C Change Summit 2024

Presentation

Embodied Carbon: The next step in decarbonising real estate

Auditorium

Welcome and Introductions

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Global Cement and Concrete Association

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Quick Definitions

Embodied carbon: The greenhouse gas emissions arising from the manufacturing, transportation, installation, maintenance, and disposal of building materials.

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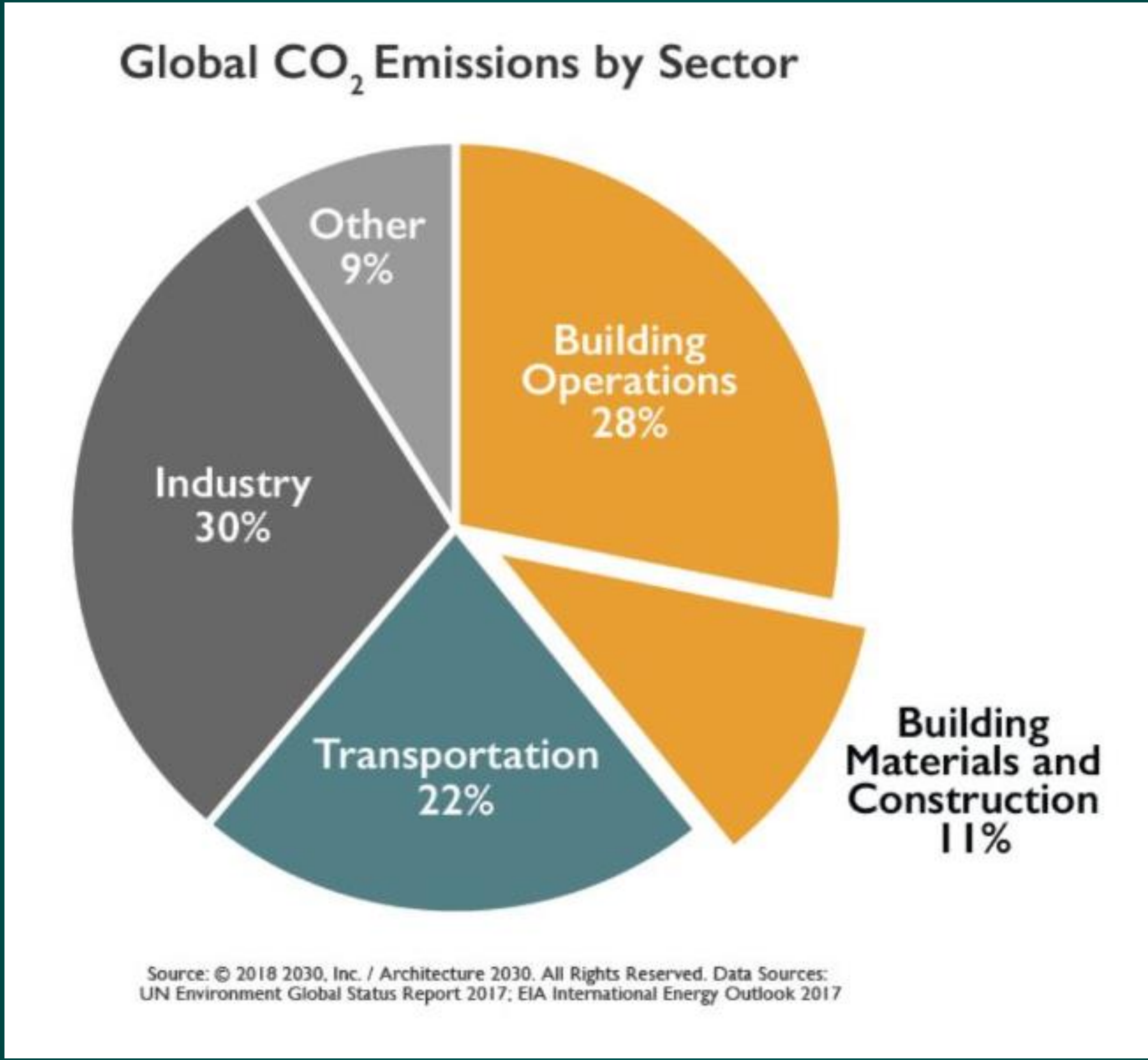
Global CO_2 Emissions by Sector
Other 9%
Building Operations 28%
Industry 30%
Transportation 22%
Building Materials and Construction 11%
Source: © 2018 2030, Inc. / Architecture 2030. All Rights Reserved. Data Sources: UN Environment Global Status Report 2017; EIA International Energy Outlook 2017

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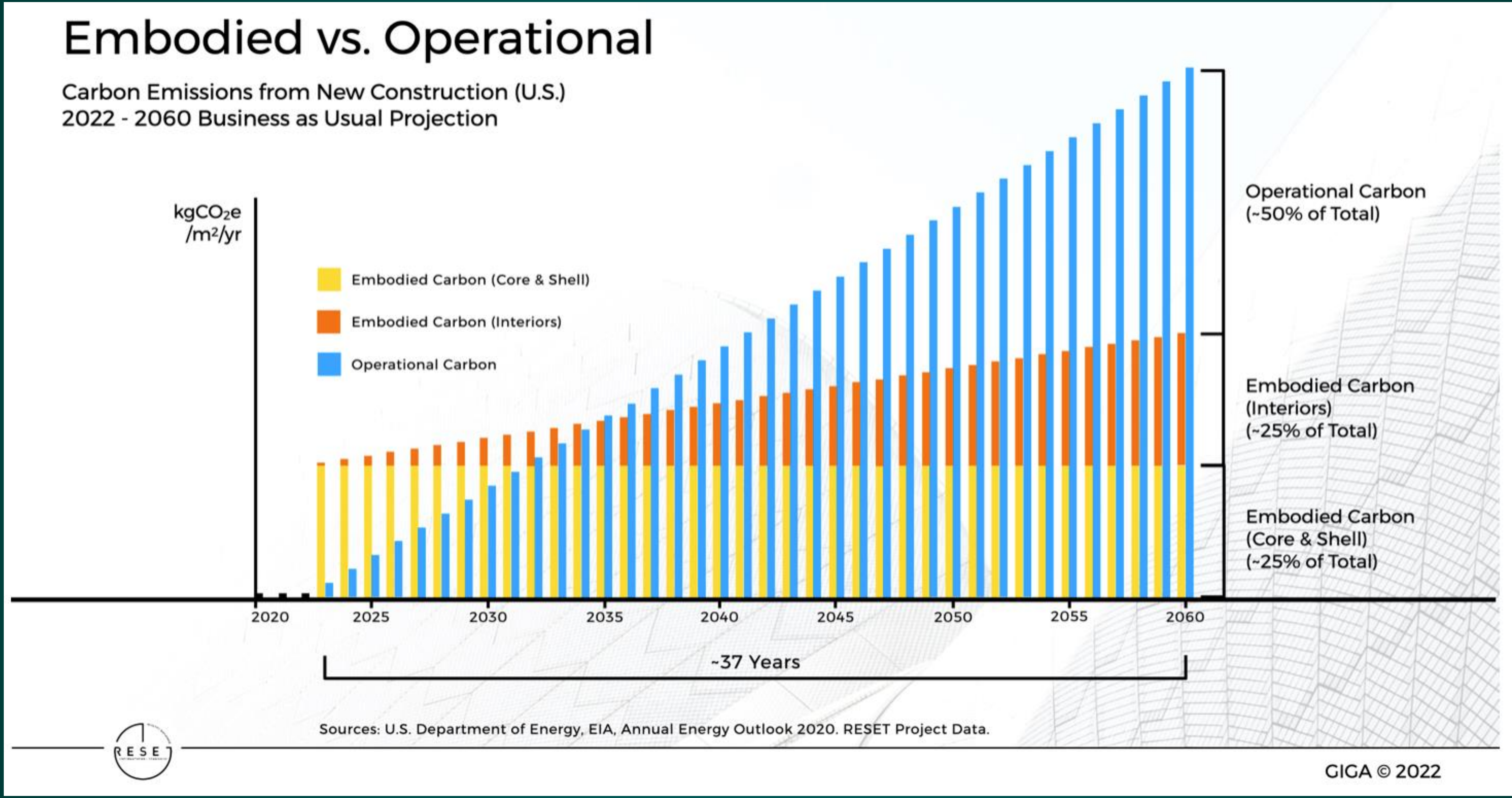

Embodied vs. Operational
Carbon Emissions from New Construction (U.S.)
2022 - 2060 Business as Usual Projection
kgCO2e /m2/yr
Embodied Carbon (Core & Shell)
Embodied Carbon (Interiors)
Operational Carbon
Operational Carbon (~50% of Total)
Embodied Carbon (Interiors) (~25% of Total)
Embodied Carbon (Core & Shell) (~25% of Total)
2020
2025
2030
2035
2040
2045
2050
2055
2060
~37 Years
Sources: U.S. Department of Energy, EIA, Annual Energy Outlook 2020. RESET Project Data.
RESET
GIGA © 2022

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Relevant ULI Resources

The Materials Movement:
Creating Value with Better Building Materials

uli.org/materialsmovement

Carbon Sweet Spot:
Design Tradeoffs for Embodied and Operational Carbon in New Buildings

uli.org/carbonsweetspot

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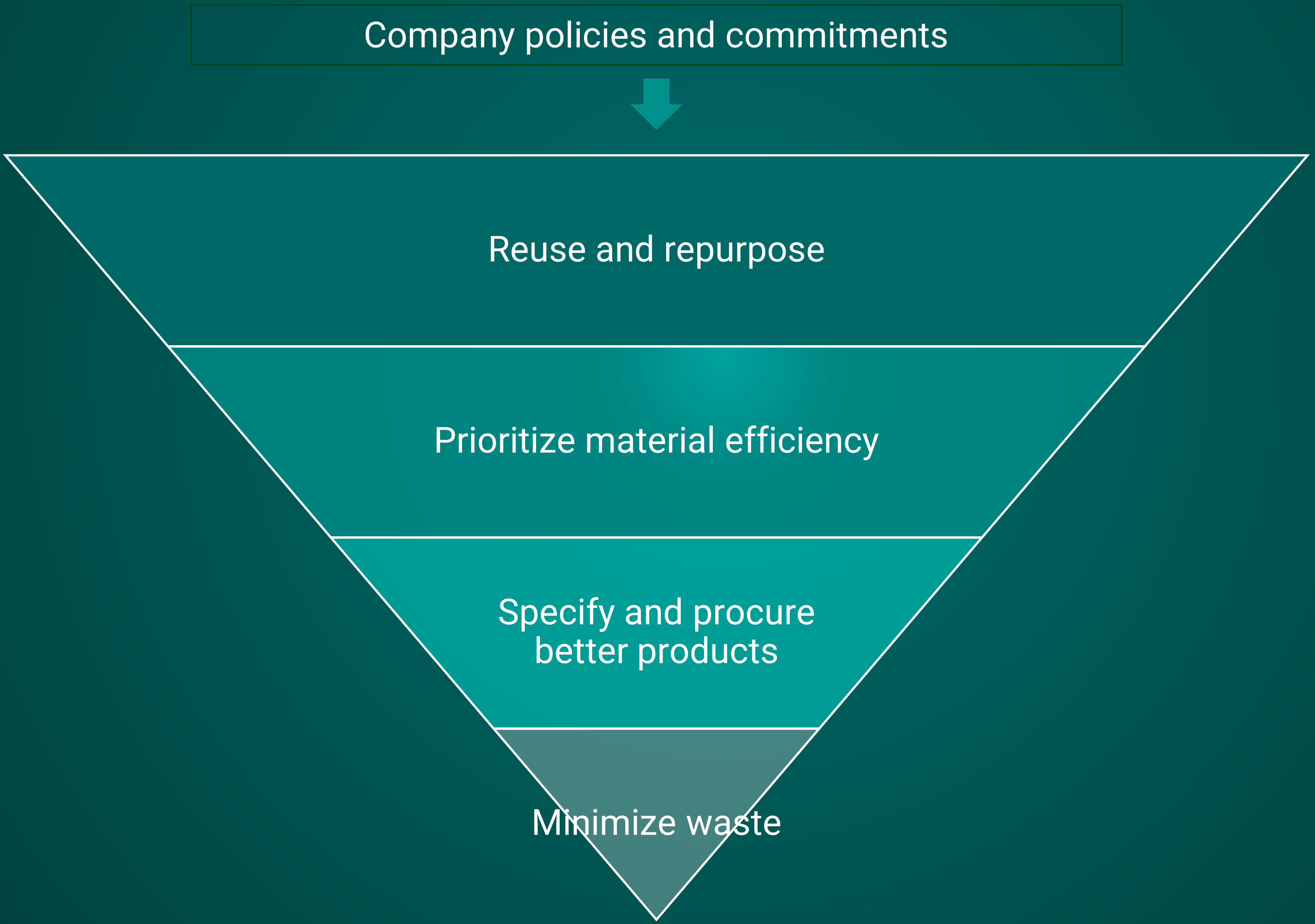
Drivers of the Materials Movement

- Regulations
- Green Building Certifications
- Occupier Demand
- Enhanced Building Value
- ESG Investing Requirements

Strategies



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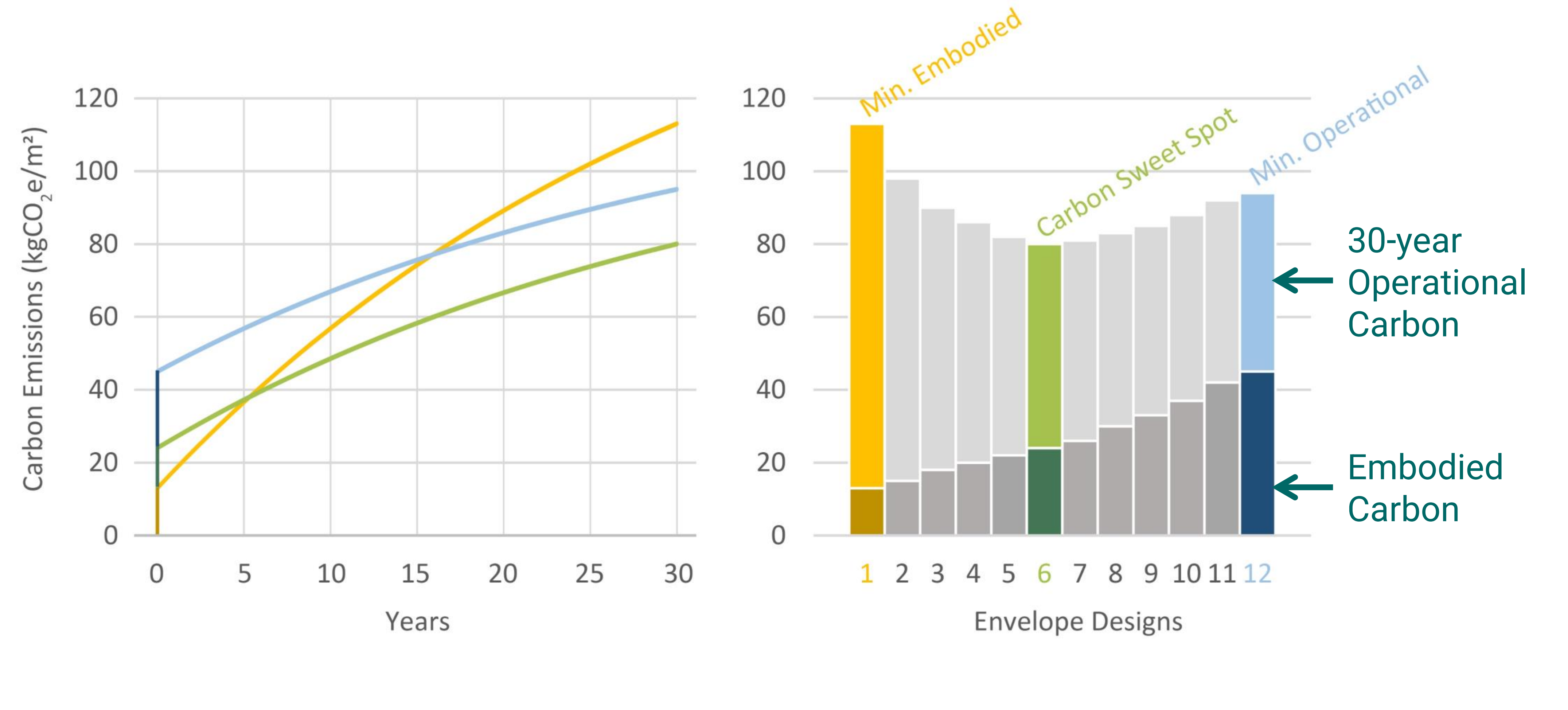
Case Study – Holbein Gardens

Holbein Gardens adaptive reuse project before (left) and after (right)

- 1980s Office Building
  Adaptive reuse by Grosvenor
- Retained the brick façade and the concrete structure
- New brickwork designed for disassembly (lime mortar)
- Used 24 tonnes of reclaimed steel
- Cemfree concrete and CLT

The "Carbon Sweet Spot"



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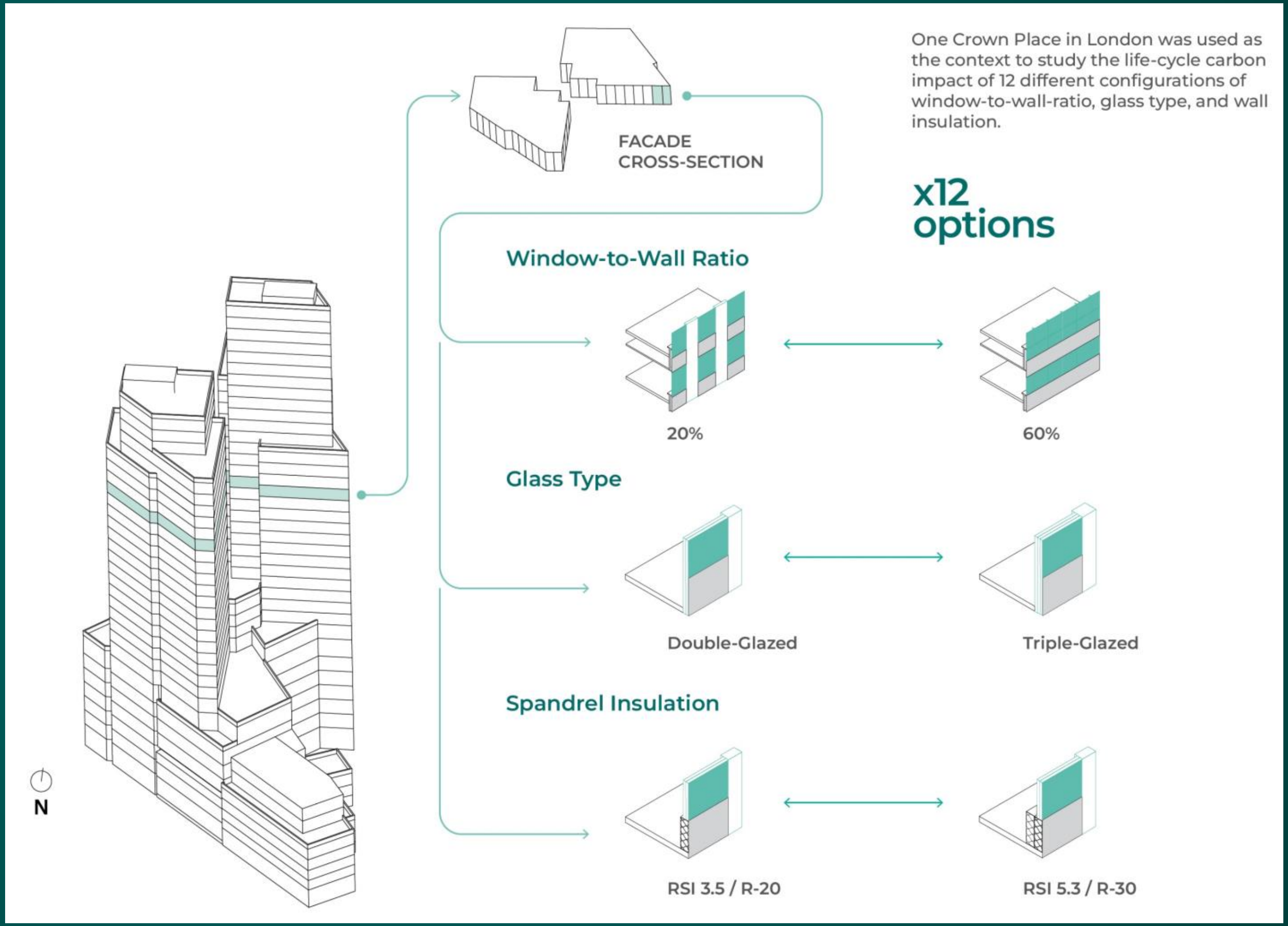
Carbon Sweet Spot Analysis Scope



Facade Parameters Studied:

1. Window-to-wall ratio
2. Glazing Type
3. Wall insulation

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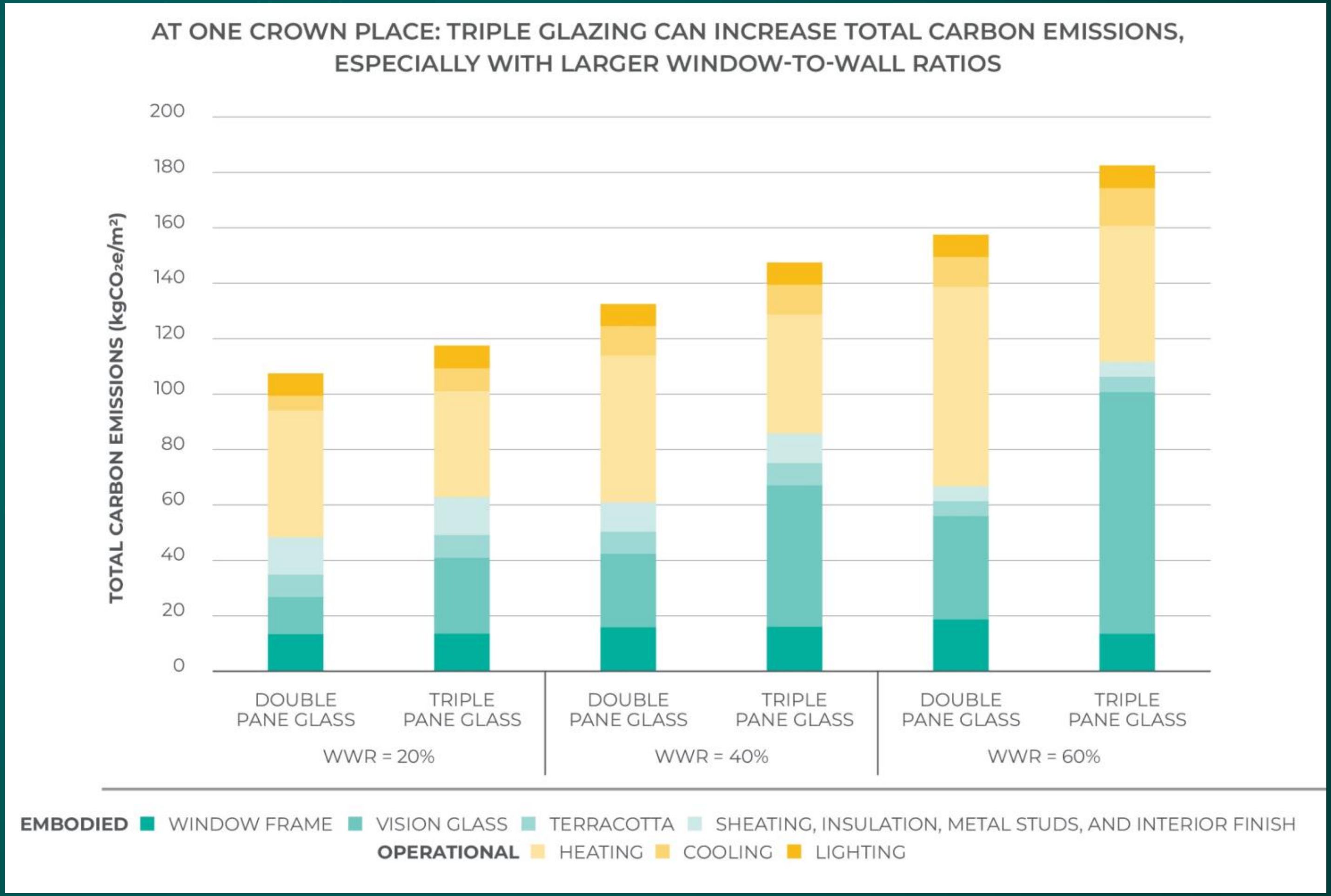
Findings – One Crown Place, London

- Window-to-wall ratios (WWR) significantly affected carbon emissions – more so than glazing type
- Triple glazing resulted in more embodied carbon emissions than it saved in operational
- Wall insulation thickness made only a marginal difference to total carbon emissions



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Carbon Sweet Spot - Conclusions

- Consider both operational and embodied carbon when assessing environmental impact of buildings – look for the **"carbon sweet spot"**
- Understand the impact of **local fuel sources** and **decarbonization policy** on tradeoffs
- Read the full report at **uli.org/CarbonSweetSpot**

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Change

UNSTUDIO

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HONG KONG • MELBOURNE • SHANGHAI


born in amsterdam
designing over 35 years since 1989
uns
UNSTUDIO


active in 58 countries
with over 450 passionate employees
uns
UNSTUDIO


we create enhanced connections
in and between cities, buildings and their inhabitants
uns
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that have a lasting impact!
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Fighting Embodied Carbon

ULI C-Change Conference

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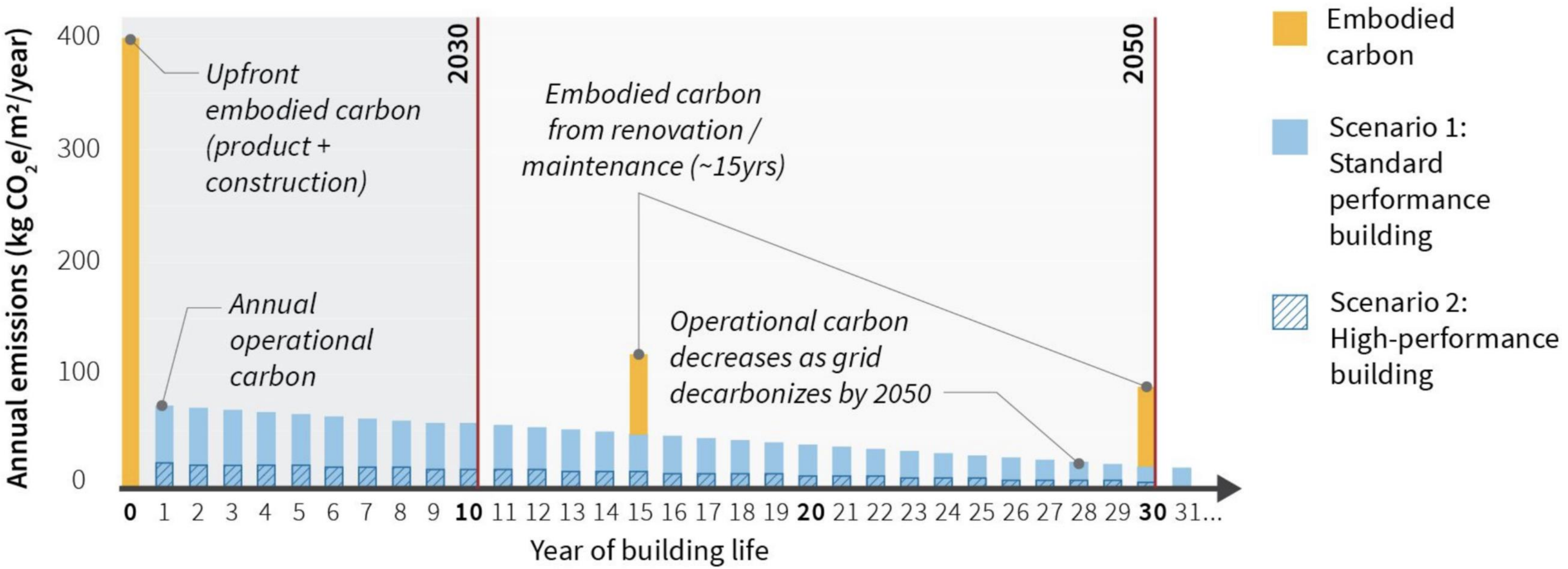
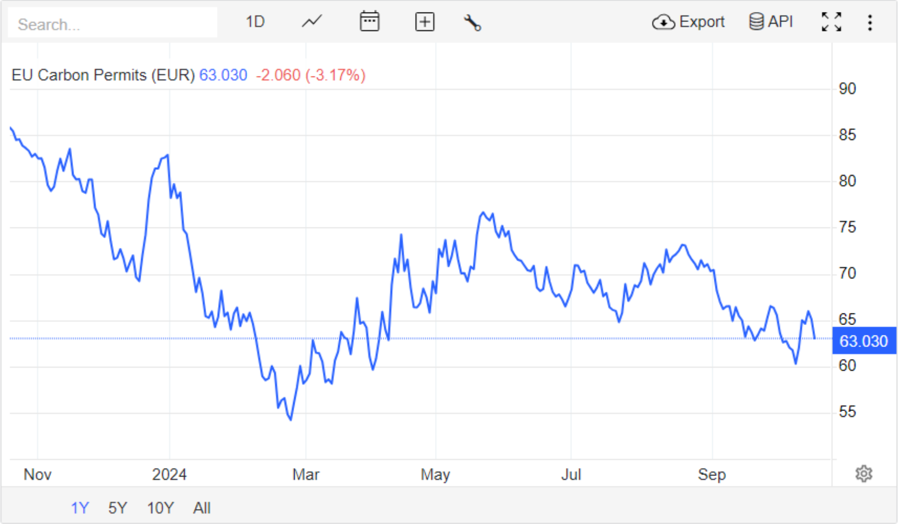
A Whole Life Carbon Approach

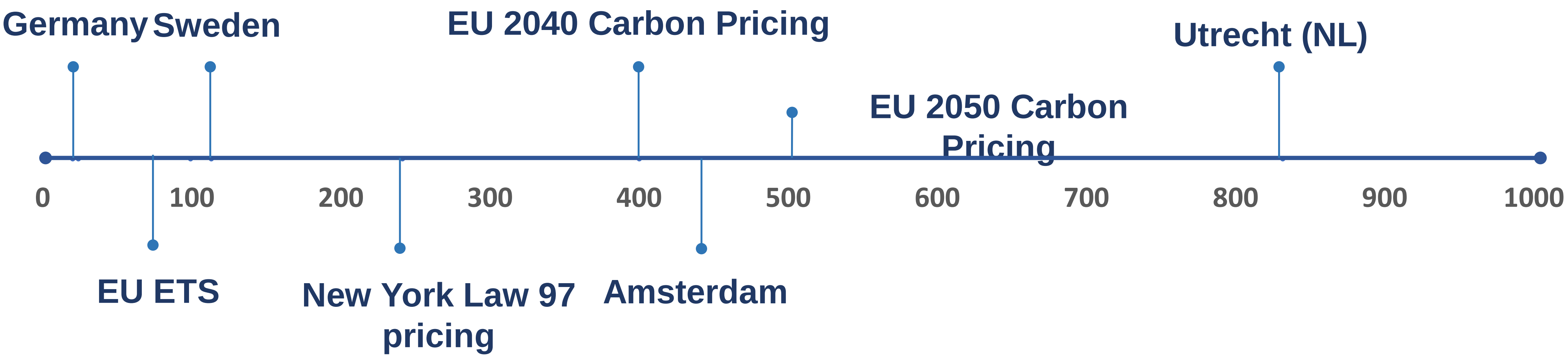


Source : https://bellona.org/news/climate-change/2023-01-embodied-carbon-101

Different Values for Carbon Pricing



Pricing in € / ton



Booking.com HQ| BPD

Netherlands, Amsterdam, Mixed-use, 72.500 m2, BREEAM Excelent

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Focus on Human Health & Wellbeing

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connecting a 5.000 person community in a health activating urban campus

net zero energy & human health focused design

Prix Versailles 2023 winner ‘worlds most beautiful campus building’

Architizer A+Awards – Voter’s Choice - Sustainable Cultural/Institutional Building’

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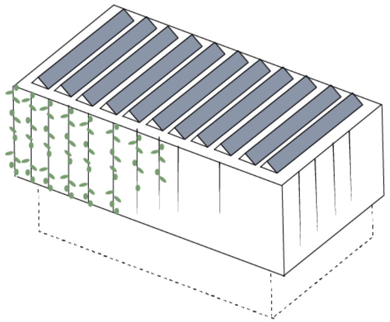
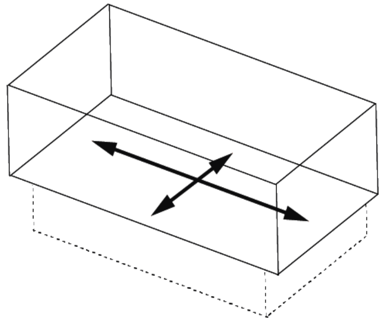
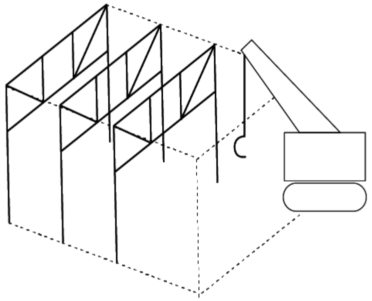
parametrically designed for future flexibility and end-of-life dissasembly



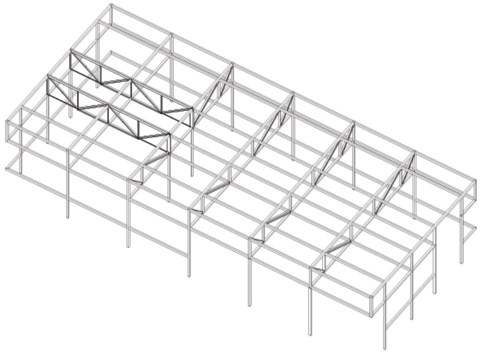
Green Façade & Energy Roof



Large Spans for Future Flexibility



Design For Disassembly



Parametrically optimized to minimize steel usage

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UNStudio. Tools.

The Platform for development

of in-house tools for UNStudio

The AI

PASCAL is the AI Ecosystem for UNStudio. Discover ChatUNS, Imaginarium Creator, Prompt Library, and The Vision—each crafted to streamline our tasks while ensuring utmost security and privacy. Our ecosystem leverages the latest technologies, providing a seamless, safe, and personalized experience.

Early Release

Go to PASCAL →

The Docs

The Documentation platform for every tool.

Pre-Release

Go to The Docs →

Modelspace

The online archive of UNStudio Models.

Pre-Release

Go to Modelspace →

Het Blog!

Updates, inspiration and maybe News

Go to Het Blog! →

UNSHub

Explore, collaborate, and drive Research & Innovation

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Go to UNSHub →

UNStudio.Tools is an innovative platform designed exclusively for UNStudio's development of **in-house tools.** With a wide range of cutting-edge technologies like AI and Carbon Builder, it **empowers our architects and designers** to create groundbreaking solutions.

The Carbon Builder

The Framework for Early Stage Carbon Calculation-

Go to The Carbon Builder →

Concept Canvas

The platform for the Conceptual Design Process.

Go to Concept Canvas →

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ChatUNS Home > AI > Chat

The Toolkit

Stream

New Chat

The Blueprints

Recent Conversations

July '24

Filename:-|-Samenvatting.pdf Reply t

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Uniek Ontsluitingsprincipes for a Vib

Aanpak voor duurzaam onderwijsgeb

Comprehensive Project Introduction

Process Optimization in Design Phase

Convincing University for Pitch with

June '24

Filename:-|-Bijlage 7 Storyline project

Verticaal Verbonden Ruimtelijk Lands

Scoring Scenarios Excel Sheet based

Redesigning Het Voorplein for a Sean

Strategic Plan to Convince Utrecht Ur

Integrated Design and Management

Promoting Health and Well-being in

Enhancing Biodiversity on the UU-Ca

Sustainable Renovation Plan for Uniel

Tools
Select what tools you want to enhance...

how does the building of the future look like

The building of the future is envisioned to be a harmonious blend of advanced technology, sustainability, and human-centric design. Here are some key features and concepts that are likely to define future buildings:

1. Sustainability

- **Energy Efficiency**: Buildings will incorporate renewable energy sources such as solar panels, wind turbines, and geothermal systems. Energy-efficient designs will minimize consumption through advanced insulation, smart windows, and energy recovery systems.
- **Green Materials**: Use of sustainable, recycled, and locally sourced materials will be prioritized to reduce the carbon footprint.
- **Water Management**: Rainwater harvesting, greywater recycling, and efficient plumbing systems will be standard to conserve water.

2. Smart Technology

- **IoT Integration**: Internet of Things (IoT) devices will be embedded throughout buildings to monitor and control lighting, heating, cooling, and security systems, enhancing efficiency and comfort.
- **Automation**: Smart home and office automation systems will allow for personalized environments, adjusting settings based on occupancy and user preferences.
- **Data Analytics**: Real-time data collection and analysis will optimize building performance and maintenance.

3. Human-Centric Design

- **Well-being**: Design will focus on the physical and mental well-being of occupants, incorporating natural light, ventilation, and biophilic elements like indoor plants and green walls.
- **Flexibility**: Spaces will be adaptable to different uses, with movable walls and modular furniture to accommodate changing needs.
- **Accessibility**: Inclusive design principles will ensure that buildings are accessible to people of all abilities.

4. Resilience

- **Climate Adaptation**: Building ... tand extreme weather conditions and natural disaste... naterials and structural

Regenerate response

Send a message.

Embodied Carbon Reduction

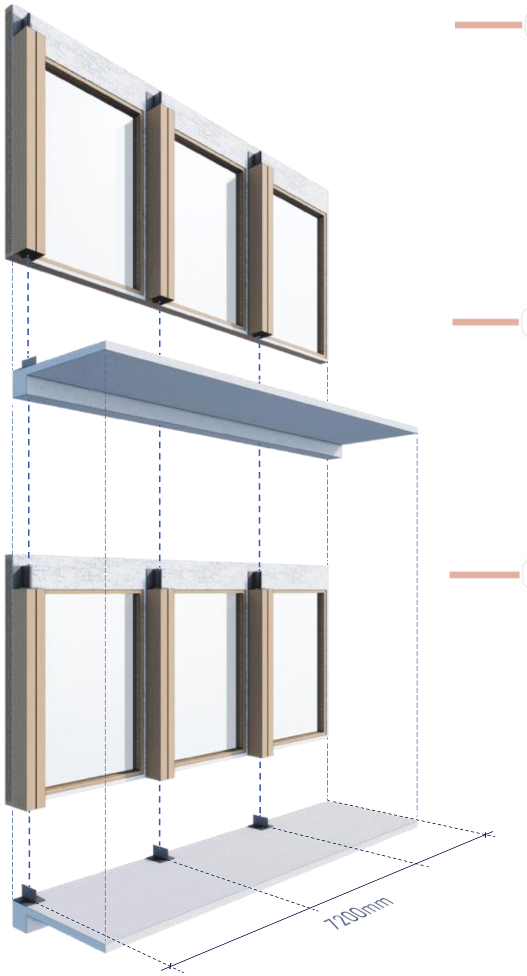
UNITED NETWORK STUDIO

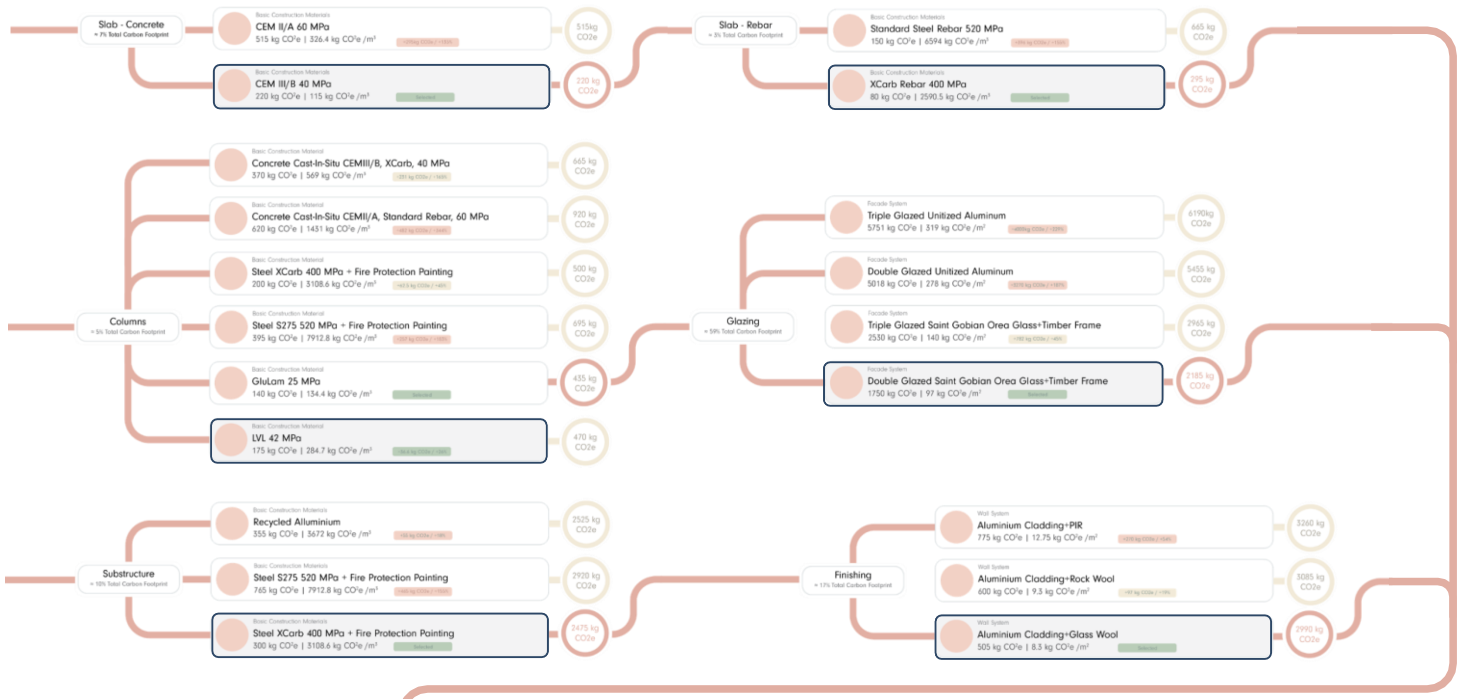
02 / BELVAL

THE CARBON STORY

EARLY DESIGN CARBON CALCULATION

Embodied Carbon Reduction: Carbonbuilder



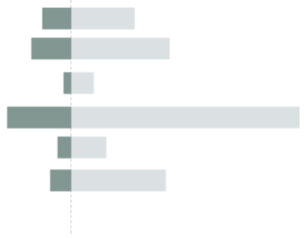


Construction Sytem	Name	Carbon Per Unit	Quantity	Total Carbon (ton CO2e)	Accumulated Carbon
Slab - Concrete	CEM III/B 40 MPa	115	1.894 m³	220	220
Slab - Rebar	XCarb Rebar 400 MPa	2590	0.030 m³	80	295
Columns	GluLam 25 MPa	135	1.044 m³	140	435
Glass	Double Glazed Saint Gobian Orea Glass+Timber Frame	97	18.02 m²	1750	2185
Substructure	Steel XCarb 400 MPa + Fire Protection Painting	3110	0.097 m³	300	2485
Finishing	Aluminium Cladding+Rock Wool	8.3	60.74 m²	505	2990

Selected Roadmap

Total Carbon: **2980 kg** CO2e

Total Carbon: **8550 kg** CO2e



The **Selected Roadmap reduces 65%** the Carbon Impact in comparison with the Highest Intesity Option

The selected roadmap reduces the embodied carbon by 65% compared to standard material usage.

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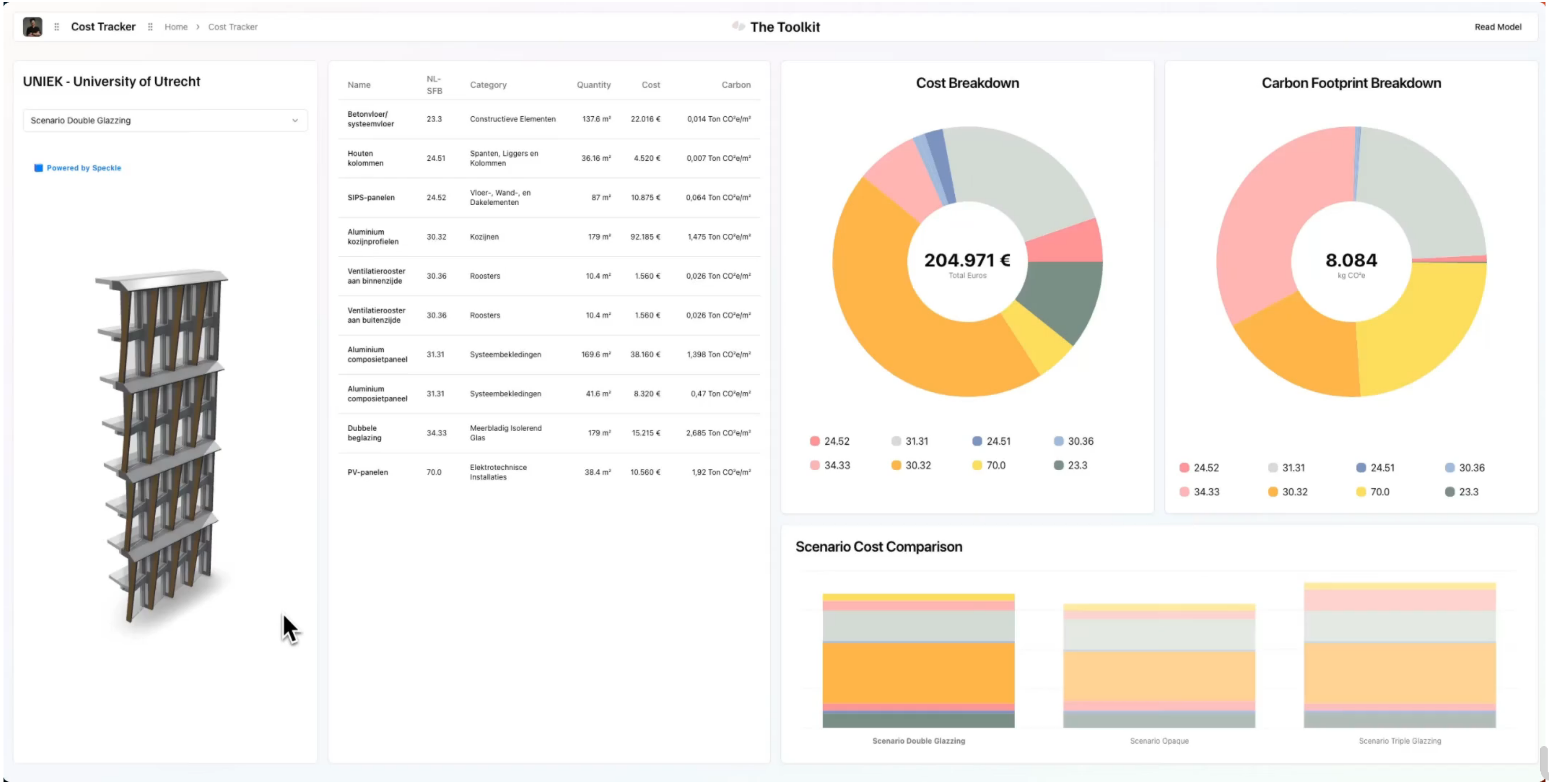
Embodied Carbon Reduction: Carbon Cost analysis



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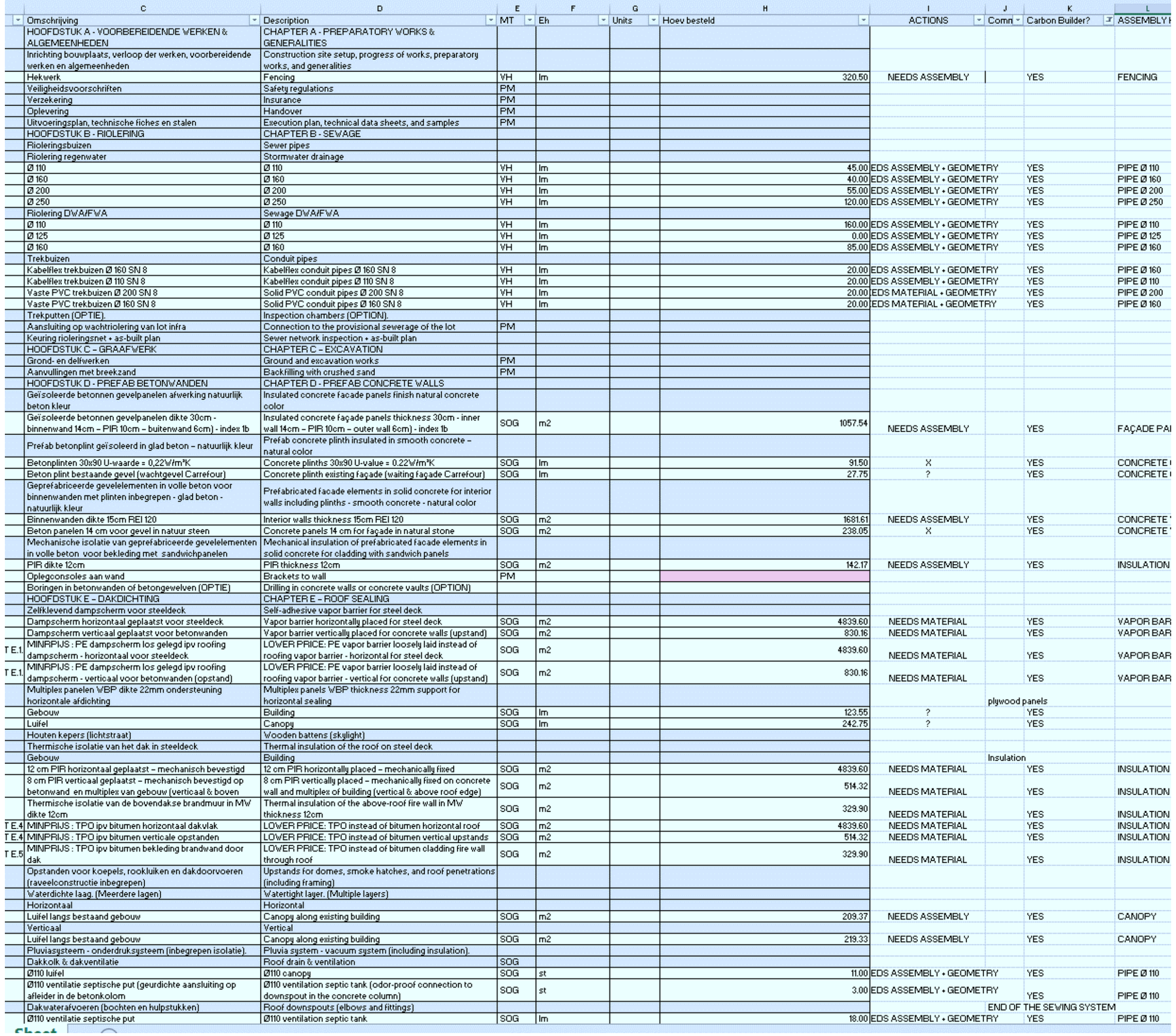
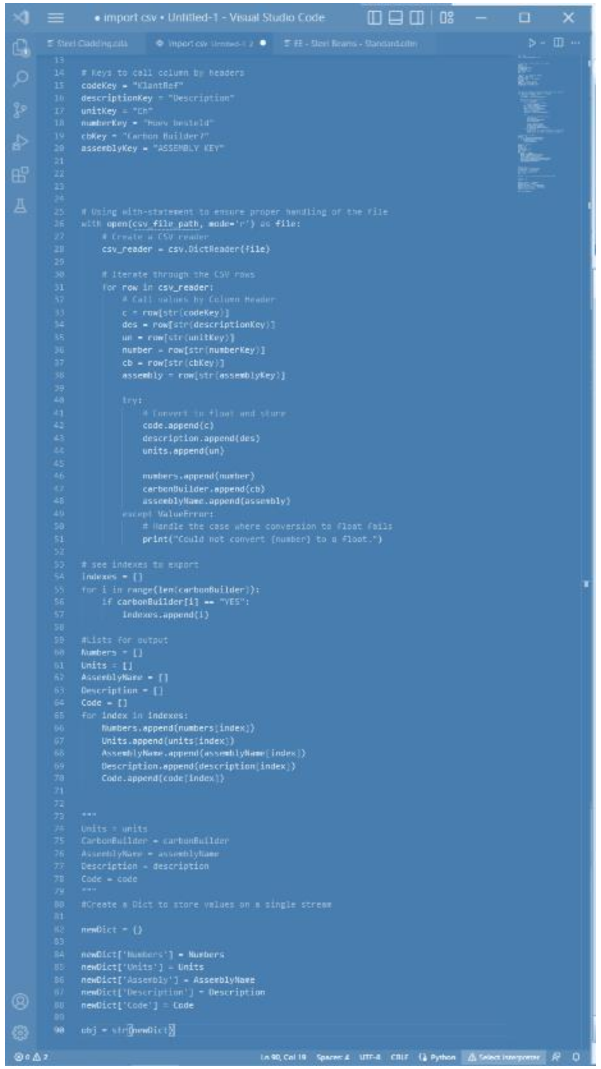
Method: Carbon Quantity aggregation



Bill of Quantities



Carbon Driver Analysis with Machine Learning

-15 KW/m2 operational energy, cutting embodied upfront carbon down by 50% to 280 kgCO2e/m2

One Helix | Breakthrough Properties | Astra Zeneca

Netherlands, Amsterdam, Life Science, 4,600 m2, BREEAM Outstanding, Negative Operational Energy Footprint

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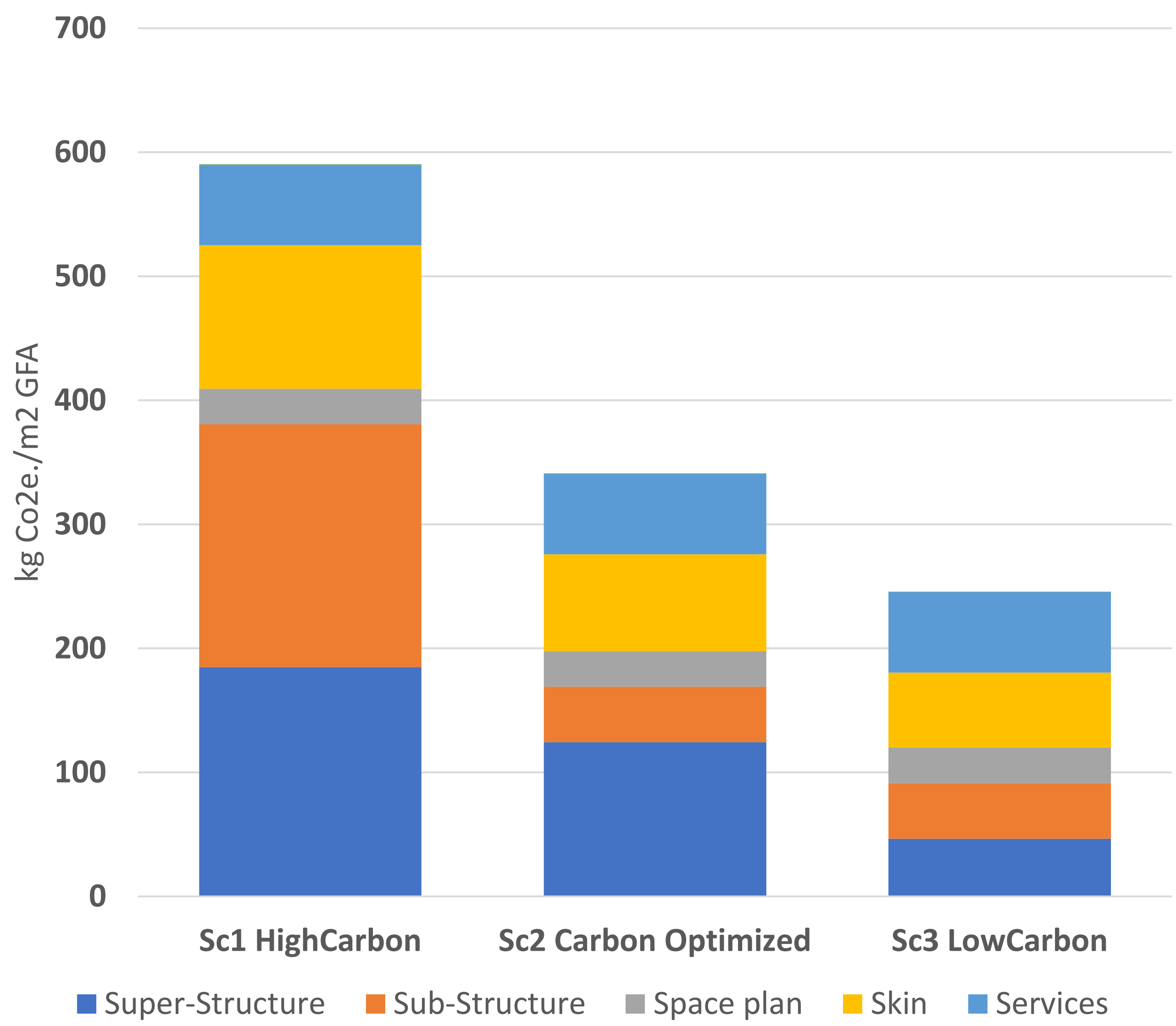
Carbon saving scenarios



(Current design)

High Carbon : *Typical concrete C30/C37 Concrete for Sub and Super Structure, typical structural steel, triple glazing with XPS.*

Optimized Carbon : *Low carb concrete C30/C37 (20% concrete granulate) with XCarb® Structural steel for structure with low carb glass and glass wool.*

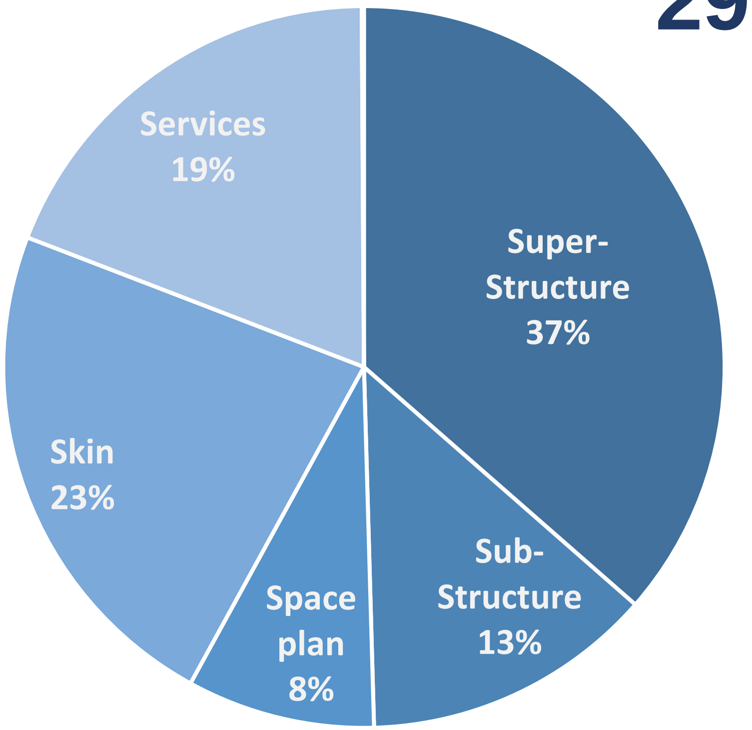
Low Carbon: *CLT floor slabs with low carb concrete and XCarb® Structural steel.*

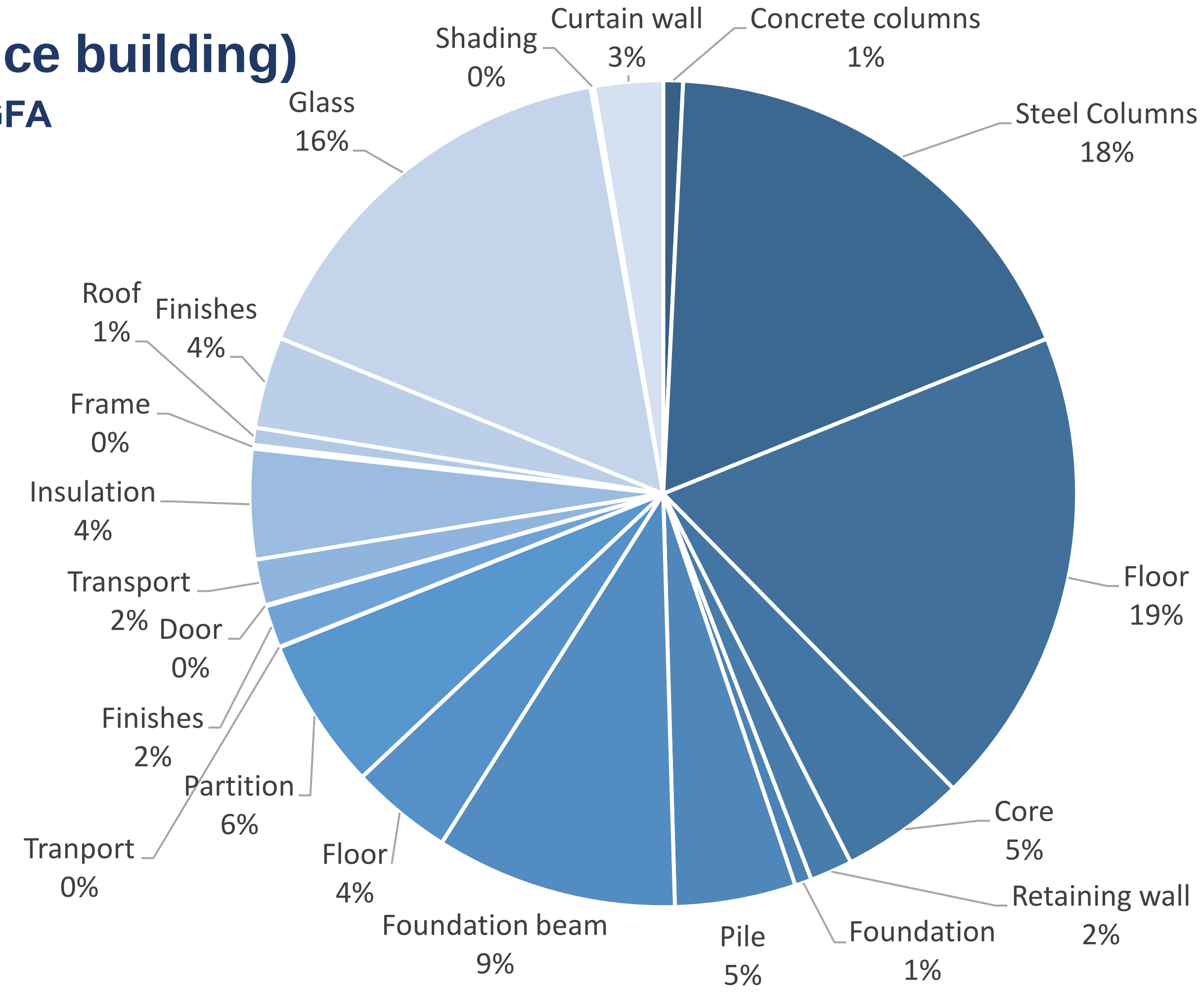
Upfront embodied carbon

GWP Potential (A1-A5)

290 (590 reference building)

kgCo2e/m²GFA





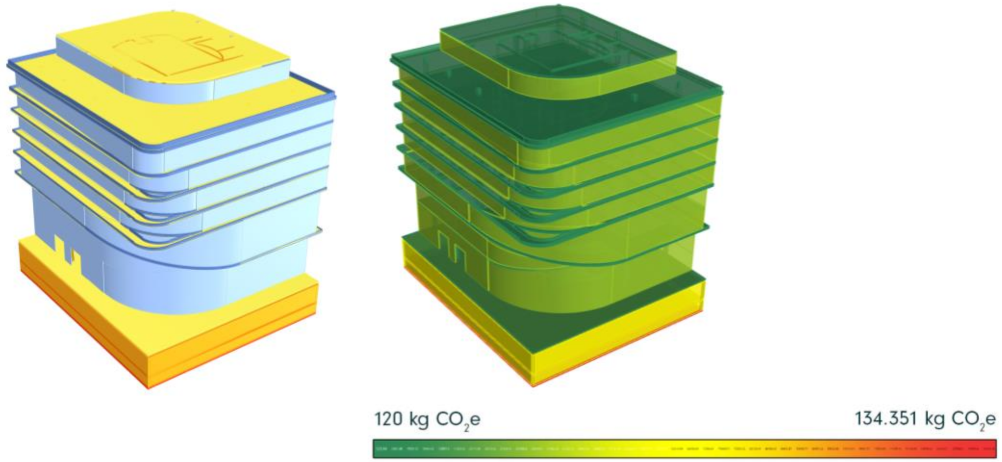
Paris Proof Targets	Embodied Carbon Kg CO2-eq. per m2			
New Construction	**2021**	**2030**	**204 0**	**2050**
Office Building	**250**	**158**	**94**	**56**

Kyklos| Atenor & Arηs (Accenture)

Luxembourg, Belval, Office, 11.500 m2, A+ EPG (35 KW/m2), BREEAM Outstanding, Well Platinum, Low Whole Life Carbon

Embodied Carbon Reduction Potential

We can potentially reduce Embodied Carbon footprint to a traditional building up to 74% to 113 Kg CO2-eq. per m2, achieving 2030-2040 goal setting.



Paris Proof Targets	Embodied Carbon Kg CO2-eq. per m2			
New Construction	**2021**	**2030**	**2040**	**2050**
Office Building	**250**	**158**	**94**	**56**

Kyklos: 113.3 Kg CO2-eq. per m2

PARIS PROOF DGBC

Kyklos

Total Carbon:
822,6 Ton CO2e
80% of Materials

Approximately 113.3 Kg CO2-eq. per m2

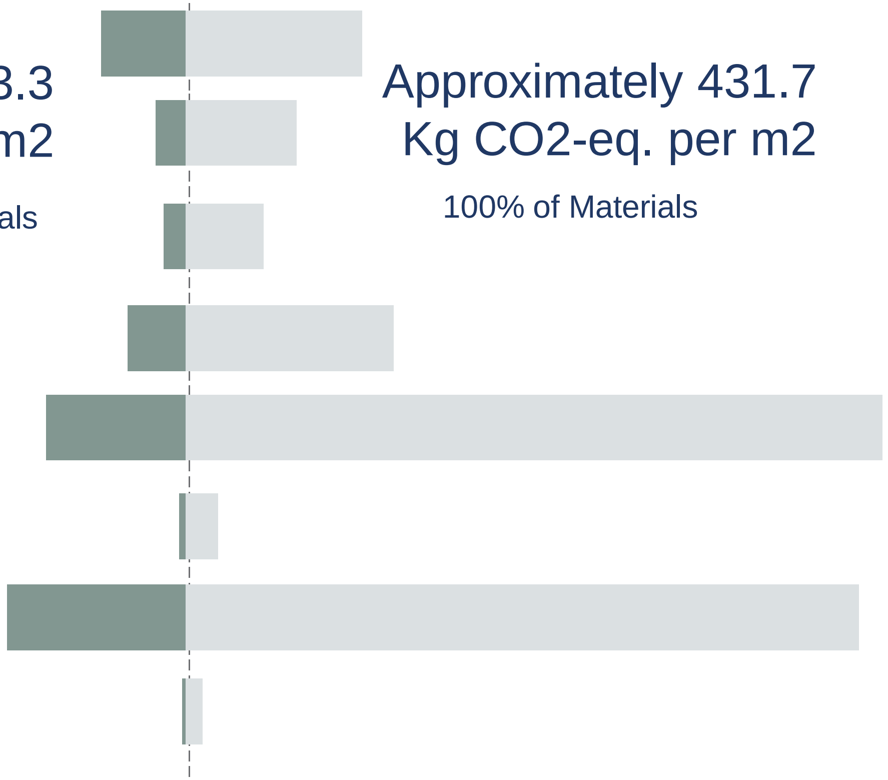
100% of Materials

Traditional Building

Total Carbon:
3.156,9 Ton CO2e
80% of Materials

Approximately 431.7 Kg CO2-eq. per m2

100% of Materials



74% reduction in carbon footprint can be achieved compared to benchmark

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Kyklos Floor-system Comparison (Non-Optimized Material Recipes)

Composite floor system (wide) + steel beams

Total Weight:
489.8 kg/m^2

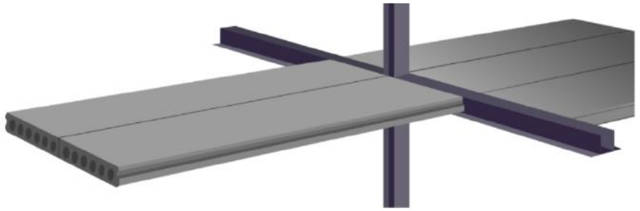
Carbon Footprint:
219.5 kgCO2e/m2

Hollow-Core floor system + steel beams

Total Weight:

308.2 kg/m2

Carbon Footprint:
76.7 kgCO2e/m2



Composite floor system (low) + steel beams

Total Weight:

389.3 kg/m2

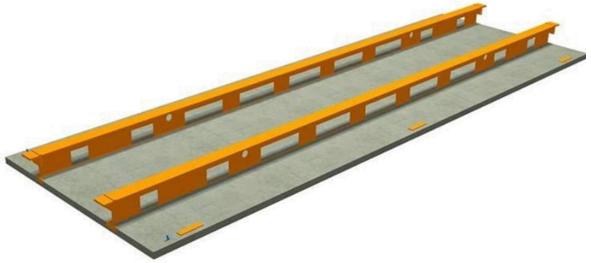
Carbon Footprint:
152.1 kgCO2e/m2

Steel concrete hybrid + steel beams

Total Weight:

306 kg/m2

Carbon Footprint:
144.2 kgCO2e/m2



Floor-system Comparison (Optimized Material Recipes)

Composite floor system (wide) + steel beams

Total Weight:
489.8 kg/m^2

Carbon Footprint:
51.4 kgCO2e/m2

Hollow-Core floor system + steel beams

Total Weight:

308.2 kg/m2

Carbon Footprint:
25.3 kgCO2e/m2

Composite floor system (low) + steel beams

Total Weight:

389.3 kg/m2

Carbon Footprint:
38.5 kgCO2e/m2

Steel concrete hybrid + steel beams

Total Weight:

306 kg/m2

Carbon Footprint:
34.1 kgCO2e/m2

From ‘worst’ to ‘best’ performing floor-system
88% reduction of Carbon Footprint per sqm.

This is for a 10.000 m2 building equivalent to what 1.554 trees absorb on Carbon over a period of 50 years (buildings assumed life-span)

Kyklos| Atenor & Arηs (Accenture)

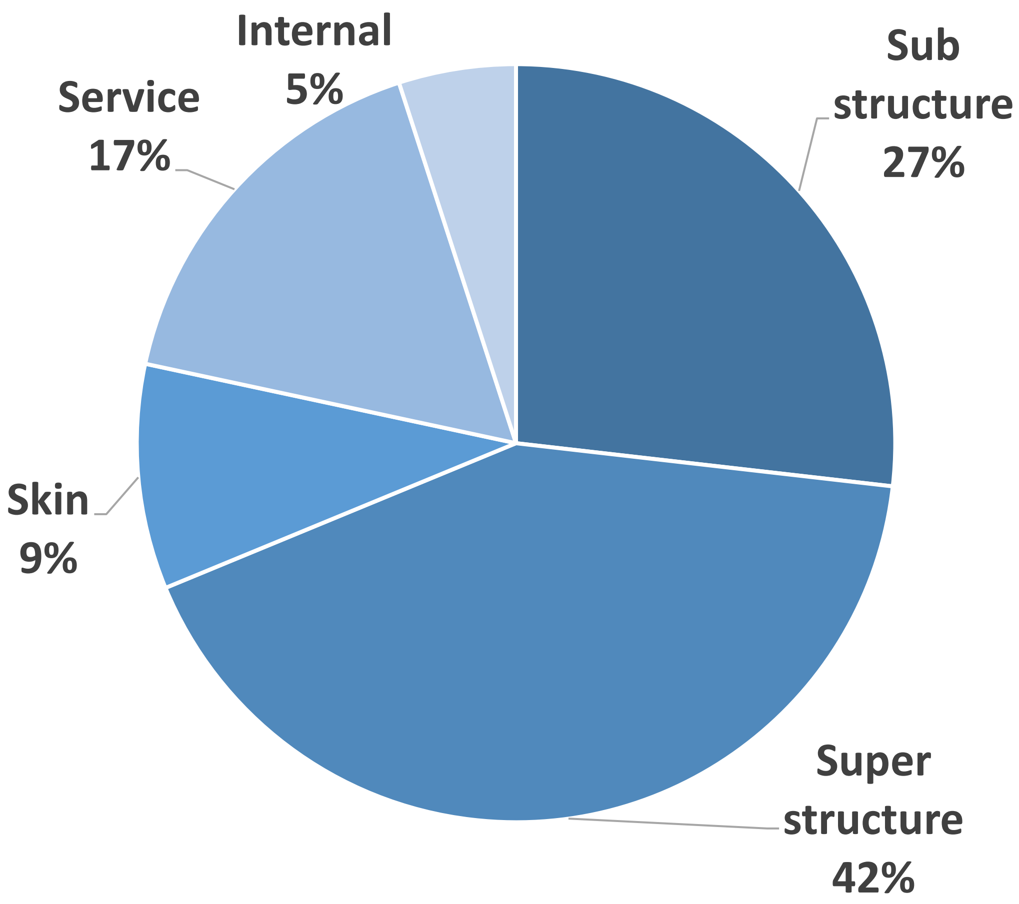
Luxembourg, Belval, Office, 11.500 m2, BREEAM Outstanding, Well Platinum, Low Whole Life Carbon

reduce to the max: upfront carbon in tall buildings

The Bridge Tower

Warsaw, Poland, Office, 55.000 m2, BREEAM Outstanding, WELL Gold.

Base Case: Upfront (embodied) carbon



GWP Potential (A1-A5)

786

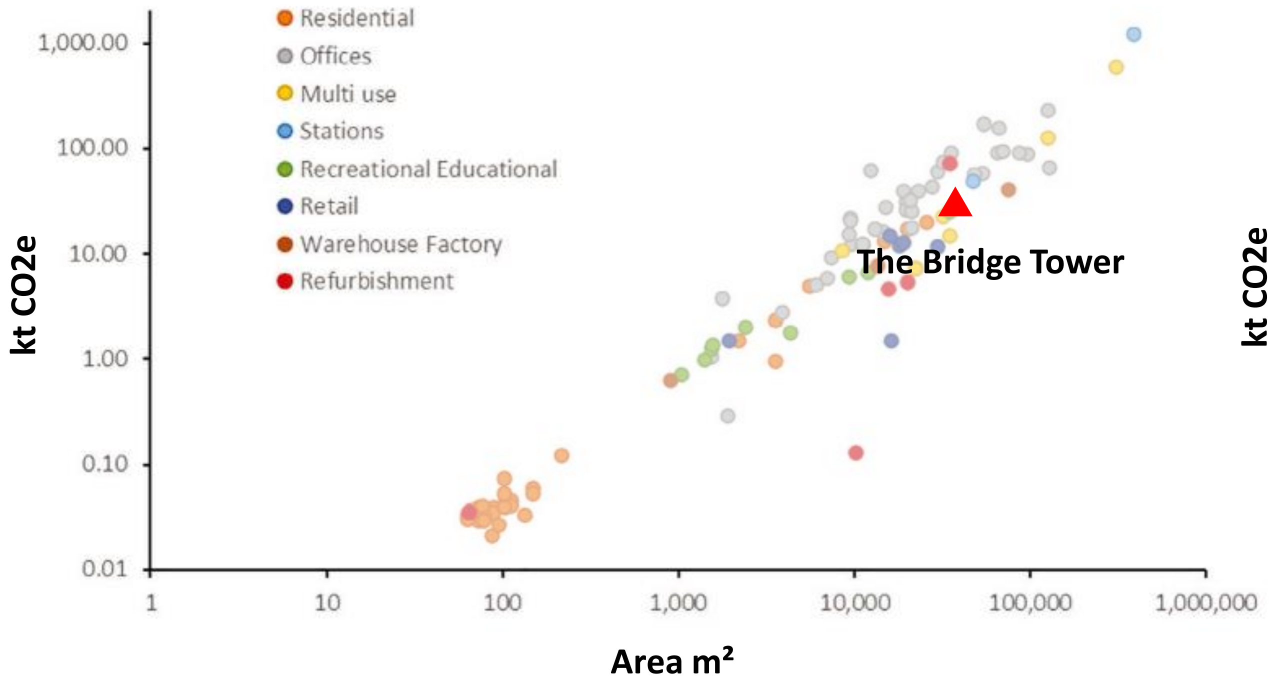
kgCo2e/m²GFA

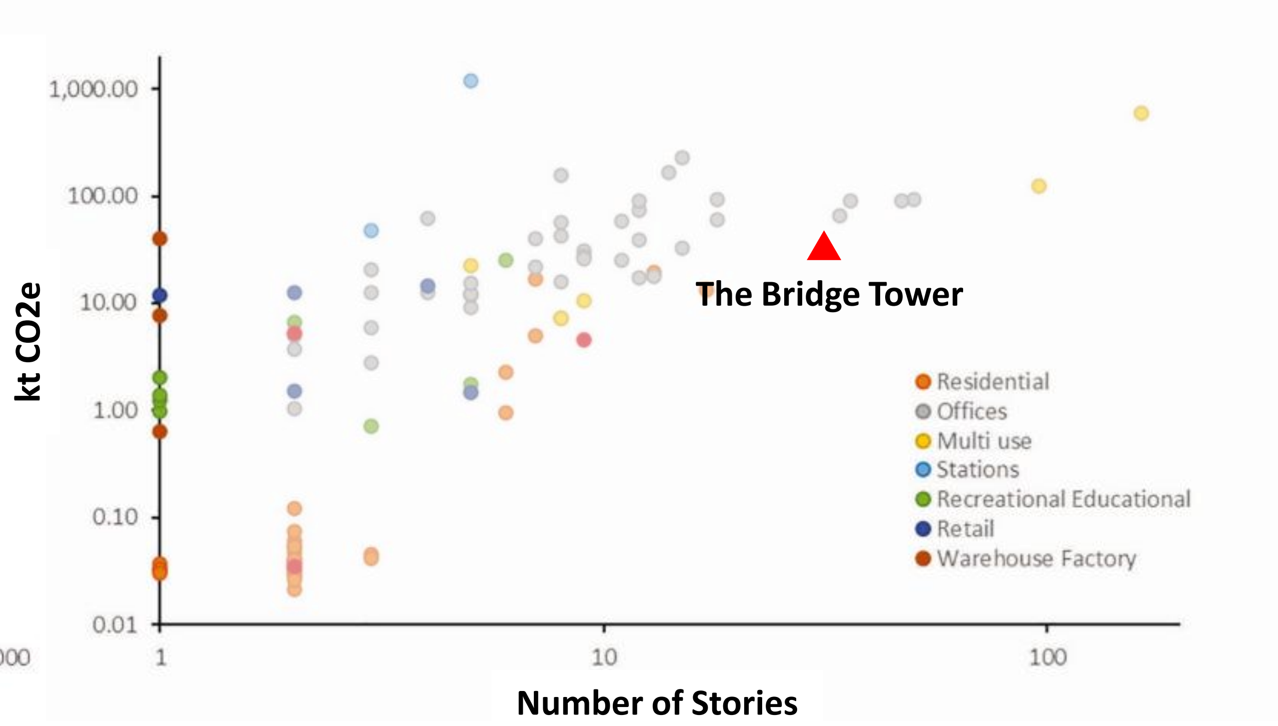
Sub- and Super structure have the largest share, with floors contributing up to 69% of it’s Embodied Carbon Footprint.

The number of basement levels (5) significantly impacts the total carbon footprint of the structure.

Concrete, steel, and glazing are major Embodied Carbon Drivers

Benchmarking the results…





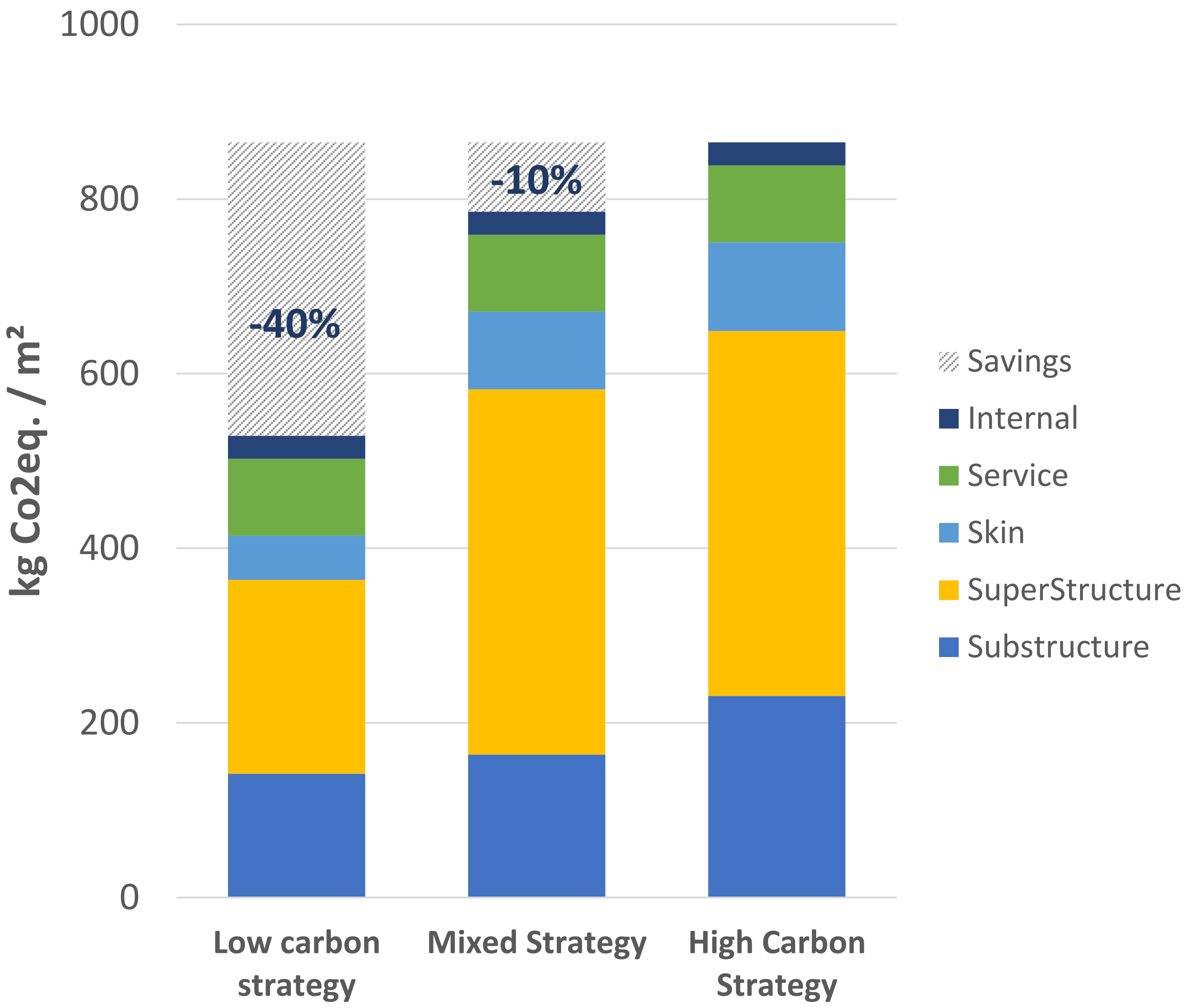
Source: https://www.istructe.org/IStructE/media/Public/TSE-Archive/2020/Carbon-footprint-benchmarking-data-for-buildings.pdf

Upto 20% of the concrete is saved with PT slabs in comparison to the reinforced slabs, saving 2,500 tons of concrete.

Equivalent to around 600 Ton of Embodied Carbon

Reduced floor thickness allows for an additional office floor within the same skin

Carbon saving scenarios



High carbon strategy uses standard concrete and triple glazing.

Mixed strategy employs low-carbon concrete in the basement, achieving 10% savings (Choosen option)

Using low-carbon glass and low-carbon concrete can reduce carbon by up to 40%.

But low carbon concrete extends construction period by over a year due to the slow curing time of the concrete….

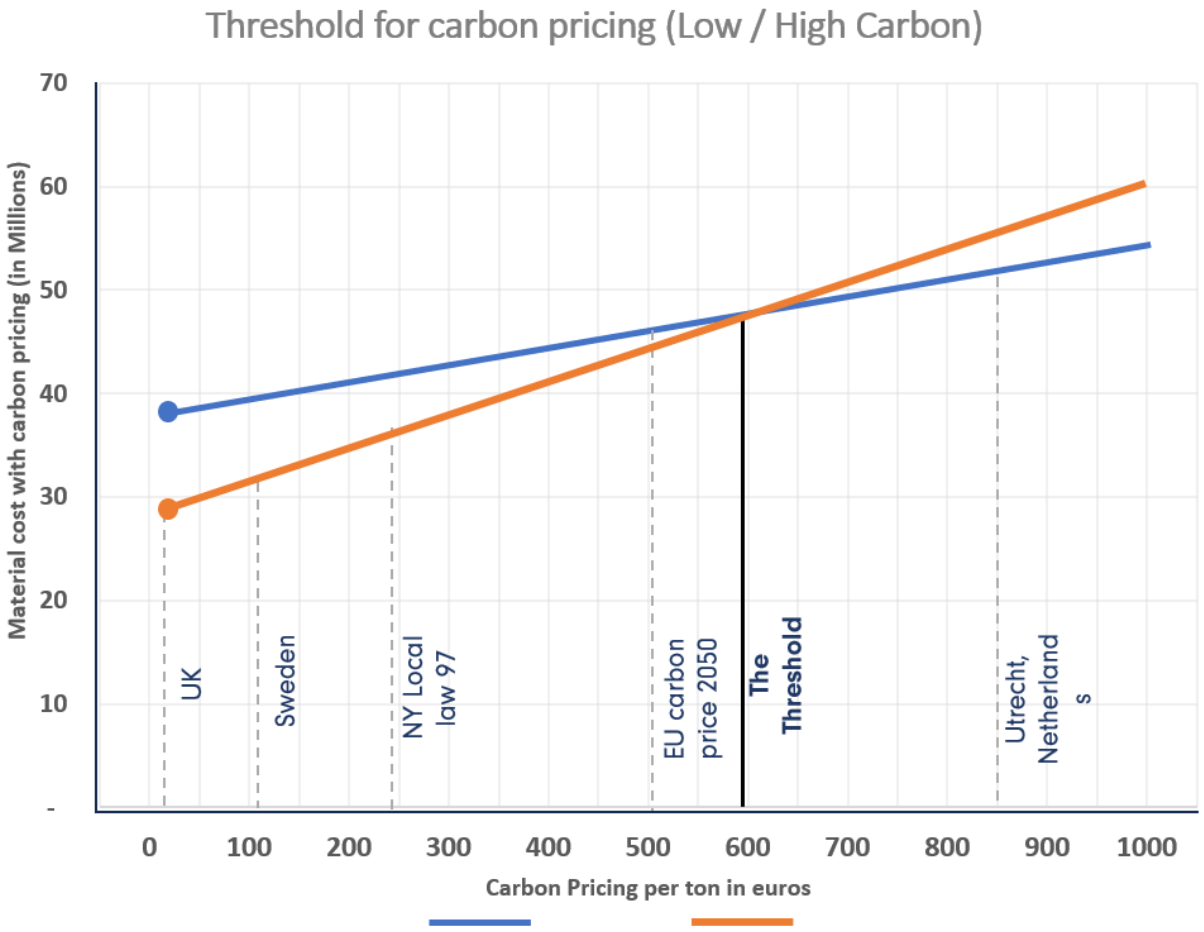
Transitioning from a ‘high’ carbon to a mixed carbon strategy already results in a saving of ~ 4,300 tons of carbon

This is equivalent to what 2,900 trees capture over a 50-year lifetime.

Shifting from high carbon to low carbon achieves an extraordinary savings of 18,500 tons of carbon, similar to planting 12,300 trees over the same period….

Threshold of carbon pricing - Present

Carbon Currency – Carbon emission x Carbon pricing per ton in euros



The initial cost for the low-carbon alternatives are currently more expensive (or too slow….).

With rising carbon taxation, the current economical tipping point could move lower

Stricter carbon pricing taxation or incentives are needed globally to drive low carbon decisions.

**The low carbon solutions of Steel, Concrete and Glass are 5%-40% more expensive than their standard products.*

**The low carbon solutions of Steel, Concrete and Glass are 5%-40% more expensive than their standard products.*

Current Carbon trading values do not validate Low Carbon Strategies

With attention significant carbon savings over 50% can be achieved without significant cost increases, even with traditional materials.

Strategies include: lightweight (composits), pre-fabrication and low carbon materials

Low Carbon Materials will however become more economical.

Significant Carbon Taxation or incentives at around EUR can tip the economical balance already today

ESG value of Carbon cutting translate however significant more valuable..

Ing.ir. Arjan Dingsté dipl. Ing. ETH NDS
Partner / Senior Architect UNStudio
Lead Digital Innovations & Lead Sustainability Innovations
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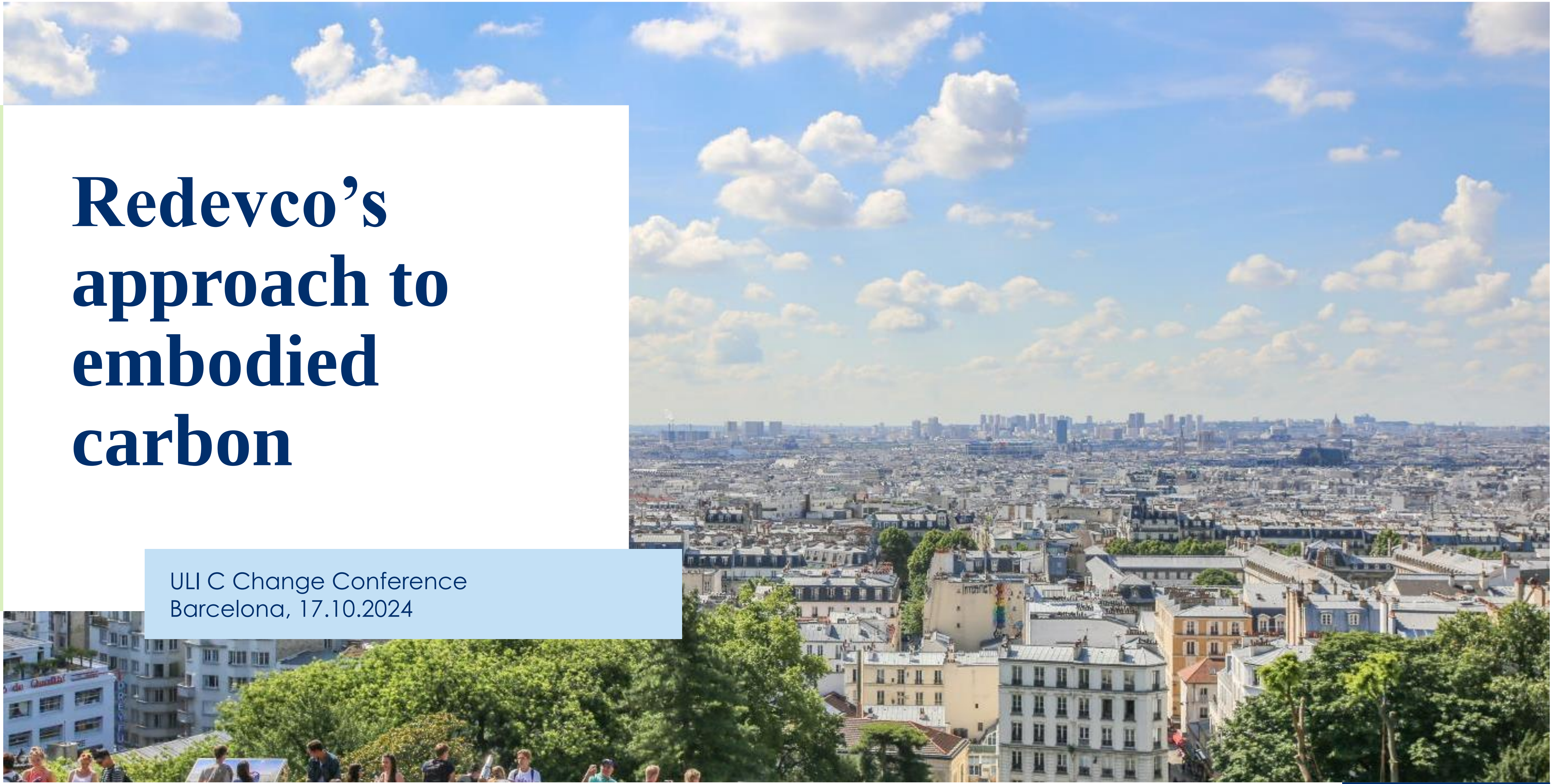
Let’s design for a better Future!

Redevco's approach to embodied carbon

ULI C Change Conference
Barcelona, 17.10.2024



REDEVCO

October 2024

Part of COFRA, a family business for 180+ years

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A diversified group of businesses, united by a common ethos to be a Force for Good

Responsible capital
ANTHOS Fund & Asset Management
Bregal Investments

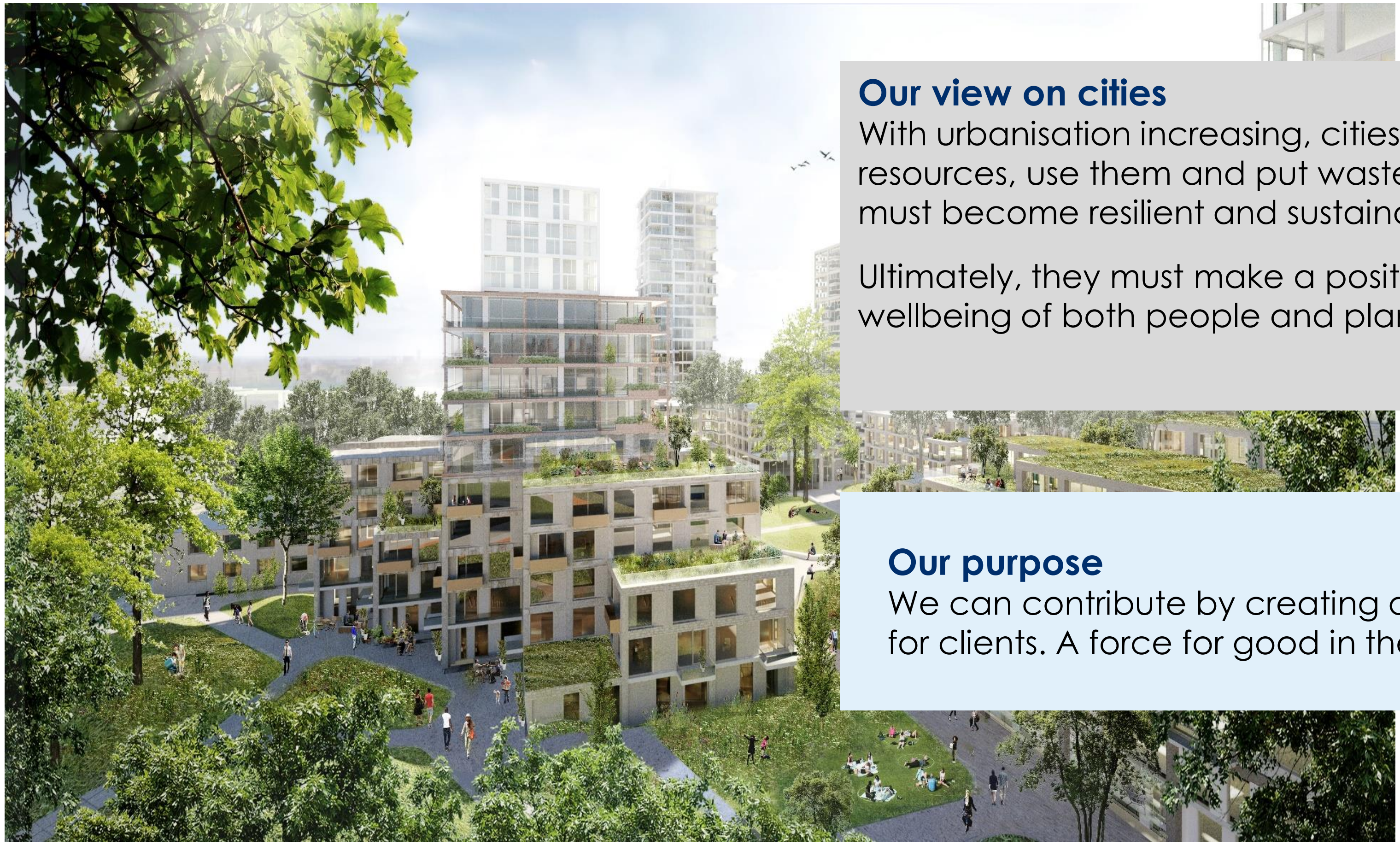
Liveable cities
REDEVCO

Feel good Fashion
C&A

Clean energy
SUNROCK

Sustainable food
ontarioplants PROPAGATION LIMITED
DALSEM

Within the COFRA we focus on liveable cities



Our view on cities

With urbanisation increasing, cities are huge magnets that draw in resources, use them and put waste into the environment. Cities must become resilient and sustainable.

Ultimately, they must make a positive contribution to the health & wellbeing of both people and planet.

Our purpose

We can contribute by creating amazing real estate outcomes for clients. A force for good in the built environment.

Sustainability ambition

Being a Force for Good in the built environment by creating positive impact in four areas

Built Environment

- Reduce whole life carbon: **Net Zero** by 2040
- Increase onsite **renewable energy** generation
- Implement **climate** adaptation measures

Natural Environment

- Aim for **biodiversity** net gain
- Responsible **water** management
- Responsible **waste** management

Social Value

- Provides spaces that meet **local needs**
- Contribute to **placemaking**
- Build strong **relationships** with stakeholders

Economic Value

- Optimise **capital value** development
- Optimise **rental growth** development
- Minimise structural **vacancy**

Underpinned commitments: 1) highest standards of **health, well being and safety**, and 2) **human rights** and **labour practices**

Read our Responsible Investment Report for more information: www.redevco.com

Redevco's 'external' commitments

SBTi

SCIENCE BASED TARGETS
DRIVING AMBITIOUS CORPORATE CLIMATE ACTION

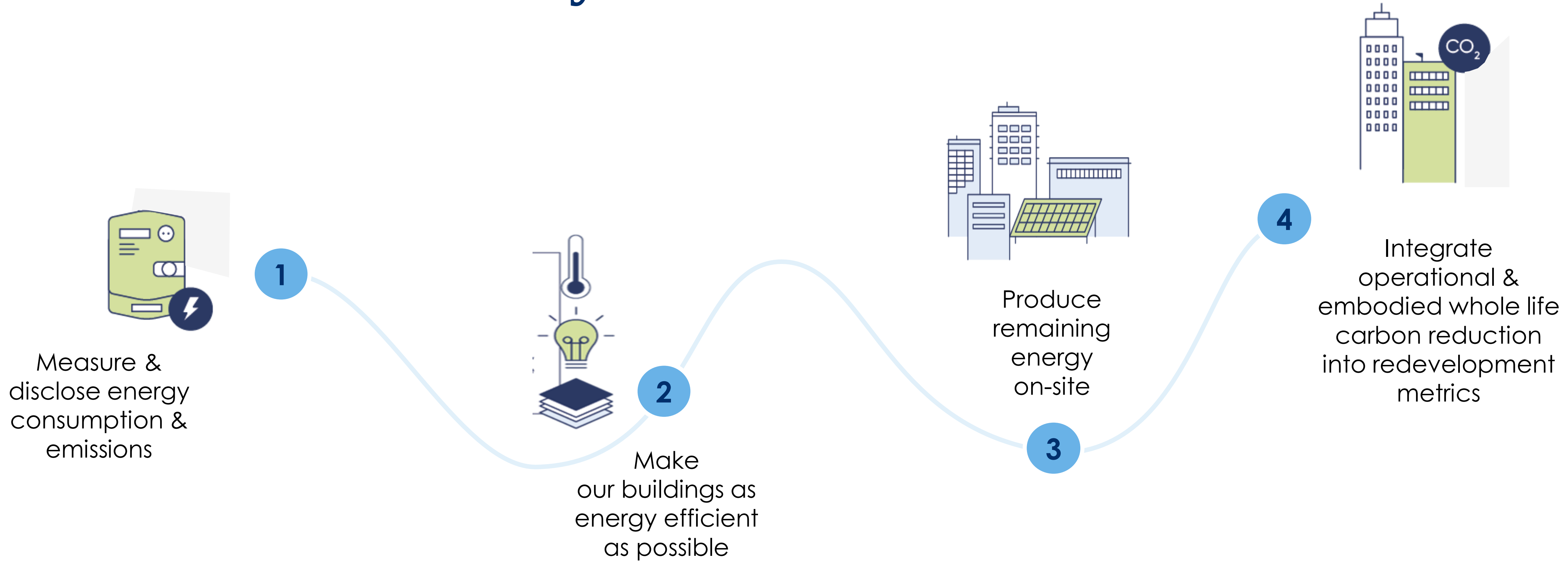
Redevco B.V. commits to reduce absolute scope 1 and 2 GHG emissions 58.5% by 2030 from 2019 base year. Redevco B.V. also commits to reduce absolute scope 3 GHG emissions 46.2% within the same timeframe.

WorldGBC NZC Buildings Commitment

Redevco commits:

- for assets under direct control (i.e., our own offices and the common areas of our AuM) to reduce (and compensate where necessary) all operational emissions by 2030
- for new developments and major renovations under direct control to reduce and compensate (for residual upfront emissions) embodied carbon emissions by 2030

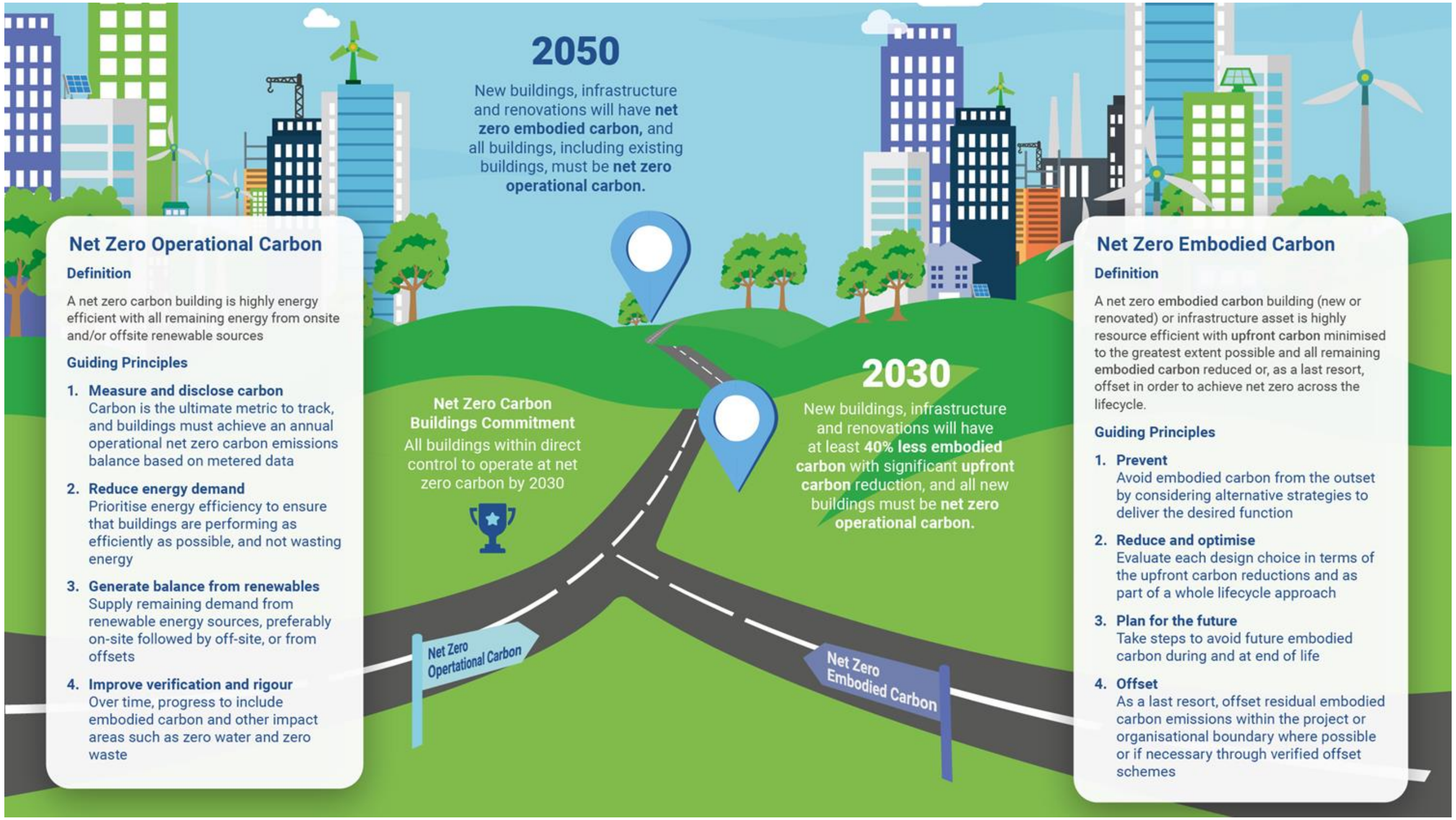
Beyond 2030, we have our “Mission 2040” target: Net Zero Carbon by 2040



Full roadmap available on Redevco.com

WE FOLLOW THE DEFINITIONS PROVIDED BY THE WORLD GREEN BUILDING COUNCIL – BUT WANT TO GO FASTER!

The ingredients of Mission 2040



Guiding principles of net zero embodied carbon

Prevent	Reduce and Optimise	Plan for the Future	Offset
Avoid embodied carbon from the outset by considering alternative strategies to deliver the desired functions	*Evaluate each design choice in terms of the upfront carbon reductions and as part of a whole lifecycle approach*	*Take steps to avoid future embodied carbon during and at end of life*	*As a last resort, offset residual embodied carbon emissions within the project or organisational boundary where possible, or if necessary, through verified offset schemes*

REDEVCO Sustainable Design Principles *

Prevent	Reduce and Optimise	Plan for the Future	Offset
▪ Retrofit first ▪ Brownfield only	▪ Scenario modelling (A1-A3) to derive optimal outcome ▪ Preference for bio-based materials	▪ Design for disassembly ▪ BIM requirement ▪ Building passport on completion (e.g., Madaster)	▪ Footprint of the (re)development only (A1-A5 and C1-C4)

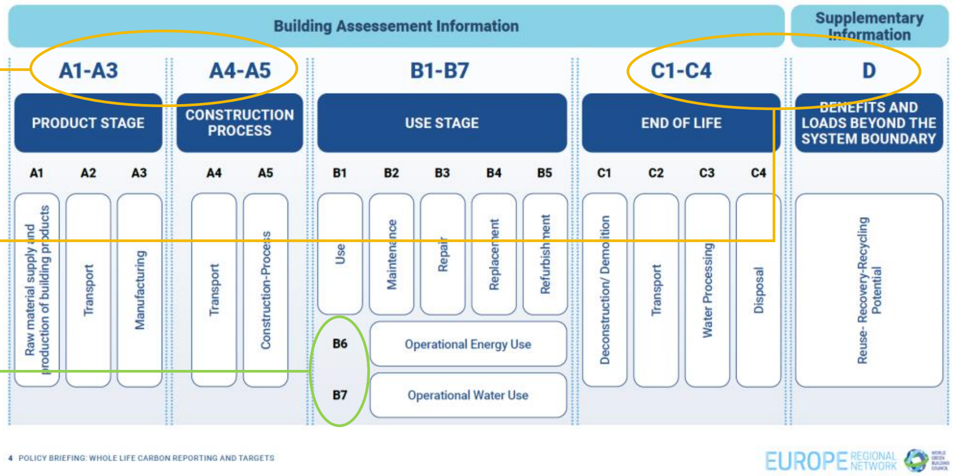
* Non-exhaustive; the impact indicators on built, nature and social topics are determined at the outset of each project

Whole Life Carbon stages

Whole Life Carbon as defined in the EU standard EN 159781 encompasses both the operational carbon of buildings through their use, and the upfront embodied carbon impact of the manufacturing, transportation, construction, as well as end-of-life phases of built assets.

Embodied Carbon boundary includes:

- A1-A5 upfront embodied carbon related to new construction works
  - We include redevelopment of existing assets (any structural works that touch the fabric of the building in question)
- Embodied carbon related to onsite deconstruction works (C1-C4 and D of the current life cycle end)

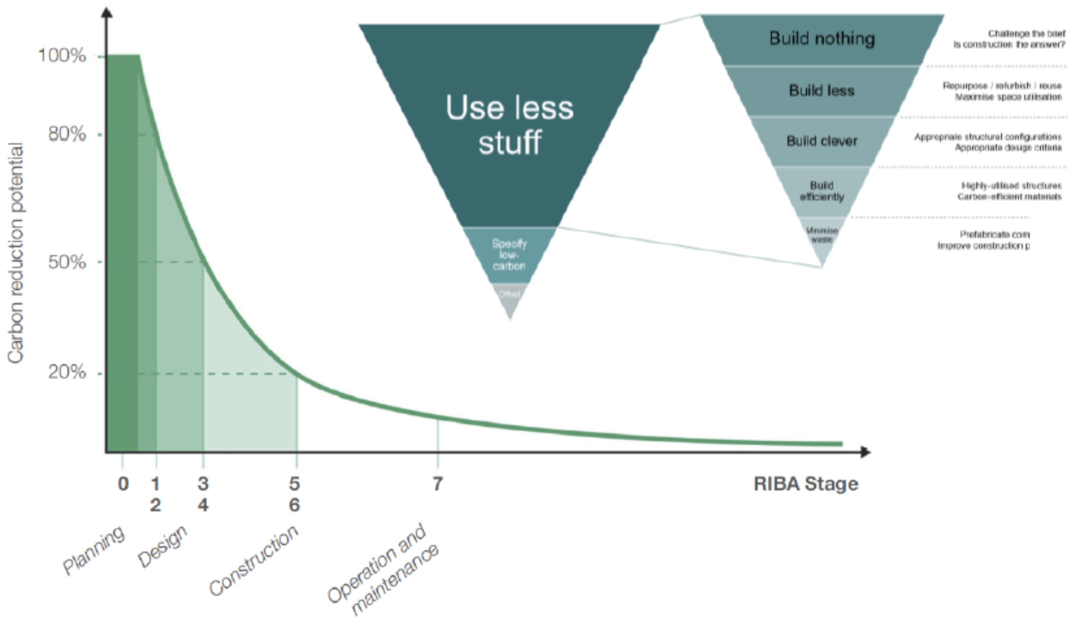


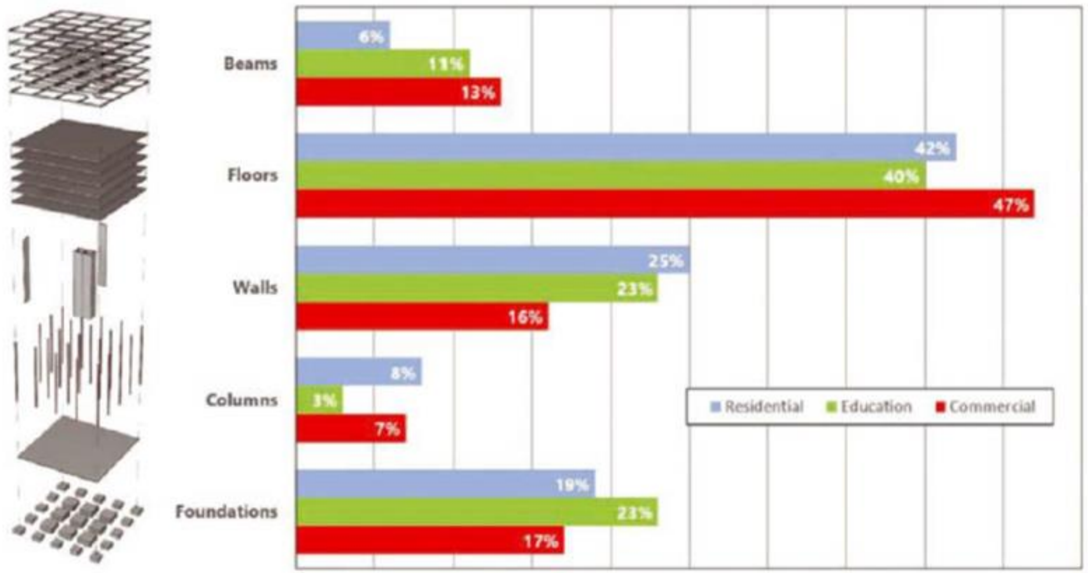
Already being tracked and monitored by Redevco:

- B6 Operational Energy Use (tenant emissions)
- B7 Operational Water Use

WLCA calculations are becoming the norm for (re)developments and are included as a requirement in our Sustainable Design Brief

Greatest impact at the earliest stages of a project





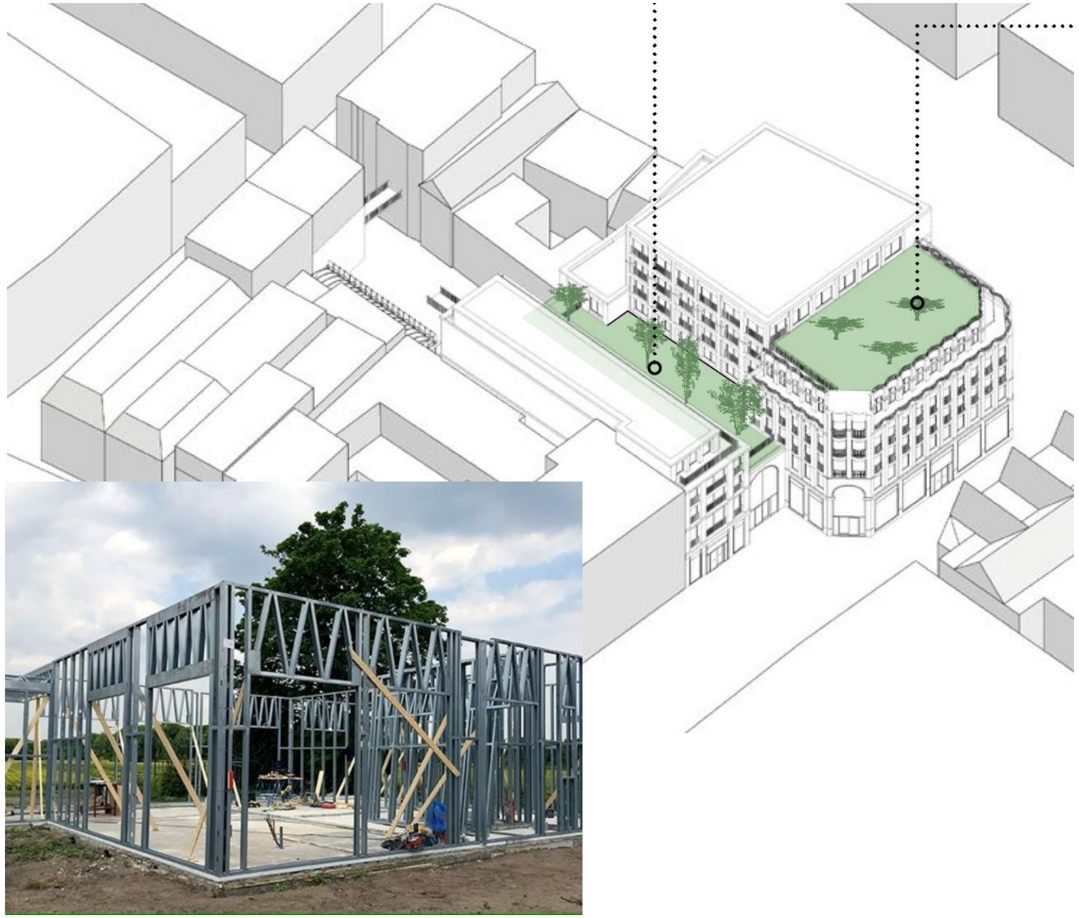
Using a NZC design guide to inform deliberate decision-making

- Steps 1 to 4 are critical elements to the reduction of operational emissions and must be implemented at ‘natural moments’ in a building’s lifecycle (new lease; redevelopment)
- Steps 5 and 6 more relevant at major refurbishment or redevelopment moments to look to the whole lifespan of a building and tackle embodied carbon and scope 3 emissions
- Eliminating fossil fuels as a heating source has significant impact on CO_2 emissions reduction, yet this is also the biggest challenge to convince (retail) tenants to invest in alternatives; less of an issue if we are in control of or responsible for installations
- Focusing on these points more deliberately will drive down the whole life carbon of our AuM

Source: Cundall

Case Study: Herestraat, Groningen

Groningen Herestraat – Planned works



- Demolish 2^{nd} and 3^{rd} floor
- Strip ground floor and 1^{st} floor
- Ground floor and 1^{st} floor will remain retail
- Basement will become a public bicycle storage
- Adding 4 floors (2^{nd} – 5^{th}) with 44 apartments
- Discussion on timber vs. steel (steel frame)
- All electric
- Green roofs ("green street")
- Biodiversity Net Gain

Groningen Herestraat – Embodied Carbon Impact

- Our Sustainable Design Brief targets **200 kg CO_2e/m^2** for RIBA stages A1-A5
- (Industry average for redevelopment of existing buildings is still ca. 500-600 kg CO_2e/m^2)
- This project's LCA calculation shows an upfront embodied carbon of **432 tons CO_2e**, equating to **155 kg CO_2e/m^2**
- Redevco has adopted a carbon price of **€120/ton CO_2e**
- The internal carbon fee 'charged' to this development is therefore ca. **EUR 52,000.-**

Groningen, Herestraat Upfront Embodied Carbon (A1-A5)	Embodied Carbon t CO2e	ICF €120/t	Impact of ICF on Dev Profit	Impact of ICF on Dev IRR
Upfront Embodied Carbon intensity – Current FDP Groningen design score - **155** kg/m2	431.7	€ 51,804	(-1.2%)	(-0.18%)
Upfront Embodied Carbon intensity – Redevco Design Brief budget - **200** kg/m2	557.0	€ 66,844		

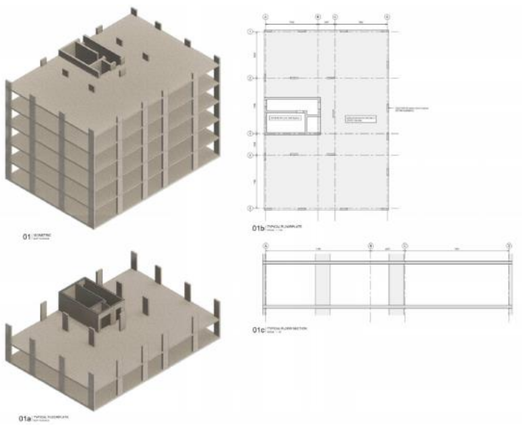
- Choosing to retain a significant portion of the existing building and being very deliberate about design choices and recycling and re-using existing materials yields a significantly lower embodied carbon footprint

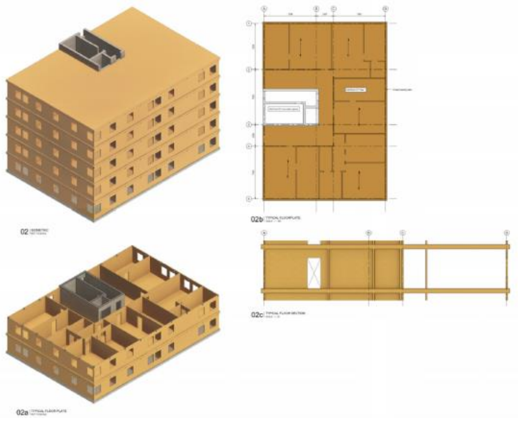
Groningen Herestraat – Projected Future State

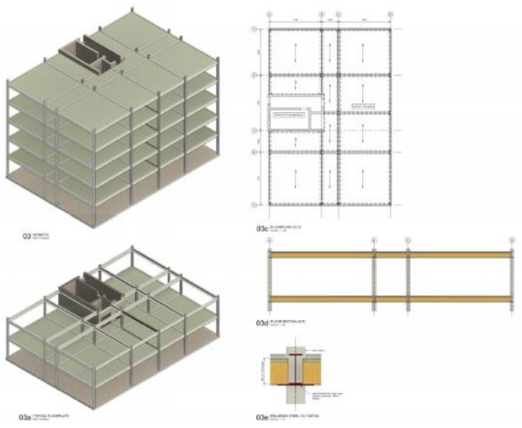
Case Study: Minerva Way, Glasgow

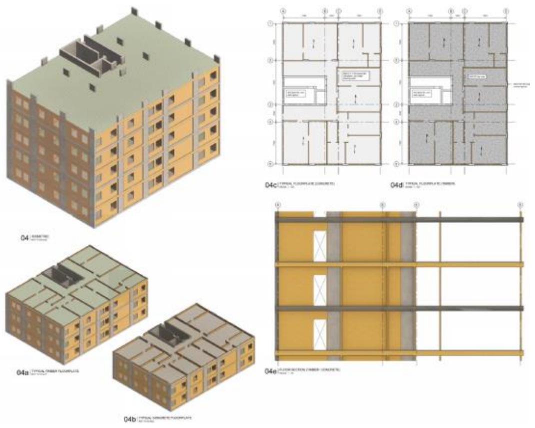
Modelling exercise on the EC of the structure

RC Flat Slabs	CLT and bearing walls	CLT on steel	CLT on sandwich RC









Modelling exercise on the EC of the structure

RC Flat Slabs	CLT and bearing walls	CLT on steel	CLT on sandwich RC
A1-A5 absolute: 141 tons CO_2e A1-A5 intensity: 179 $kgCO_2e/m^2$	A1-A5 absolute: 125 tons CO_2e A1-A5 intensity: 159 $kgCO_2e/m^2$	A1-A5 absolute: 184 tons CO_2e A1-A5 intensity: 234 $kgCO_2e/m^2$	A1-A5 absolute: 153 tons CO_2e A1-A5 intensity: 195 $kgCO_2e/m^2$
Biogenic carbon: 0 tons CO_2e Biogenic carbon: 0 kg CO_2e/m^2	Biogenic carbon: -254 tons CO_2e Biogenic carbon: -324 $kgCO_2e/m^2$	Biogenic carbon: -180 tons CO_2e Biogenic carbon: -229 $kgCO_2e/m^2$	Biogenic carbon: -127 tons CO_2e Biogenic carbon: -162 $kgCO_2e/m^2$
A-C absolute: 155 tons CO_2e A-C intensity: 198 $kgCO_2e/m^2$	A-C absolute: 135 tons CO_2e A-C intensity: 172 $kgCO_2e/m^2$	A-C absolute: 193 tons CO_2e A-C intensity: 246 $kgCO_2e/m^2$	A-C absolute: 167 tons CO_2e A-C intensity: 213 $kgCO_2e/m^2$
D absolute: 12 tons CO_2e D intensity: 15 $kgCO_2e/m^2$	D absolute: -80 tons CO_2e D intensity: -102 $kgCO_2e/m^2$	D absolute: -102 tons CO_2e D intensity: -130 $kgCO_2e/m^2$	D absolute: -32 tons CO_2e D intensity: -40 $kgCO_2e/m^2$

N.B. Current UK EPD's and WLC assessment methodologies assume timber is burnt at end-of-life (thereby emitting sequestered CO_2) which negatively impacts the WLCA…so remain pragmatic w.r.t. LCA tooling and interpretation!

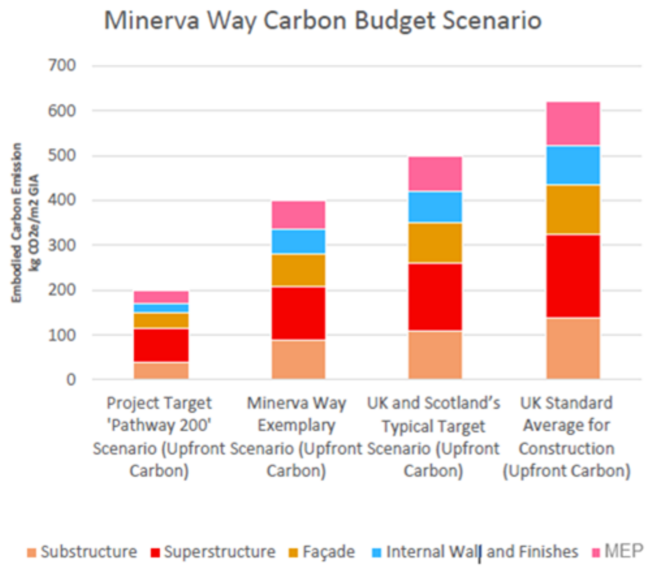
Performance against Design Brief KPIs

	Current Performance	Redevco's UK Residential Design Brief
Floor average area weighted U-value	0.12 W/m2K	0.15 W/m2K
External wall average area weighted U-value	0.15 W/m2K	0.15 W/m2K
Roof average area weighted U-value	0.09 W/m2K	0.15 W/m2K
Glazing area weighted U-value (including frame)	1.20 W/m2K	1.20 W/m2K
Window g-value	40%	30% - 40%
Window VLT	71%	-
Thermal bridging (y-value)	0.05 W/m2K	<0.04 W/m2K
Air Permeability (@50Pa)	3 m3/h/m2	2 m3/hr/m2
System type	Exhaust ASHP	No local fossil fuel
Space heating – Heat Pump (COP)	3.3	2.85
Domestic Hot Water (DHW) – Heat Pump (COP)	2.0	2.85
Central AHU maximum specific fan power	0.73 W/l/s - 0.88 W/l/s	1.2 W/l/s
AHU heat recovery	85 % – 86 %	85 %
Energy Use Intensity	41.6 kWh/m2	<41.6 kWh/m2 in line with the Local CRREM 2040 1.5oC scenario for multi-family residential buildings
BREEAM In-Use Assessment Pre-assessment score	Anticipated Outstanding	BREEAM score: ≥85% corresponding to an "Outstanding" BREEAM rating
Home Quality Mark assessment score	4.25 (4.5 -4.75 possible as scheme develops)	≥4
WELL assessment score	Platinum (with operational confirmation required as scheme develops)	Platinum
Embodied carbon	400-450 kg co2/m2	200 kg co2/m2

- Redevco's Sustainable Design Brief was shared with the design team partners at the outset of the project
- Our brief is intentionally aspirational, challenging the team to think out-of-the-box to find workable solutions
- Based on this particular project at this particular stage in the design process, the choices at that moment complied with 15 of 18 KPIs
- The Embodied Carbon (EC) target was not met, although it is still substantially lower than current market averages

Impact of ICF on returns – Glasgow, Minerva Way

Glasgow, Minerva Way Upfront Embodied Carbon (A1-A5)	Embodied Carbon t CO2e	ICF €120/t	Impact of ICF on Dev Profit	Impact of ICF on Dev IRR
Upfront Embodied Carbon intensity – Current Minerva Way design score - **400** kg/m2	14,607	€1,752,840	(-3.7%)	(-0.63%)
Upfront Embodied Carbon intensity – Redevco Design Brief budget - **200** kg/m2	7,304	€876,420		
Upfront Embodied Carbon intensity – UK & Scotland's best practice budget - **500** kg/m2	18,259	€2,191,050		
Upfront Embodied Carbon intensity – UK standard average budget - **620** kg/m2	22,677	€2,721,284		



Cundall WLC circular design report

The WLC circular design report compared our current design with 3 other scenarios:

1. The Redevco Design Brief carbon intensity budget of 200 kg/m2 (which appeared beyond reach in this case)
2. The UK & Scotland best practice budget of 500 kg/m2
3. And the UK standard average performance of 620 kg/m2

Progress made and lessons learned

- Redevelopments have typically yielded 40% improvement in Energy Intensity and Carbon Intensity
- Whilst already impactful – and in line with our CO_2 reduction glidepath modelling – it's not sufficient to really be 'Paris Proof' and be considered resilient to avoid 'stranded asset risk' (carbon perspective)
- We are now challenging our design teams (architects, engineers and consultants) to design for EI performance in line with CRREM 2040 targets – typically representing a 70-80% reduction
- We're now layering in upfront embodied carbon targets too with an internal carbon fee as an incentive to drive deliberate design, materials and construction methodology choices, understanding there may well be trade-offs between embodied carbon choices and future expected operational carbon emissions
- We want to work with partners that are also keen to experiment, to seek out better solutions, to raise the bar, and demonstrate what's possible – and we're convinced it will translate to value

WE FEEL A RESPONSIBILITY TO ACT

We must act…

1.) because it's the right thing to do (and it's an expression of our shareholders' mission)

2.) legislation will force us to at some point, as countries live up to their commitments made as part of the Paris Agreement, and efforts are ramped up to transition to a low carbon world

EVEN IN MOMENTS OF ADVERSITY, WE MUST REMAIN CONVINCED THAT EVERY LITTLE BIT COUNTS

What do we want our legacy to be?

We can do better…

We must do better…

We keep learning on the journey…

"Yes, the planet got destroyed. But for a beautiful moment in time we created a lot of value for shareholders."

Thank you for your attention.

Global Cement and Concrete Association

CONCRETE FUTURE

Global Perspectives on Decarbonising the Whole Life Cycle of Concrete

Dr Andrew Minson

Director for Concrete and Sustainable Construction, GCCA

DPhil CEng FICE FIStructE

Barcelona , October 2024

GCCA Membership

Our Members

Asia Cement Corporation
Breedon Group
BUA Cement
Buzzi
Cementir Holding
Cementos Argos
Cementos Moctezuma
Cementos Pacasmayo
Cementos Progreso
CEMEX
Cimenterie Nationale
Çimsa Cement
CNBM
CRH
Dalmia Cement
Dangote
Emirates Steel Arkan
Fletcher Building
GCC
Heidelberg Materials
Holcim
Hima Cement
Huaxin Cement
JK Cement
JSW Cement
Medcem
Misr Cement Group
Molins
Nesher Israel Cement Enterprises
Norm Cement
Northern Region Cement Company (Saudi Arabia)
Orient Cement
PT Solusi Bangun Indonesia
SCHWENK Zement
Secil
Siam Cement Group
Siam City Cement
Taiheiyo Cement
Taiwan Cement Corporation
TITAN Cement Group
TPIPOLENE
UltraTech Cement
UNACEM
Vassiliko Cement
Votorantim Cimentos
YTL Cement
Yura Cement

National & Regional Association Partners

Asociación de Fabricantes de Cemento Portland – Argentina
Asociación de Productores de Cemento – Peru
Associação Brasileira de Cimento Portland – Brazil
Association of German Cement Manufacturers (VDZ) – Germany
Association Professionnelle des Cimentiers – Morocco
Betonhuis – Netherlands
BIBM – Europe
CANACEM – Mexico
Canadian Precast Prestressed Concrete Institute
Cement Association of Canada
Cement Concrete & Aggregates Australia
Cement Industry Federation – Australia
Cement Manufacturers Association – India
Cement Manufacturers Ireland
China Cement Association
Concrete NZ – New Zealand
European Cement Association (CEMBUREAU)
European Federation Concrete Admixtures
European Ready Mixed Concrete Organisation
Federación Iberoamericana del Hormigón Premezclado – LatAm
Federación Interamericana del Cemento (FICEM) – LatAm
Japan Cement Association
Korea Cement Association
Mineral Products Association – United Kingdom
National Ready Mixed Concrete Association – USA
Portland Cement Association – USA
South India Cement Manufacturers Association
Thai Cement Manufacturers Association
The Spanish Cement Association (Oficemen)
Turkish Cement Manufacturers Association (TürkÇimento)

Global Perspectives on Decarbonising the Whole Life Cycle of Concrete

1 **Essential Role of Concrete**

2 **Global Roadmap**

3 **Low Carbon Procurement**

4 **Role of Project Teams**

Global Cement and Concrete Association

CONCRETE FUTURE

Essential role of concrete

1

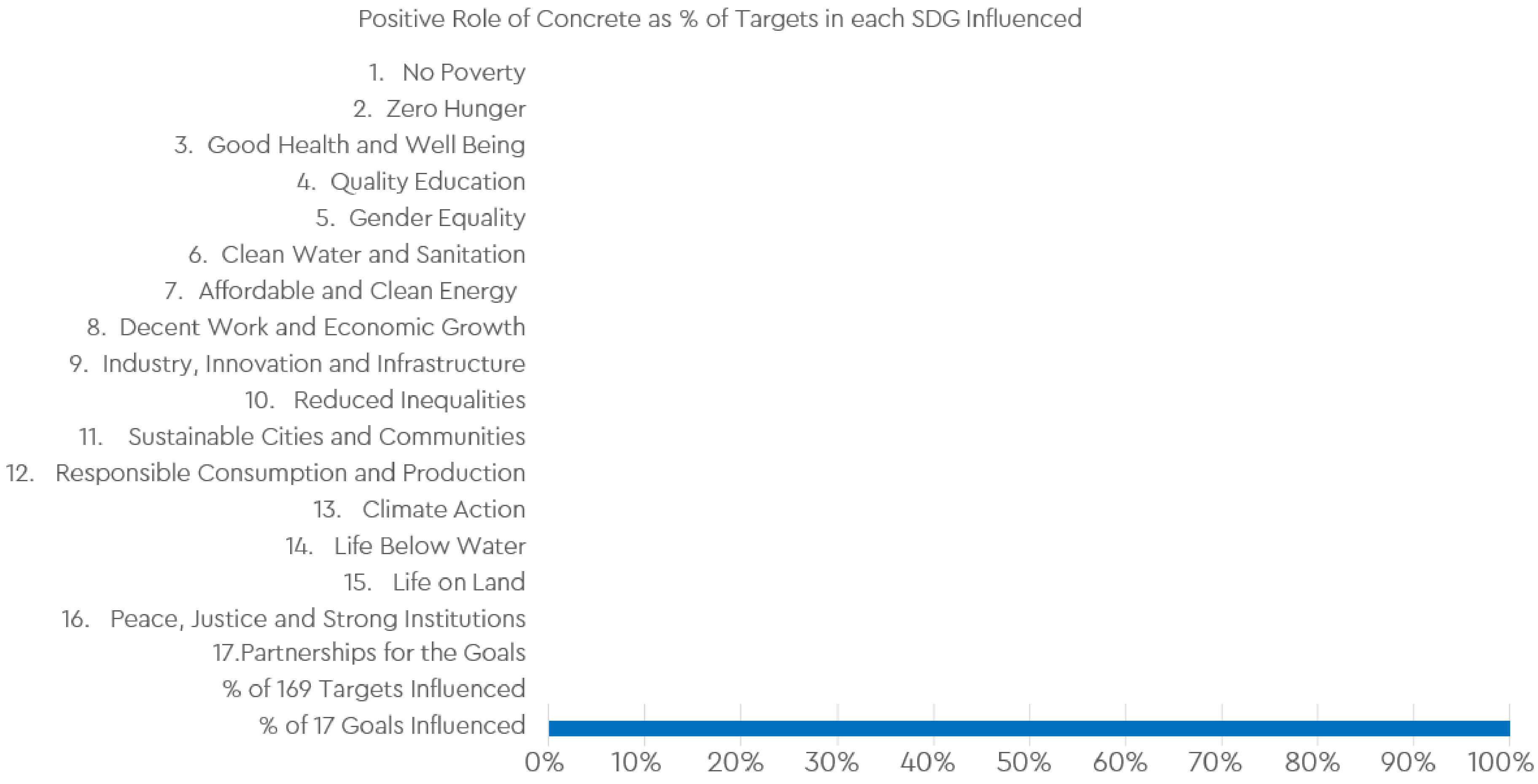
UN Sustainable Development Goals

UNOPS, a UN agency, has published a report which identified that the built environment supports society in reaching 92% of the 169 targets in the 17 UN SDGs.

This 92% figure derives from consideration of all parts of the built environment: infrastructure (water, waste, energy, transport and digital communications), buildings and facilities.

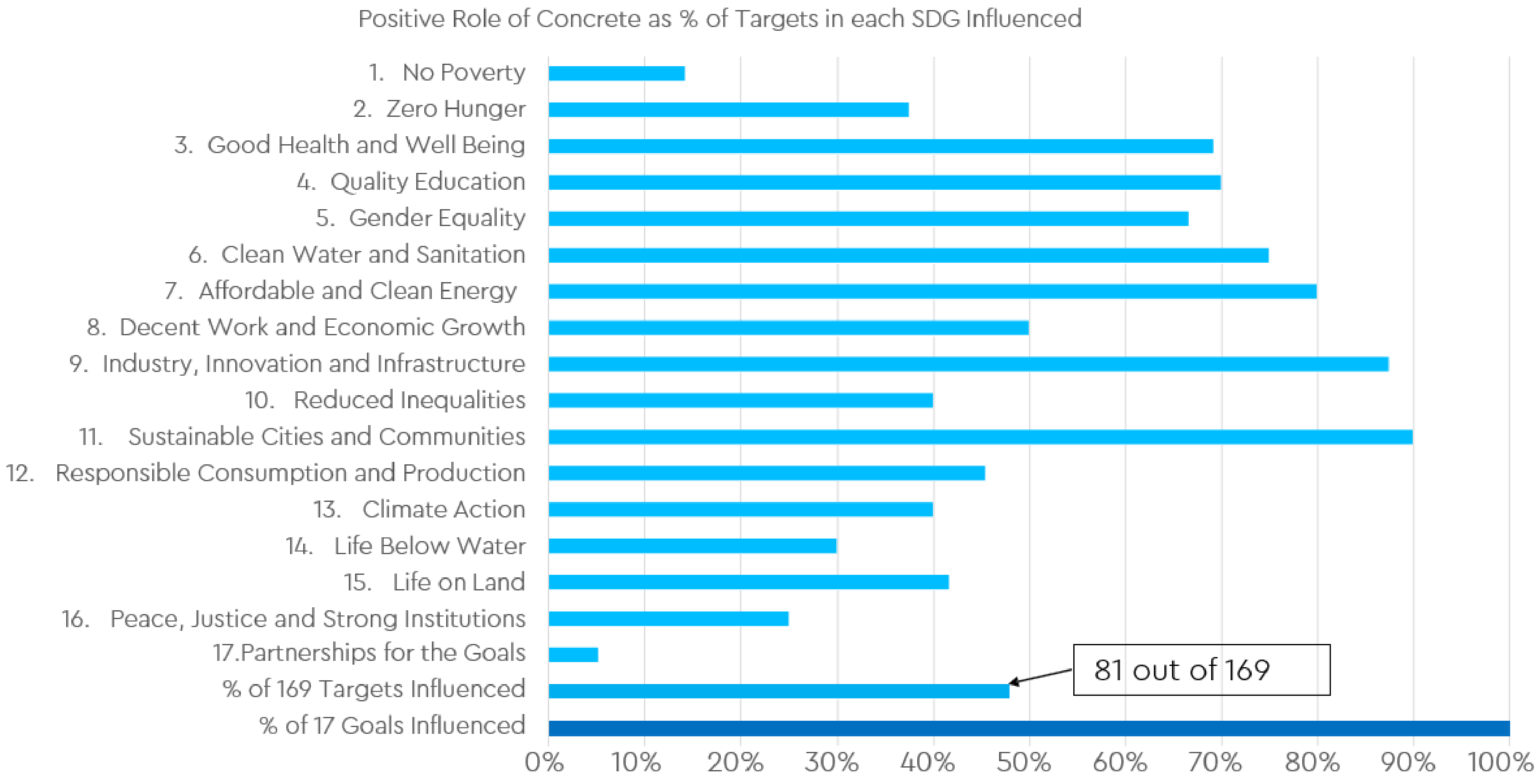
92% built environment supports society in reaching 92% of the 169 targets

Positive Role of Concrete in achieving each UN SDGs



Source: Minson A, The UN Sustainable Development Goals and Concrete, fib Symposium 2020 , Concrete Structures for Resilient Society pp2237-2244

Positive Role of Concrete in achieving each UN SDGs



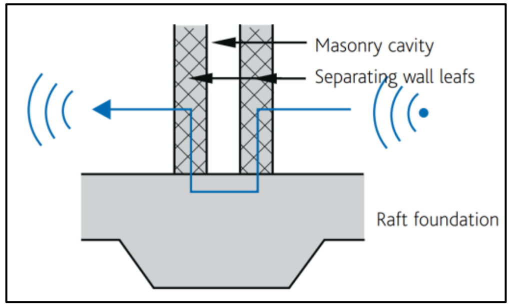
Source: Minson A, The UN Sustainable Development Goals and Concrete, fib Symposium 2020 , Concrete Structures for Resilient Society pp2237-2244

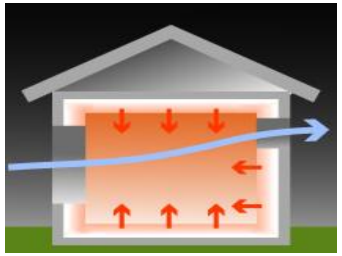
Performance benefits of concrete

- Strength
- Durability
- Resilience
- Fire Resistance
- Acoustic performance
- Flood resilience
- Thermal mass







JOHNNY MILANO/The New York Times/Redu

Concrete is essential… But needs to be decarbonised

"Three quarters of the infrastructure that will exist in 2050 has yet to be built.

Without credible action now, future generations will have no liveable planet to build upon.

The United Nations stands ready to support you in accelerating the transformation of your industry.

I invite all cement companies to join this vital endeavour."

António Guterres
Secretary-General
of the United Nations

World's infrastructure needs to 2050

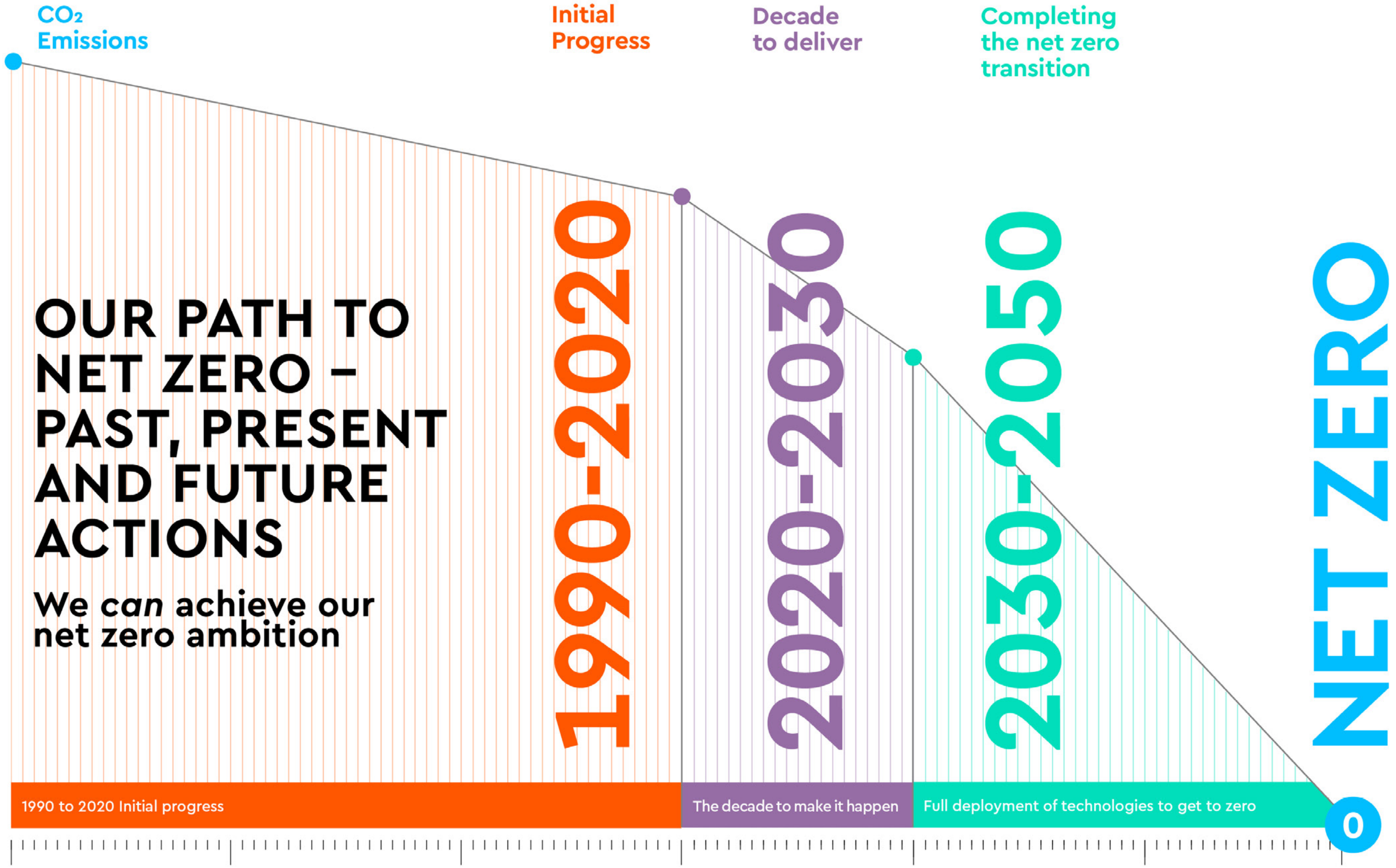
Global Cement and Concrete Association

CONCRETE FUTURE

Global Roadmap to Net Zero

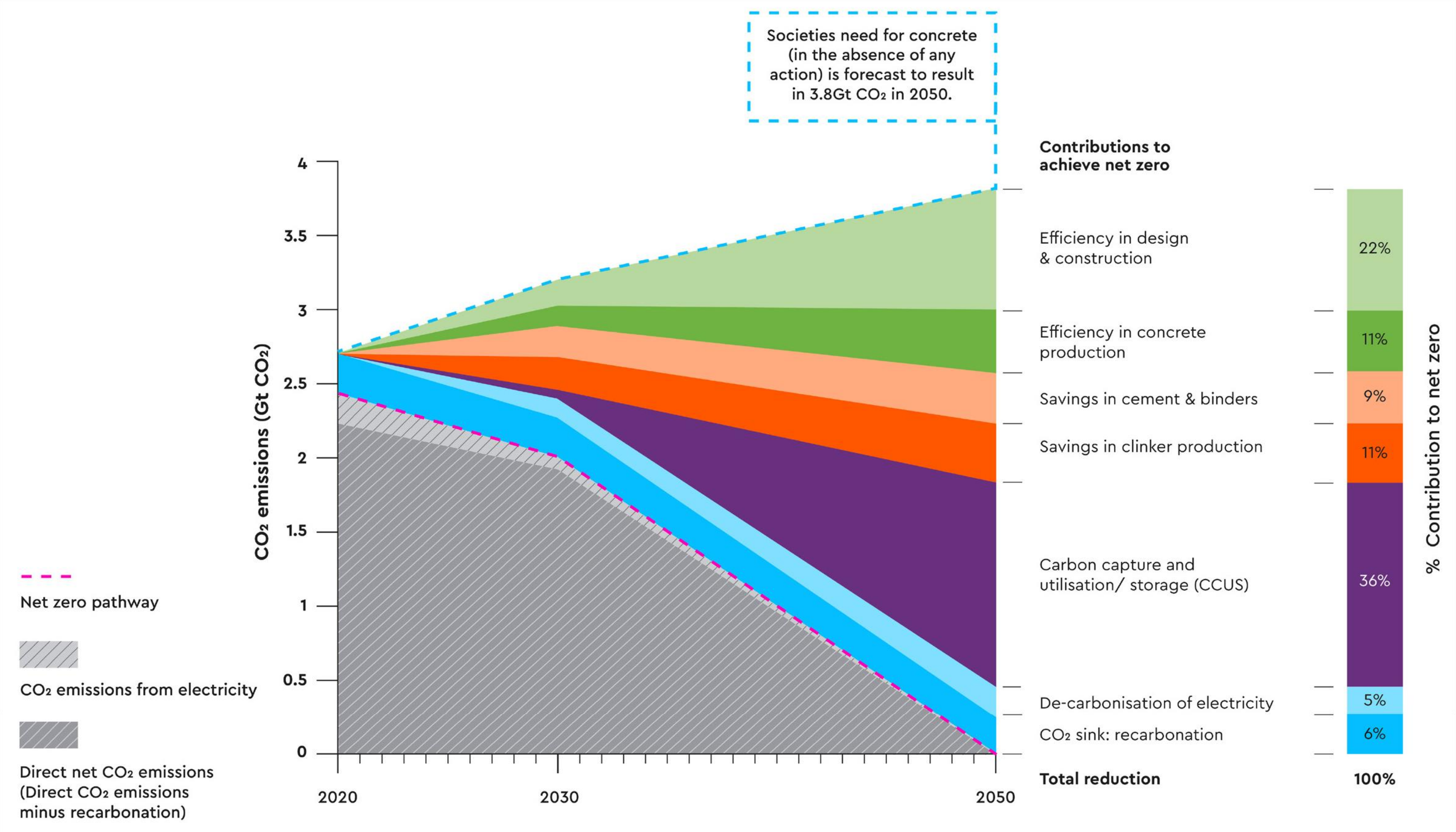
2

Global Roadmap to Zero



Global Roadmap to Zero

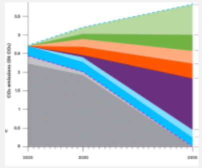
https://gccassociation.org/cement-industry-net-zero-progress/



Country Roadmaps: Accelerator Initiative by GCCA

- GCCA initiative launched March 2022: catalyst for country roadmaps
- Initiative is showing good progress
- A key step in regulatory transition and financing discussion

KEY DELIVERABLES

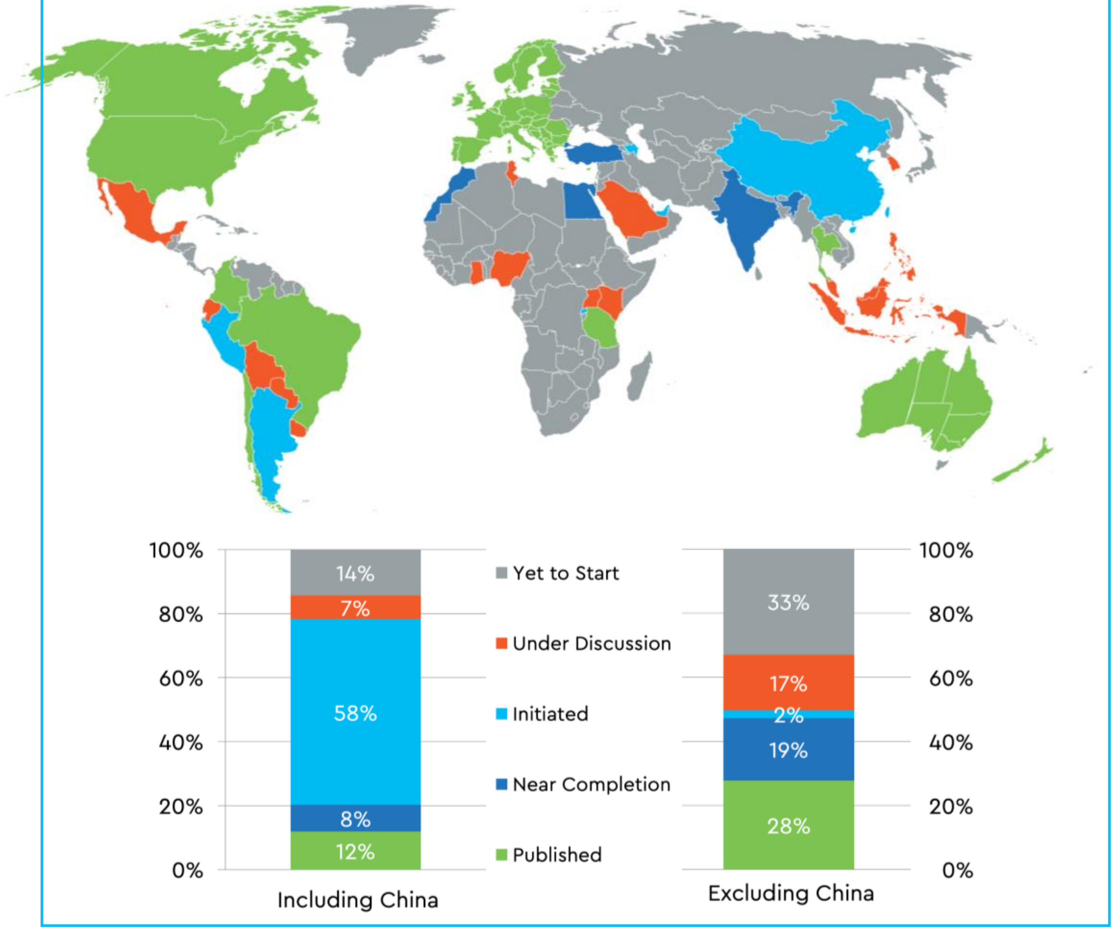


Roadmap Levers and CO_2 impact
Per lever, quantification of potential CO_2 reduction 2030 & 2050

Policy
Per lever, identification of enabling policies

Lighthouse Projects
Per lever, identification of lighthouse projects

Progress of Roadmaps around the globe



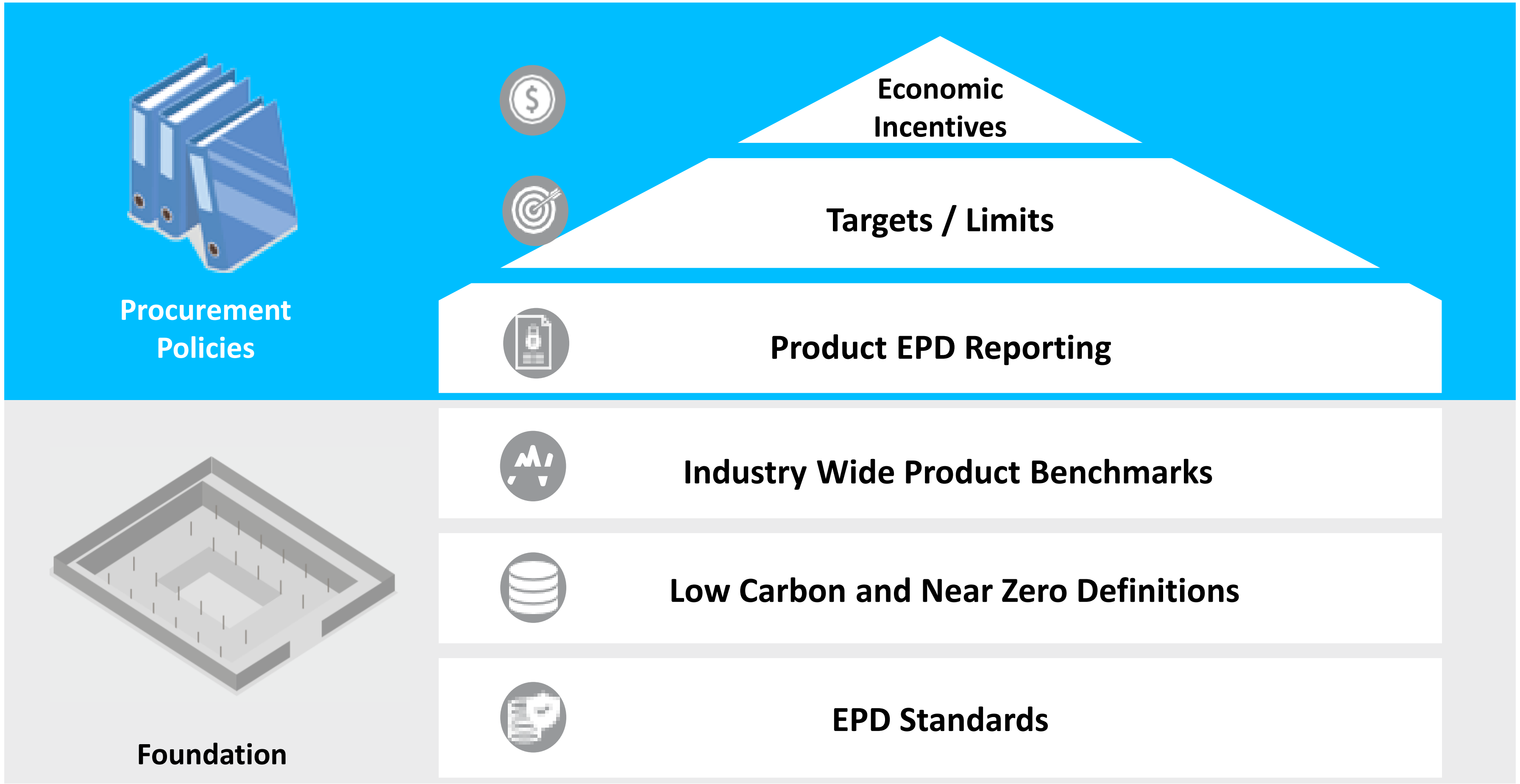
Global Cement and Concrete Association

CONCRETE FUTURE

Low Carbon Procurement

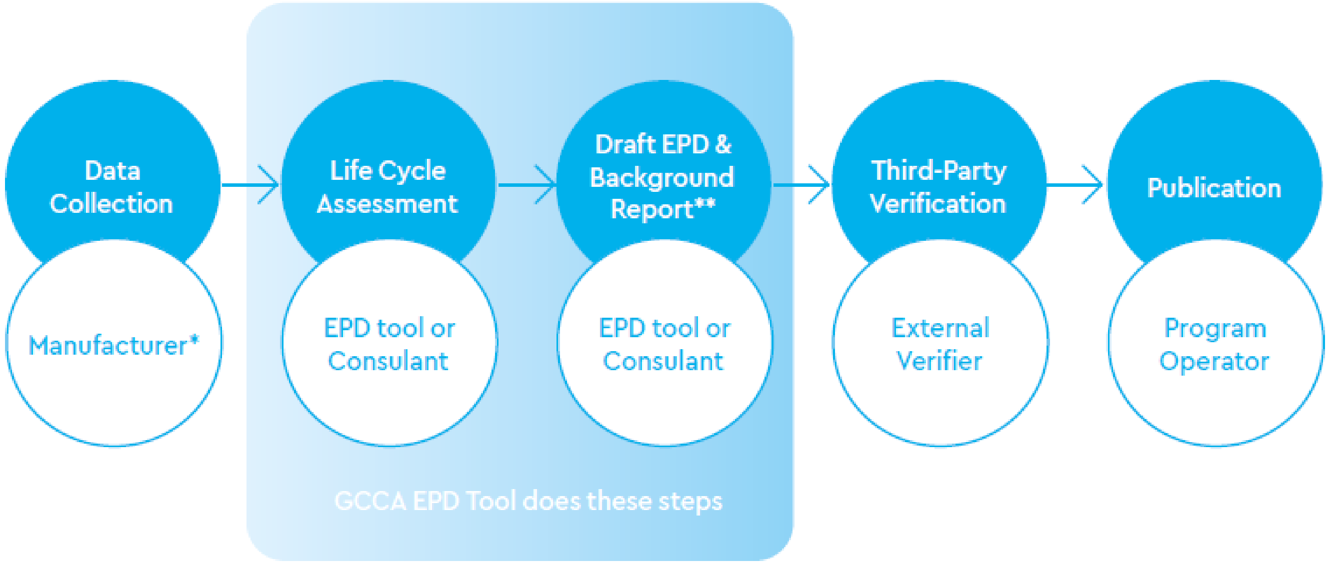
3

Low Carbon Procurement



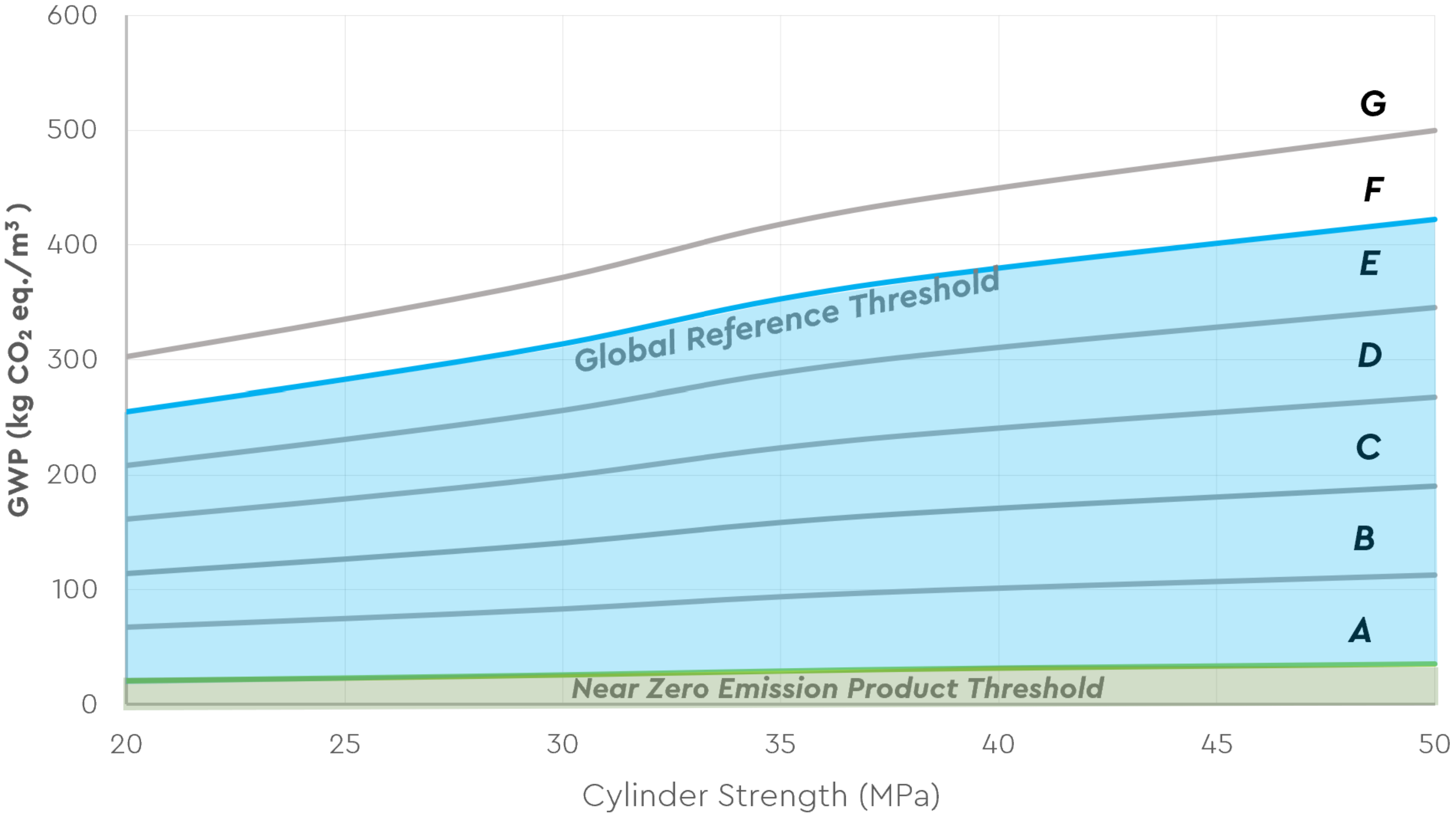
GCCA EPD Tool

Supports companies to prepare Environmental Product Declarations (EPDs) for
cement, concrete, aggregates and precast products.
Easy and at a lower cost



** The manufacturer manages all stages and liaises with many points of contacts*
*** The background report contains confidential information and is only used by the external verifier*

GCCA Low Carbon and Near Zero Definitions for Concrete



Global Cement and Concrete Association

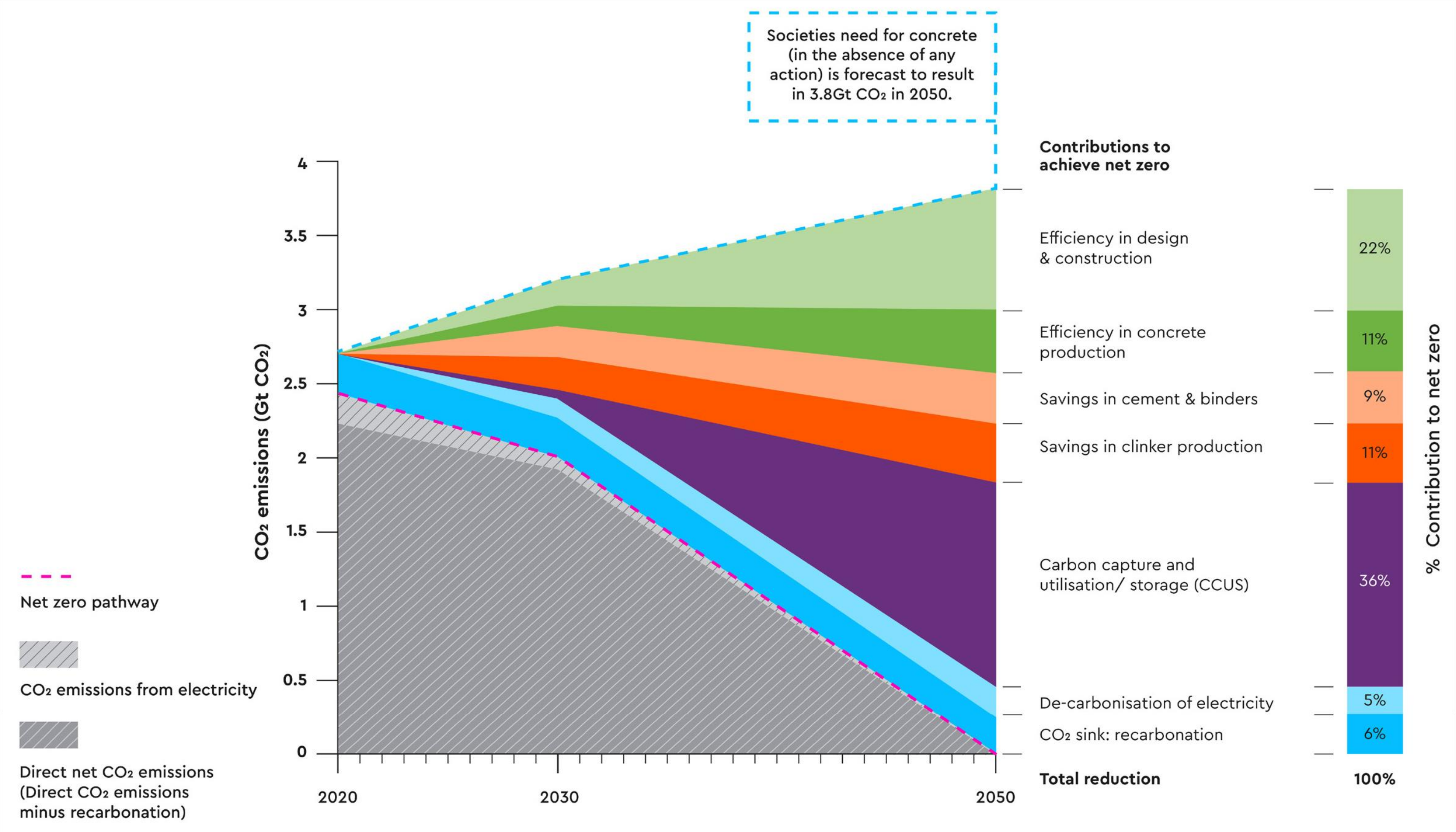
CONCRETE FUTURE

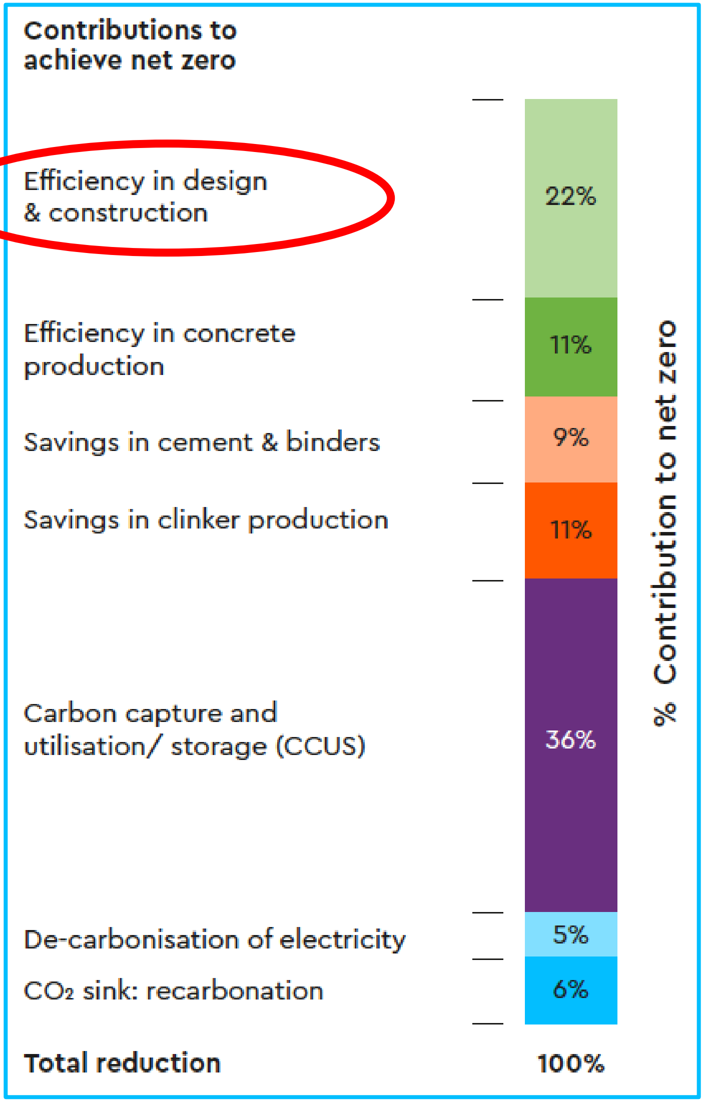
The role of project teams

4

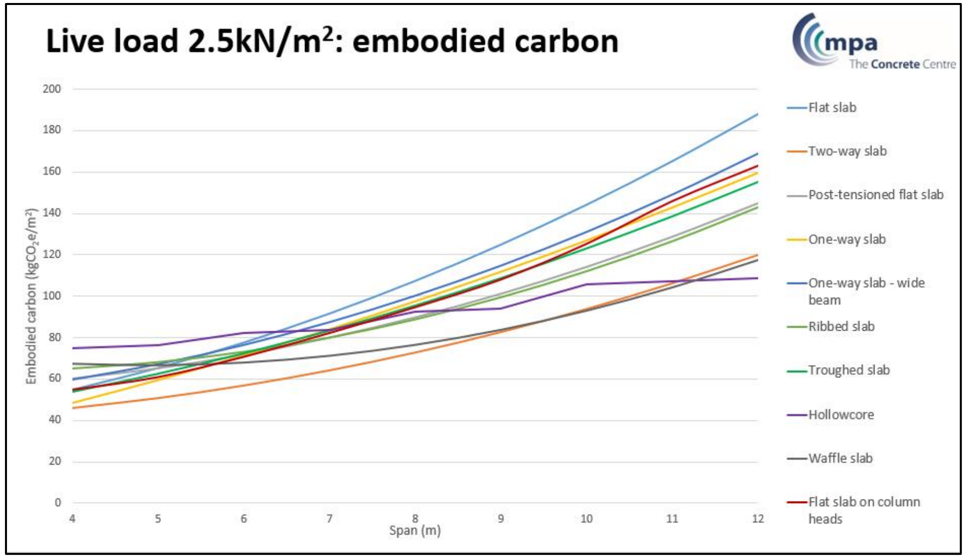
Global Roadmap to Zero

https://gccassociation.org/cement-industry-net-zero-progress/



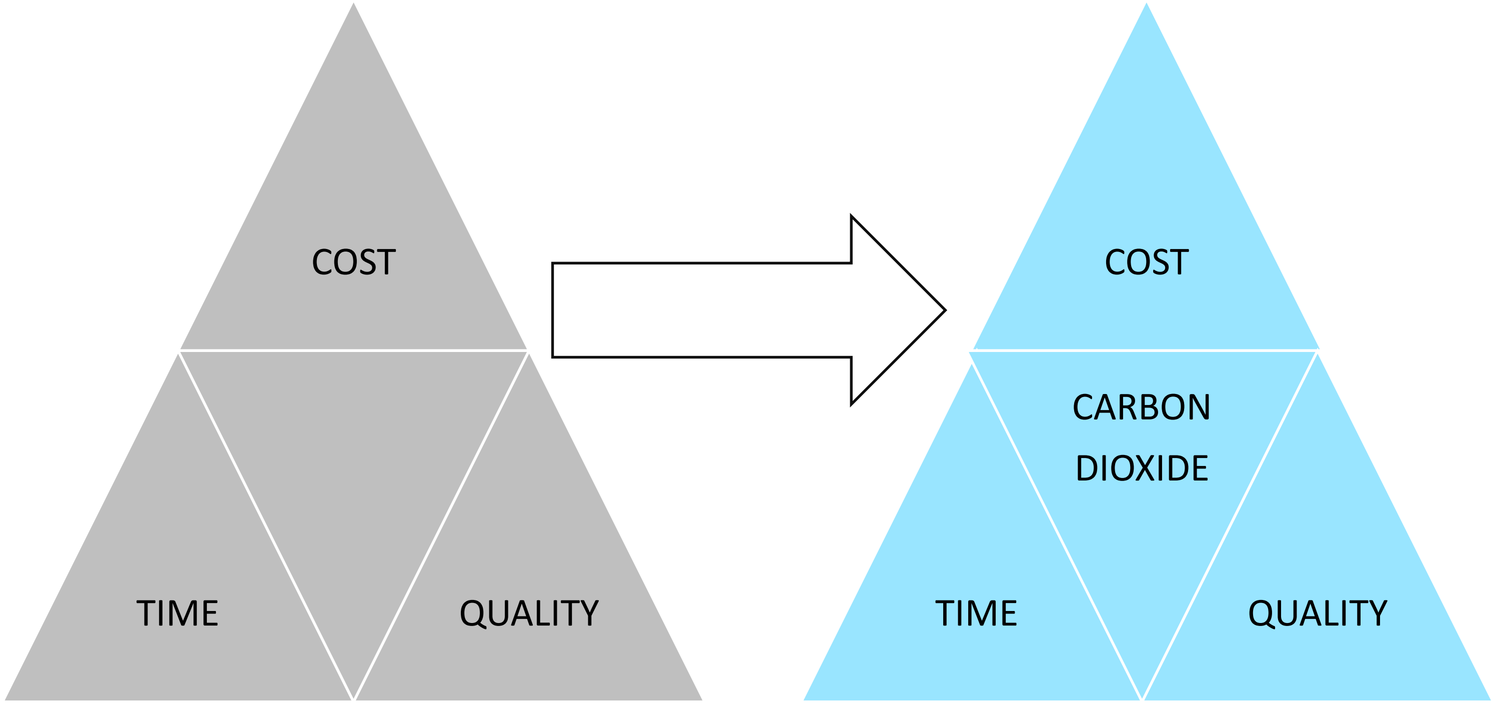


- Client brief to designers to enable optimisation
- Design optimisation
- Construction site efficiencies
- Re-use and lifetime extension

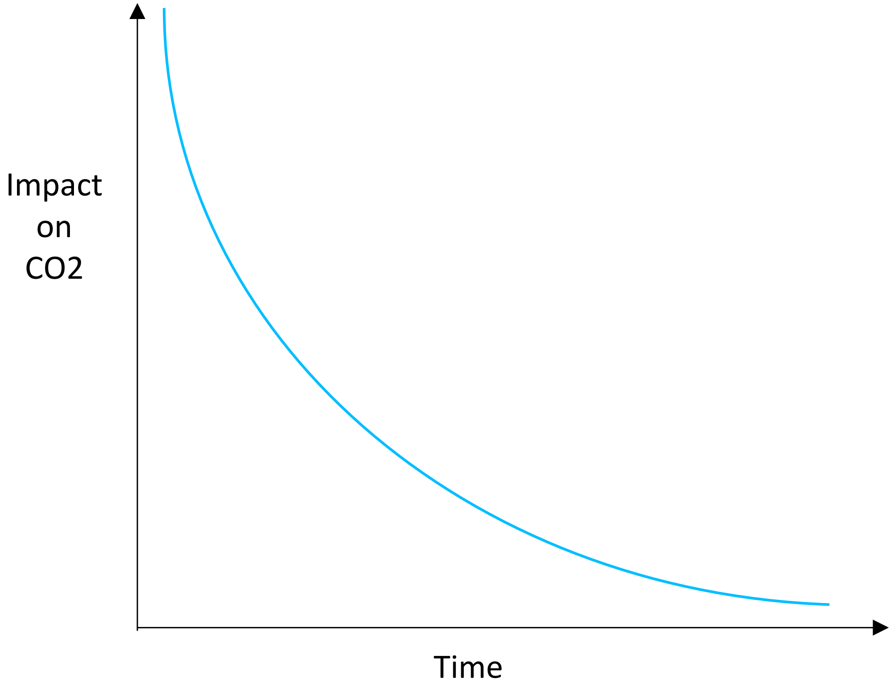


Past/Current

Current/Future



Impact v Project Stage

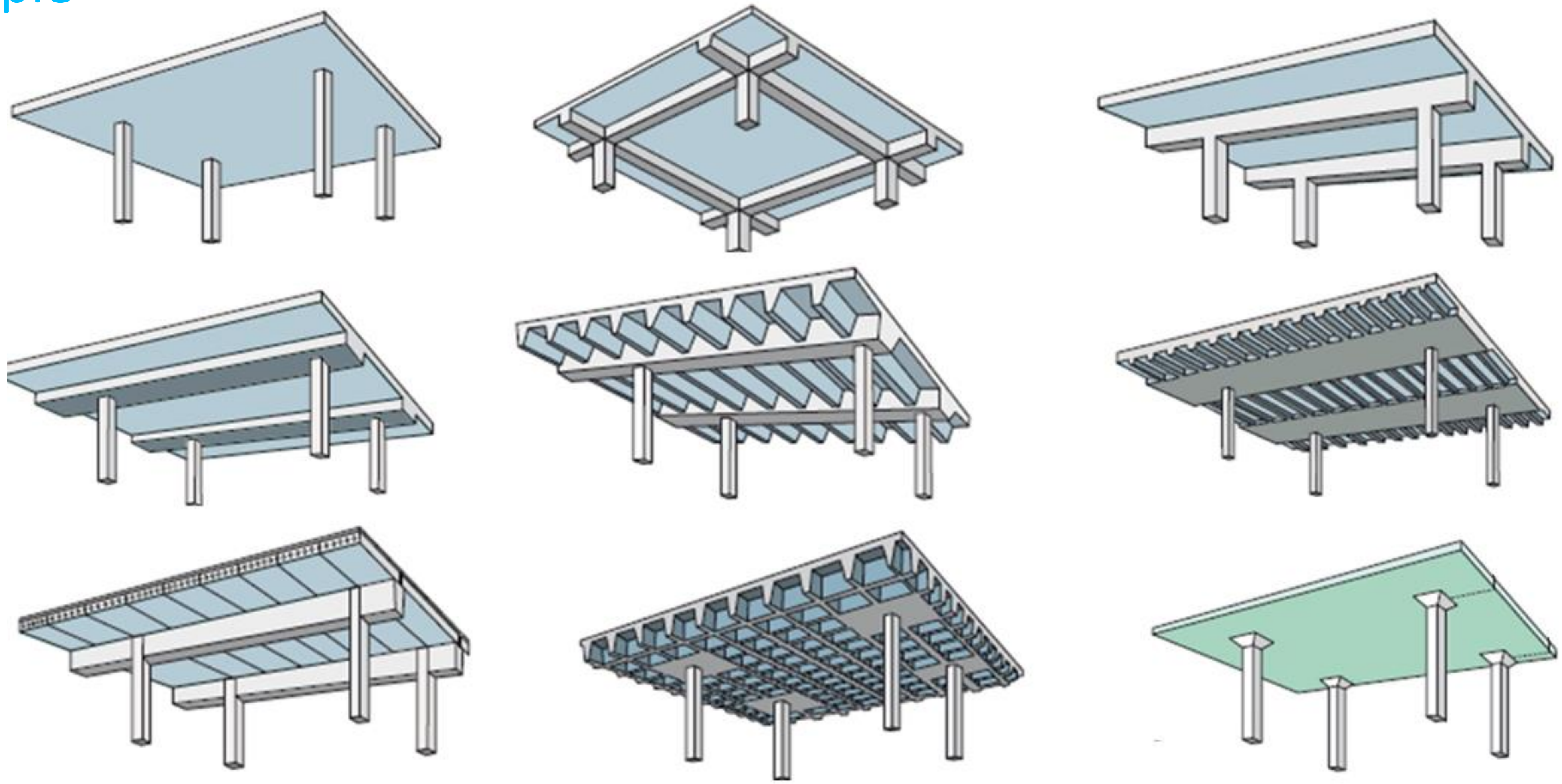


Substage	Description	Lever to reduce concrete construction carbon footprint
Concept	Material Emissions Choices relevant to construction in all materials	1. Choice of **reuse/re purpose** of existing
		2. Choice of **utilisation of asset(s)** (what floor area is actually needed)
		3. Choice/optimisation of **building form/massing**
		4. Choice of **grid sizes** to reduce material demand
		5. Choice of **loading** to reduce material demand
		6. Choice of level of **future flexibility/adaptability** of structure
		7. Choice of **design life** – in context of overall material demand over lifetime of this and subsequent project on site
	Avoidance of other emissions	8. Choice of **concrete as more than structure** – e.g. exposed finish to reduce ceilings, floor and wall finishes (e.g. coloured concrete); exploitation of thermal mass to reduce services
		9. Choice of **concrete avoids need for other materials** such as fire protection
		10. Choice of **concrete avoids long term maintenance and replacement**

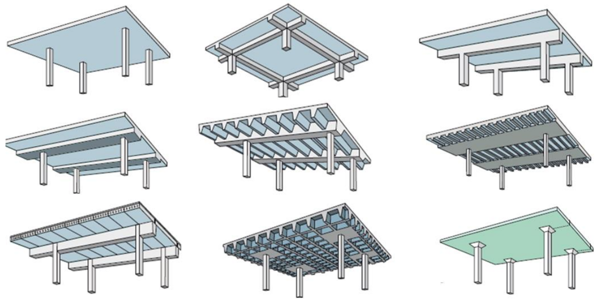
Legend: Role most able to move lever

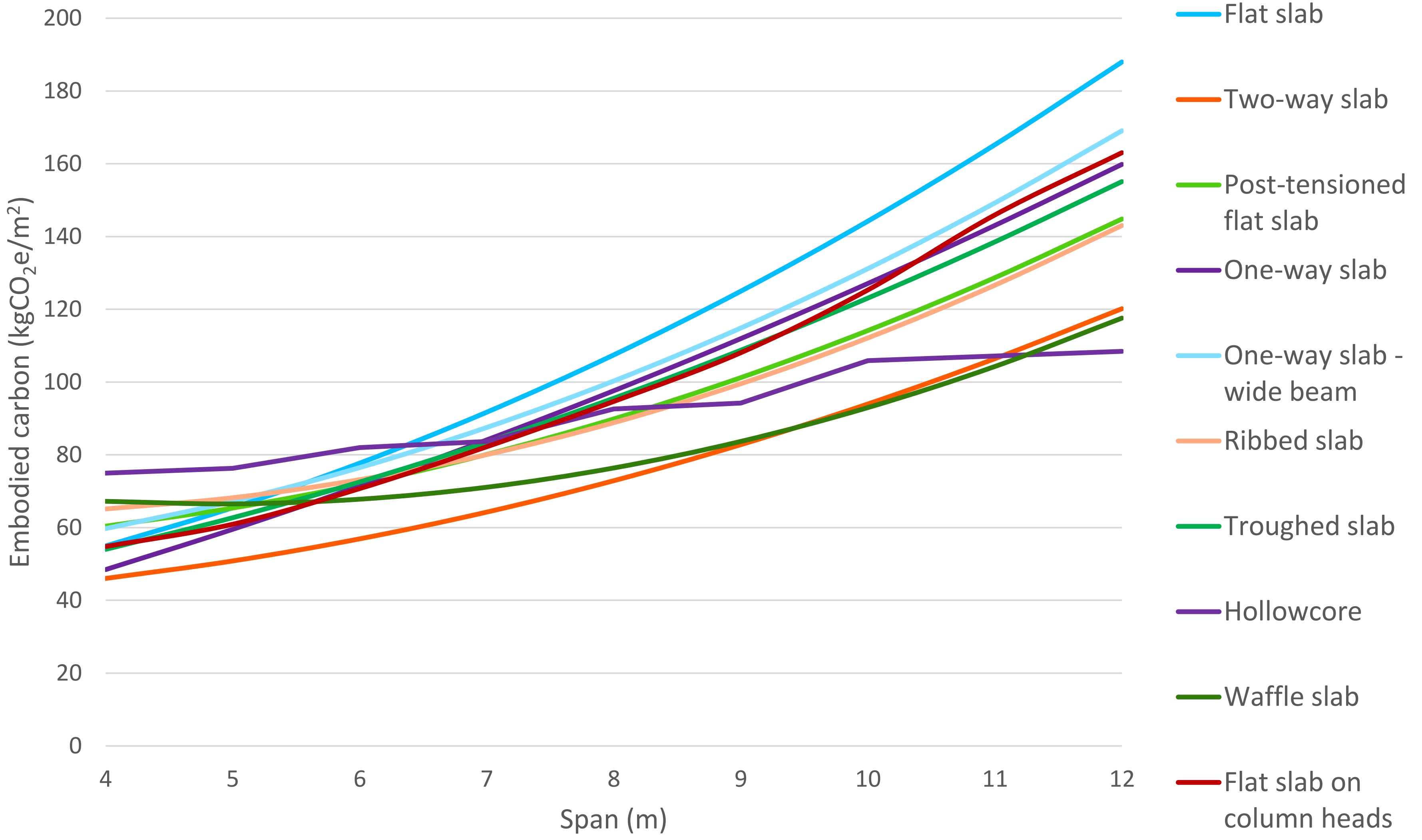
(blue)	Client
(green)	Client (designer) or Designer

Building Example



Building Example

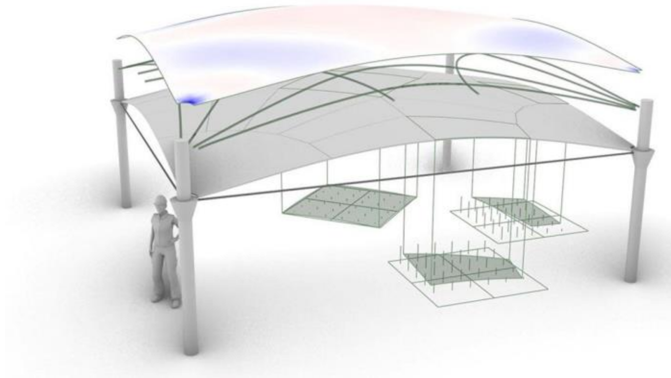




Thin vaulted floor slab could slash embodied carbon by 60%

Robot-manufactured curved ‘thin shell’ panels on columns and a raised floor

ACORN (Automating Concrete Construction), by Universities of Bath, Cambridge and Dundee



Global Cement and Concrete Association

CONCRETE FUTURE

Thank you!

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