BDP. Ideas

Civil & Structural Engineering

# How engineers can tackle the climate emergency

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# Beyond net zero through creative and intelligent engineering

Digby Stuart Library, University of Roehampton, UK

# Time to take the lead

**Now is the time for civil and structural engineers to take the lead in the climate emergency, by significantly reducing carbon emissions within the built environment.**

Construction accounts for nearly 40% of the world's carbon emissions. To date, the focus has been on cutting operational carbon emissions. But now civil and structural engineers must come to the fore by reducing embodied carbon emissions. These emissions, created in the production of materials and construction processes, make up nearly a third of the industry's carbon output. We can and should lead the charge towards net zero and beyond. We can do this through the materials we choose and the construction methods we specify.

We should start every project by posing key questions:

- Can we in fact build nothing by retroftting and refurbishing instead?
- Can we build less through leaner and more efficient design?
- Can we build better with as much reused and recycled material as possible?

Only bold actions, powered by creative and intelligent engineering, can decarbonise our industry.

**John Roycroft**
**Principal, Chair of Civil and Structural Engineering**

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# Protecting the planet

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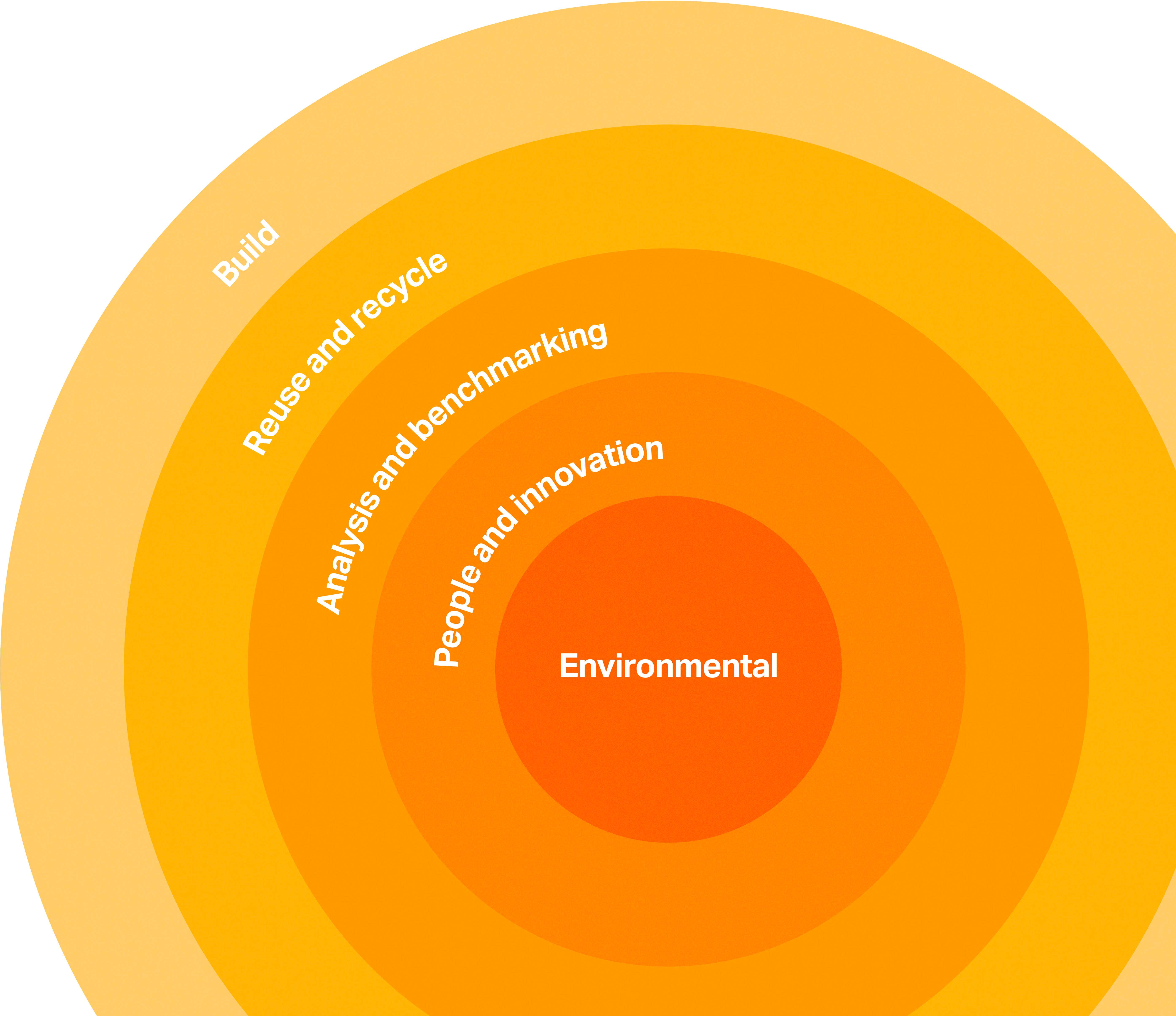
# A natural view

**Putting the environment at the centre of a design shifts an engineer's perspective. How can we meet the brief with a minimal – and even a positive – impact on the natural environment?**

People and innovation, benchmarking and analysis, and reuse and recycling all have a role to play, as the following pages will show. Building something new from scratch should be an action of last resort.



# An organic approach

**From the concept stage, we need to consider all potential inhabitants of a space, from the flora and fauna to humans. We can do this through site surveys and thorough cataloguing of species, both permanent and migratory.**

We need to break down silos between the client, ecologists, civil and structural engineers, architects, sustainability experts and landscape architects. Collectively we can shape a sustainable design that meets the brief as well as protecting and nurturing the environment. This collaborative approach will help us move away from carbon-hungry projects in favour of innovative designs that sequester carbon, improve air quality, boost biodiversity and improve our physical and mental health.

Cornmill Gardens, Lewisham Open Space, London, UK

# Cross-sector collaboration

In Southend-on-Sea, BDP worked collaboratively to create The Launchpad, an innovation hub featuring a meadow, green roof, bird boxes, permeable paving and a swale. The result was a small carbon footprint, an attractive biodiverse habitat and cleaner water entering the watercourse. Such sharing of ideas must accelerate. We must embrace the latest thinking from ecologists, sustainability experts and research bodies such as the Construction Industry Research and Information Association (CIRIA), and continue to learn about and apply the latest technologies and software. We should nurture these natural ecosystems as if our very lives depended on them, because ultimately they do.

Launchpad Innovation Hub, Southend-on-Sea, UK

**We should nurture these natural ecosystems as if our very lives depended on them, because ultimately they do.**

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# The central role of the engineer

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# Proactive, not passive

**Engineers should forensically interrogate proposals to measure the 'whole life' carbon loads of an evolving design and challenge proposals that fail to decarbonise.**

This way, engineers can challenge budgets and cut carbon from all stages, from concept design through to handover and use.

Location, setting, orientation, ground conditions and materials are all vital factors in determining the amount of embodied carbon in a structure.

Engineers can interrogate and define all these elements to cut embodied carbon. They can also challenge and transform a 'demolition and new build' mindset into a low-carbon strategy focussed around retrofit and reuse.

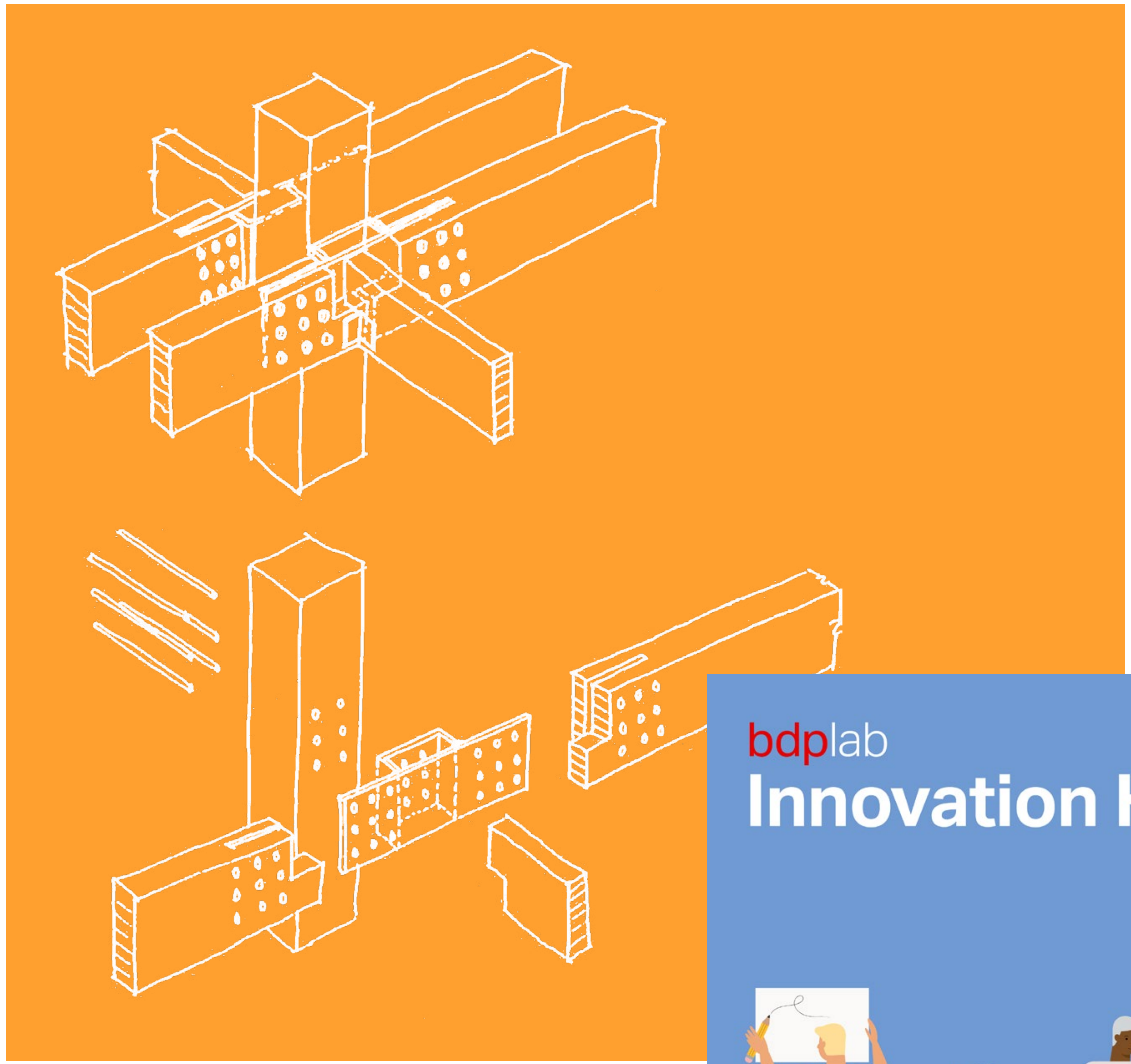
# Creating an ideas-led culture

**Practices should give engineers at every level – from young graduates to profession leads – the chance to contribute innovative ideas and change the way an organisation thinks.**

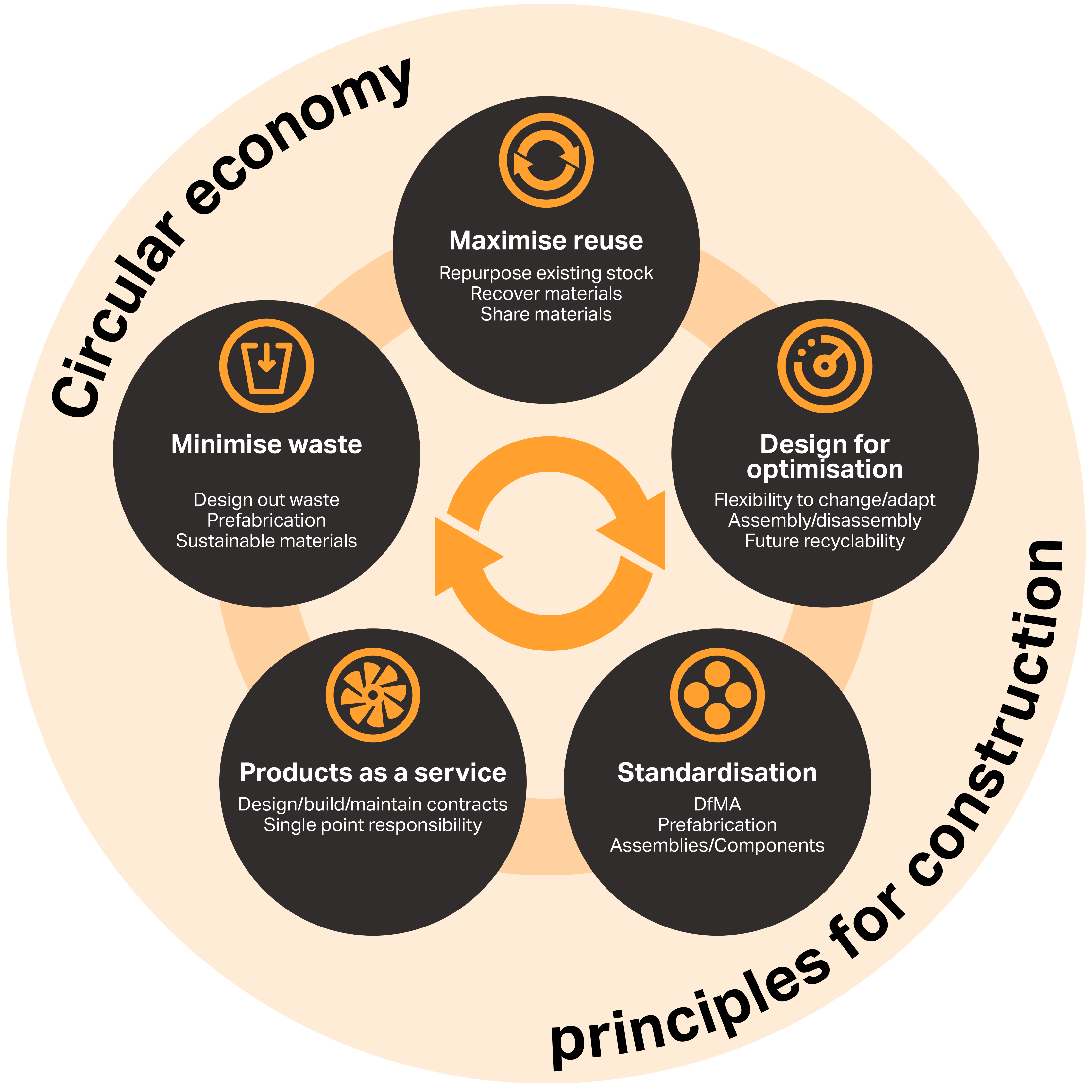
At BDP, we have launched a 'laboratory' to develop ideas from any quarter. Members of staff at any level, from any discipline and any location, can suggest a new BDP Lab initiative. Once agreed, we pull together integrated teams to develop these ideas into benchmarks, typologies and tools for adoption across the business.

For example, we've drawn together engineers, architects, interior designers and modern methods of construction (MMC) specialists to create standard layouts for hospital bays, resulting in low-cost and low-carbon designs being adopted across numerous UK healthcare schemes.

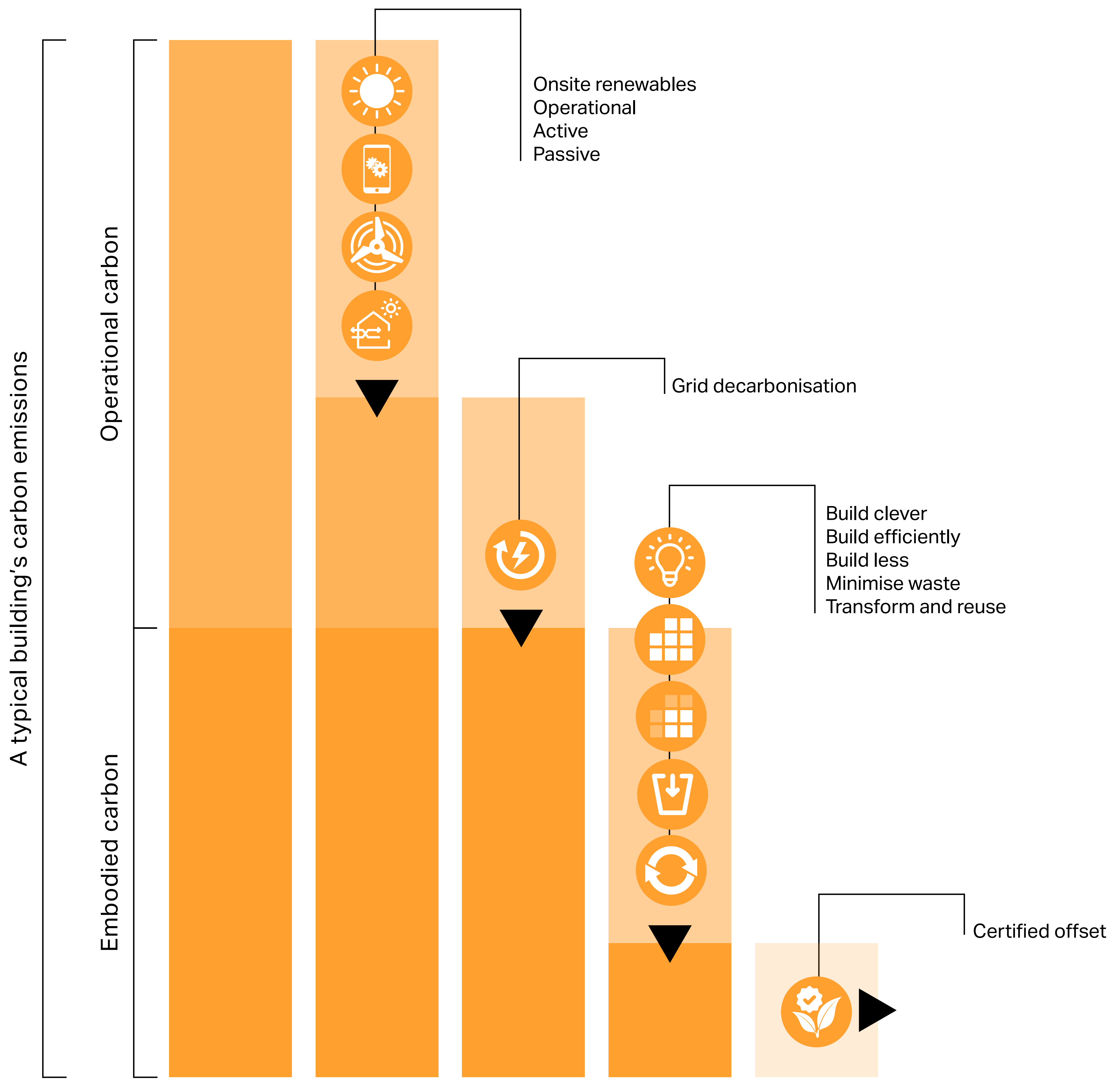
Only by cutting through the hierarchy and embracing an ideas-led culture, will engineering practices like ours remain nimble and relevant.



# Roadmap for carbon reduction




**Circular economy:** carbon reduction principles




**Route to net zero:** getting the sequencing right

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# Analysis and benchmarking

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# Developing industry standards

**Benchmarking is one of our most powerful tools in tackling the climate emergency. As standard, the industry must measure the amount of embodied carbon in every scheme and strive to lower emissions with every new build.**

We need to set out maximum kilograms of $CO_2$ equivalent per square metre limits for all building types, from hospitals and schools, to blocks of flats and car parks.

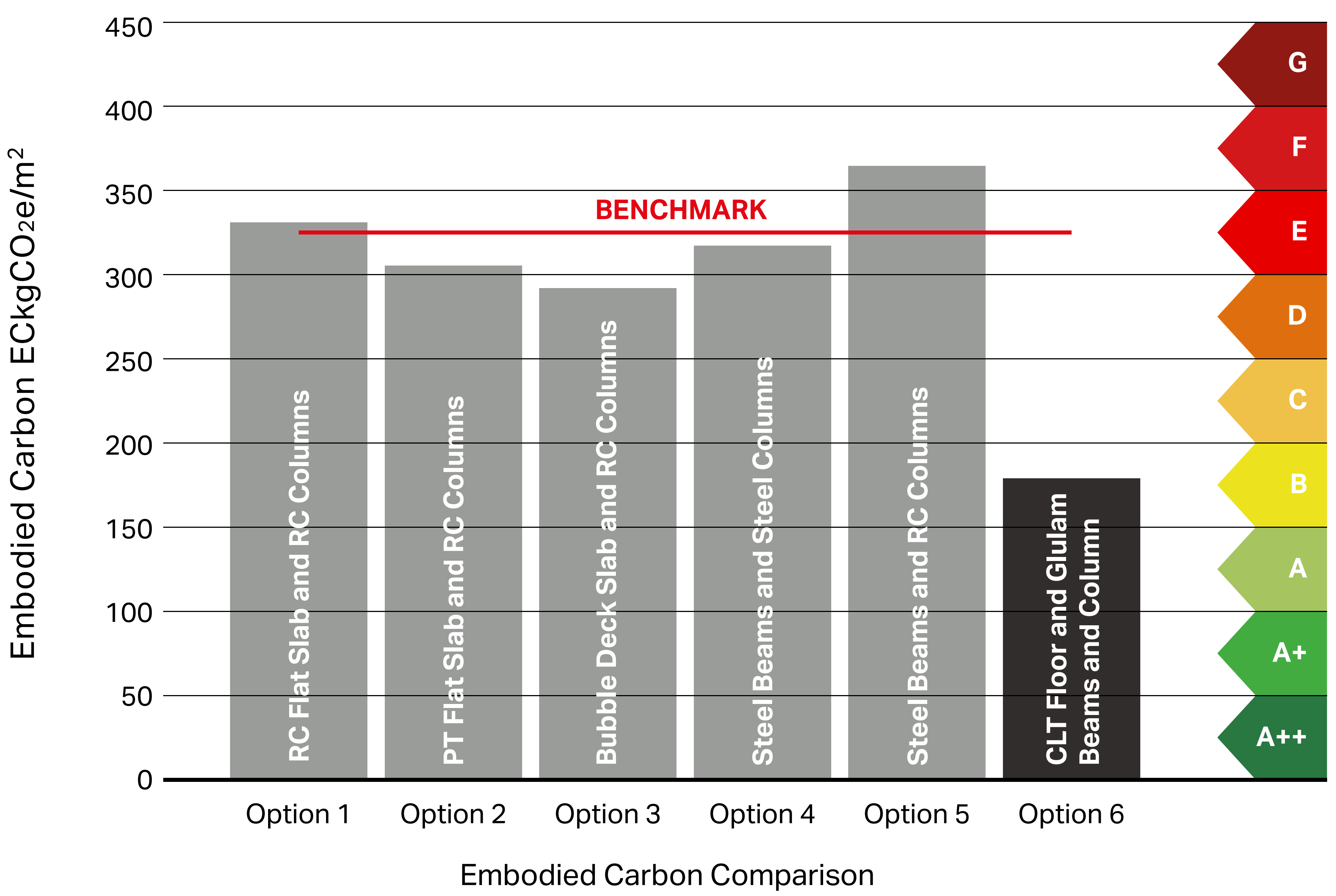
We're using our modelling software to generate multiple frame types, foundation options, configurations and construction materials and are feeding these outputs into the benchmarking tool. This allows us to measure material quantities and embodied carbon values for multiple possible concepts, which will inform and guide the design.

We'd like to see this tool adopted by the industry from concept through to technical design stages, helping us set benchmarks and share progressive carbon-reduction strategies.

Learning and Teaching Centre, Brunel University London, UK

# Enterprising green standards

**Industry standard benchmarking tools can raise the bar for pioneering green buildings. Norwich's Enterprise Centre, which BDP engineers designed to have a lifespan of more than a hundred years, won 40 industry awards. Our designs draw upon traditional skills and materials and combine this with modern design tools and knowledge.**




Enterprise Centre, Norwich Research Park, UK

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BDP's designs drive low-carbon materials, promote local and traditional construction methods. For the Enterprise Centre at Norwich Research Park, local Thetford Forest timber, Norfolk straw, recycled crushed aggregate and flint informed the specification.

Enterprise Centre, Norwich Research Park, UK

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# Reuse and recycle


Leighton House Museum, London, UK

# Retrofit revolution

## Refurbishing and retrofitting buildings will dramatically cut our industry's carbon emissions.

We can play an active role early on, modelling retrofit options that are sustainable, cost-effective, structurally efficient and fit for purpose. Lean design and early-stage supply chain engagement can bring real benefits. We can harness the microclimate to optimise solar gain, minimise the impact of structural interventions, reduce running costs and challenge conventional load restrictions to further cut carbon.

As an industry, we must back campaigns such as Architects' Journal's RetroFirst, which is pushing for the reuse of buildings and associated VAT cuts. Policies are an important contributor to change.

National Army Museum, London, UK

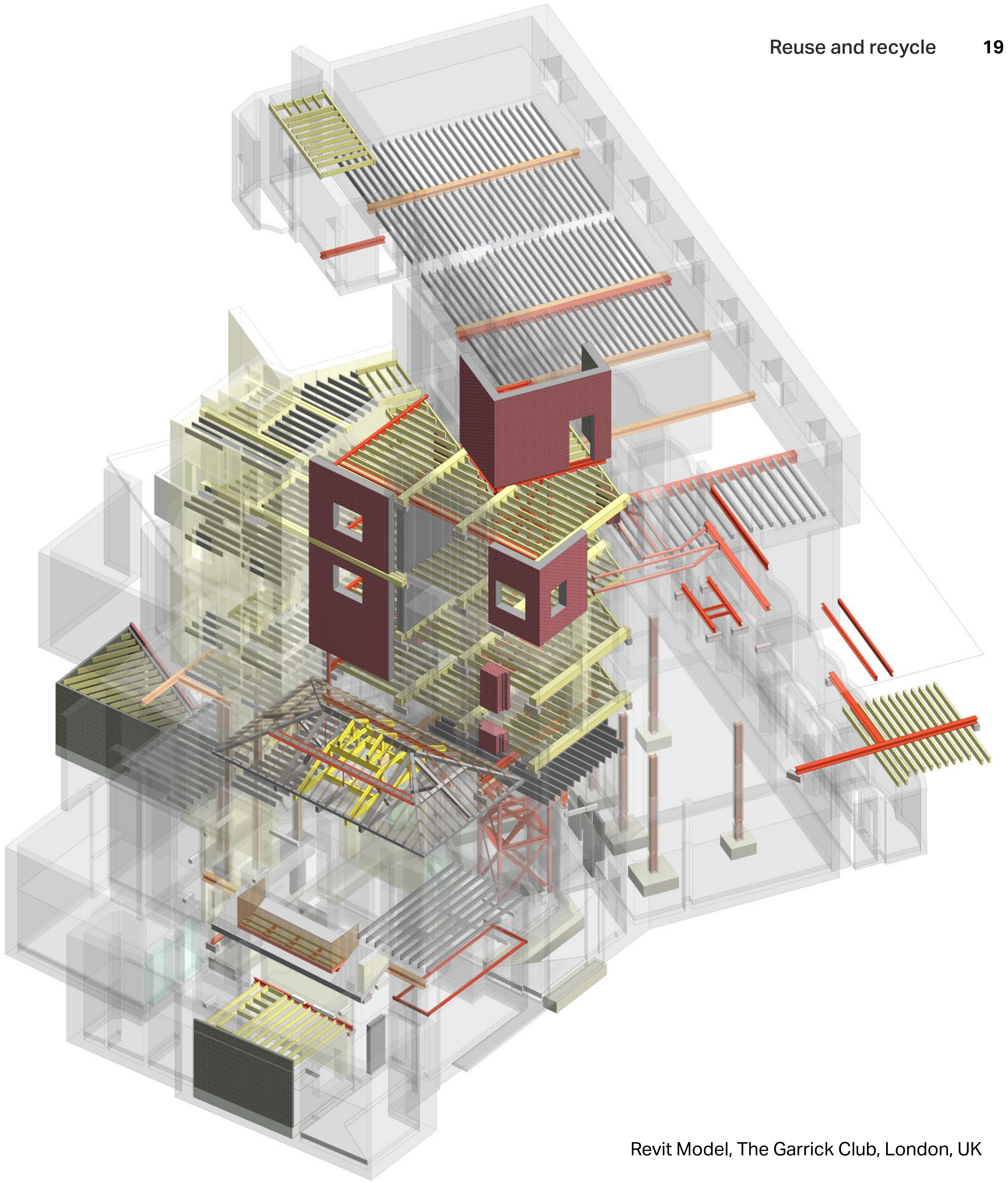
# Tradition meets cutting edge

## Some of the most successful reuse projects combine old and new technologies.

For example, a traditional masonry building can be given a new lease of life by adding lightweight and sustainable materials such as prefabricated cross-laminated timber. Investigating passive techniques, disassembling existing building elements for reuse and integrating renewable technology into the structure will also secure a lower-carbon future.

At the Garrick Club, a Grade II* listed historic members' club in London, we created a three-storey wing using new timber supported by existing load-bearing masonry.

Our refurbishment opened up access to people of all abilities and unlocked new spaces, creating new offices, function rooms and bedrooms, all within an 1860s fabric.



Revit Model, The Garrick Club, London, UK

# Circular economy

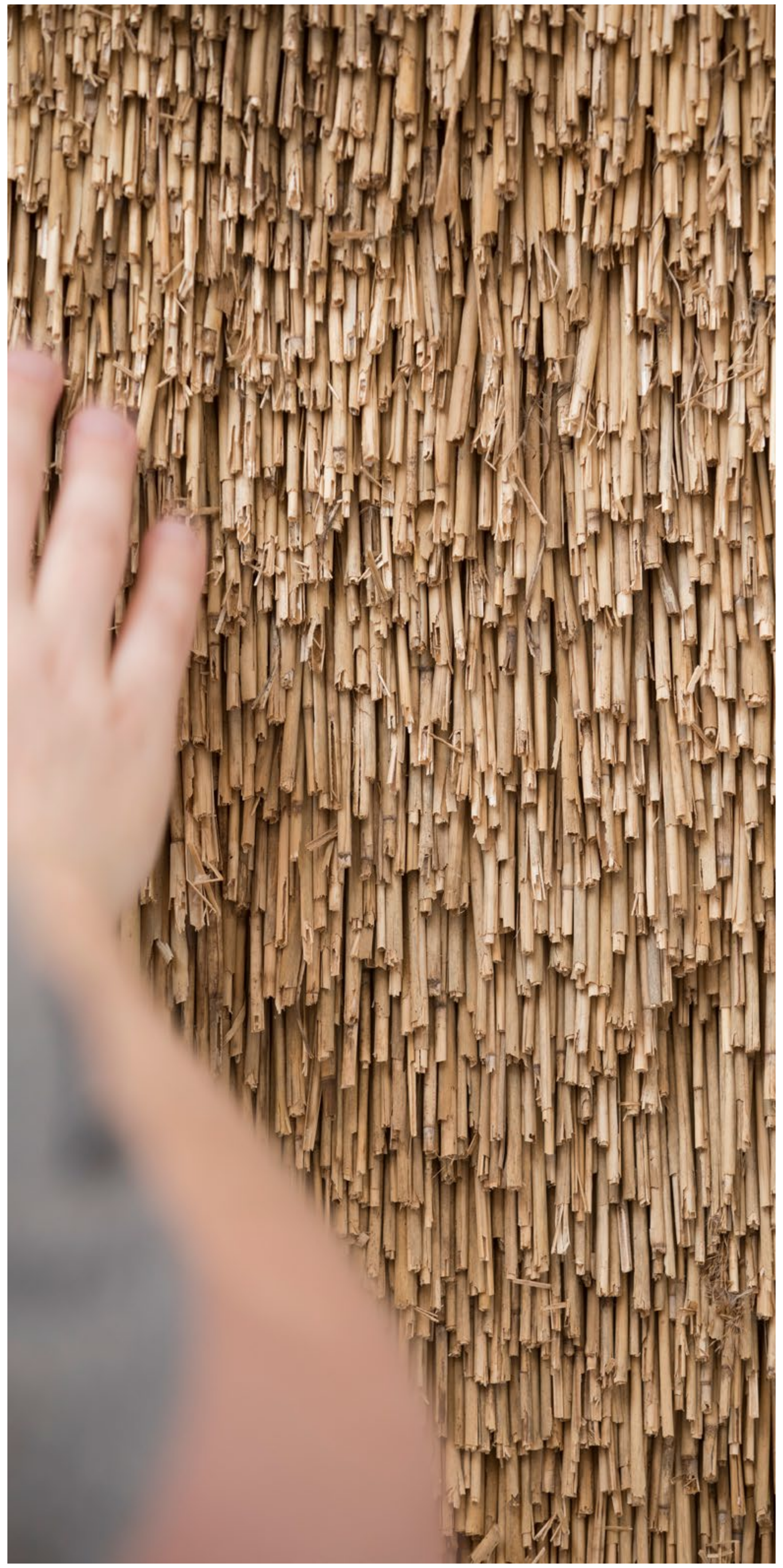
**'Demountable' is a core engineering philosophy. All engineers should design structures that can be easily dismantled at the end of their natural life, so that their components can be reused in other schemes to reduce future carbon footprints.**

But we need to be more ambitious. We should be incorporating recycled components into all our buildings – both retrofitted and brand new – right now and not just in 50 years' time. To achieve this, we need a comprehensive database of components and a responsive supply chain.

# Materials come first

**The design process should be turned on its head. Currently we design a form and then source components to create it. Instead we should start with available materials and work out how they can be utilised to meet the client's needs.**

As a start, engineers should maximise recyclable, standardised components in their designs and keep detailed records of their dimensions, grades, connections and capacities for their peers of the future. A simple 'demountable' checklist at the end of every design change, complete with targets, will help embed this culture change.



Enterprise Centre, Norwich Research Park, UK

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# Intelligent and creative design

80 Atlantic Avenue, Toronto, Canada

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# Designing for a long, flexible life

**Sustainability and flexibility are often at loggerheads. To drive down carbon, we always strive for the most efficient design. This means we often challenge and reduce load threshold specs, to avoid piling in materials for loads that will never materialise.**

But if a developer seeks a flexible, multi-use structure – for example, one that is capable of accommodating a transformation from office to retail space – a traditional approach would be to specify larger elements to support heavier loads, which would inevitably ramp up embodied carbon in the columns and floors.

The solution lies in guiding the building owner to define 'flexible' at concept stage and helping them avoid carbon-hungry specs for future incarnations that will likely never happen. We can even assess the carbon impact of strengthening columns and floors in future, so we only spend the carbon when it is needed.

80 Atlantic Avenue, Toronto, Canada

# Modern methods of construction

## Modern methods of construction (MMC) is a leaner, lighter approach that saves carbon, time and materials.

The industry often pushes for ever taller landmark buildings. Instead we should build our structures on MMC principles: high-performance, low carbon and economies of scale.

Offsite prefabrication cuts waste and emissions. In the factory we can manufacture at scale in a safe environment and eliminate fabrication errors. We can also bind lower-carbon alloys such as cement-free (CEM-free) concrete, which takes longer to cure than its carbon-heavy cousin, ahead of schedule.

But the industry can't follow a traditional design process and bolt on MMC at the end of the technical design stage. Engineers, MMC contractors, designers and clients need to engage at the concept design stage, exploring how MMC can deliver against low-carbon goals from the start.

Digby Stuart Library, University of Roehampton, UK

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# Global ideas pool

**At BDP we have created an MMC working group to share the latest thinking from around the globe.**

We meet quarterly, pooling lessons learned from our offices in the UK, Canada, USA, India, UAE, China, Ireland, Singapore, Peru, Japan and The Netherlands.

We plug this expertise into multidisciplinary teams and live projects. We take the lead by modelling parametrically from the concept stage, cycling through multiple grid and material options to optimise low-carbon designs.

# Hybrid design

**Hybrid design melds the traditional with cutting edge. It involves combining materials and construction techniques to cut carbon and costs.**

At Barrow-in-Furness we created a hybrid cross-laminated timber (CLT) and steelwork structure instead of using a traditional concrete composite.

By marrying traditional steelwork skills with timber expertise we drove down the building's embodied carbon, cut programme time and upskilled the industry. We also combined off-site and on-site fabrication to reduce on-site activities and site waste.

Furness Academy, Barrow-in-Furness, UK

# Designing for extreme weather



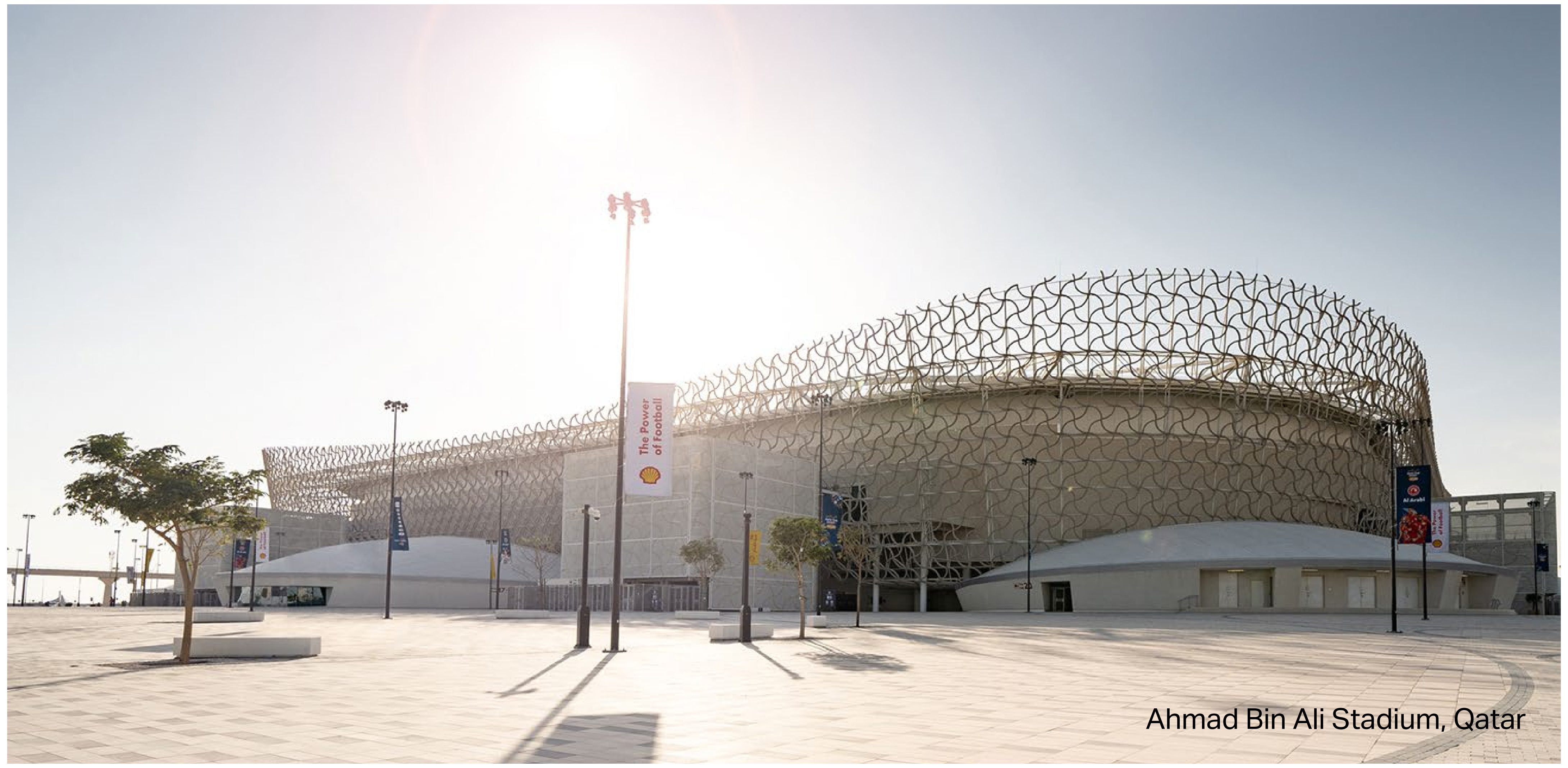
## No matter how hard we work to protect our environment, extreme weather events such as heatwaves, droughts and storms will become more severe and frequent.

Engineers have to design low-carbon structures that can both withstand such shocks and reduce carbon emissions by harnessing environmental conditions.

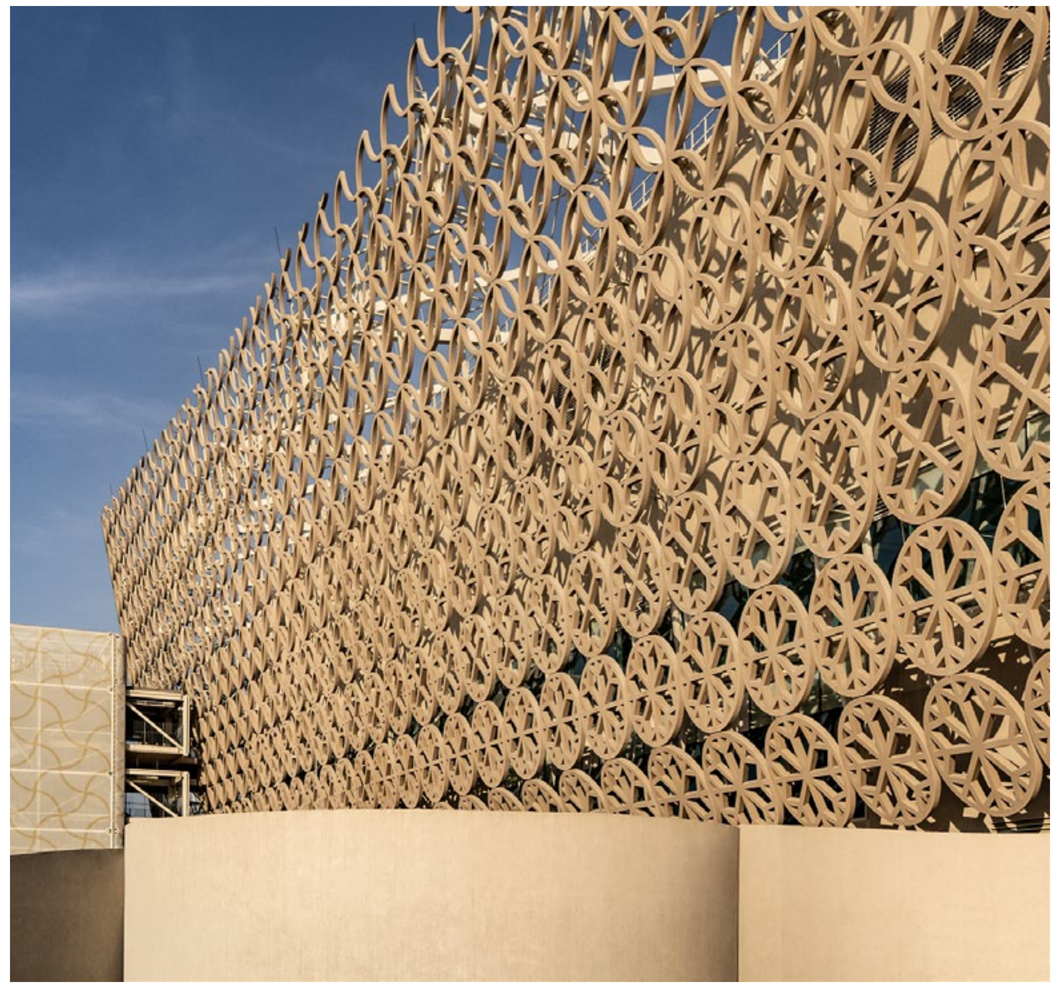
Qatar's 2022 Fifa World Cup stadia are prime examples of such adaptation and resilience.

In summer, the desert country bakes in temperatures in excess of 45°C. Come winter, stiff northerly winds usher in dust storms and coastal swells, while heavy downpours, thunder and lightning are spring fixtures.

BDP Pattern used parametric tools, which create complex forms from an initial set of environmental and usage parameters, to design Qatar's new Ahmad Bin Ali Stadium. Winds passively cool the building, helped by solar-powered fans, while the structure has been designed to withstand the strongest shamal gusts. Approximately 90% of the 40,000-seat venue was built using recycled materials from the site's previous stadium.



Ahmad Bin Ali Stadium, Qatar



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# What next?

# Our collective responsibility

**The building industry has a key role to play if we are to keep global temperatures from rising by more than 1.5°C above pre-industrial levels.**

The World Green Building Council has set an ambition for every building to be net zero carbon by 2050, calling upon governments and businesses worldwide to act.

Engineers across the planet have declared a climate and biodiversity emergency under the Institution of Structural Engineers and Institution of Civil Engineers (ICE) campaign to embed regenerative design practice.

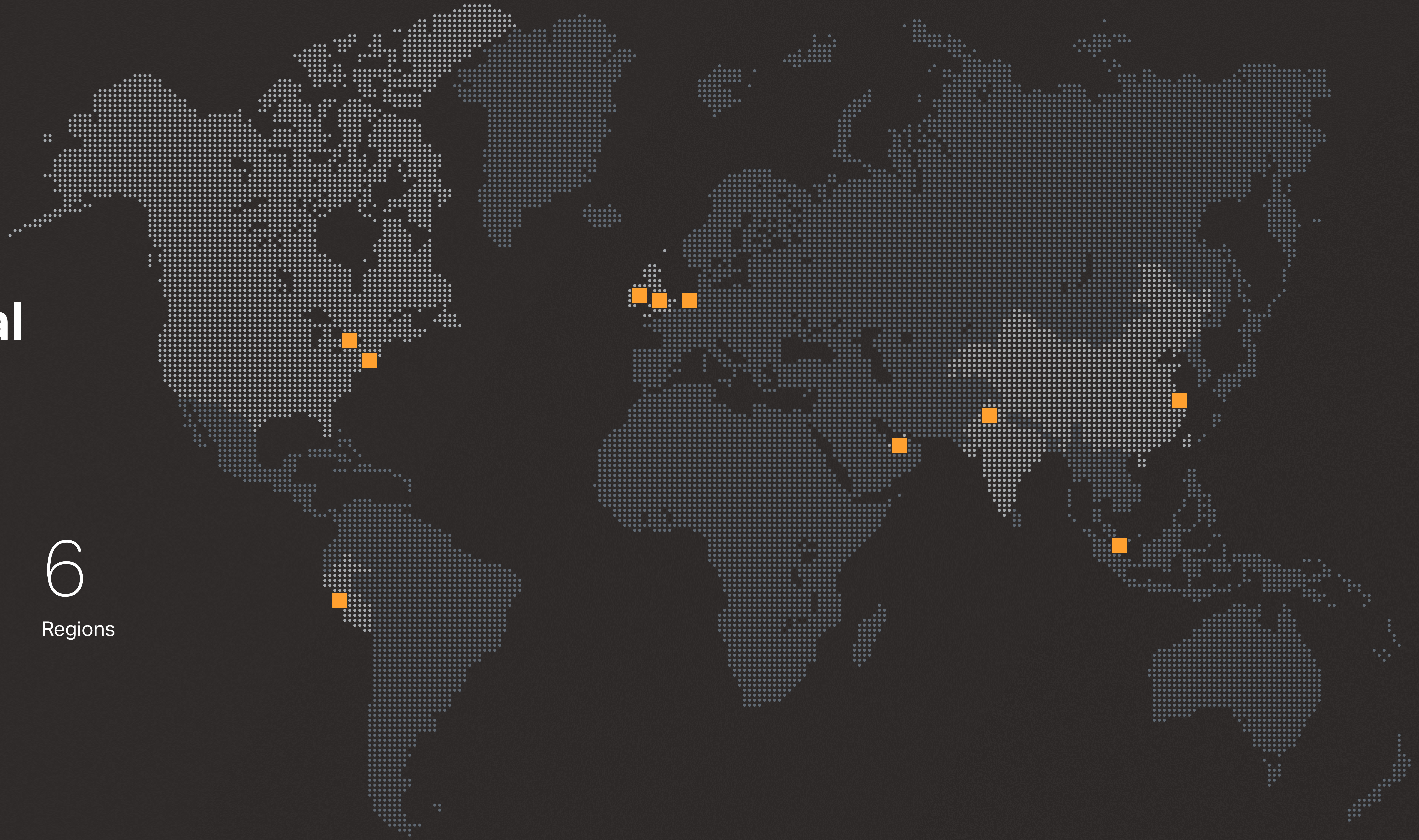
BDP has signed the Engineers Built Environment declaration. By harnessing creative and intelligent engineering, we will strive to take all our projects 'beyond net zero'.

Now we are calling on civil and structural engineers, clients and developers across the world to help meet this challenge with us.

ice Institution of Civil Engineers

IStructE

# Our global practice



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**MENA**
Abu Dhabi

**Asia Pacific**
New Delhi
Shanghai
Singapore

BDP is different. Our unique position as a collective with experts spanning the spectrum of the built environment gives us a special status and capability in the design world.

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