Infrastructure and Society
UKCRIC

May 2022

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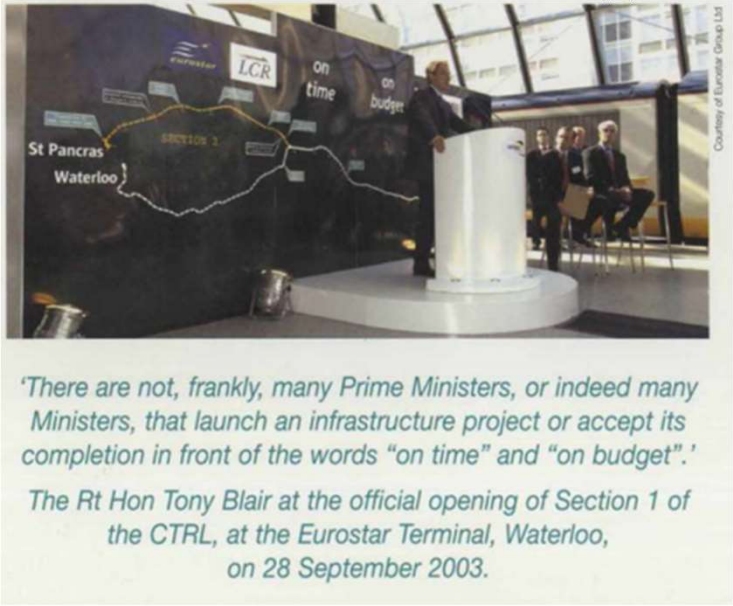
Designers for infrastructure and cities

Used to be:

- Is it stable
- Does it work
- Build it safely
- Build on time and to budget



'There are not, frankly, many Prime Ministers, or indeed many Ministers, that launch an infrastructure project or accept its completion in front of the words "on time" and "on budget".'

The Rt Hon Tony Blair at the official opening of Section 1 of the CTRL, at the Eurostar Terminal, Waterloo, on 28 September 2003.

Now:

- Is it resilient
- Is it low carbon
- Is it whole life low carbon
- What broader benefits
- What is its impact on Nature / biodiversity
- How can it benefit society / Social Value
- Jobs / levelling up…..

And mid 2022

- More for less / How can I spend less?

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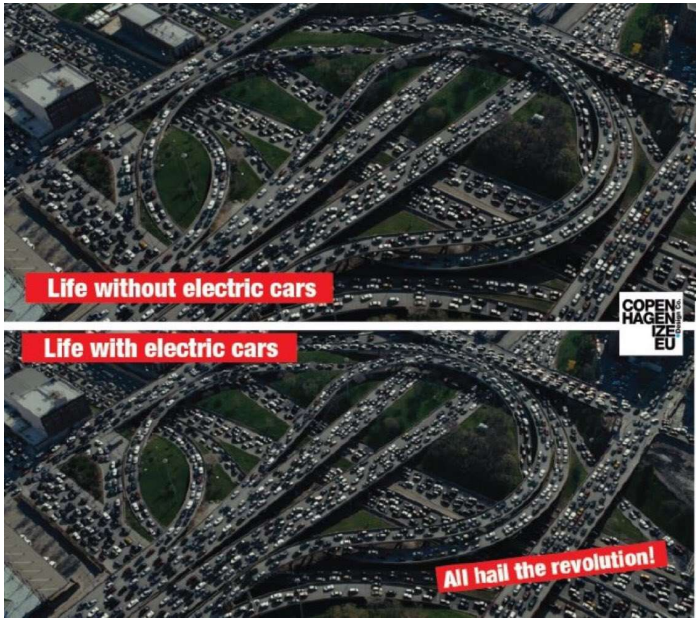
We need to make better choices

- Not just more CAVs



https://twitter.com/_dmoser/status/1355467640635076612/photo/1

https://twitter.com/berkie1/status/1355231750272786435/photo/1

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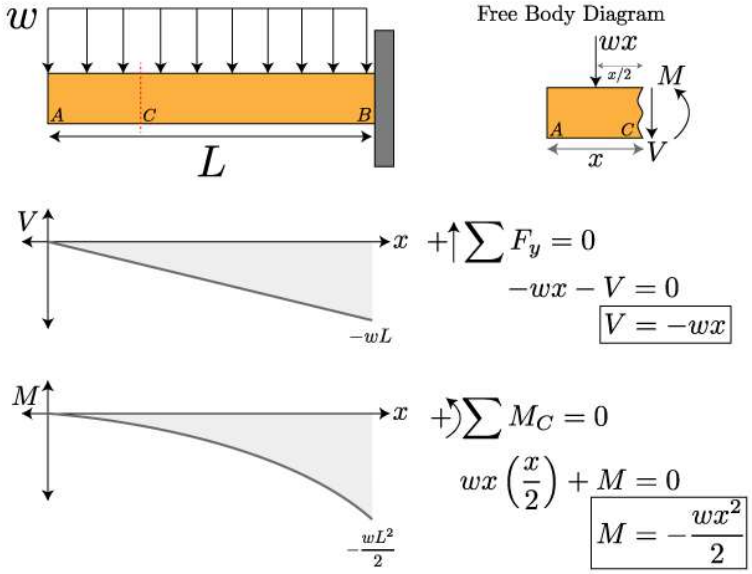
Engineer design – what's the most difficult thing to understand?!



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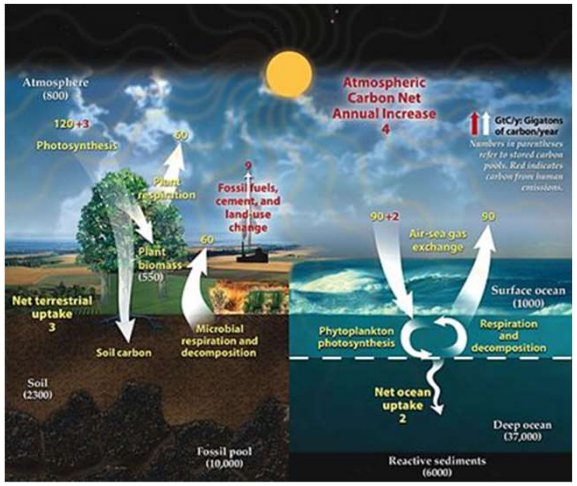
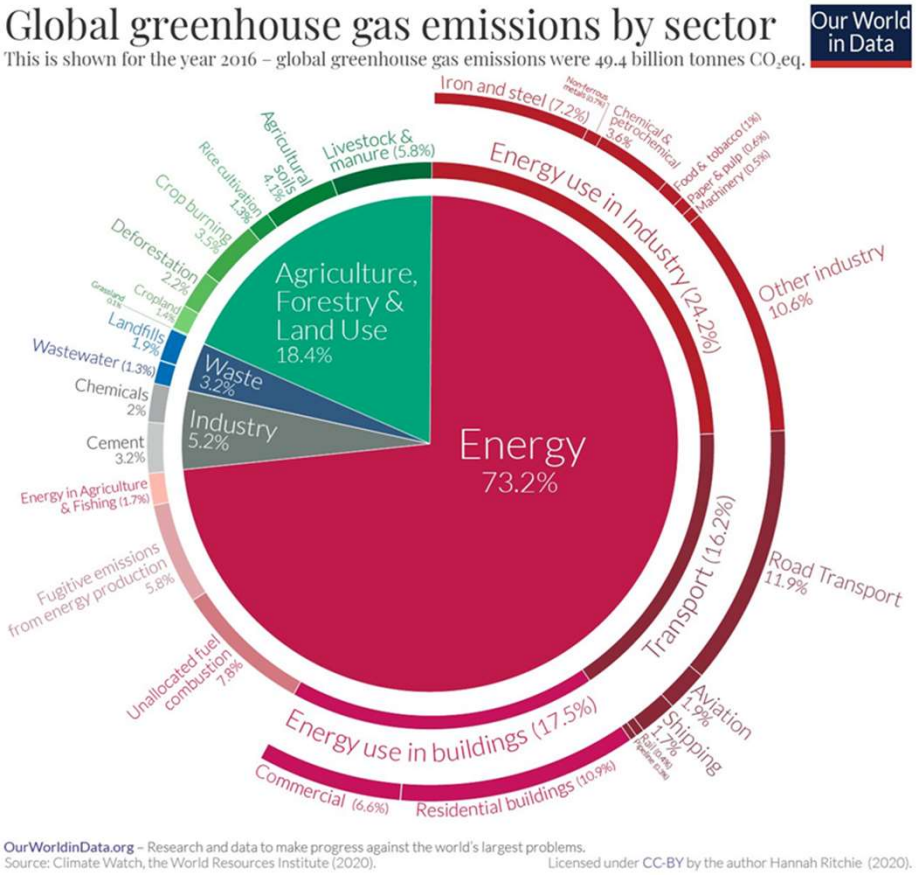
What does NET ZERO actually mean?

GHG = CO2 + CH4 + ……

- Globally it is clear
- Nations – fairly clear
- City regions / companies – less clear





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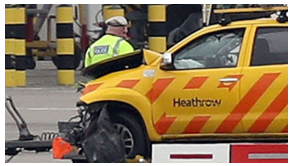
PAS 2080: Future infrastructure – Saving whole-life Carbon

- A new engineering system – learn the units
- Need data to normalise and develop rules of thumb

- Low carbon = CapCarb + OpCarb + UseCarb



Control

Influence

Invest to save

Optimise to reduce

- To be done Whole System

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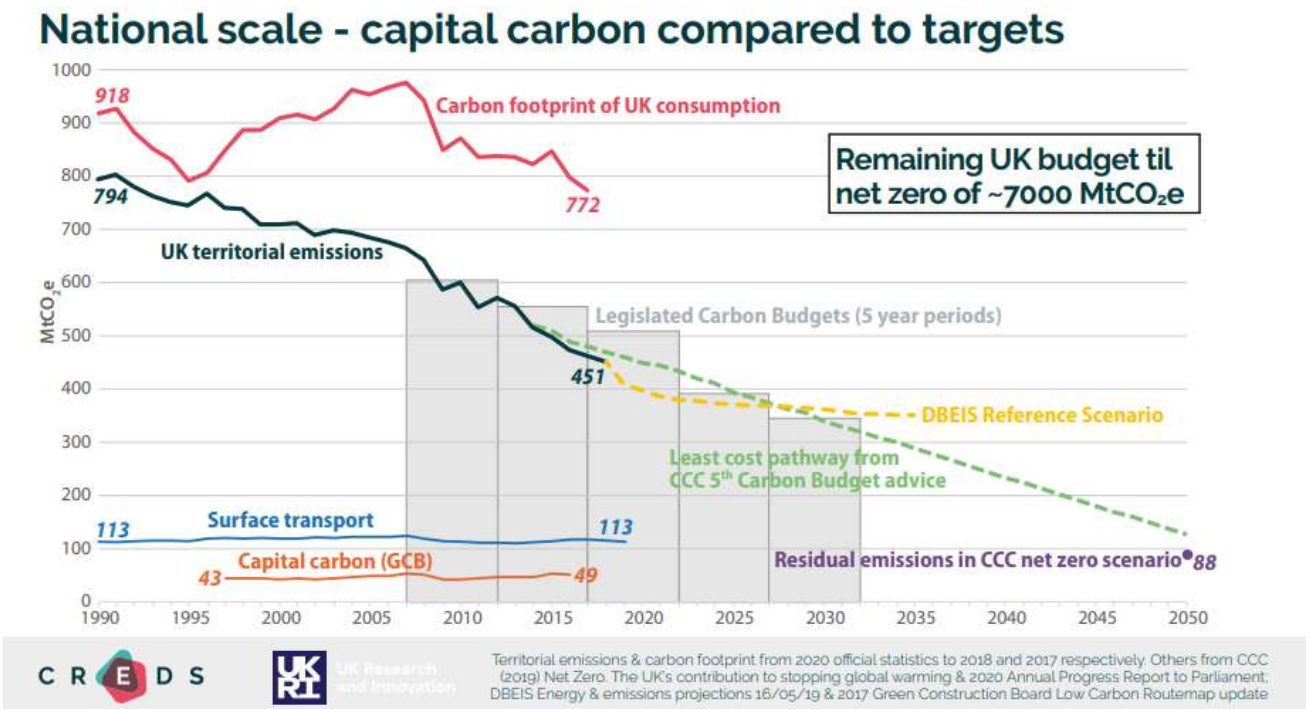
Low carbon infrastructure?



$MtCO_2e/yr$	Cap Carb	Op Carb	Use Carb	Total Carb
Comms	0.8	0.6	1.2	2.6
Energy	4.4	59.5	132.0	195.9
Transport	3.8	0.2	168.7	172.8
Waste	0.05	18.8		18.8
Water	1.1	4.3	17.6	23.0
Total	10.2	83.4	319.5	413.1

Thank you to jannik.giesekam@strath.ac.uk

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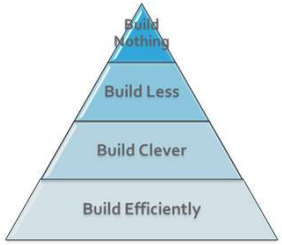
And the project scale?

Project scale - capital carbon



10 kt | 100 kt | 1 Mt | 10 Mt

M54-M6 Link Road
81,890 tCO2e
1.6 miles new road
2 new junctions
& some realignment

A14 extension
981,432 tCO2e
23 miles of upgrades
7 miles widening
new bypass
& local modifications

HS2
13.3 MtCO2e

Heathrow 3rd runway
3.6 MtCO2e

Newport M4
0.5 MT

Lower Thames Crossing
2.0 MT

Land Area Requirements for DAC and Reforestation

CDR approach	Area (km^2) needed to capture 1 million tonnes of CO_2	
Reforestation (global average)	862	
	Area for DAC system	**Area for energy source**
DAC: Solvent + natural gas with carbon capture	0.4[a]	
DAC: Solvent + solar PV	0.4[a]	7.7[b]
DAC: Solvent DAC + geothermal	0.4[a]	1.5[b]
DAC: Sorbent DAC + solar PV	1.2-1.7	23
DAC: Sorbent DAC + geothermal	1.2-1.7	4.7

Sources: Reforestation numbers based on Cook-Patton et al. 2020; DAC numbers based on Carbon Engineering, 2020; DOE 2019; Stevens et al. 2017; NASEM 2019; Baker et al. 2020.

WORLD RESOURCES INSTITUTE

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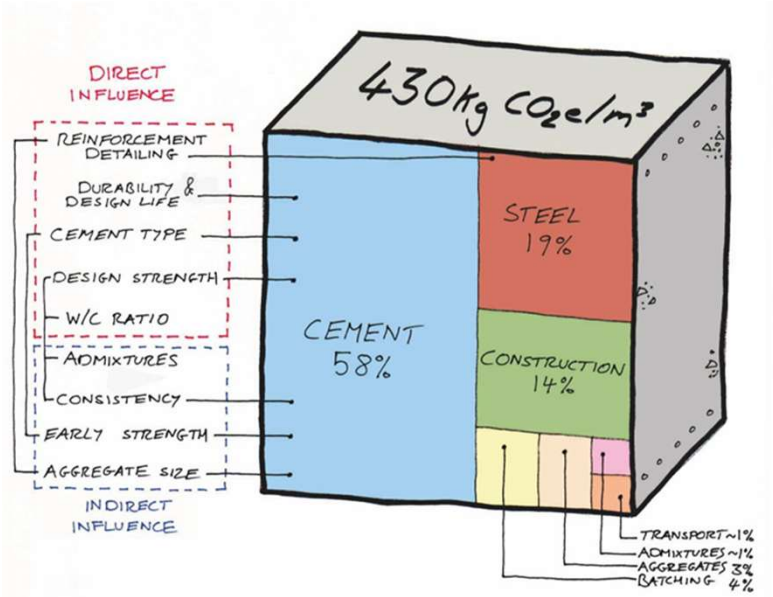
And in those projects…..

- We must reduce Capital (embodied) Carbon to the fullest extent
- But not so that the asset can't perform
- Always satisfy the client sought OUTCOME
- And also don't compromise Whole Life Carbon
- Example – new rail project



https://www.istructe.org/journal/volumes/volume-99-(2021)/issue-2/how-can-we-reduce-the-embodied-carbon-of-concrete/

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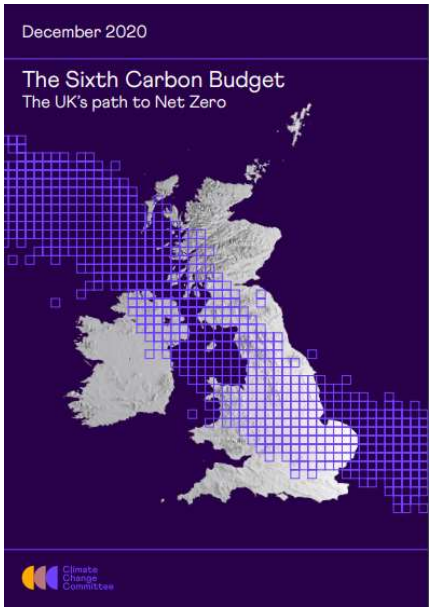
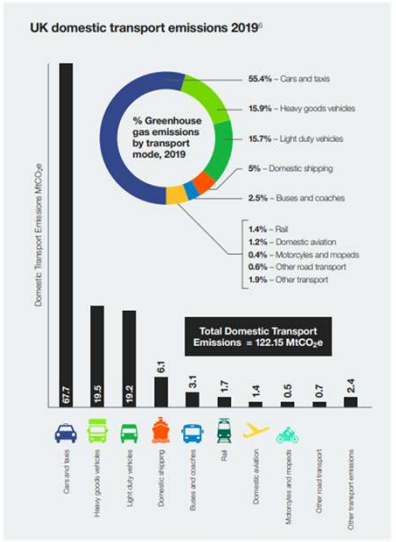
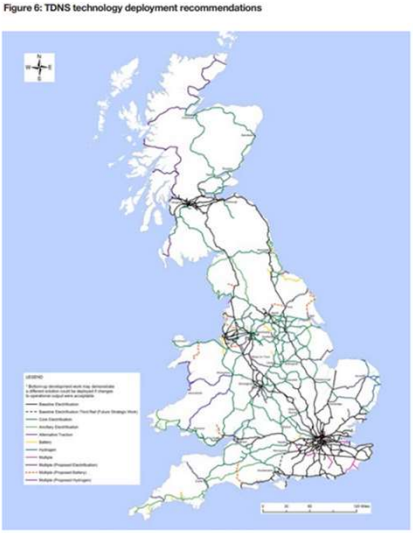
And UK policy context – new subjects being created!







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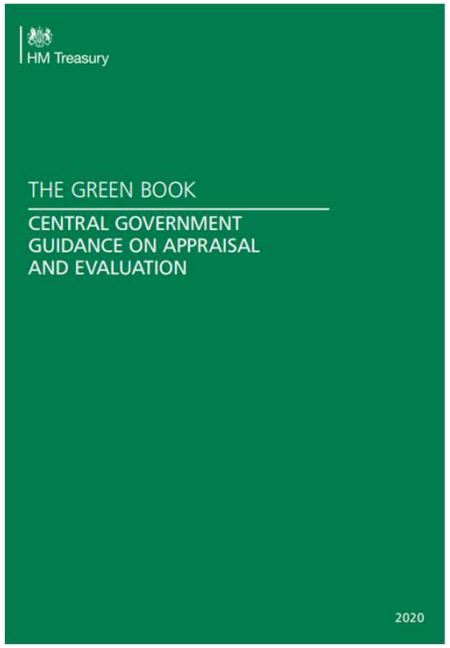
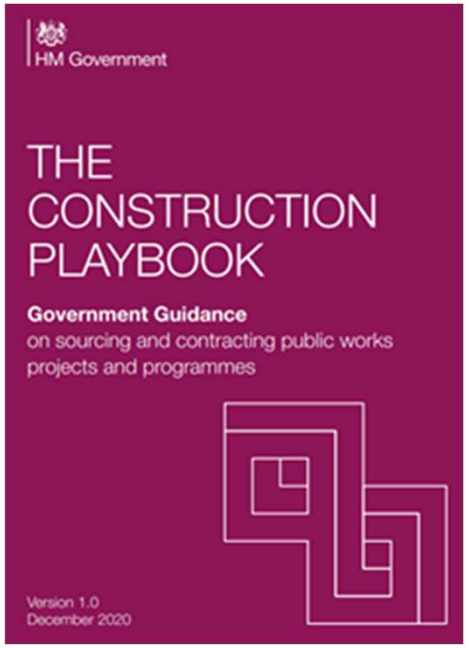
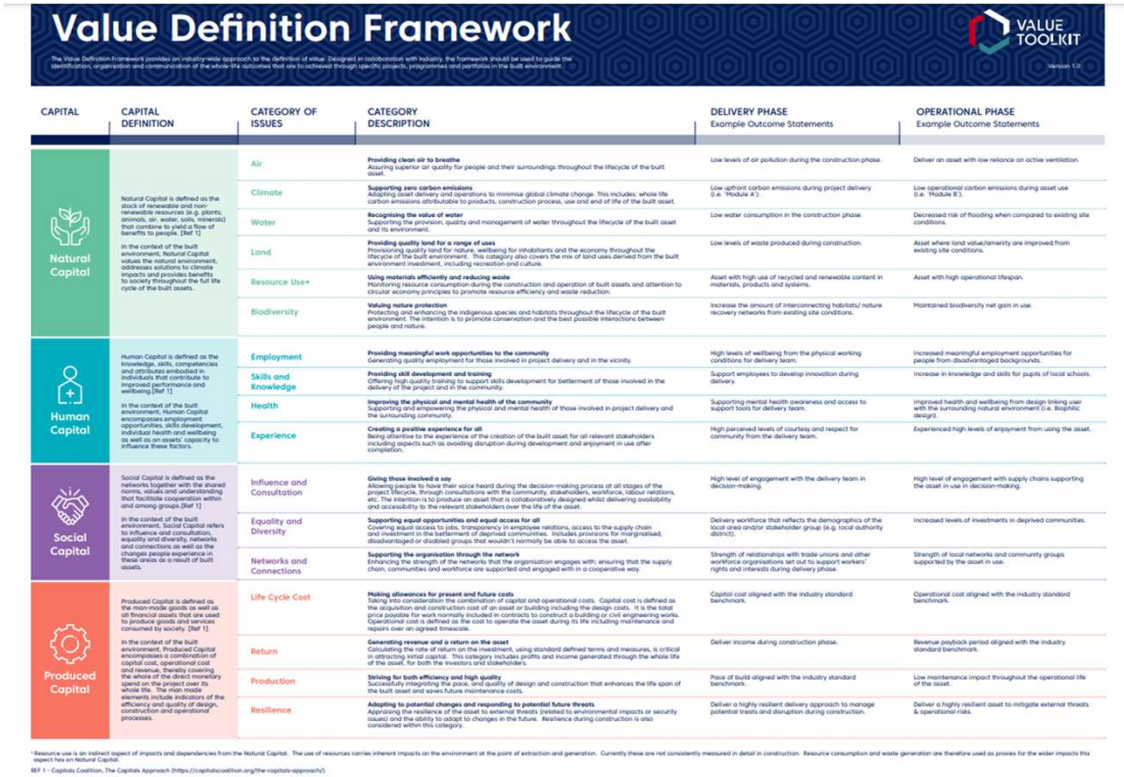
Picking the right projects to build – we have paradigm change!







Value Definition Framework

VALUE TOOLKIT

CAPITAL	CAPITAL DEFINITION	CATEGORY OF ISSUES	CATEGORY DESCRIPTION	DELIVERY PHASE Example Outcome Statements	OPERATIONAL PHASE Example Outcome Statements
Natural Capital	Natural Capital is defined as the stock of renewable and non-renewable resources (e.g. plants, animals, air, water, soils, minerals) that combine to yield a flow of benefits to people. [Ref 1] In the context of the built environment, Natural Capital values the natural environment, addresses solutions to climate impacts and provides benefits to society throughout the full life cycle of the built assets.	Air	**Providing clean air to breathe** Assuring superior air quality for people and their surroundings throughout the lifecycle of the built asset.	Low levels of air pollution during the construction phase.	Deliver an asset with low reliance on active ventilation.
		Climate	**Supporting zero carbon emissions** Adopting asset delivery and operations to minimise global climate change. This includes: whole life carbon emissions attributable to products, construction process, use and end of life of the built asset.	Low upfront carbon emissions during project delivery (i.e. 'Module A').	Low operational carbon emissions during asset use (i.e. 'Module B').
		Water	**Recognising the value of water** Supporting the provision, quality and management of water throughout the lifecycle of the built asset and its environment.	Low water consumption in the construction phase.	Decreased risk of flooding when compared to existing site conditions.
		Land	**Providing quality land for a range of uses** Provisioning quality land for nature, wellbeing for inhabitants and the economy throughout the lifecycle of the built environment. This category also covers the mix of land uses derived from the built environment investment, including recreation and culture.	Low levels of waste produced during construction.	Asset where land value/amenity are improved from existing site conditions.
		Resource Use+	**Using materials efficiently and reducing waste** Monitoring resource consumption during the construction and operation of built assets and attention to circular economy principles to promote resource efficiency and waste reduction.	Asset with high use of recycled and renewable content in materials, products and systems.	Asset with high operational lifespan.
		Biodiversity	**Valuing nature protection** Protecting and enhancing the indigenous species and habitats throughout the lifecycle of the built environment. The intention is to promote conservation and the best possible interactions between people and nature.	Increase the amount of interconnecting habitats/ nature recovery networks from existing site conditions.	Maintained biodiversity net gain in use.
Human Capital	Human Capital is defined as the knowledge, skills, competencies and attributes embodied in individuals that contribute to improved performance and wellbeing.[Ref 1] In the context of the built environment, Human Capital encompasses employment opportunities, skills development, individual health and wellbeing as well as on assets' capacity to influence these factors.	Employment	**Providing meaningful work opportunities to the community** Generating quality employment for those involved in project delivery and in the vicinity.	High levels of wellbeing from the physical working conditions for delivery team.	Increased meaningful employment opportunities for people from disadvantaged backgrounds.
		Skills and Knowledge	**Providing skill development and training** Offering high quality training to support skills development for betterment of those involved in the delivery of the project and in the community.	Support employees to develop innovation during delivery.	Increase in knowledge and skills for pupils of local schools.
		Health	**Improving the physical and mental health of the community** Supporting and empowering the physical and mental health of those involved in project delivery and the surrounding community.	Supporting mental health awareness and access to support tools for delivery team.	Improved health and wellbeing from design linking user with the surrounding natural environment (i.e. Biophilic design).
		Experience	**Creating a positive experience for all** Being attentive to the experience of the creation of the built asset for all relevant stakeholders including aspects such as avoiding disruption during development and enjoyment in use after completion.	High perceived levels of courtesy and respect for community from the delivery team.	Experienced high levels of enjoyment from using the asset.
Social Capital	Social Capital is defined as the networks together with the shared norms, values and understanding that facilitate cooperation within and among groups.[Ref 1] In the context of the built environment, Social Capital refers to influence and consultation, equality and diversity, networks and connections as well as the changes people experience in these areas as a result of built assets.	Influence and Consultation	**Giving those involved a say** Allowing people to have their voice heard during the decision-making process at all stages of the project lifecycle, through consultations with the community, stakeholders, workforce, labour relations, etc. The intention is to produce an asset that is collaboratively designed whilst delivering availability and accessibility to the relevant stakeholders over the life of the asset.	High level of engagement with the delivery team in decision-making.	High level of engagement with supply chains supporting the asset in use in decision-making.
		Equality and Diversity	**Supporting equal opportunities and equal access for all** Covering equal access to jobs, transparency in employee relations, access to the supply chain and investment in the betterment of deprived communities. Includes provisions for marginalised, disadvantaged or disabled groups that wouldn't normally be able to access the asset.	Delivery workforce that reflects the demographics of the local area and/or stakeholder group (e.g. local authority district).	Increased levels of investments in deprived communities.
		Networks and Connections	**Supporting the organisation through the network** Enhancing the strength of the networks that the organisation engages with; ensuring that the supply chain, communities and workforce are supported and engaged with in a cooperative way.	Strength of relationships with trade unions and other workforce organisations set out to support workers' rights and interests during delivery phase.	Strength of local networks and community groups supported by the asset in use.
Produced Capital	Produced Capital is defined as the man-made goods as well as all financial assets that are used to produce goods and services consumed by society. [Ref 1] In the context of the built environment, Produced Capital encompasses a combination of capital cost, operational cost and revenue, thereby covering the whole of the direct monetary spend on the project over its whole life. The man made elements include indicators of the efficiency and quality of design, construction and operational processes.	Life Cycle Cost	**Making allowances for present and future costs** Taking into consideration the combination of capital and operational costs. Capital cost is defined as the acquisition and construction cost of an asset or building including the design costs. It is the total price payable for work normally included in contracts to construct a building or civil engineering works. Operational cost is defined as the cost to operate the asset during its life including maintenance and repairs over an agreed timescale.	Capital cost aligned with the industry standard benchmark.	Operational cost aligned with the industry standard benchmark.
		Return	**Generating revenue and a return on the asset** Calculating the rate of return on the investment, using standard defined terms and measures, is critical in attracting initial capital. This category includes profits and income generated through the whole life of the asset, for both the investors and stakeholders	Deliver income during construction phase.	Revenue payback period aligned with the industry standard benchmark.
		Production	**Striving for both efficiency and high quality** Successfully integrating the pace, and quality of design and construction that enhances the life span of the built asset and saves future maintenance costs.	Pace of build aligned with the industry standard benchmark.	Low maintenance impact throughout the operational life of the asset.
		Resilience	**Adopting to potential changes and responding to potential future threats** Appraising the resilience of the asset to external threats (related to environmental impacts or security issues) and the ability to adapt to changes in the future. Resilience during construction is also considered within this category.	Deliver a highly resilient delivery approach to manage potential treats and disruption during construction.	Deliver a highly resilient asset to mitigate external threats & operational risks.

+Resource use is an indirect aspect of impacts and dependencies from the Natural Capital. The use of resources carries inherent impacts on the environment at the point of extraction and generation. Currently these are not consistently measured in detail in construction. Resource consumption and waste generation are therefore used as proxies for the wider impacts this aspect has on Natural Capital.

REF 1 - Capitals Coalition, The Capitals Approach (https://capitalscoalition.org/the-capitals-approach/)

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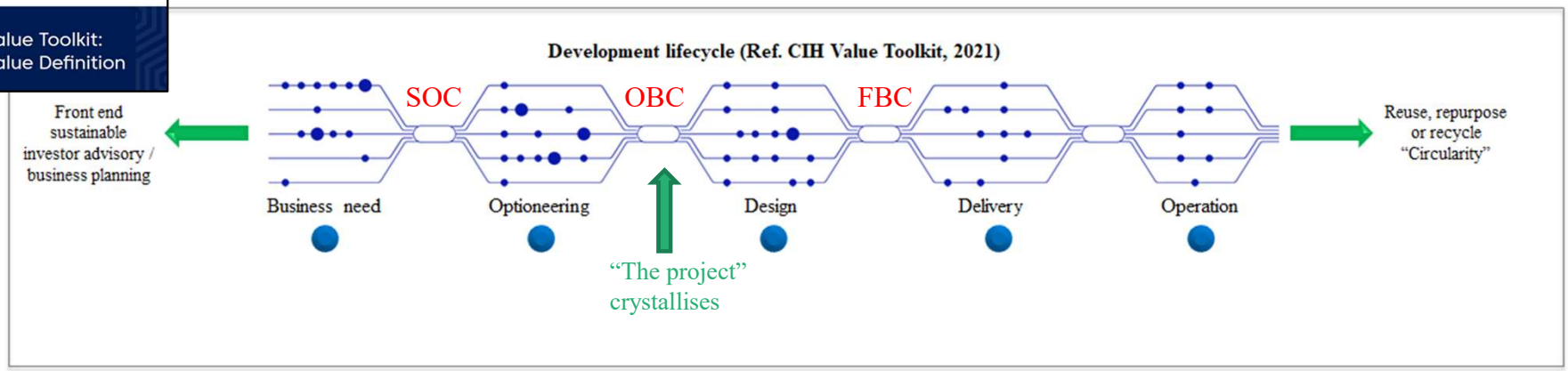
CIH Value Toolkit - 1

CONSTRUCTION INNOVATION HUB

Value Toolkit:
Value Definition



Solution agnostic – might not build?
Agree client's **mission** and **outcomes**
Leading to tangible **benefits**
Align stakeholders
Client reflection on purpose

Commercial strategy ready to procure
In parallel with planning, **design** etc

Find single optimal solution
Choose how to deploy team

Infrastructure and Projects Authority

Eight principles for project success

Principle 1: Focus on outcomes

https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/901126/IPA_Principles_for_Project_Success.pdf

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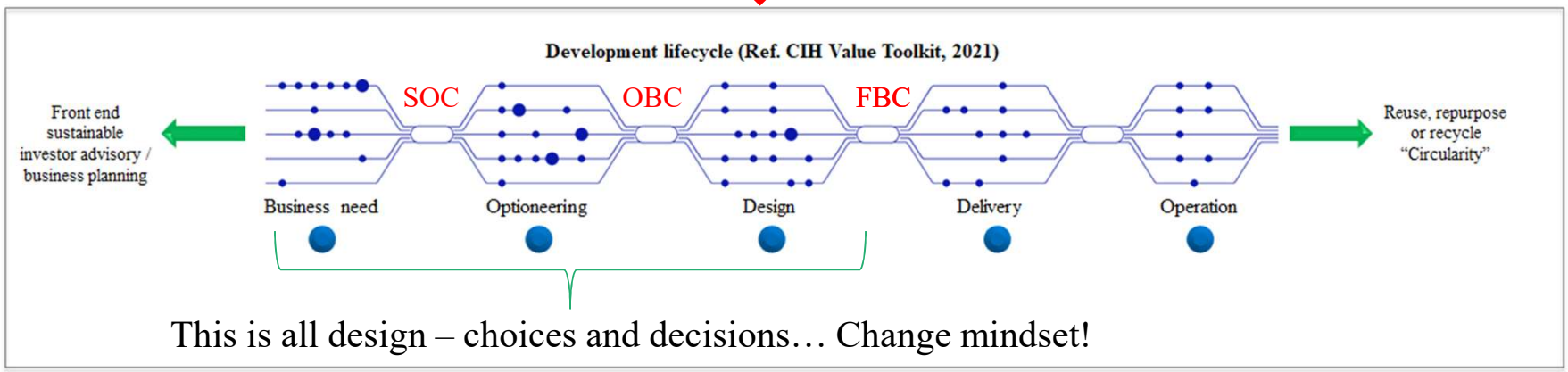
CIH Value Toolkit - 4

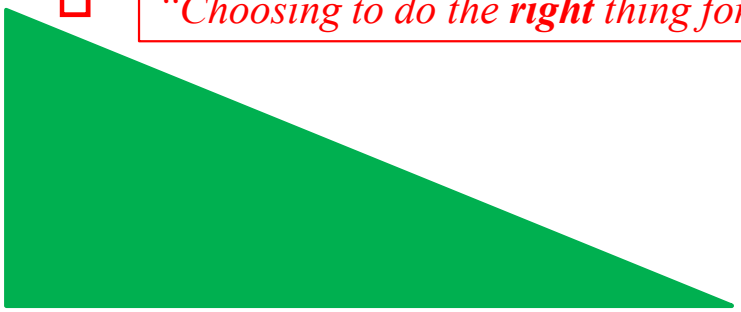
"Doing the wrong thing well?"



This is all design – choices and decisions… Change mindset!

*"Choosing to do the **right** thing for long-term societal benefits"*

Impact of design decisions on outcomes



Do more at the start for impact – think carefully to choose to do the **right** projects

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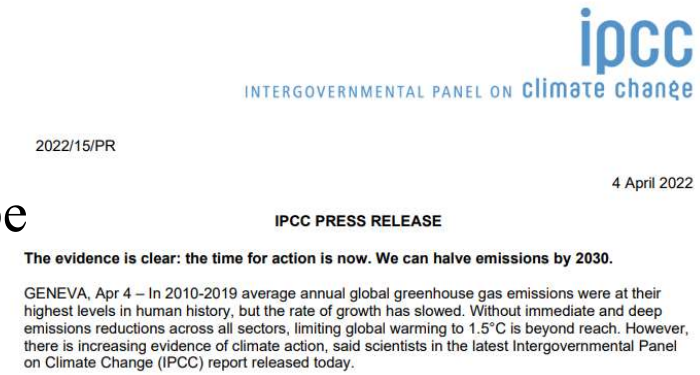
Challenges

- 3 crises: time is very short – are we doing enough?
  - How do we fix so many things together (and they have to be fixed in tandem)?!
- Are engineering degrees fit for purpose in what they teach?
  - So many new topics and sciences – many of which are just nascent and no one knows
  - We need to upskill in big systems thinking
  - I started life as a geotechnical engineer – for a blend of art and science – would I now? What would be more fun? Which skills might offer me a career for 45 years?
- Is post qualification experience sufficient to upskill current engineers
- Are we teaching engineers enough about finance and political activism, to engage with key decision makers – and ideally join them



ipcc
INTERGOVERNMENTAL PANEL ON climate change

2022/15/PR

4 April 2022

IPCC PRESS RELEASE

The evidence is clear: the time for action is now. We can halve emissions by 2030.

GENEVA, Apr 4 – In 2010-2019 average annual global greenhouse gas emissions were at their highest levels in human history, but the rate of growth has slowed. Without immediate and deep emissions reductions across all sectors, limiting global warming to 1.5°C is beyond reach. However, there is increasing evidence of climate action, said scientists in the latest Intergovernmental Panel on Climate Change (IPCC) report released today.

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