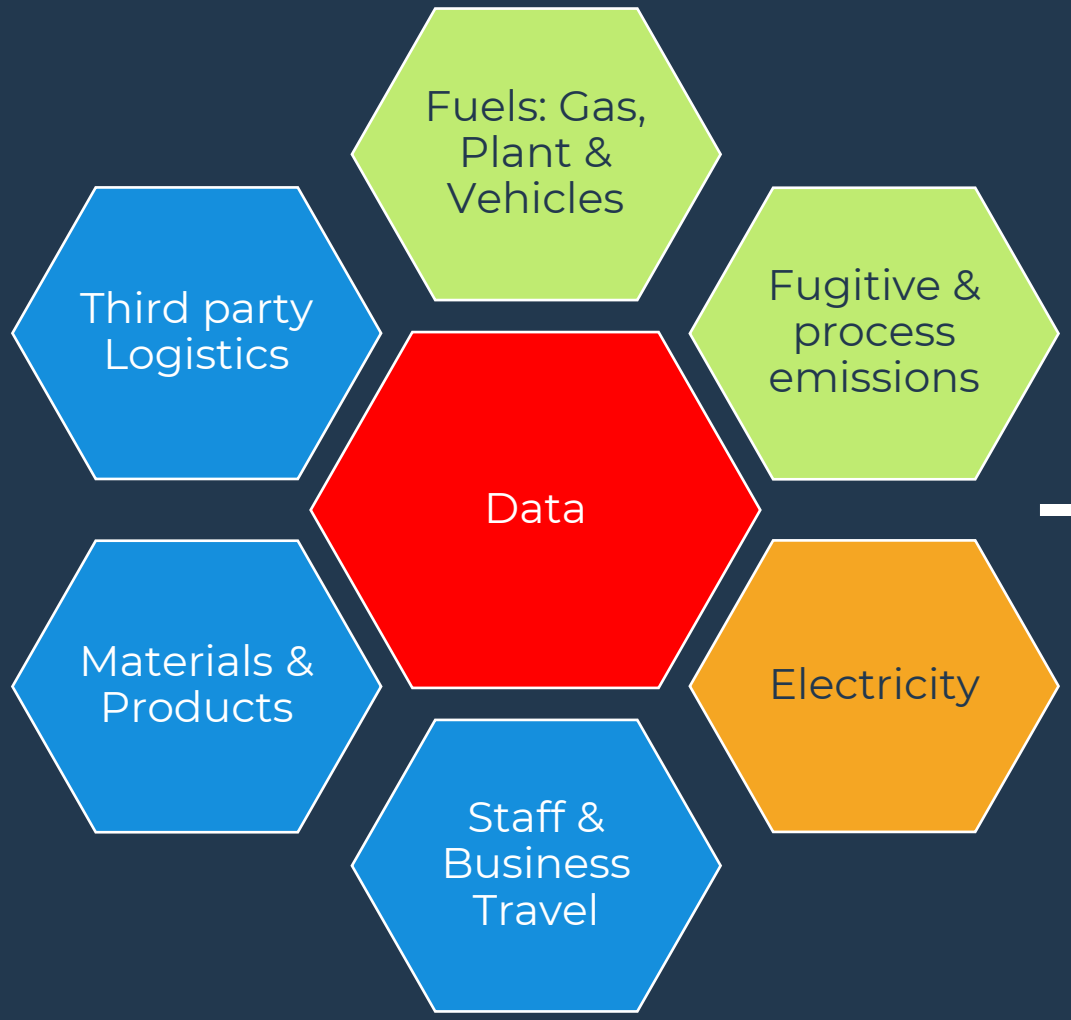


Kinds of Data

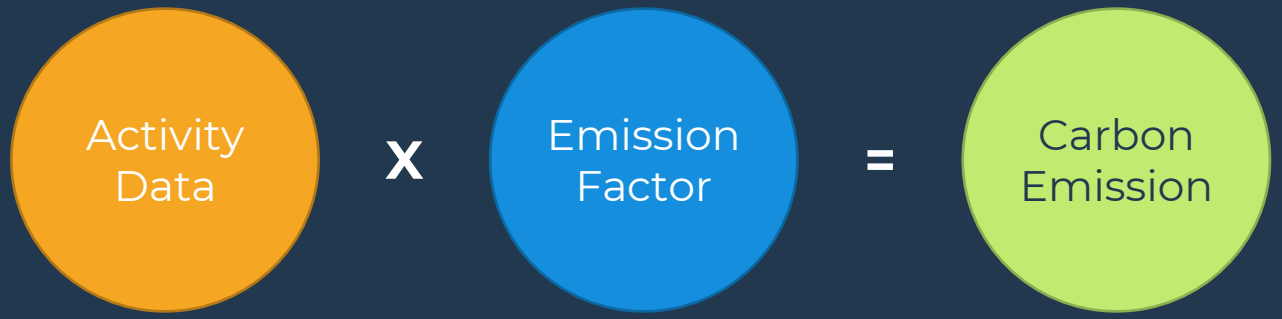
- Litres of fuel (diesel, LPG…)
- Litres of refrigerant
- kWh of electricity
- Mileage travelled
- Tonnes, m^3 of materials

Where is the Data

- Fleet
- Estates
- HR / Travel agent
- Procurement
- Suppliers
- Designers/ consultants

How to calculate a carbon footprint

- **A carbon footprint is**



- **For example**

- **$KgCO_2e$ ("equivalent")** takes into account all the main GHGs emitted: CO_2, CH_4 and N_2O, etc.
- Think about **units of measurement** and converting between them: factors of a thousand

Some Fundamentals- Emissions Factors
Comparing Power Sources and Modes of Travel

1 kWh grid electricity =

0.262 kg CO_2e

1 kWh diesel =

0.336 kg CO_2e

500 p.km by train =

18 kg CO_2e

500 km by car =

84 kg CO_2e

500 p.km by airplane =

122 kg CO_2e

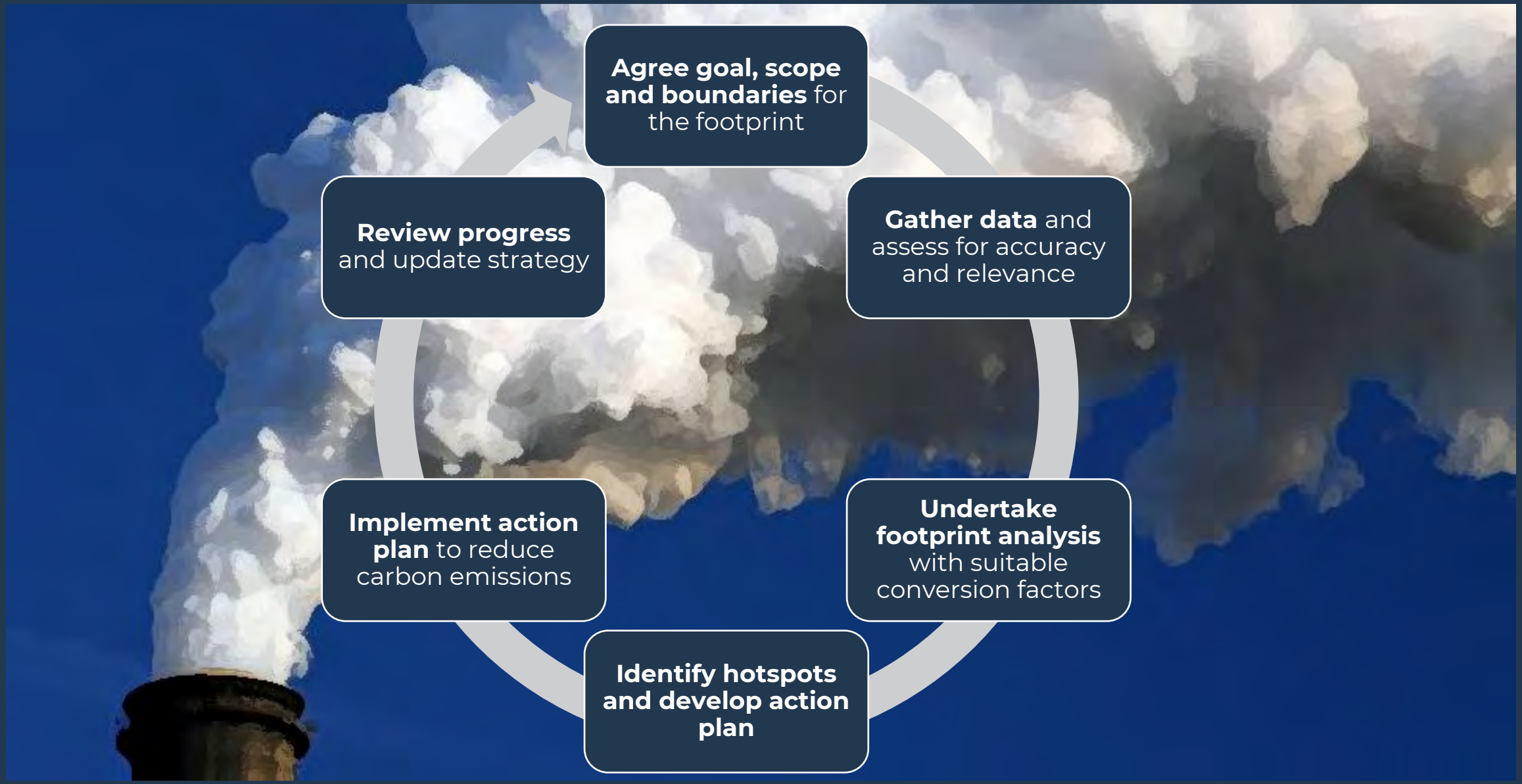
Some Fundamentals- Emissions Factors
Comparing Materials

But can vary greatly with

- Raw material source
- Recycled content
- Other additives, e.g., PFA, GGBS
- Manufacturing energy source
- Shipping / transport

Supplier engagement and EPDs !

Process for carbon reduction



Exercise

Exercise: Calculate the carbon footprint for design

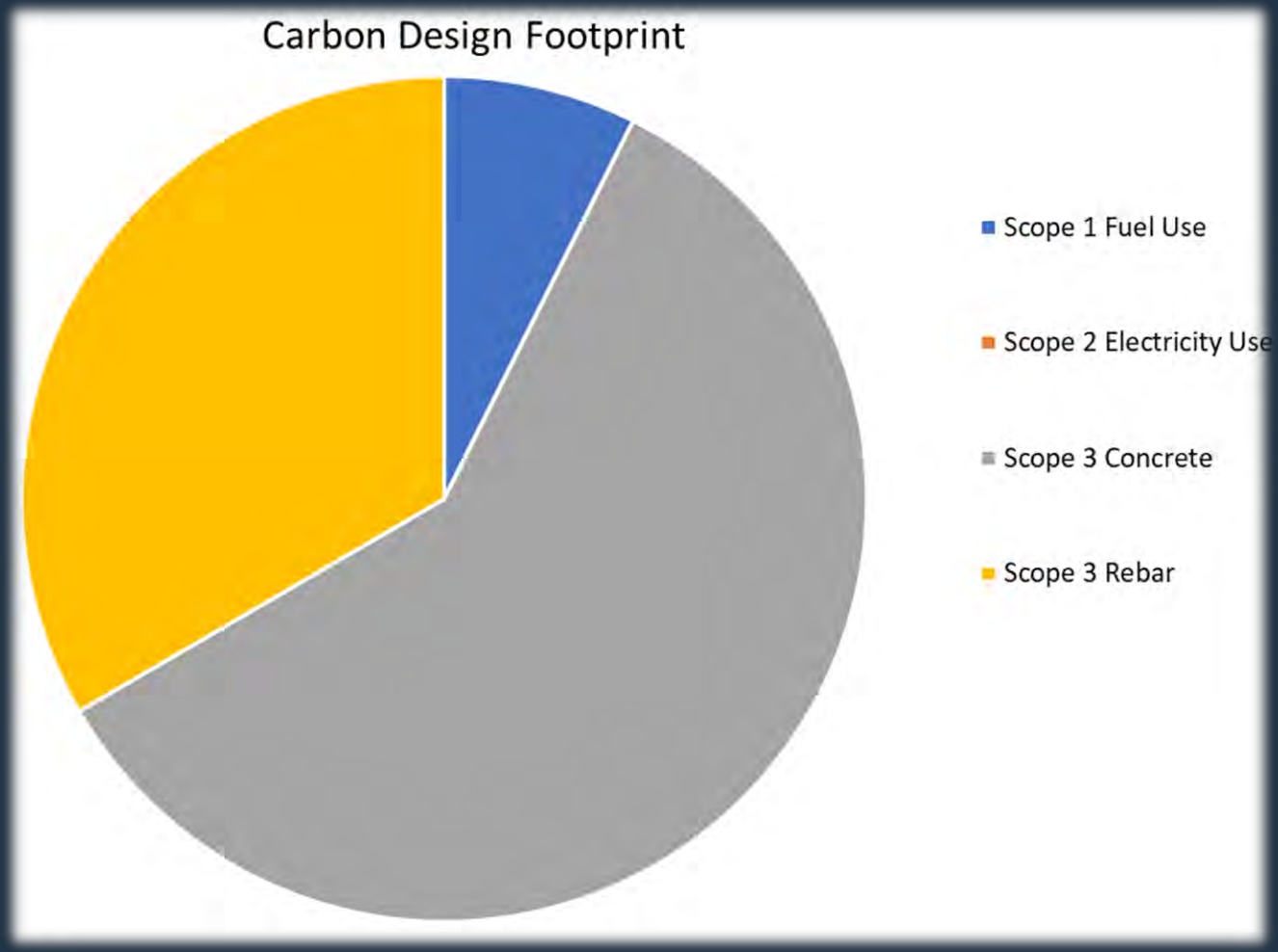
Calculate the carbon footprint for the design using the data below and emissions factors in the excel sheet and total them under Scopes 1, 2 and 3, as well as the overall total

- 950,000 litres of diesel used in your own excavators and dump trucks
- 5.2 MWh grid electricity in welfare accommodation and temporary offices
- 85,000 m^3 concrete
- 5,950 tonnes rebar

And the answers are…

- Scope 1: 2,430 tCO_2e
- Scope 2: 1 tCO_2e
- Scope 3: 32,853 tCO_2e

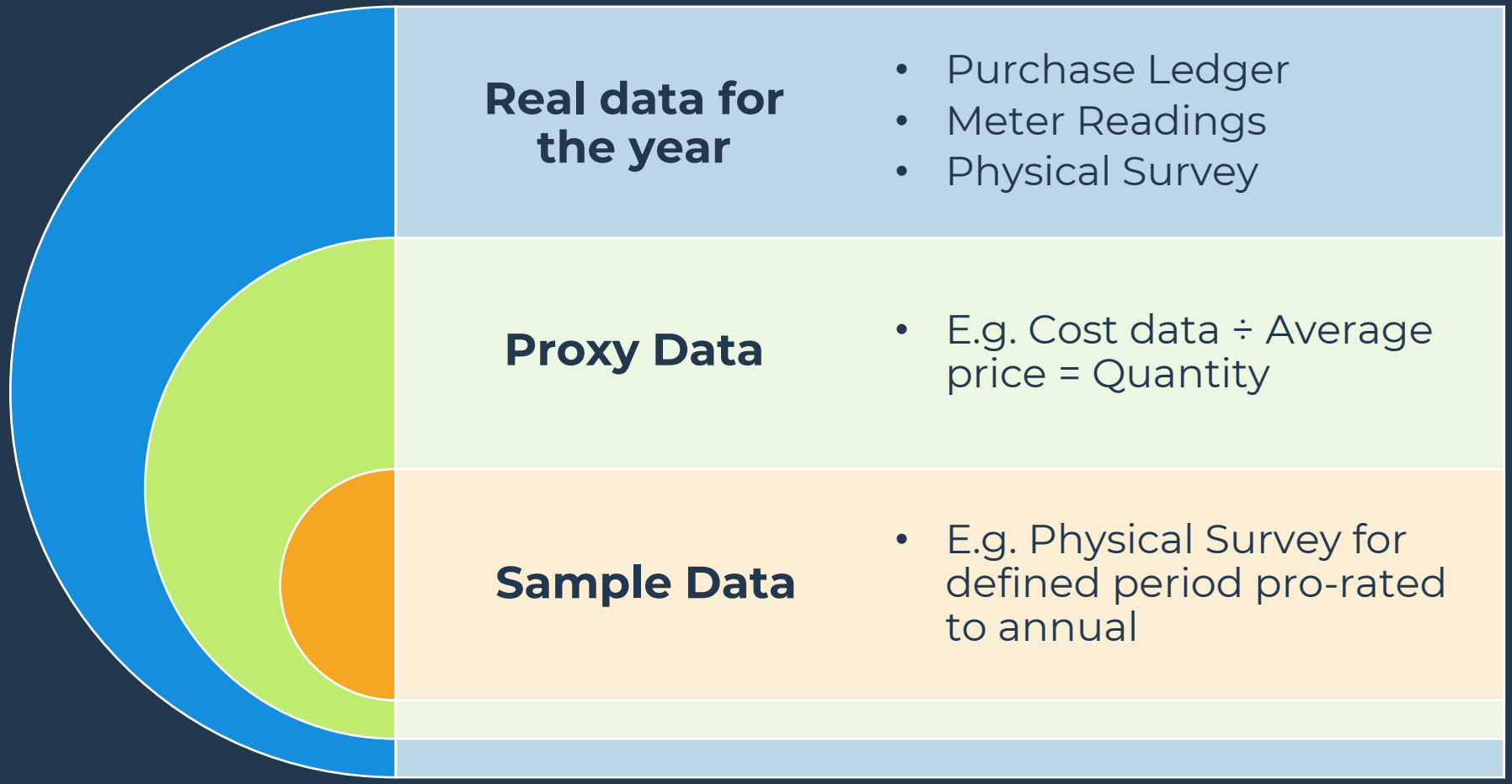
- Total: 35,283 tCO_2e



Break for Tea – back in 5 mins

Primary Activity Data Sources

Sources of Data – Quantities (tonnes, m^3, etc.)



Challenges in Carbon Footprinting

Data

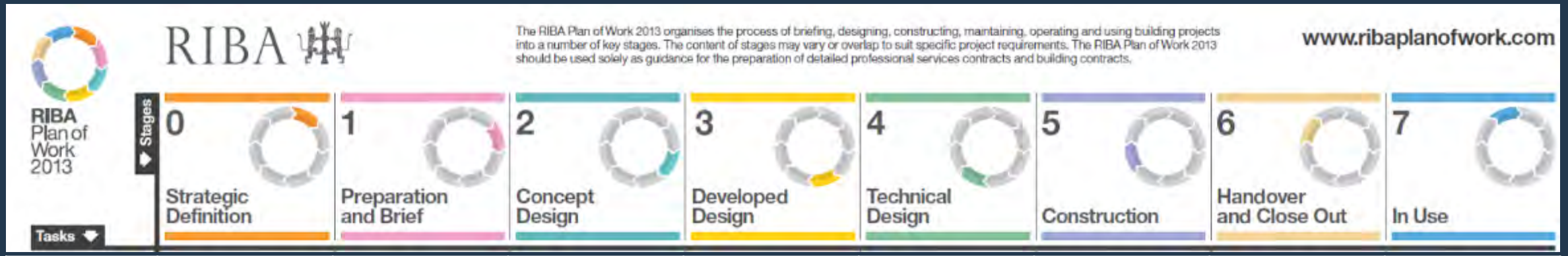
- Relevant data to your situation
- Reliable, unbiased data
- Up-to-date data

Time

- Control and influence
- Time constraints - what do you have time to collect?
- Pareto 80/20

Tools for designing our Carbon

RIBA Plan of Works: 2020



(Net zero) Embodied Energy and CO2 (kWh/m2/yr and kgCO2/m2/yr)	Prioritise total or partial **reuse of existing facilities, buildings, components** or materials. Consider the scope of new build elements and set ambitious **embodied energy targets.**	Assess site or existing buildings for reusable parts or components. **Define embodied energy and carbon target outcome**, including the boundaries of the assessment with regard to **net-zero carbon and certification methodologies**.	**Review the embodied energy and carbon of materials and construction processes** in the context of the building's lifespan and operational strategy. Minimise high embodied energy material, **prioritise low carbon and recycled materials**. Avoid inefficient/ wasteful use of materials. Design out waste where possible.	**Use embodied energy and carbon assessment** to test relative impacts of design options as part of whole life costs. **Prioritise low carbon materials**. Create a baseline carbon budget as an outcome target.	Integrate and communicate **detailed design strategies to deliver outcomes for embodied energy and carbon**. Include materials, construction, manufacturing and supply decisions. Describe the relationship with operational energy and conditioning strategies. Update the carbon budget and included in the specification.	**Update embodied energy and carbon assessment**. Review impact of the construction process against the carbon budget.	**Assess the Sustainability Outcomes for embodied energy and carbon** through final assessment of the Asset Information model to compare to initial carbon budget.	Gather **Post Occupancy Evaluation data** to evaluate, for example, the appropriateness of thermally massive elements.
Other carbon aspects	Operational energy and carbon, being mindful of relationships between embodied and operational, transport and connectivity, as well as whole life £ and carbon costs for design, construction, maintenance and refurb							

SCHOOL

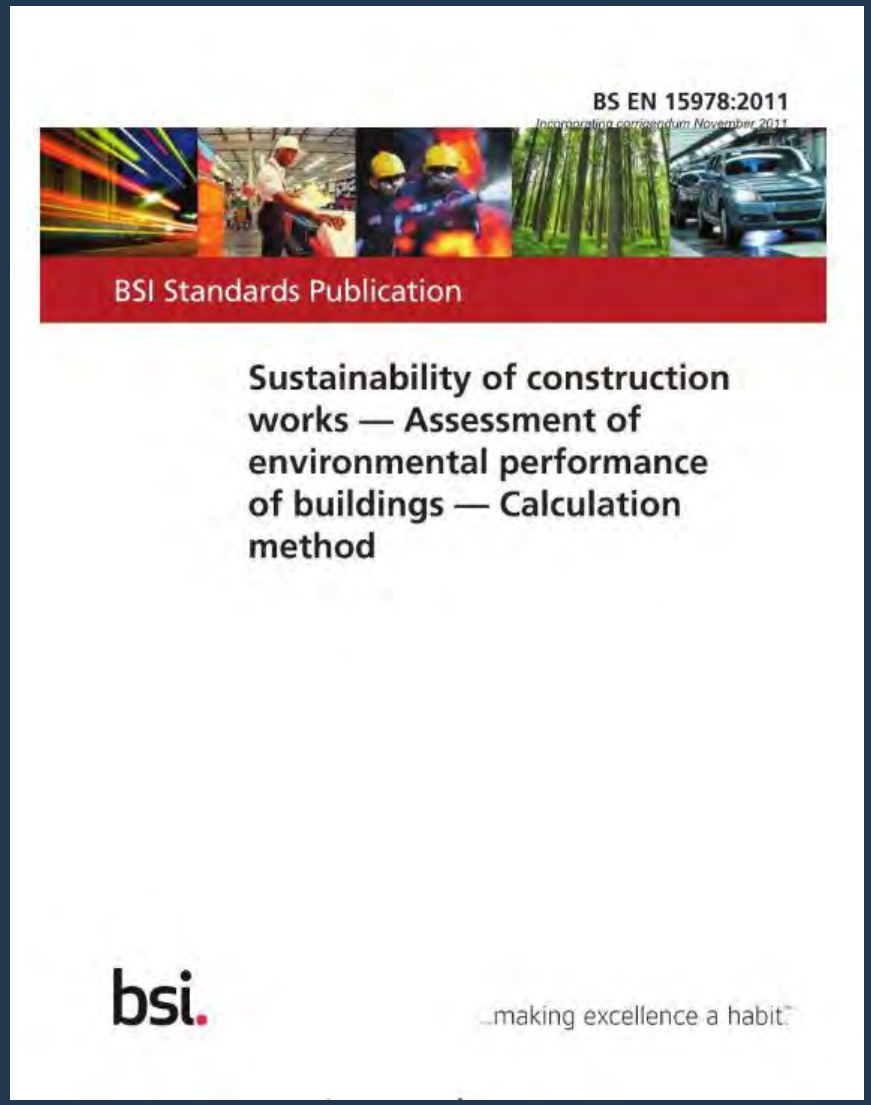
https://www.architecture.com/-/media/GatherContent/Test-resources-page/Additional-Documents/2020RIBAPlanofWorkoverviewpdf.pdf

Introduction to relevant standards

BS EN 15978

BS EN 15978

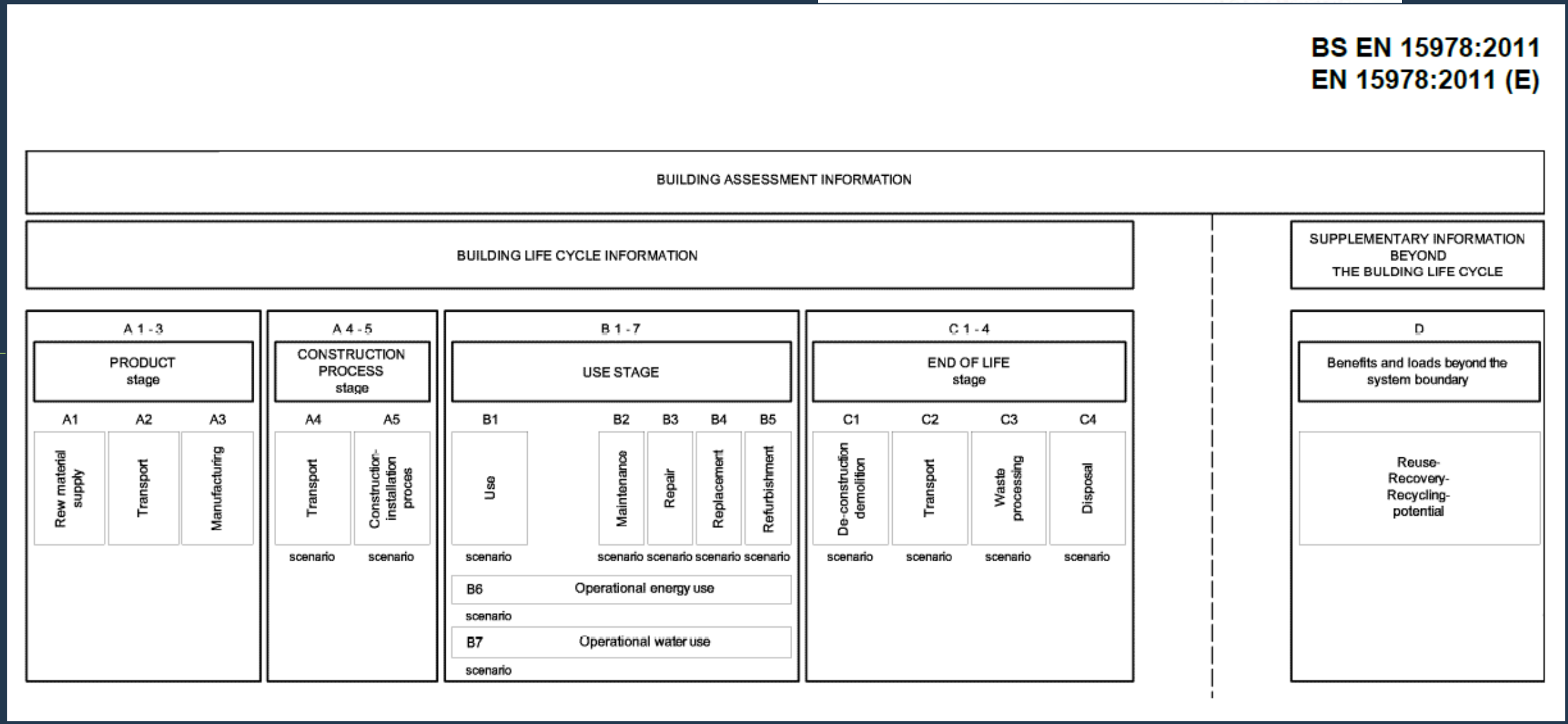
- Applicable to construction projects, services and processes
- Provides a structure to capture all aspects of carbon emissions
- Encompasses life cycle: manufacture, construction, operation, maintenance and demolition
- Allows for fair comparison and a robust route to reducing carbon impacts
- Covers all environmental impacts of a construction project



Introduction to relevant standards

BS EN 15978

BS EN 15978



Introduction to relevant standards

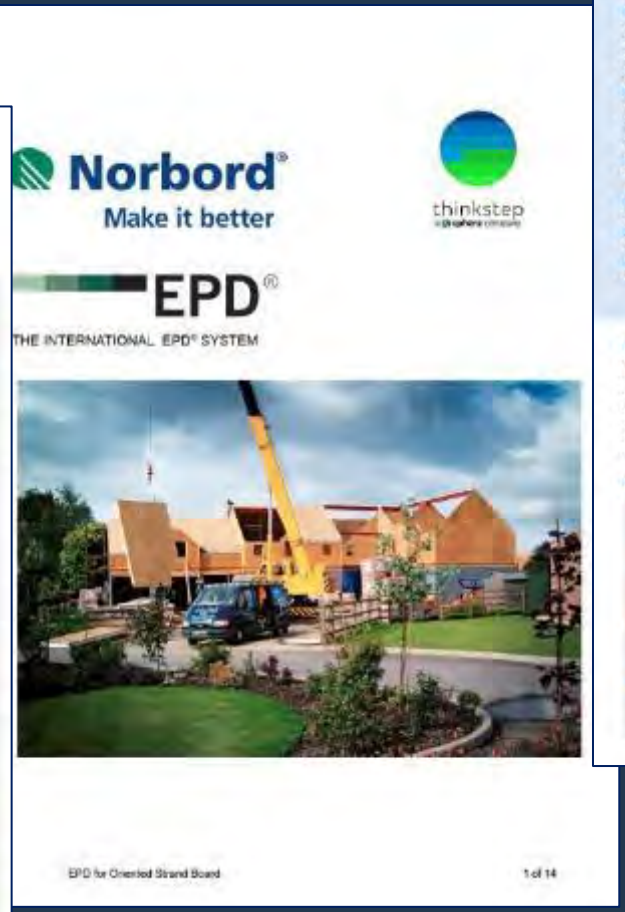
BS EN 15804

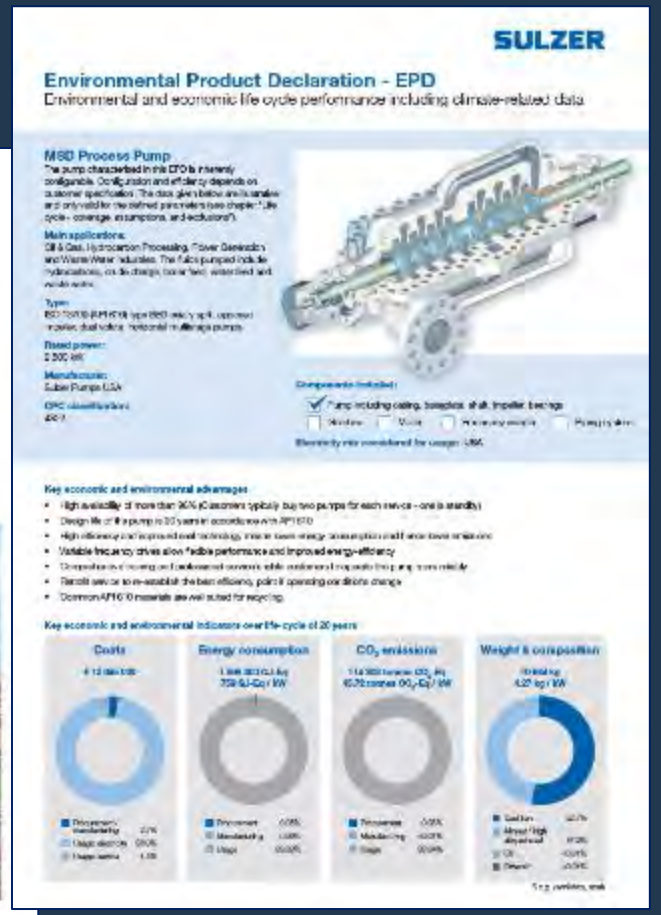
BS EN 15804

- Applicable to construction products, services and processes
- Provides a structure to ensure that all EPDs are derived, verified and presented in a harmonized way
- EPDs communicate verifiable, accurate, non-misleading environmental information for products
- Allows for fair comparison and a robust route to reducing environmental impacts
- EPDs = Environmental Product Declarations

Environmental Product Declarations: EPDs

A summary of the costs and environmental impacts from the manufacture and expected use of a product

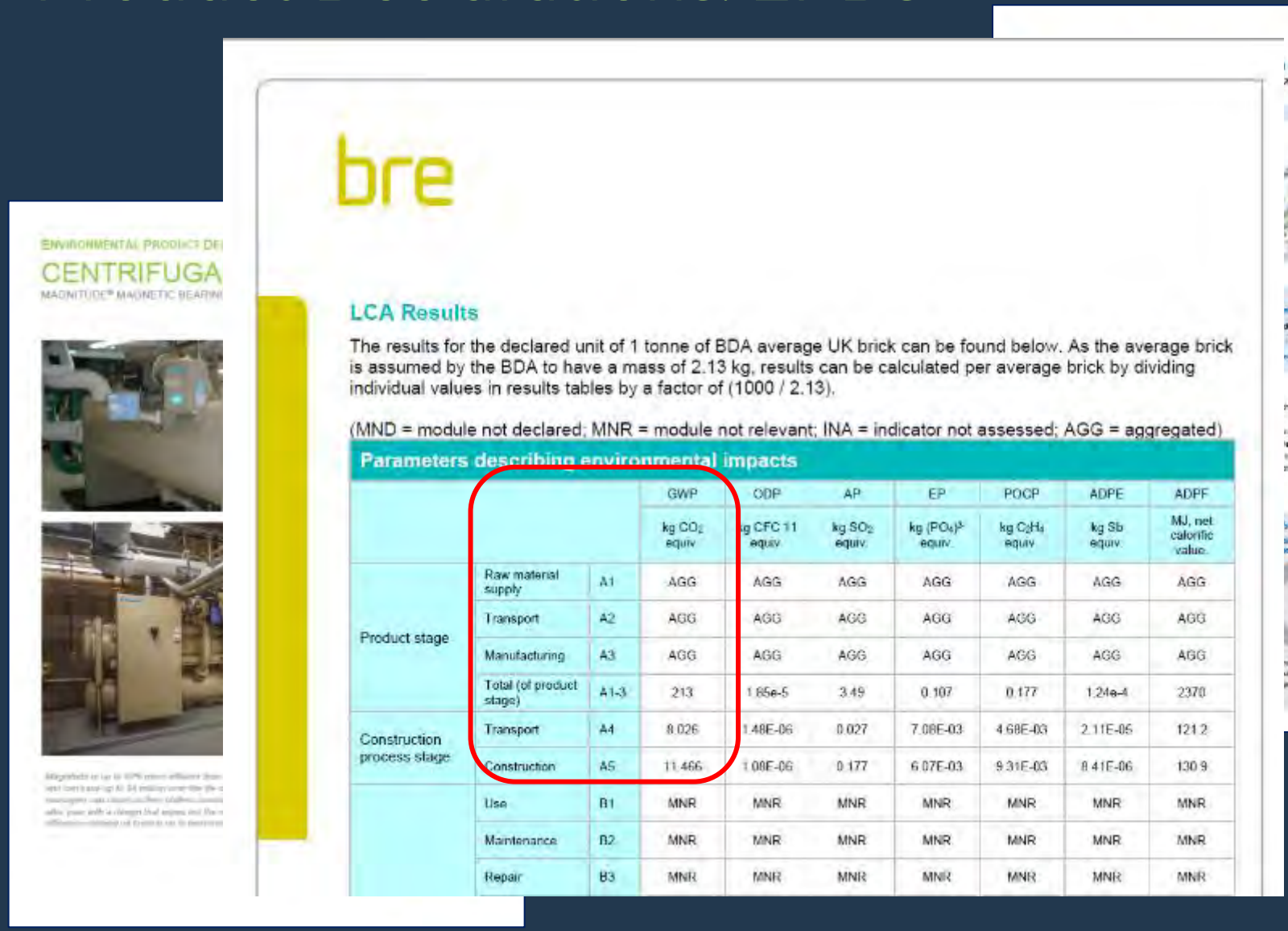




SUPPLY CHAIN SUSTAINABILITY SCHOOL

Environmental Product Declarations: EPDs

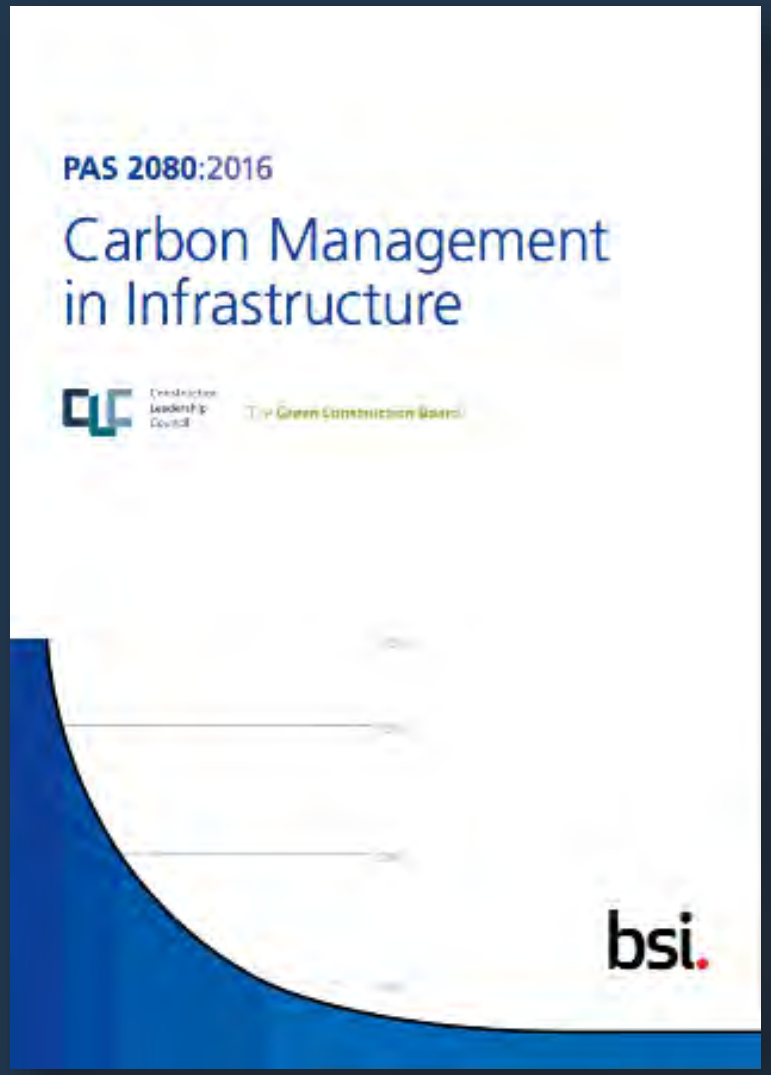
A summary of the costs and environmental impacts from the manufacture and expected use of a product



SUPPLY CHAIN SUSTAINABILITY SCHOOL

Introduction to relevant standards

PAS 2080: 2016

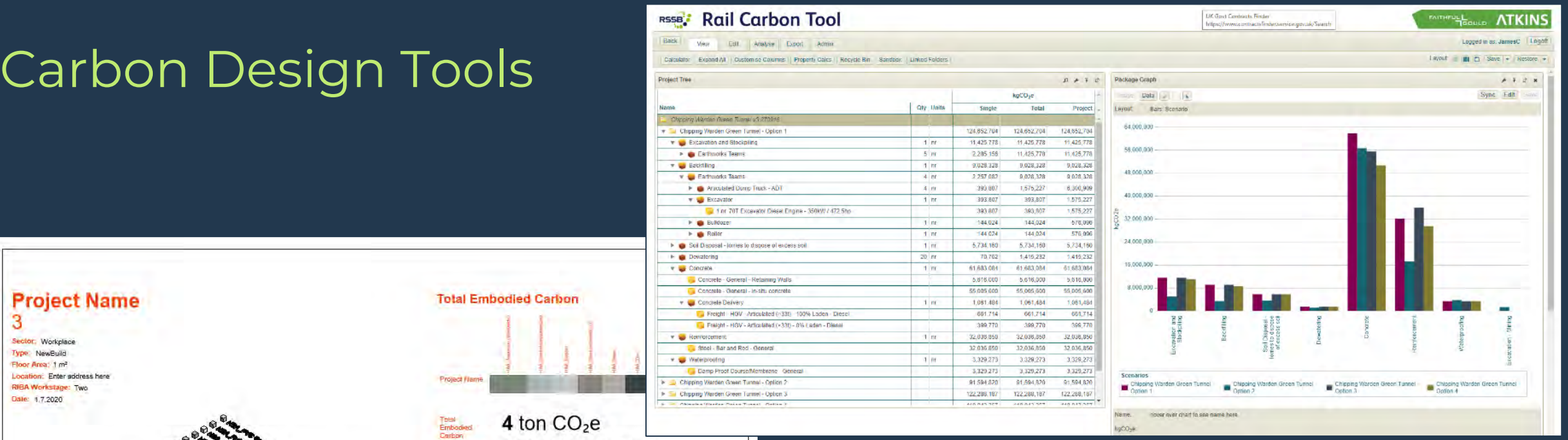


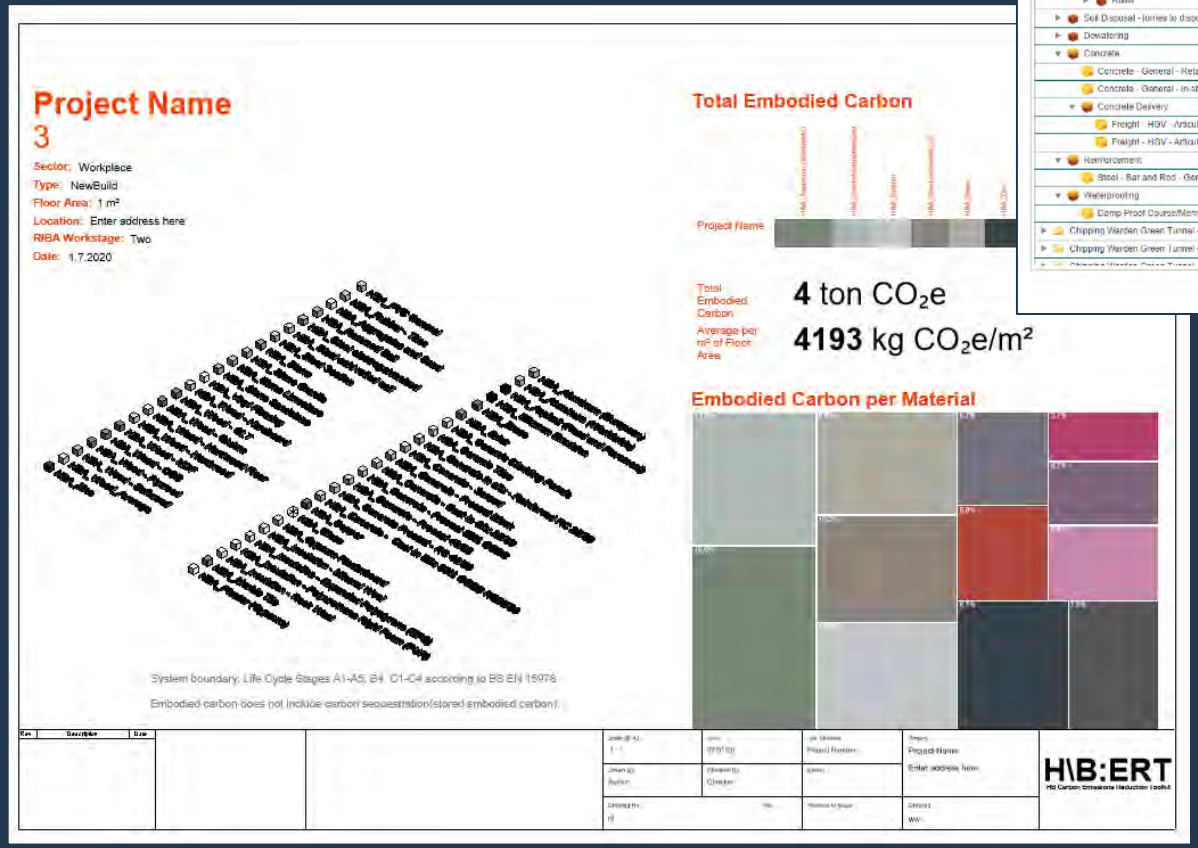
- Management of carbon reduction across infrastructure value chain
- Determining baselines, establishing metrics and setting targets
- Selecting carbon emissions quantification methodologies
- Reporting at appropriate stages & visibility of performance
- Continual improvement of management and performance

PAS2080: 2016

https://www.railindustrycarbon.com/Account/LogOn?ReturnUrl=%2f

Carbon Design Tools





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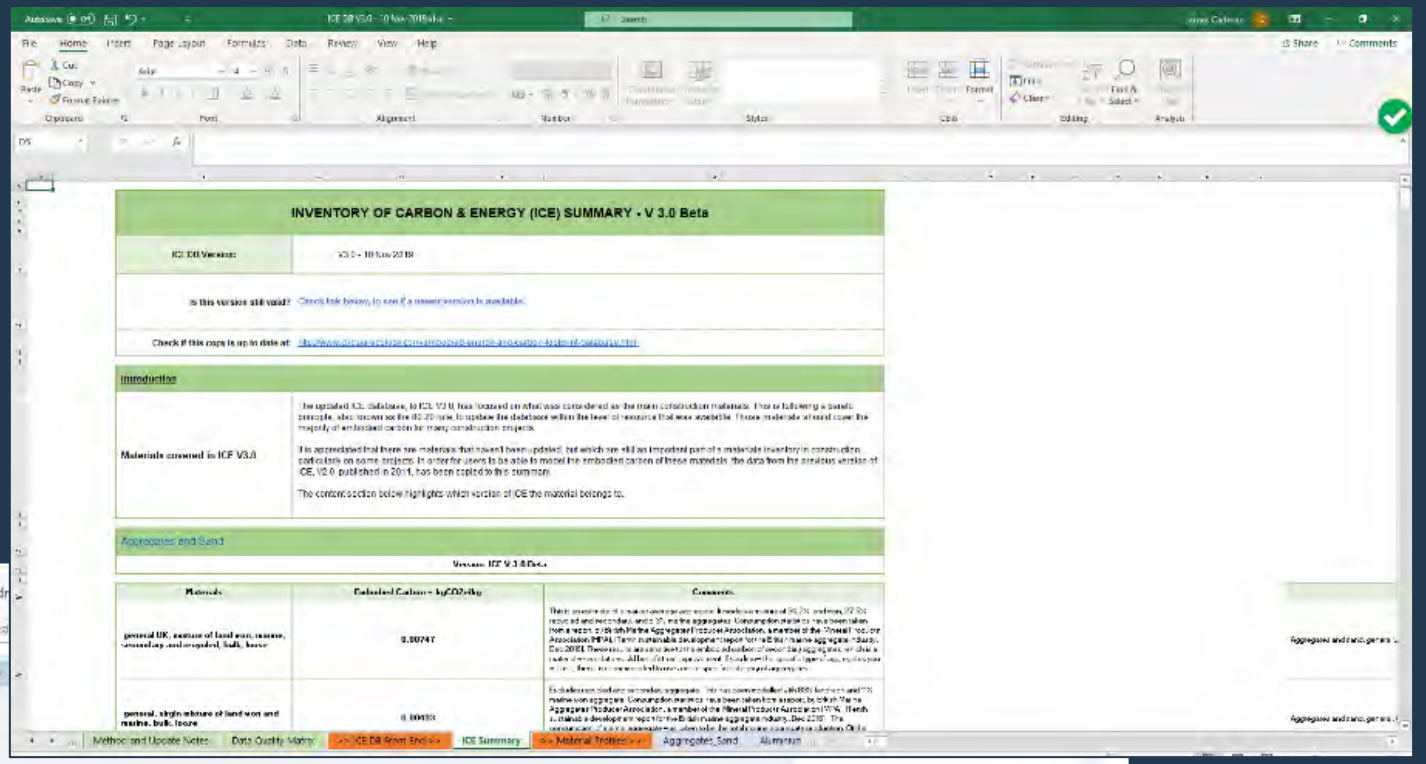
https://www.hawkinsbrown.com/services/hbert

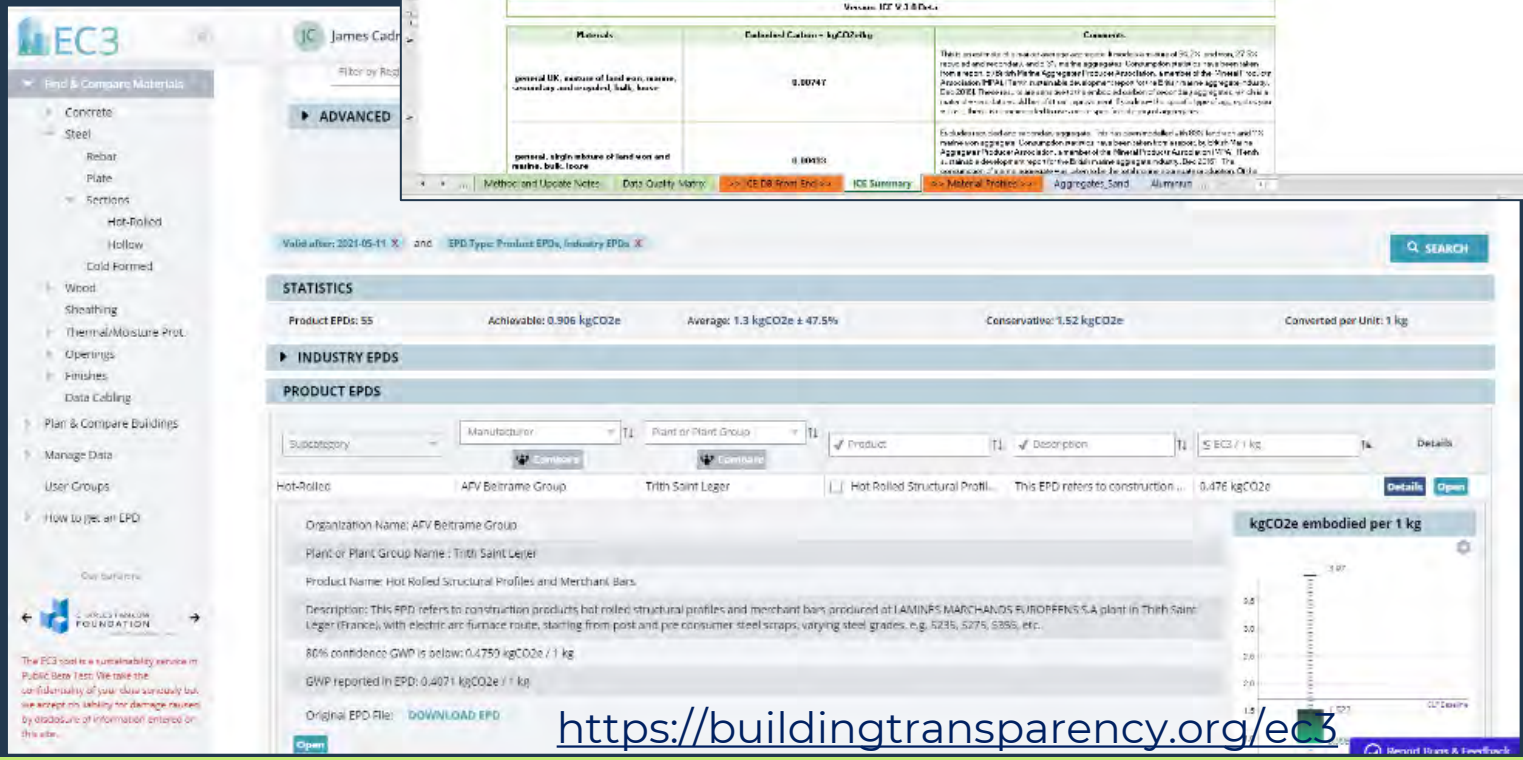
http://www.circularecology.com/embodied-energy-and-carbon-footprint-database.html

Databases

BECD
Built Environment Carbon Database

bre · CARBON TRUST · CIBSE · CIC CIOB · ice · IStructE · RIBA · RICS · UK GBC





https://buildingtransparency.org/ec3

SUPPLY CHAIN SUSTAINABILITY SCHOOL

Resources Guidance – Free Carbon Data and Tools

- **Defra/BEIS 2021 Greenhouse gas reporting conversion factors :** the UK Government's database of carbon factors for fuel, energy, transport, and materials, updated annually. https://www.gov.uk/government/publications/greenhouse-gas-reporting-conversion-factors-2021
- **Bath Inventory of Carbon and Energy (ICE)** database: a well-established database of embodied carbon factors for a variety of materials, updated periodically. http://www.circularecology.com/embodied-energy-and-carbon-footprint-database.html
- **Supply Chain School Carbon Calculator:** a free tool from the School to measure scope 1, 2 and 3 emissions in your supply chain. https://carbon.sustainabilitytool.com/
- **The Embodied Carbon in Construction Calculator (EC3) Tool:** a database of EPDs for construction products https://buildingtransparency.org/ec3
- **Carbon Trust Carbon Calculator** for SMEs: The Carbon Footprint Calculator has been designed to help UK based SMEs measure their corporate emission footprint following GHG Protocol Guidance, including direct emissions from fuel and processes (Scope 1 emissions) and those emissions from purchased electricity (or Scope 2 emissions) for the assets they operate https://www.carbontrust.com/resources/tools/carbon-footprint-calculator
- **Highways England Carbon Tool:** a free-to-download Excel tool to calculate carbon emissions for operational, construction and maintenance activities undertaken on behalf of Highways England that draws on Defra and Bath ICE datasets www.gov.uk/government/publications/carbon-tool
- **The RSSB Rail Carbon Tool** is a web-based tool that allows you to calculate, assess, analyse, report and reduce your rail project carbon footprint by evaluating low-carbon options using verified, centrally-available carbon factor data that draws on Defra and Bath ICE datasets https://www.railindustrycarbon.com/
- **Environment Agency Carbon Calculator:** a free-to-download tool to calculate the carbon impact of different material and transport options in your project www.ice.org.uk/knowledge-and-resources/best-practice/environment-agency-carbon-calculator-tool
- **Hawkins\Brown: Emission Reduction Tool \.** An open source Revit-based tool that enables design teams to quickly analyse and clearly visualise the embodied carbon emissions of different building components and construction material options at any time during the design process. https://www.hawkinsbrown.com/services/hbert

Business Reality

National Grid

“One idea that’s really worked is the start of a 5% carbon weighting on our new construction projects.

We’re saying to our suppliers that if you can design a lower-carbon solution you stand a better chance of winning our business.”

National Grid Example

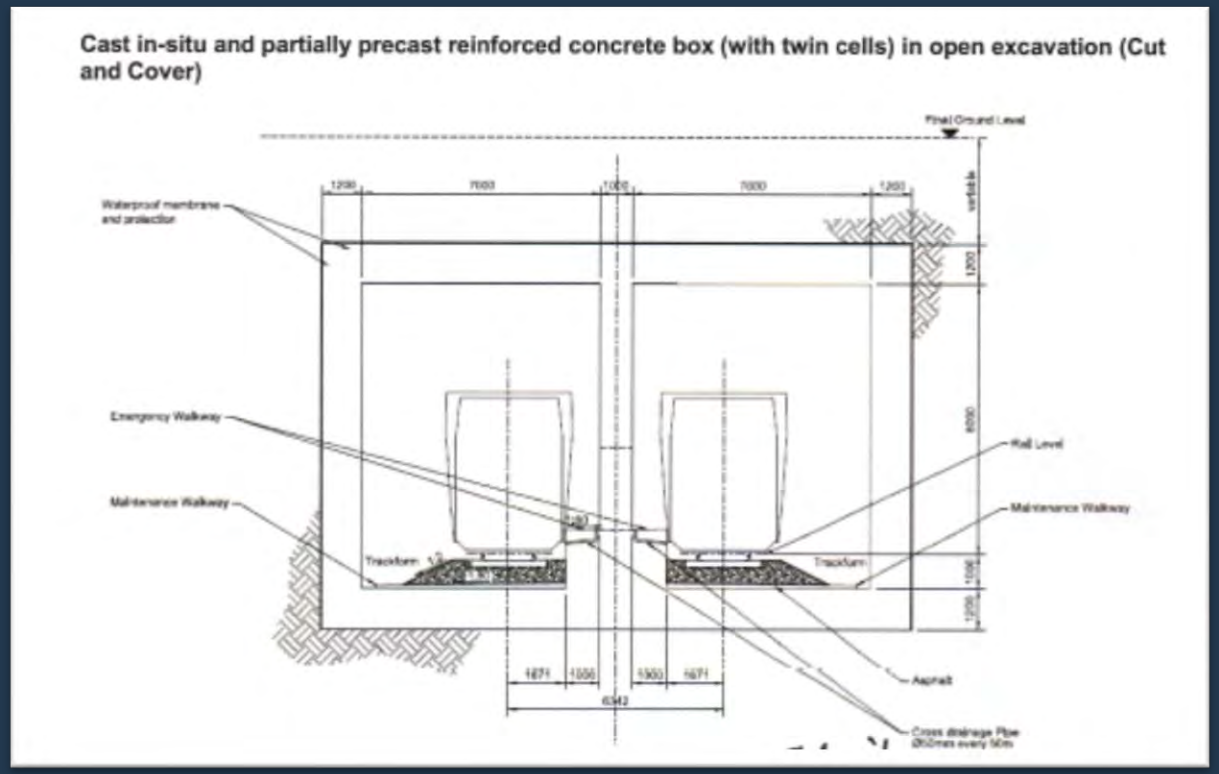
- New electricity substation at Wimbledon
- Smarter thinking on design and use of materials
- Calculated carbon savings of 20% across the asset's life, equivalent to about 39,000 tCO2
- Saved £3 million in costs compared with the original design

"By having clear data on carbon emissions, we can use energy and resources more efficiently. We've been able to prove the business case that lower carbon can equal lower cost"

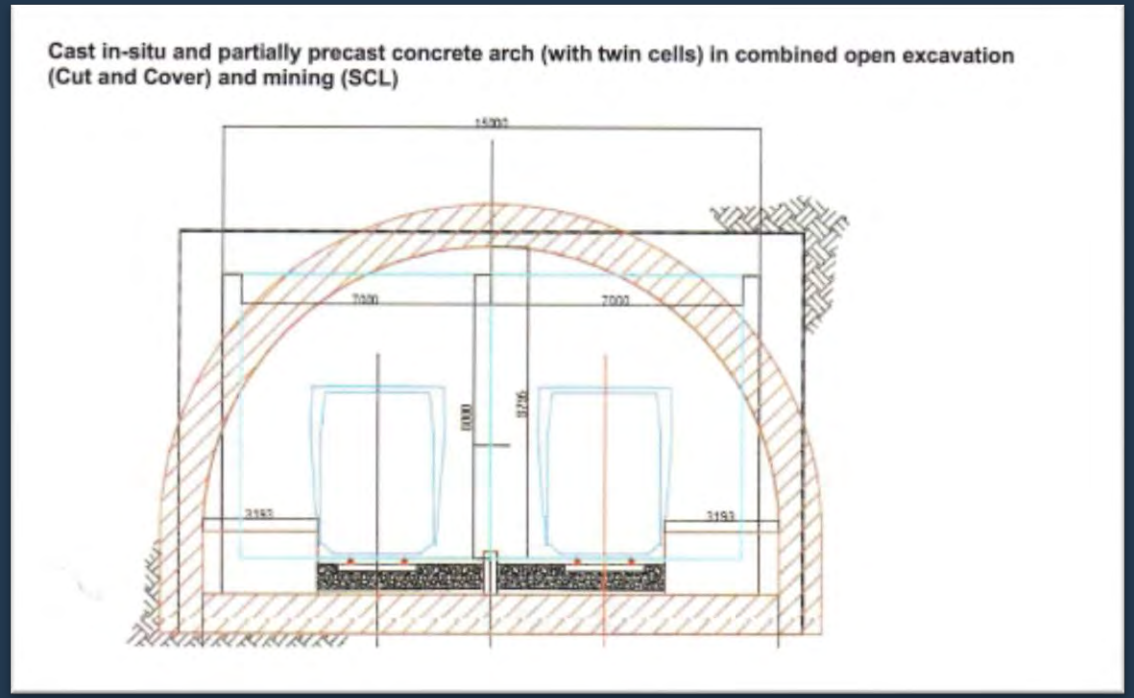
Case Study of Designing for Carbon Reduction

Example: building a train tunnel

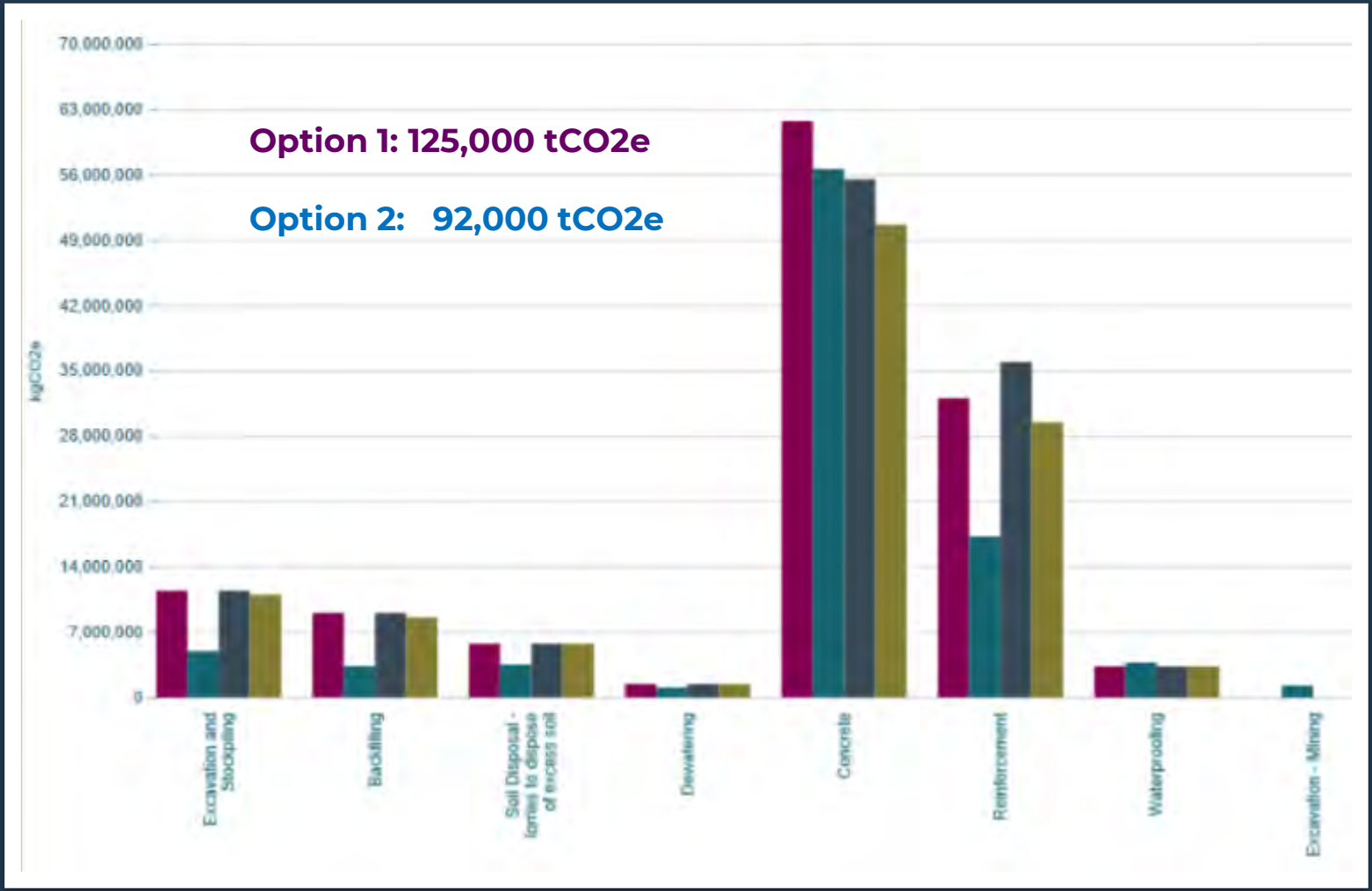
Different Engineering Options



- Variations on
  - Cut & cover and/or mining
  - Concrete and/or steel
  - Boxes and/or arches

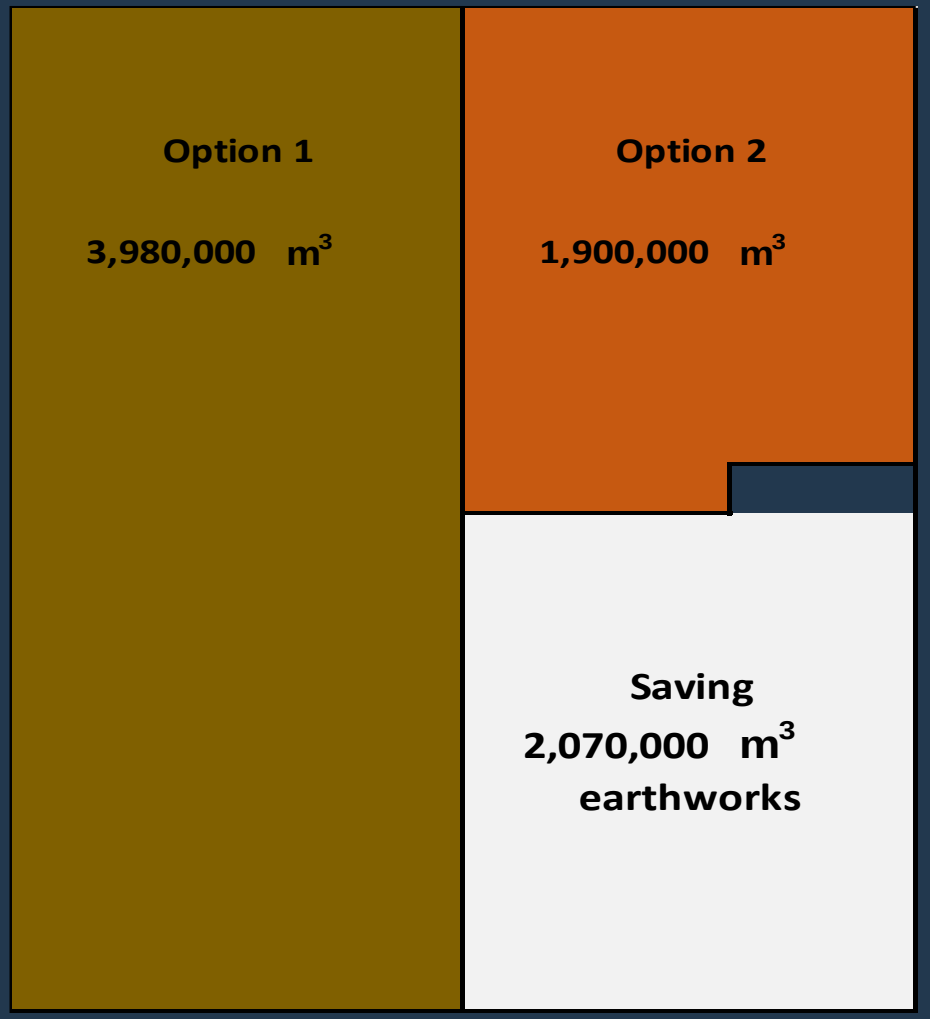


Carbon impacts for the options



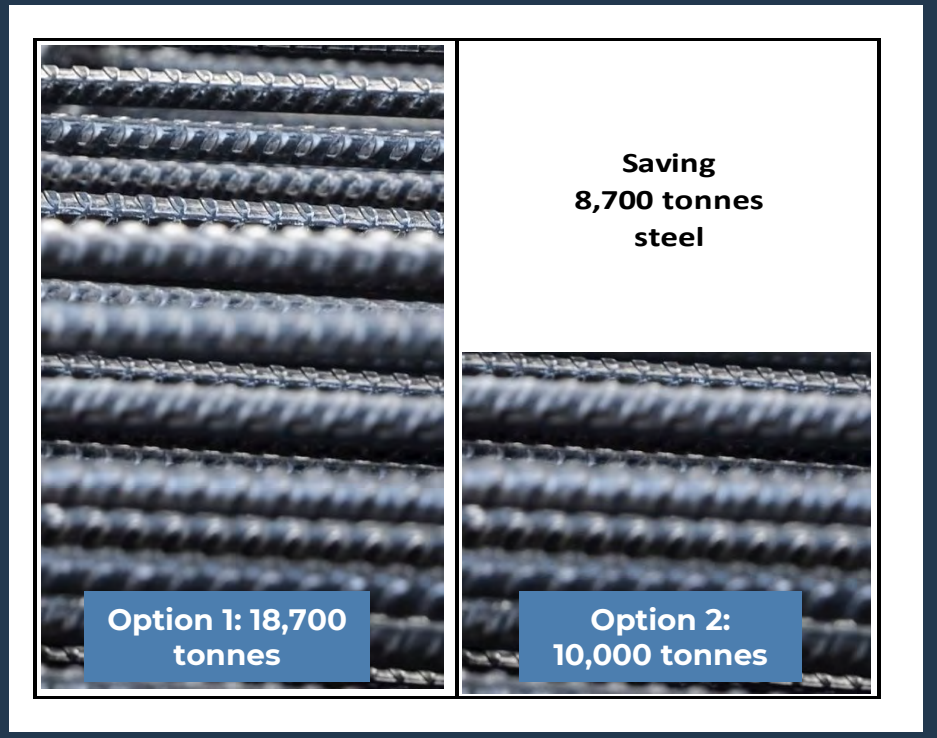
1. Excavation
2. Backfilling
3. Soil disposal
4. Dewatering
5. Concrete
6. Reinforcement
7. Waterproofing
8. Mining

Carbon and Earthworks savings



SUPPLY CHAIN SUSTAINABILITY SCHOOL

Concrete and steel savings



SUPPLY CHAIN SUSTAINABILITY SCHOOL

Carbon Equivalency

- 33,000 tCO2e saved is equivalent to avoiding:
  - 1000 HGVs, each driving 24,000 miles; or
  - 40 full A380 flights from LHR to NYC; or
  - Emissions from grid electric and gas used in 10,000 UK homes for a year – roughly equivalent to a town the size of Aberdare, Pontypridd, Winsford, or Beverley

https://www.constructionenquirer.com/2021/11/16/hs2-hails-big-carbon-saving-on-uks-longest-rail-bridge/

https://www.pbctoday.co.uk/news/planning-construction-news/hs2-colne-valley-viaduct/101860/

The end of the training... for now...

...but the beginning of your carbon reduction plans!....

Questions, Answers and Feedback

Thank you!

James Cadman

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