

# SPEED & SCALE

**Innovation strategy**  
May 2022

# To redefine the boundaries of ambition.

The world is changing.

This is how Mace is responding.

From the beginning Mace has been shaped around a clear purpose.

For over 30 years we have pursued a better way – challenging ourselves to dream bigger, transform and innovate.

As the world around us changes and new challenges arise, we believe we have a greater responsibility than ever before to create opportunities for communities to thrive, and we have a role to play in doing so sustainably.

Our 2026 Mace Business Strategy outlines our ambitious plans for the next five years, as a purpose-driven business committed to leaving a lasting legacy for people and the planet.

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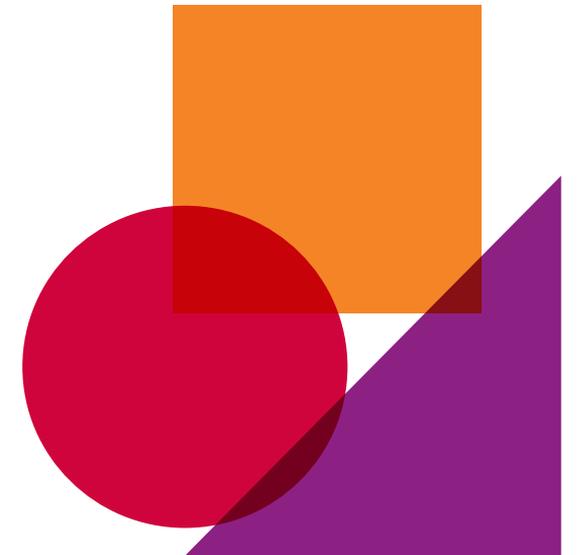
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# SPEED AND SCALE

## Our innovation strategy



**Mark Reynolds**  
Group Chairman and Chief Executive

### Speed and scale

Our Innovation Strategy v2.0 comes at a pivotal time for both Mace, and our sector.

While there still appears to be a mountain to climb in the fight against climate change, I believe the construction sector is well on the way to being a positive force for change. It has to be.

With close to 40% of carbon emissions being attributable to the built environment, our industry must play its part in addressing climate change.

As momentum grows from across the industry – and wider public attention turns to carbon generated from the built environment – I believe we might just have a movement on our hands that will finally see construction come together to tackle the biggest challenge of our time.

A challenge that comes at a time when the increased volatility we have seen around the world of late is providing many more risks to mitigate and adapt to such as energy security and material price volatility.

By adopting transformative solutions, many of which are available to us today, we can revolutionise how, what and where we build and operate the facilities we create – but it’s going to take a momentous effort from every corner of our industry.

This focus on reducing carbon is supported by a drive for improved productivity and improved decisions via data. We can deliver better outcomes more consistently across all projects if we further promote the key principles of collaboration with supply chain partners, increased application of smart construction techniques and the effective use of digital and data.

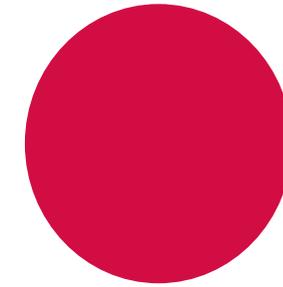
Fortunately, we have a powerful ally in this fight: **innovation.**

However, while many solutions are in hand, their deployment is nowhere near where it needs to be. We’ll need massive investment and robust policies across the globe to make our innovations more affordable.

We need to scale the ones we have – immediately – and invent the ones we still need. In short, we need both the now, and the new. Which leads to the emphasis behind version 2.0 of our Innovation Strategy: **Speed and Scale.**

To achieve the goals and objectives set out in Mace’s 2026 Business Strategy, and to truly ‘redefine the boundaries of ambition’ for our clients, we must move forward with speed in both testing and proving the value of new products and technologies.

And once we are confident in a product or technology’s capability to support our ambitions, we must move to scale its use across our projects, services and geographies at pace. Working across our three focus areas for innovation to make a significant impact in the ongoing transformation of the construction industry.



A transformation that accelerates our response to the climate emergency.

### Net Zero Carbon



A transformation that makes a step change in our productivity.

### Construction to Production



A transformation that drives value in data and digital.

### Digital & Data

### Driving our own business transformation

Our first Innovation Strategy – launched in 2017 – set the direction for the areas where Mace was seeking to differentiate itself (Digital, Assemble, Operate), and how we intended to do so (process and behaviours).

Within that strategy, we confirmed a commitment to annual research and development investment that has allowed us to build our capability and reputation as one of the sector’s leading innovators over the past five years by investing c.£325m in R&D projects and achieving significant milestones: the completion of the Jump Factory project in 2018, the launch of our Mace Tech business in 2019, and our ‘Steps Without Footprints’ Net Zero Carbon commitment in 2020.

As global trends have accelerated, we have continued to be agile in our approach, flexing our strategy and delivery models to capitalise on the opportunities afforded to us, and to create our own.

We’ve proven since 2017 that with the right investment and governance around innovation our delivery can be faster, safer, more sustainable and more productive – all while continually improving the quality of the service we deliver to our clients.

But to continue to drive change, we need to be able to capture the value of existing innovation more effectively and to invest in the next generation of technology and processes for new innovative solutions.

Which leads to this strategy.

### Our innovation strategy 2.0

This strategy aims to clearly set out how we’ll manage and invest effectively through a revised innovation process and a series of roadmaps that set out both our vision and plan to achieve our ambitious goals by 2026.

I believe we’ve outlined a bold and transformational change to how Mace operates, focusing on the three primary areas in which we seek to deliver distinctive value: Net Zero Carbon, Construction to Production and Digital & Data.

For each area we set out research and development roadmaps demonstrating the areas we will invest our resources into and set the targets and milestones we will measure ourselves against – such as our first zero diesel construction site this year.

Within the strategy we also set out a new framework to manage the innovation pipeline – and importantly, a new ‘Ambition Fund’ to provide our employees the opportunity to accelerate their own ideas in support of our innovation goals.

I hope overall that this strategy will serve as a guide to how we think the industry can change and evolve over the next four years, and our role within that change.

We can’t achieve it alone – it will take collaborative work and investment from the entire construction industry, as well as support from our clients. However, the benefits we will realise, if we take the next step forward at scale and speed will be transformative.

“I hope overall that this strategy will serve as a guide to how we think the industry can change and evolve over the next four years, and our role within that change.”



# TRACKING THE FUTURE

## Exponential change for the industry

“The pace of change has never been this fast, yet it will never be this slow again.”

*Canadian Prime Minister Justin Trudeau, Davos Conference, 2018*

Technological change continues to impact all aspects of our lives and culture, from the way we work and live individually, to the way our societies and governments continue to change in response to both anticipated trends – such as aging populations in the global north and the transition to renewable energy) and unexpected ones, such as the rapid rise of remote working during the COVID-19 pandemic.

To manage this acceleration of change effectively and ensure that we can leverage it as an industry requires bold and innovative ideas from both private and public sectors. At Mace, we have a long legacy of looking forward and finding a better way – and so rising to this challenge is part of our DNA.

This is the age of exponential change.

### Responding to exponential change in construction

Pressure on infrastructure and the built environment is growing across the world. Populations are growing rapidly, particularly in global cities, and countries across the world are grappling with the challenge of scaling up infrastructure and construction delivery while balancing the need to urgently reduce our impact on the environment.

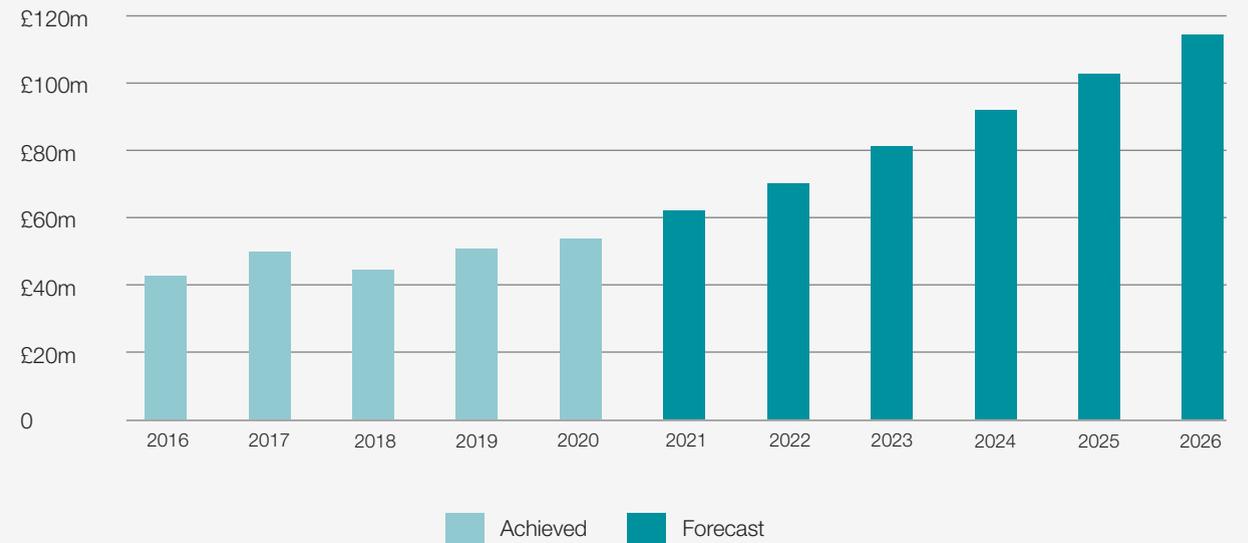
As we look towards global population growth of 3bn by 2050, it's clear that the global construction industry needs to deliver change at pace if it is to meet the needs of the communities it serves. To do so there are both a number of key challenges, and many more opportunities we must explore, to overcome those challenges.

### Addressing the climate emergency

A new societal imperative – addressing the climate emergency, is acting as a powerful change agent for challenging productivity and methods of delivery.

We must take rapid action to decarbonise the delivery and operation of the built environment and respond to future trends. The built environment accounts for almost 40% of all carbon emissions, so radical changes in every part of our industry are urgently needed.

Mace annual R&D spend



Across the world, societies are already struggling with the impact of climate change and as this accelerates the need to ensure buildings and infrastructure are resilient will become more urgent.

Innovation and collaboration at a speed and scale previously unprecedented in the construction industry is required to both reduce our impact on the environment, and to enhance biodiversity across the world.

As an example, powering our rapidly growing world in a sustainable way will require huge investment in renewable energy globally, in the race to decarbonise. The cost of renewable energy will continue to fall rapidly, best exemplified by the cost of solar energy, which has seen a 500x reduction since 1975.

# SPEED AND SCALE

## through synergy

While defined as three individual focus areas, we have already realised increased speed and scale of innovation when all three are considered holistically. Each roadmap compliments the others in the capabilities and skills we develop. And solutions that consider all three focus areas are consistently the best solutions in terms of outcomes.

As an example, our digital and data activities underpin the ambitions of both carbon reduction, and moving from Construction to Production. Likewise, innovation in Construction to Production consistently reduces embodied carbon.

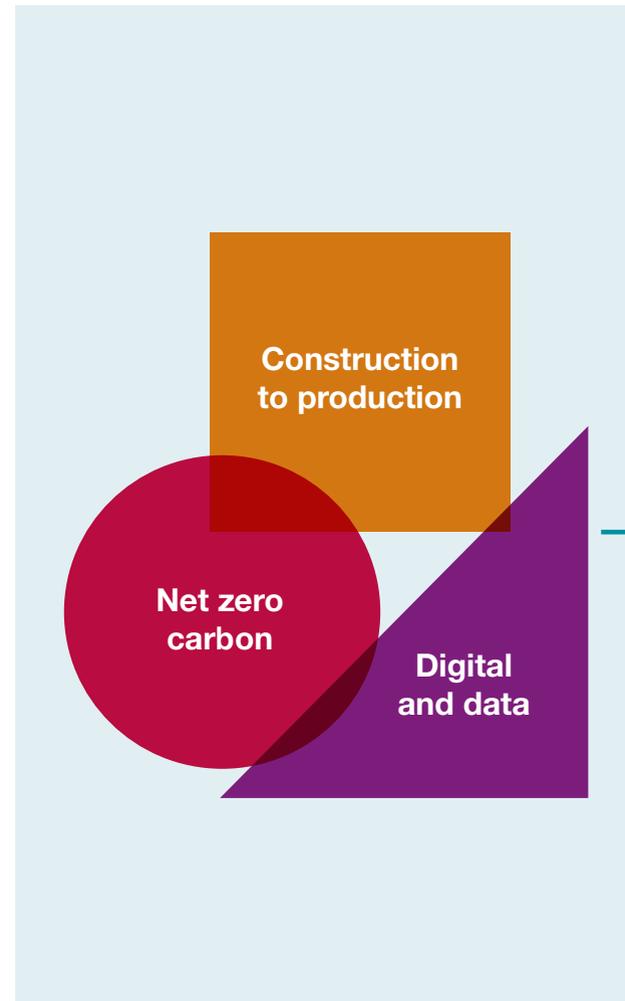
### Strategic innovation priorities

Aligned to our three focus areas, the Mace Executive Board have committed to invest in, develop and deploy a number of strategic innovation priorities centrally between now and 2026 to ensure successful delivery of the roadmaps.

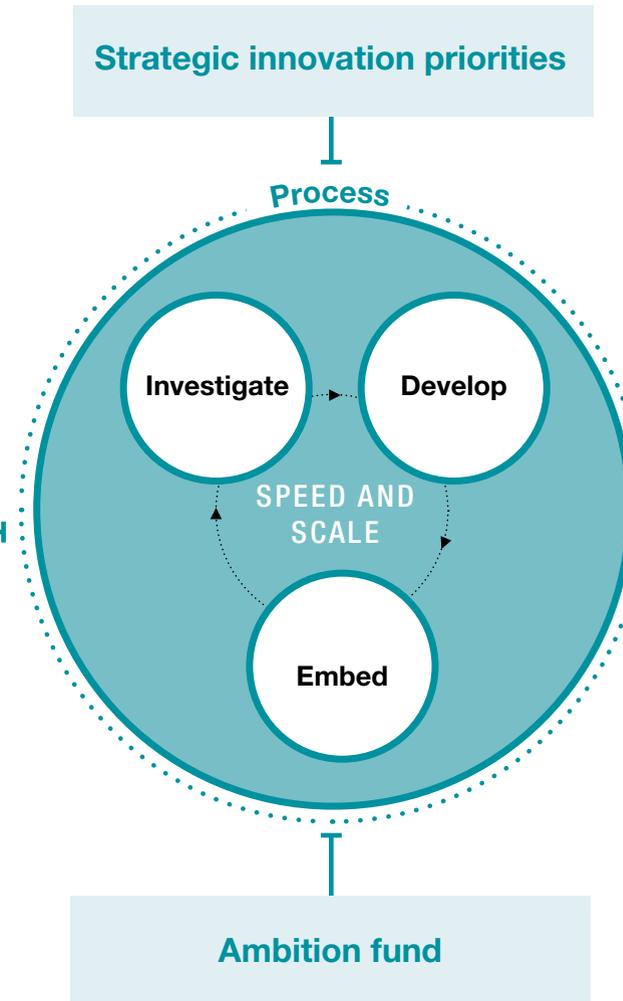
### Ambition Fund

Newly launched as part of this innovation strategy, our Ambition Fund will allow our people to identify and demonstrate innovation and R&D projects aligned to support delivery of our three focus areas.

### Our innovation focus



### Our innovation process



### Our improved outcomes



## Skills and labour availability

Aging populations in the global north, and a systemic challenge of the construction sector not attracting new entrants in past decades is significantly impacting workforce availability in many countries.

This means that new homes, schools and hospitals will take longer to build, cost more and potentially increasingly struggle to attain quality standards, which isn't acceptable.

Although technology offers some solutions to this challenge – as new technology reduces the labour requirements of some elements of construction – it also presents a challenge as the skills and people we need to attract and retain changes and we begin to compete with sectors that are traditionally seen as more attractive.

However quickly we transform how we deliver, the reality is that we will also need to upskill our existing workforce to create new jobs, at a pace previously unseen. The shift to a Net Zero economy will create hundreds of thousands of additional jobs globally and require new skills.

As one example, the UK 'Heat and Buildings Strategy' forecasts doubling of the labour market for key trades (an additional 50,000 jobs) over the next 20 years to transition all homes from gas boilers to electric heat pumps.



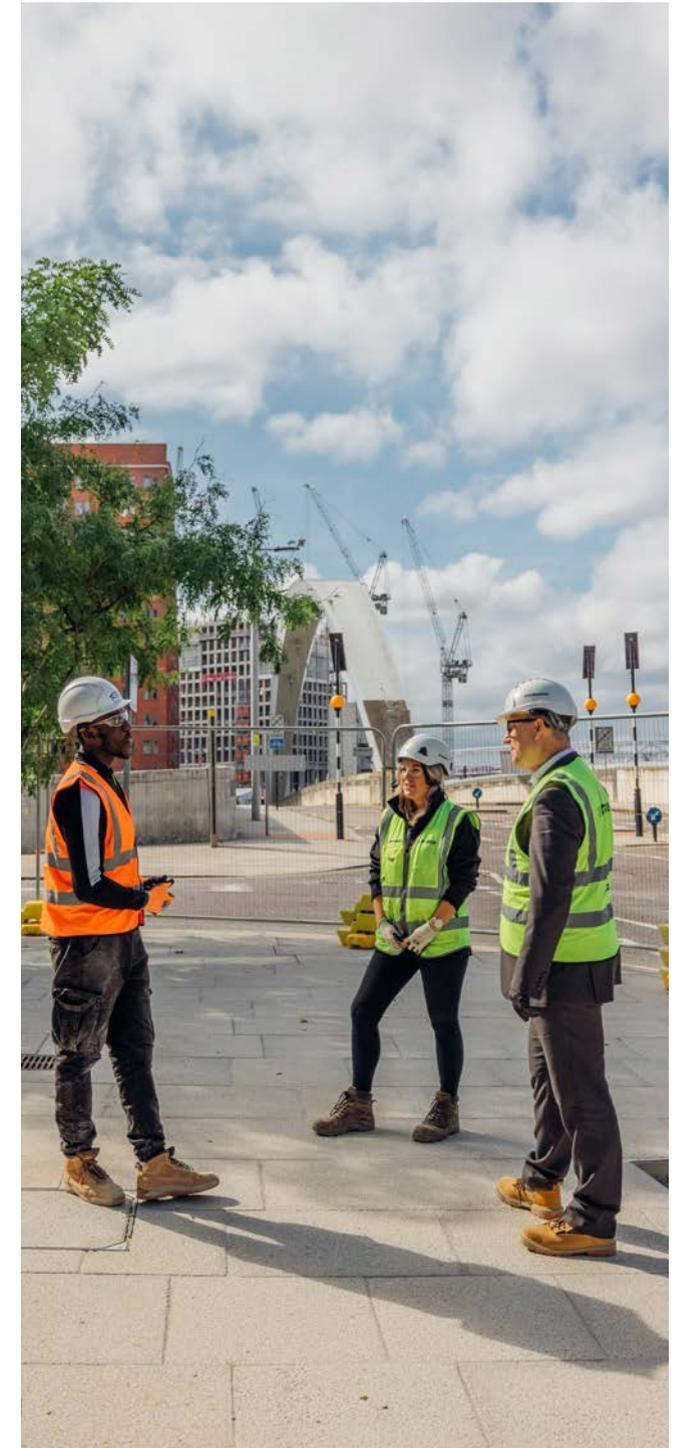
## Regulations and policy

As we exit the seismic shifting of a global pandemic, the construction industry is currently facing the risk of a chaotic period characterised by resource scarcity, price volatility, safety and quality problems, set against a backdrop of regulatory reform where the technical bar is rightly being raised in terms of things such as building safety and carbon.

Expectations around our delivery are rightly changing – and we cannot continue to work as we have done in the past. Governments and regulators across the world have increasingly complex expectations of our delivery - and innovation again has a key role to play in helping to effectively mitigate these risks and rise to the challenge of tougher regulations and policies.

In the UK, for example, we will soon see a requirement for a 'golden thread' on all construction projects that will allow owners and occupiers to trace every element of a build from inception, design and delivery. By 2026 this will be standard practice – but to get there we know that many parts of the industry will have to change how they work.

So exponential change in construction is both producing new challenges and exposing systematic existing ones – and if we get it right, it's clear that there is a huge opportunity on offer: the application of technology to create better transparency of all aspects of the project lifecycle, and entirely new products and ways of working to create a step change in building quality and performance.



# EXPONENTIAL TECHNOLOGY GROWTH

## Tracking the trends

“People often overestimate what will happen in the next two years and underestimate what will happen in ten.”

Bill Gates

One demonstration of where traction is accelerating in the marketplace is the increase in investment in construction technology. Since v1.0 of our Innovation Strategy in 2017 we have seen an exponential increase in the total funding, and therefore availability and value creation, of start-ups, with this trend expected to continue to grow.

This investment drives the proliferation of technology that we are able to deploy on our projects and programmes.

It increases the choices and expectations of our clients, partners and suppliers. It increases the breadth and diversity of capability in our sector, as those from different backgrounds enter into the industry. And it increases our potential to improve our productivity and efficiency.

Data from the technology industry tracker Pitchbook records total U.S start-up deal fundings in 2021 at \$330 Billion, near doubling of the previous annual record in 2019.

Looking specifically at construction and real estate technology, data from venture capital fund Building Ventures records early stage ‘built environment’ deals as increasing in 2021 by 300%; faster than technology investment overall, but still only representing a small percentage of overall venture capital funding.

In 2021, for the early- and mid-stage deals (Seed, Series A, B, and C) within the ‘built environment’ category, there were 612 funding rounds in 2021 (a 76% increase since 2020).

The value of these grew to \$8.2Billion (2.8x compared to \$2.9B in 2020). With investment in technology continuing to grow, we look at three key areas where increased investment will enable industry transformation in the next 5-10 years.

### Technologies

#### Data / models



BIM



GIS



Digital Twins

#### Robotics / Automation



Autonomy



Drones UAV

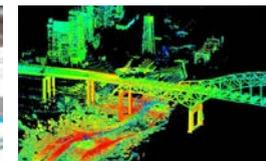


Robotics

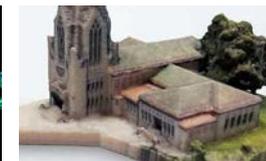
#### Vision



AR/VR



LiDAR



Photogrammetry

#### Methods



Advanced Materials

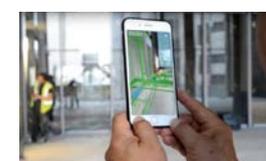


Modular Prefab



3D Printing

#### Smart Buildings / Cities



Mobile



IoT



(TeX) Tenant Experience

#### Other technologies



Blockchain



AI/ML



5G/LTE/WiFi



Electric vehicles



BMS

**Vision: mixed reality and visualisation**

With increasing adoption of digital technologies to improve the overall project lifecycle from conceptual design to construction, alternative reality technologies such as augmented reality (AR) and virtual reality (VR) are increasingly finding their use cases to improve accuracy, efficiency and safety of construction projects, says GlobalData, a leading data and analytics company.

While alternative reality technologies are gaining bigger traction in the gaming and entertainment industries, the relevance to construction - through merging the digital and physical view of jobsites and simplifying communication education, is propelling construction companies to leverage AR and VR technologies to save time, reduce errors, prevent rework and create a long-term return on investment.

**Key trends:**

- engaging end users in design process through VR
- using augmented reality to deliver more effective safety training
- offsite inspections using augmented reality to allow remote working
- visualising building information modelling in the field
- supporting facility management in the field using remote maintenance
- visualising real-time project delivery performance information ie. control rooms



Image courtesy of XYZ Reality

**Robotics and automation: distributed manufacturing**

Driven by both a looming labour and skills crisis forecast for this decade and a long-held ambition to improve safety, quality and productivity across the construction industry, an acceleration of investment in robotics and automation is both desirable and inevitable.

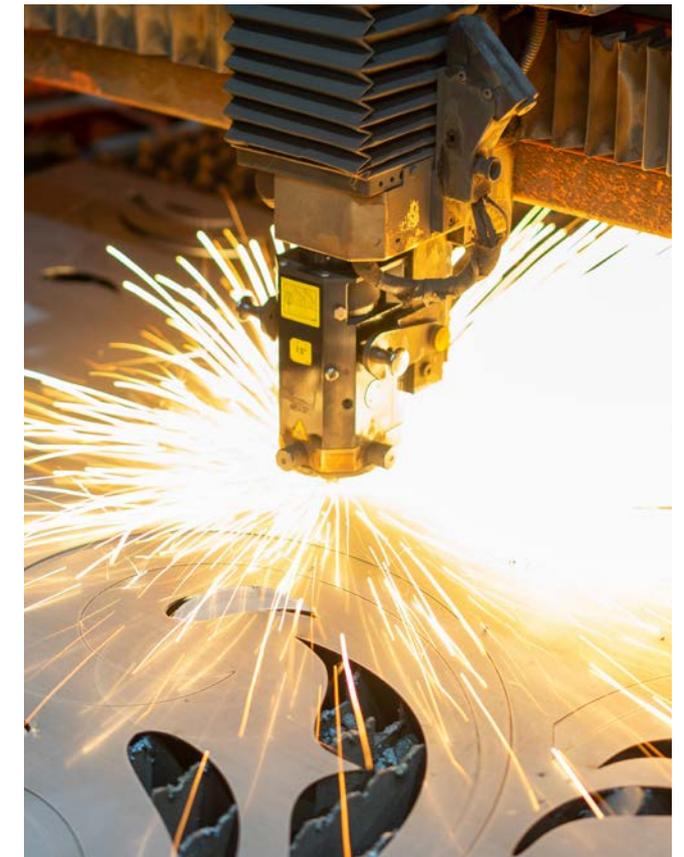
Robotic automation offers the potential to enhance productivity, efficiency and manufacturing flexibility throughout the construction industry, including automating the fabrication of modular homes and building components off-site, robotic welding and material handling on building sites and robotic 3D printing of houses and customized structures.

As well as production, automation points towards a future where machine replaces manual labour in areas where safety, quality or environmental impact demands it, such as drone scanning of large or dangerous structures, or automation of on-site plant and machinery.

The mining industry already automates large plant and truck movements, and National Highways have produced a report and roadmap to 'connected and autonomous plant' reaching scale in the infrastructure sector in 2035.

**Key trends:**

- scanning tall / expansive structures using drones
- on-site collaborative robots improving productivity
- automation of rebar production
- automation of light gauge steel frame production
- automated heavy machinery improving safety performance



## Connectivity

Increased connectivity has a significant role in helping to accelerate the digital transformation of our industry in coming years. The advent of 5G provides many opportunities to increase the deployment of technologies across our sites and workplaces, improving data capture and information access at all stages of a project lifecycle.

The high bandwidth and low latency of 5G will allow companies to both increase the use of technology, and provide more resilient and reliable application of technology on our projects. All work can be linked to high-resolution, rich, contextual BIM models on or about the site. Video capture and remote conferencing will make remote projects more accessible to all, providing real-time visual information to project teams when and where they need it, with a status update on site plans and conditions being updated on each and every action.

There are many examples of how 5G use in operation offers a significant step towards unlocking the 'Digital Twin,' using sensors and adjacent data sources to understand the performance and use of space in real time, and potentially unlocking the ability to move from preventative and predictive maintenance to machine learning and self-aware, sensing systems.

With 5G trials already underway across the globe, it is expected that the proliferation of data and insight to improve outcomes is one of the biggest changes between now and 2026.

### Key trends:

- connected site machinery - improving productivity and availability, and unlocking remote or autonomous construction operations
- connected site components - increasing telematic and operating performance data, providing the potential for real-time insights and improvements
- connected supply chain - live order status and tracking for materials, components and sub-assemblies to mitigate risk and increase efficiency of logistics and assembly

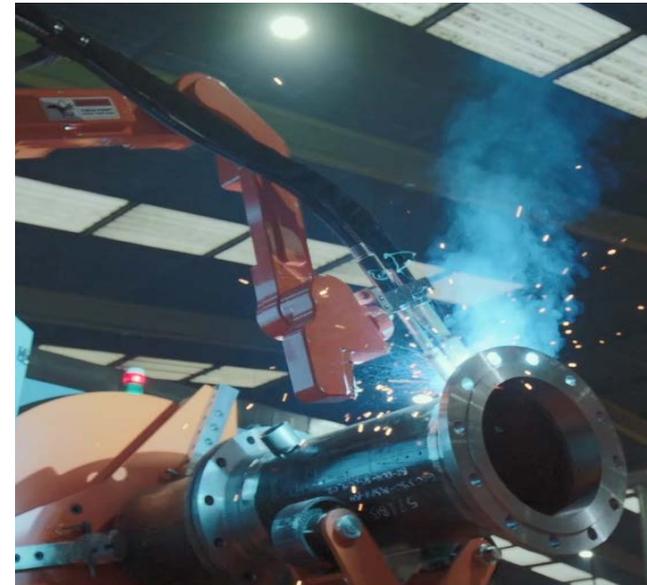


## Materials: advanced materials and techniques

Advancements in construction materials are now demonstrating exceptional properties with the promise of making buildings and infrastructure smarter, more sustainable, energy-efficient, and resilient.

These numerous and wide-ranging solutions include innovative alternatives to traditional building materials as well as enhanced forms of existing materials.

Examples of such materials range from new forms of concrete (lower carbon, with fibers that alter its resistance and durability or with air purifying capabilities), glass with enhanced qualities (electrochromic glass, photovoltaic embedded glass), to 3D printed concrete for building elements such as formwork through to printed homes.



## Key trends:

- geothermal piles and photovoltaic glass driving improved energy performance
- the increasing global provision of large-scale 3D printers for proprietary cement-based ink
- 3D Printing transforming delivery, including of entire housing stock, large structures
- graphene in concrete
- self-healing concrete

**“making buildings and infrastructure smarter, more sustainable, energy-efficient, and resilient.”**

# MAKING IT HAPPEN

## Realising the speed and the scale

The next three sections of this strategy lay out how we'll enhance the management of innovation and research and development at Mace, there are three roadmaps and assessments around our focus areas that will shape that investment, and finally a vision of our end-goal: a connected industry that leverages the power of current and future technology to improve outcomes.

Our original Innovation Strategy set out a governance approach and investment ambitions that remain broadly unchanged – but we've introduced a number of new initiatives around how we'll develop the skills we need, how we'll encourage our colleagues to approach innovation and how we'll measure our performance.

### Our approach

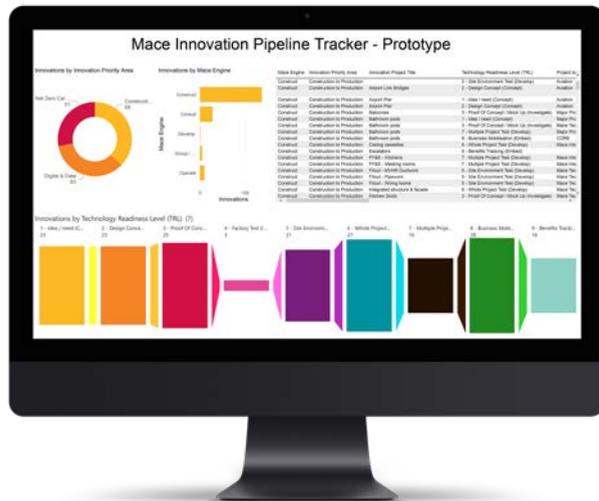
**Our innovation pipeline: supporting innovation to accelerate our aspirations.**

Across Mace's three innovation priorities we are currently tracking more than 170 innovation and research and development projects across all aspects of our business, all helping to accelerate our ambitions laid out in the roadmaps within this strategy.

The pipeline, which captures all activity at each stage of our innovation process, with

the owners, timescales and decision-making points mapped out, provides an ability for all Mace colleagues to understand our approach to research and development, both planned and in practice, and how to contribute where applicable.

By providing clear visibility of our pipeline, we're able to ensure that Mace is driving innovation across all aspects of our business, supporting our aspiration to be both more resilient, and more receptive, to the rapid transformation of technologies and societies.



STAGE	CONCEPT		INVESTIGATE		DEVELOP			EMBED	
TRL	1	2	3	4	5	6	7	8	9
	Idea / Need	Design Concept	Proof of Concept	Factory Test	Site Environment Test	Whole Project Test	Multiple Project Test	Business Mobilisation	Benefits Tracking
BU DECISION	Do we want to strategically explore this?		Do we want to invest further in this at this time?		Does the innovation pass the test criteria at each level?			Are anticipated benefits realised?	
BU GATEWAY	◆		◆		◆			◆	
BOARD GATEWAY			◆ A		◆ B			◆ C	
RESOURCE	Internal Mace staff		Mace staff / engineers / CAD / products / materials / samples		Full scale materials / bespoke equipment (eg. lifting, logistics, wrapping, protection, samples, testing software)			Comms / marketing / quality assurance	
COSTS	Staff costs		Detailed design / modelling / prototypes / mock-ups etc		Installation and testing / additional assurance & checking procedures / scope and interface management / reporting and feedback			Staff costs	
FUNDING	Business unit / central		Targeted funding required (supplier / central / grants / R&D credits)		Project-funded (plus increased risk and/or margin erosion)			BU / central No further "funding" required. Benefits banked at project / BU level	

## Our innovation process: managing innovation through effective governance

To effectively manage and assure progress against the innovation strategy, the Innovation Board will be adopting a newly updated innovation process.

The process, which sets out four distinct phases of an innovation project, mapped against 'technology readiness levels' will ensure we manage all innovation projects across the group with clarity and consistency. You can see more about the technology readiness levels in the next section of the strategy.

The innovation process is expected to be managed primarily at business unit level, using templates and processes set out in the Innovation SharePoint folder.

Business units are responsible for the governance and gateway assessment and adhering to the Board Gateways at relevant stages. Innovation Board reviews at stage gates A through D will assess the technical and commercial potential of the proposed initiative, with an emphasis on the potential return on investment and the identified pipeline and go-to market strategy.

## How we'll deliver it

### Investing in skills and capabilities: developing and training our people to accelerate our aspirations.

With the pace of change continuing to accelerate, it is evident that to act with the speed and scale required of the exponential age requires a shift in mindset, and an almost continuous acquisition of new skills and capabilities for all of us.

This is why Mace is placing increasing importance on supporting its people as one of the key priorities of the 2026 Business Strategy: Grow Together.

Each of our three focus areas will be supported through training programmes through to 2026.

- **Net Zero Carbon** - 101 Training (currently available to all staff)
- **Construction to Production** - introductory training (launching in 2022)
- ▲ **Digital & Data** - Digital Training Academy (launching in 2022)

With the diffusion of new technologies and products to help meet the demands of the modern age and support our transition to a net zero economy, our ability to learn and harness new skills is fundamental to succeed.

For the people and companies who understand and embrace this shift, the exponential age creates a huge opportunity – but to leverage it, we must ensure that we can attract, retain and develop the right people with the right skills.



## Mace's 'Ambition Fund'

### Accelerating innovation through additional funding

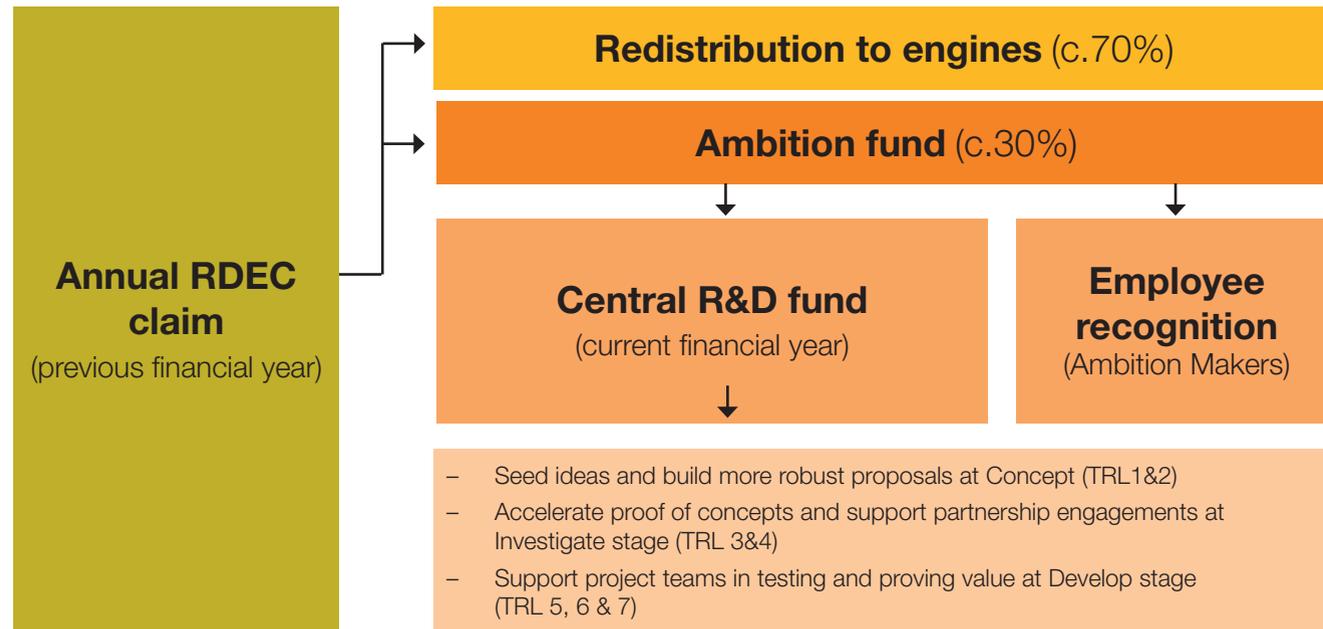
To achieve the aspirations of the 2026 Business Plan to increase innovation and research and development, a new approach to the allocation of the research and development earned tax credits (RDEC) is proposed creating a central fund for investment in strategic research and development programmes: our 'Ambition Fund'. We currently invest more than 2.5% of our annual revenue each year into new innovation, technology and processes, and aim to increase that to 3.5% by 2026.

Creation of an 'Ambition Fund' provides the opportunity to use the RDEC as an investment fund to accelerate any innovation that both meets the strategic priorities of the group and will generate the greatest return on investment (ROI).

Mace's new proposal will see 30% of the total RDEC rebate placed into a central fund and used to competitively drive new investment in innovation that benefits the entire group. With the remaining 70% being distributed to the business units where the relevant R&D took place.

This approach will see circa £1m made available each year to be bid on by aspiring innovators, designers and problem solvers across Mace to trial, test and accelerate new products and technologies, transforming how the business delivers the built environment.

Governance of the fund and establishing and measuring against KPIs will be carried out by the Innovation Steerco, adopting the newly updated innovation process.



The first round of funding bids are due to be submitted later this year, and the first awards are due to be made in late Q3 2022. At first the process will only be open to Mace employees and projects – but by 2023 we expect to be inviting supply chain partners to bid for funding.

#### How we govern it:

#### Our Innovation Steerco: enabling change and encouraging ambition

Mace's Innovation Steerco, first established in 2017, remains in place to oversee all innovation and research and development activity within the group, chaired by Chairman and Group CEO Mark Reynolds. The primary purpose of the steerco, which meets bi-monthly, is to monitor and review the overall innovation 'upstream' pipeline and research and development activity that complements the Mace 2026 Business Strategy. More information on the Innovation Steerco, including links to all papers and minutes from previous boards, is available on the innovation Infomace pages.

#### Our innovation KPIs: measuring the speed & scale of our innovation activity

To measure the success of our innovation strategy, and all activity carried out in support of our innovation Roadmaps, we will be introducing two new KPIs to report progress against.

These metrics are inspired by the intention of this strategy to introduce 'speed & scale' to our innovation journey to 2026.

- **KPI1 – SCALE:** Number of innovation projects/ products reviewed and at what stage (measuring volume of ideas & innovation activity across group)
- **KPI2 – SPEED:** Time taken from initiation (activity started) to revenue generation (measuring the success of the innovation process and the supporting factors around it)

The targets for these KPIs will be set at Engine level and reported against quarterly at the Innovation Steerco.

# HOW WE'LL GET THERE

## Our innovation roadmaps

To realise the ambitions of our 2026 Business Strategy and our purpose, we will develop our capabilities across the business, innovating in three primary areas to exceed our client's expectations:

### ● Net Zero Carbon

### ■ Construction to Production

### ▲ Digital & Data

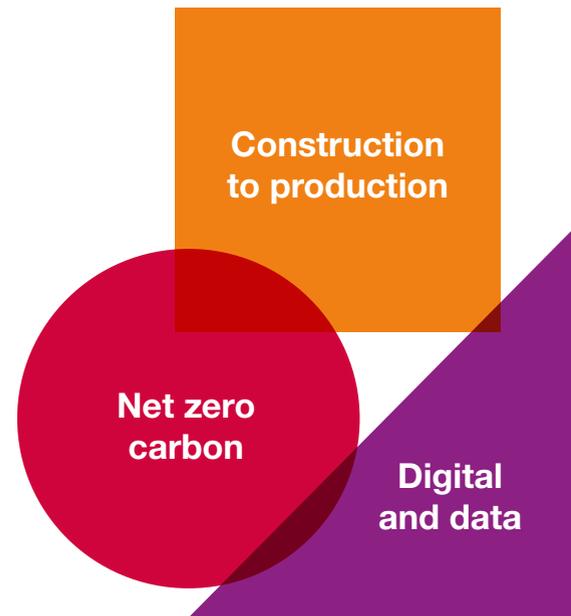
To do so, Mace will require a sustained period of innovation and research and development across both its own business, and its supply chain partners. We have developed innovation roadmaps to set out the capability we will develop and focus our investments over the next 10 years.

These aren't static plans – they're living documents that will continue to change. As we learn and new technologies emerge, we will review and adapt the roadmaps to align with our needs and what adds value to our clients and our business.

Alongside each roadmap we've also produced a technological readiness assessment of a number of areas under each focus areas, which demonstrates how far along the line we are to embedding each new innovation at scale.

Our roadmaps provide guidance on the route we're taking, while our readiness assessments provide a detailed breakdown of the specific innovations and projects we're investing in right now to delivery change.

Each activity is underpinned by clear project plans, capital investment requirements, and a 'technical readiness assessment' to ensure risk and opportunity for each innovation is effectively managed. Progress against these roadmaps will be governed by their respective boards within Mace.



# HOW WE'LL GET THERE

## Our innovation roadmaps

We will increase our focus on using technology and data to improve productivity and decision making at all stages of the project lifecycle, and the performance of both new and existing buildings.

### Reading the roadmaps:

The information in the following roadmaps is divided into three sections:

- **Drivers:** legislation / policy changes that will require business change to effectively respond to
- **Targets:** internal targets and milestones set in the business plan that will require innovation activity
- **Activities:** planned activities to develop new capabilities, with draft timelines

### Reading our technological readiness assessments:

Each readiness assessment measures the progress we've made on specific technologies and new processes, using Mace's innovation process tracker.

From concept to investigation, development and embedding the new approach at scale across our business, you can see how far we've got.

### Our key innovation priorities:



## Net Zero Carbon

To accelerate the built environment's response to the climate emergency, we will continue to invest in skills, processes and technology to make impactful change.

Supporting our 'Steps Without Footprints' carbon reduction strategy, we will innovate both upstream in the design and specification of buildings and infrastructure, and downstream in the manufacture, transportation, assembly, operation, decommissioning and disposal of our projects.



## Construction to Production

Having established an unwavering commitment to improving productivity across the construction industry through the implementation of our 2022 business plan, our next target, to 2026, is to rapidly transform the nature of project delivery.

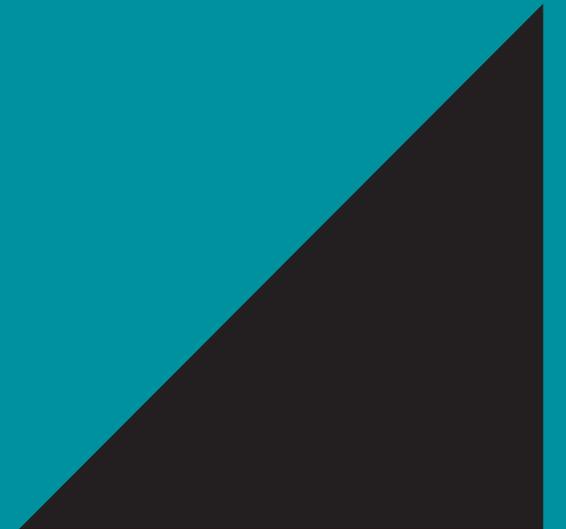
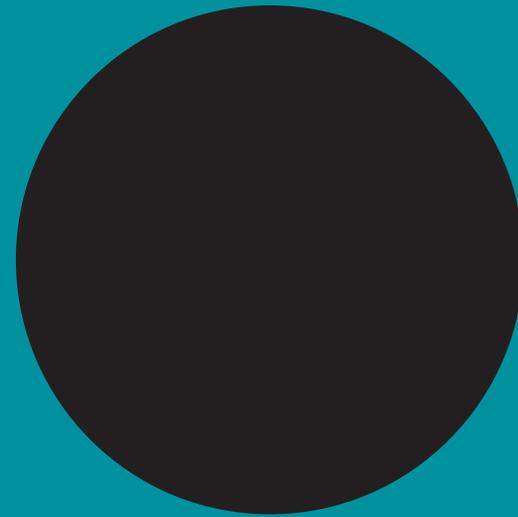
Moving from 'construction to production' to change how we design, manufacture, assemble and operate the built environment.



## Digital & Data

Following completion of our ERP implementation in 2021, we now have a strong backbone to further accelerate our digital transformation across our business operations.

# Where we're headed



# WHERE WE'RE HEADED

## Our vision of the industry in 2026

The purpose of this Innovation Strategy is to lay out our plans to transform how we deliver and operate the built environment – at scale and at speed.

It would not be complete without a summary of our vision: where we hope to get to and what we believe is possible in our industry.

This section of the strategy lays out that vision, summarising the end goal as we see it – a fully connected construction operation that delivers connected buildings and assets, all linked by fully connected data sources that can provide insight into how assets and programmes are performing.

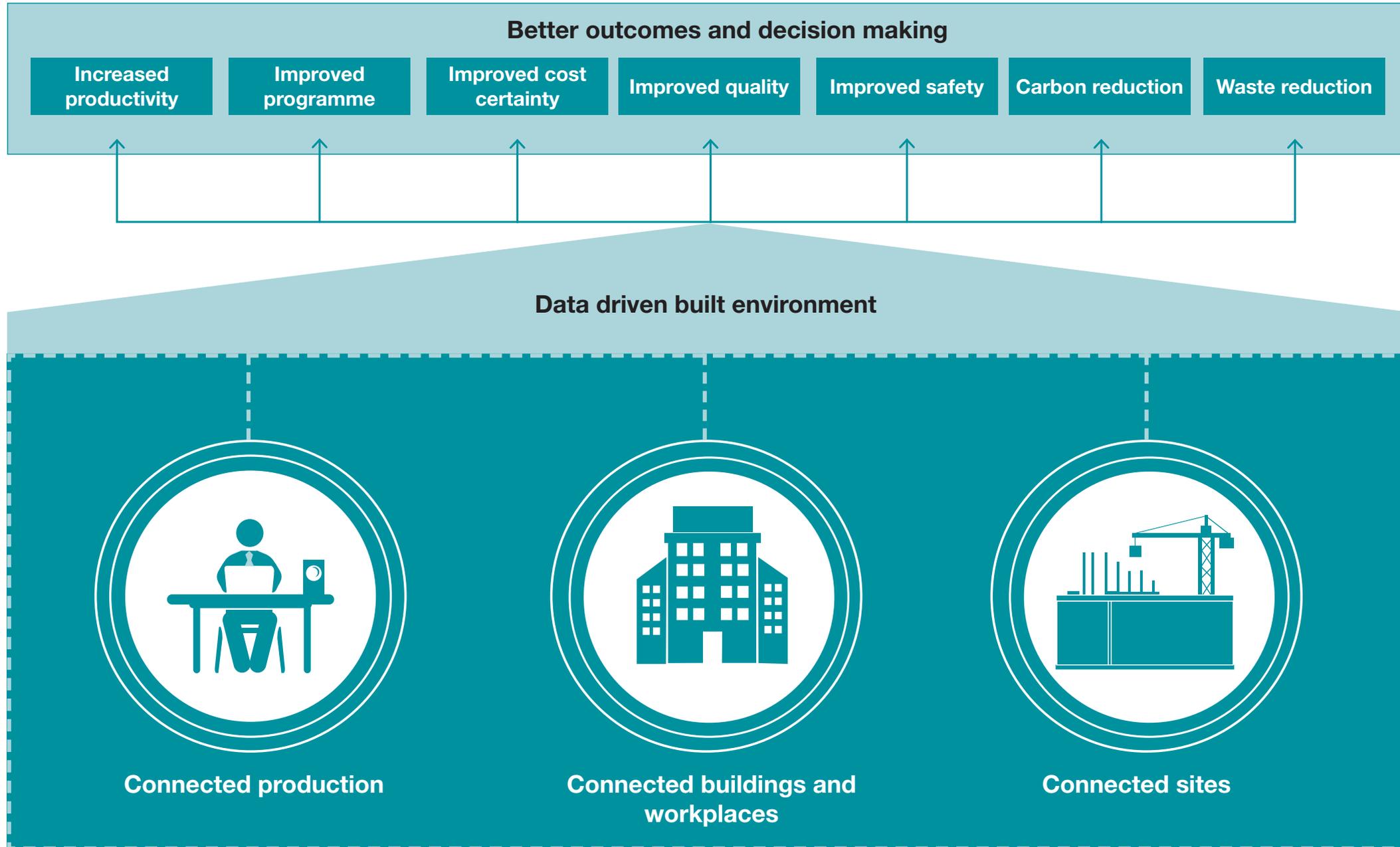
Over the next four pages, four infographics outline this vision – where we hope to be by 2026:

- **Connected data**
- **Connected production**
- **Connected assembly**
- **Connected workplace**



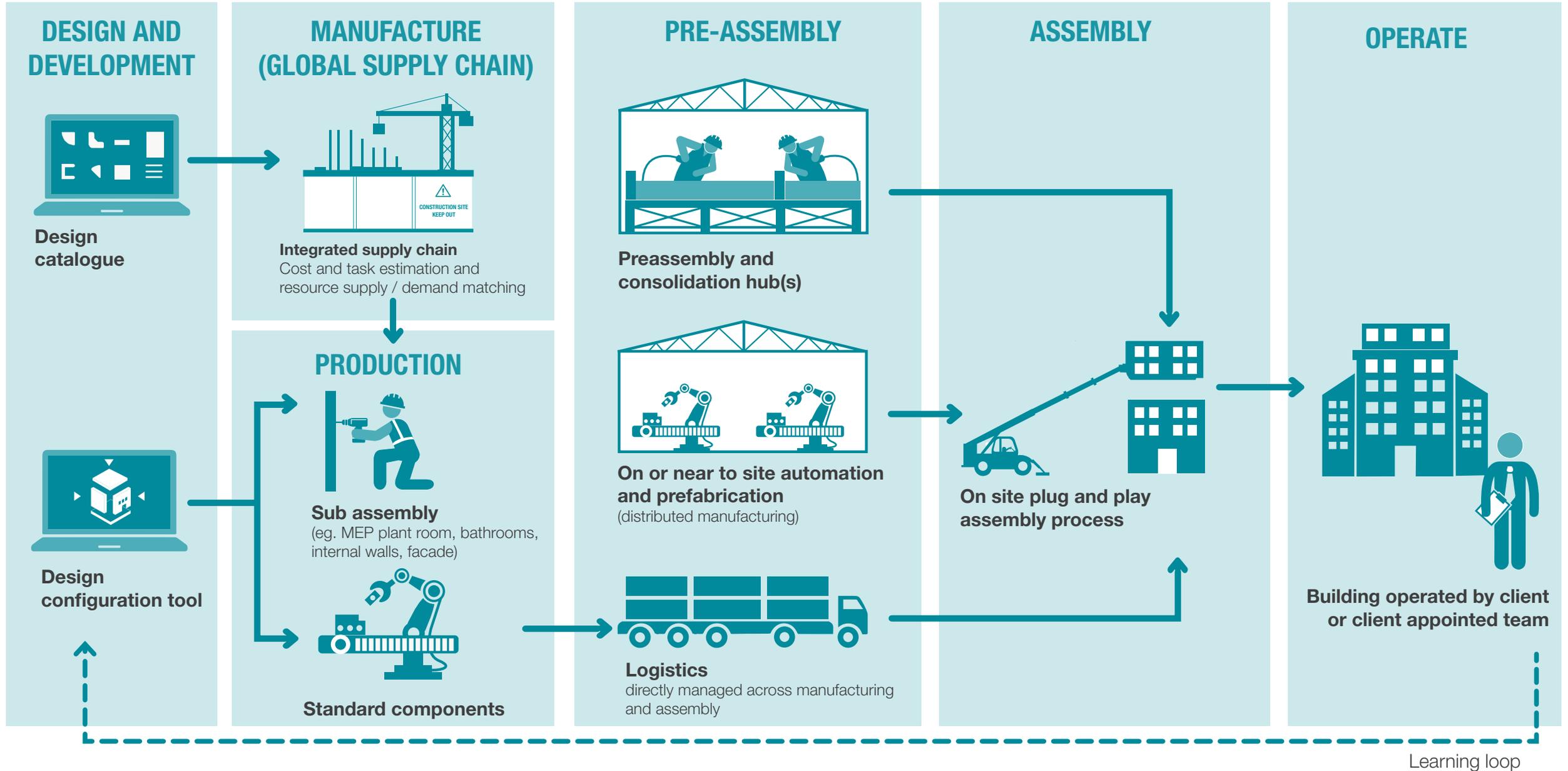
# CONNECTED DATA

Unlocking the value of data to drive better decisions at all stages of the built environment lifecycle.



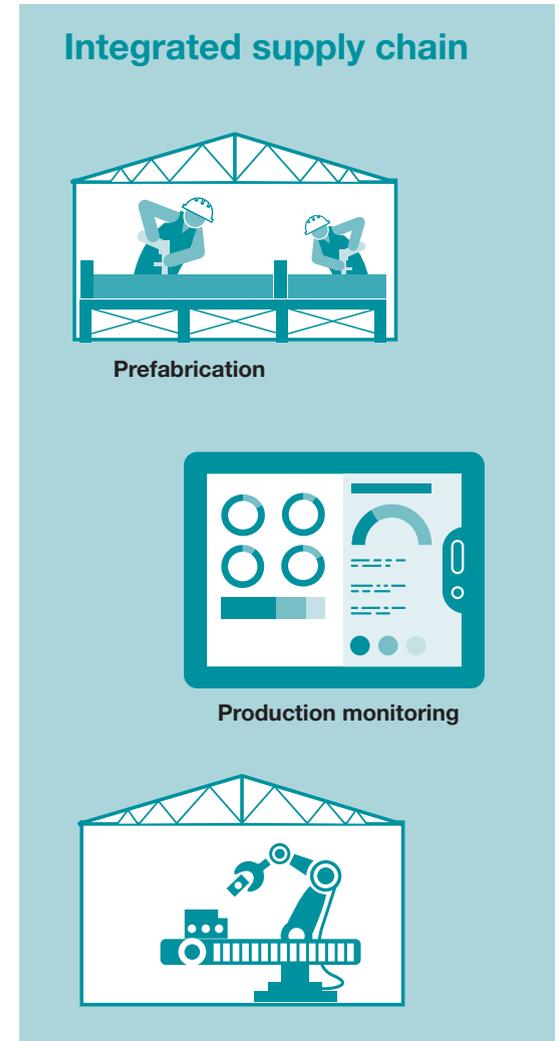
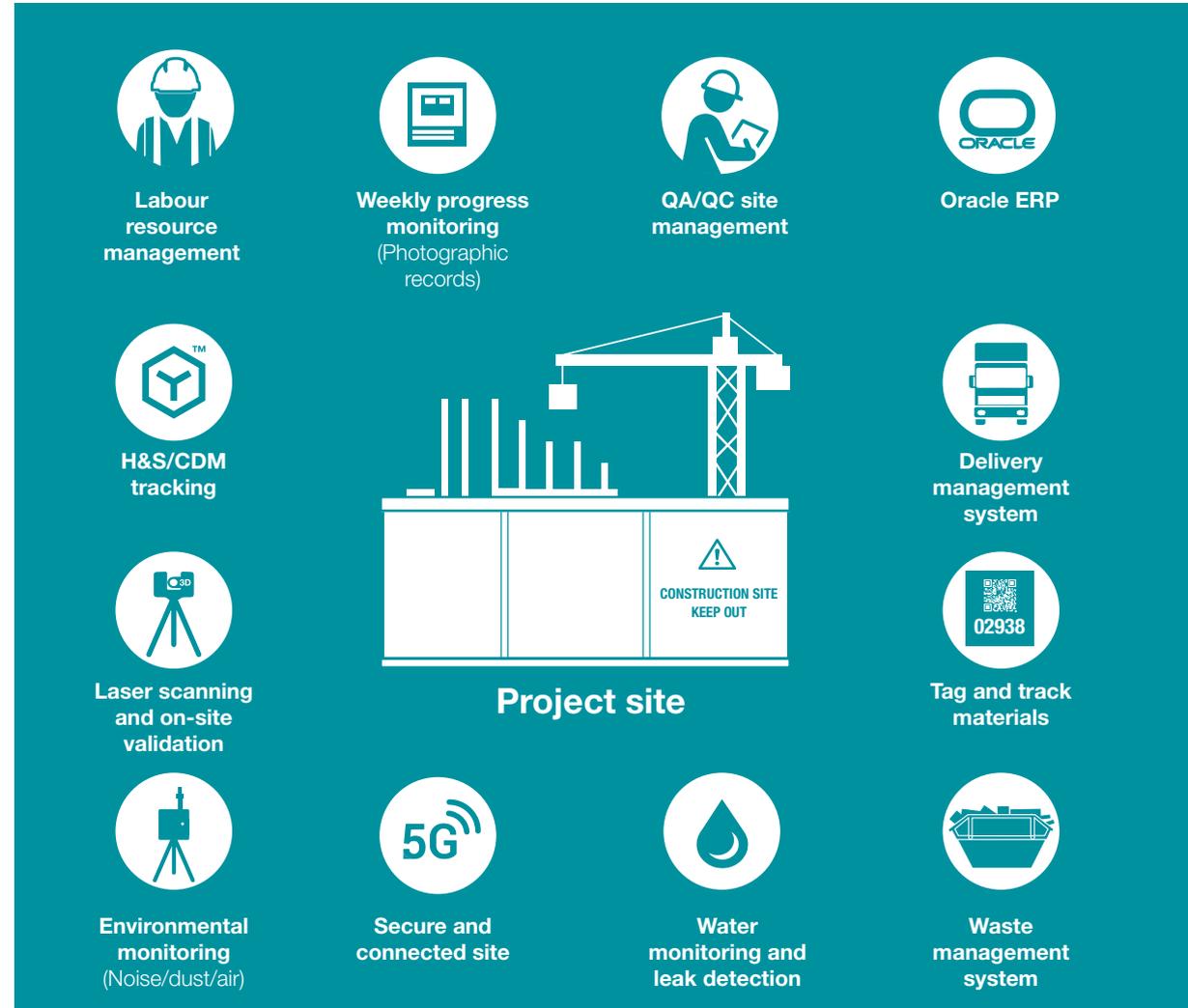
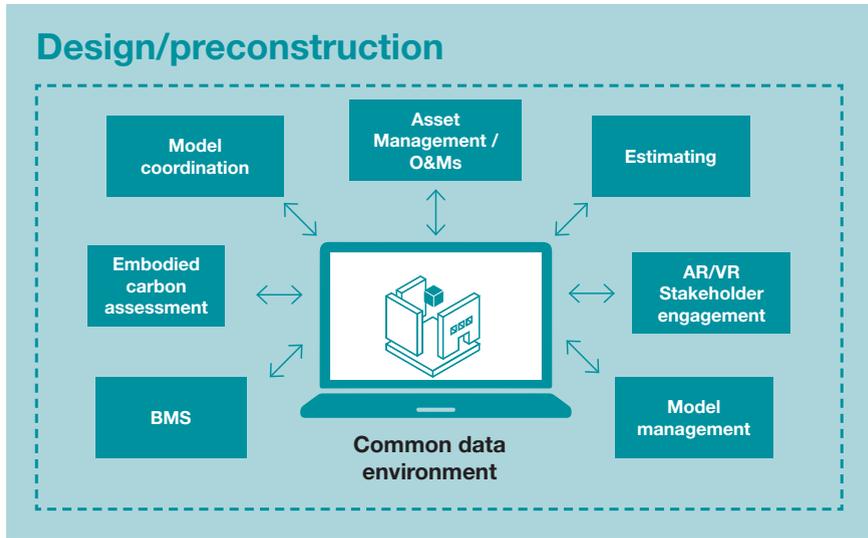
# CONNECTED PRODUCTION

Developing our Construction to Production ambition to increase integration and use of robotics and automation.



# CONNECTED ASSEMBLY

On-going application on technology supported by future 5G capabilities to benefit from real time data on all our projects.



# CONNECTED WORKPLACE

Enabling our workplaces and buildings to capture increased performance data to improve performance, wellbeing and operational efficiency.

## Smart workplace

Building users, employees, visitors



Find my colleague



Desk indicators and mobile booking



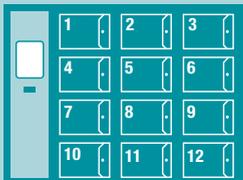
Workplace App with check in, service requests and customer feedback



Self check in/out stations



Wayfinding



Smart lockers and catering kiosks (self service)



Meeting room panels and screens

## Smart building

FM operations, workplace management



Occupancy/usage monitoring



Predictive maintenance and smart cleaning



Water usage / leak detection tech



Energy monitoring



Parking sensors



Environmental tech (air quality, temperature, humidity, lighting etc.)



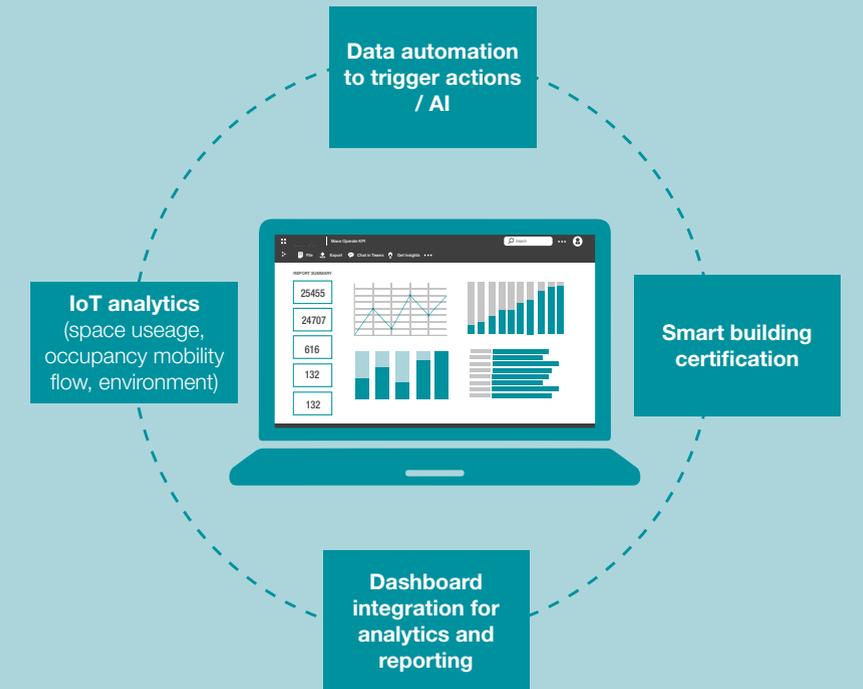
Asset tracking, management



Access control and security

## Data

Workplace insights and analytics. Collect and analyse all smart technology data to identify gaps, allowing for predictive analytics and improve ROI



# Net Zero Carbon



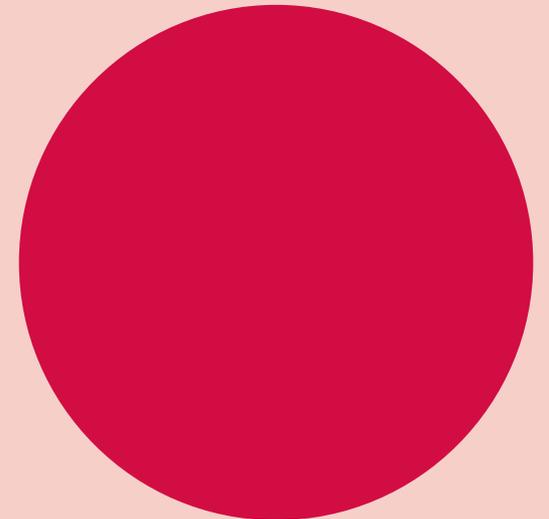
The construction industry is already making significant strides towards a more sustainable model of delivery; but progress needs to ramp up if we're to meet the ambitious goals set out in global policy to avoid 1.5 degrees degrees of global warming.

In our roadmap for this focus area, we've set out some ambitious targets for the next four years, including on scope one, two and three carbon emissions: in-line with our wider corporate targets – but also some ambitious plans for technological innovation.

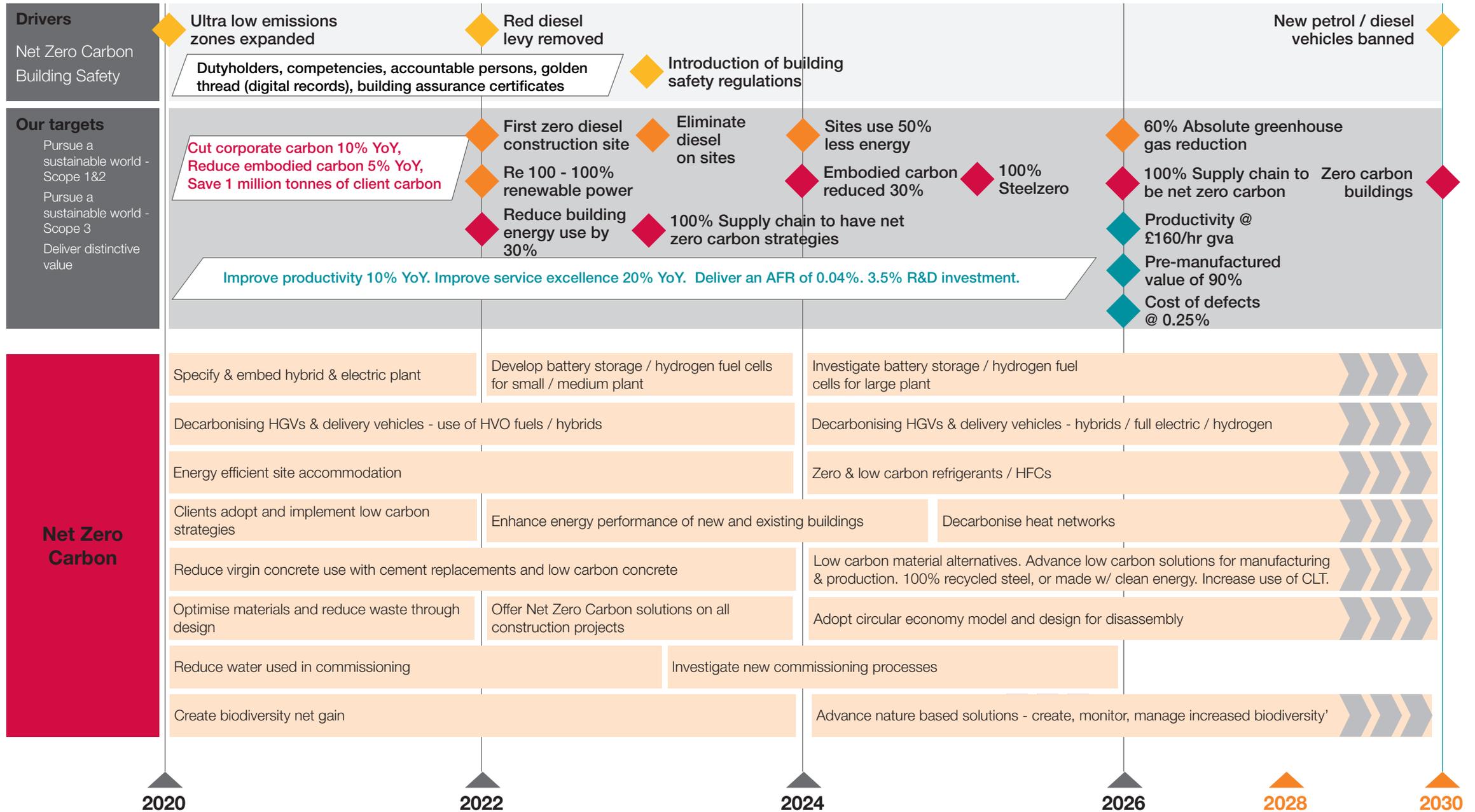
### Strategic innovation priorities

- Establishing intelligent systems and data platforms to support decarbonisation of the built environment
- Investment and trialling new hydrogen and nuclear energy solutions to power plant on site, currently ongoing.
- Increased investment in low carbon materials, plus the adoption of a full circular economy model and design for disassembly by 2030.

To get there, we'll target investment on a range of fronts, including exploring new forms of concrete delivery, energy efficient site accommodation and investing in battery storage and hydrogen energy use on site.

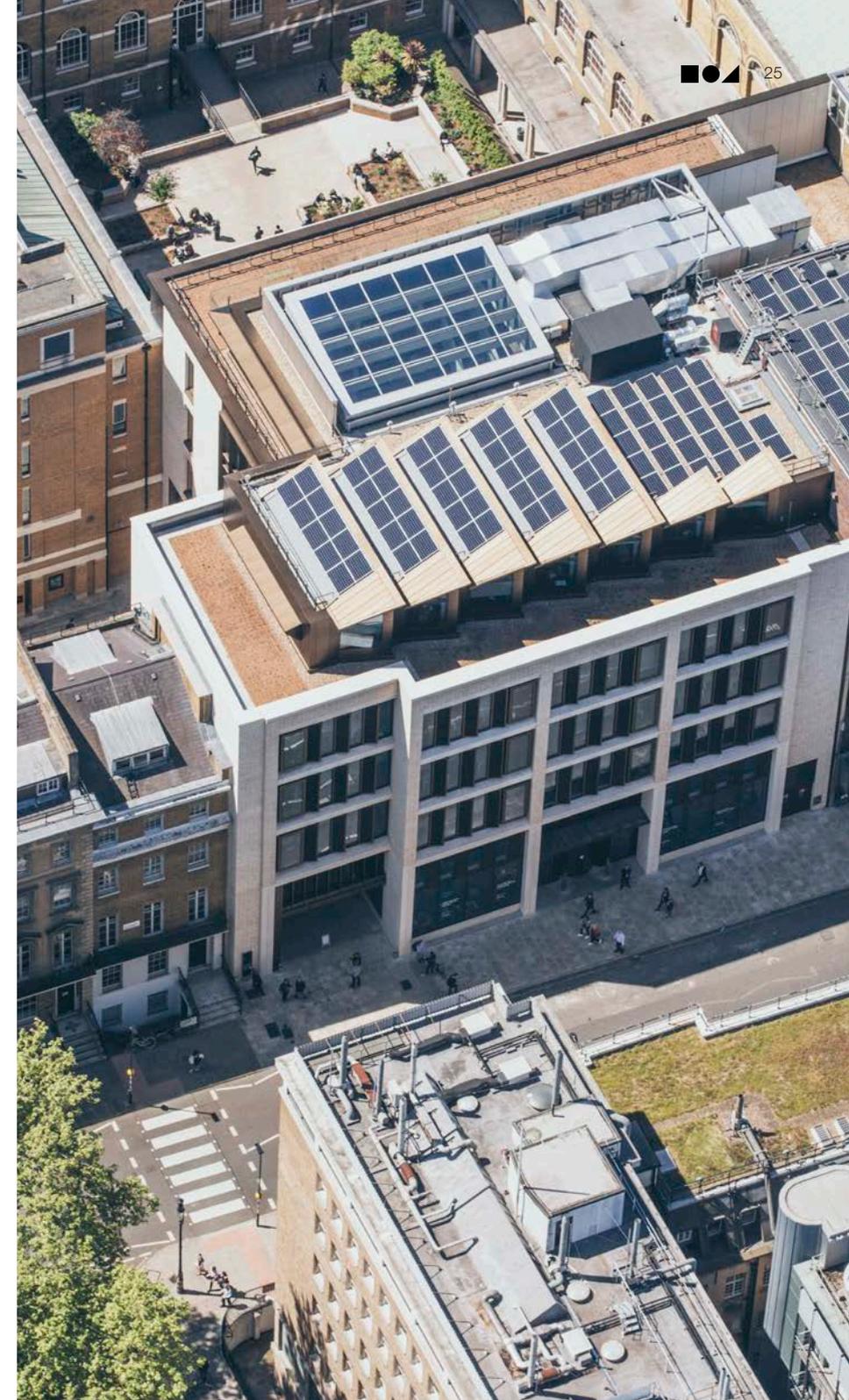


# NET ZERO CARBON

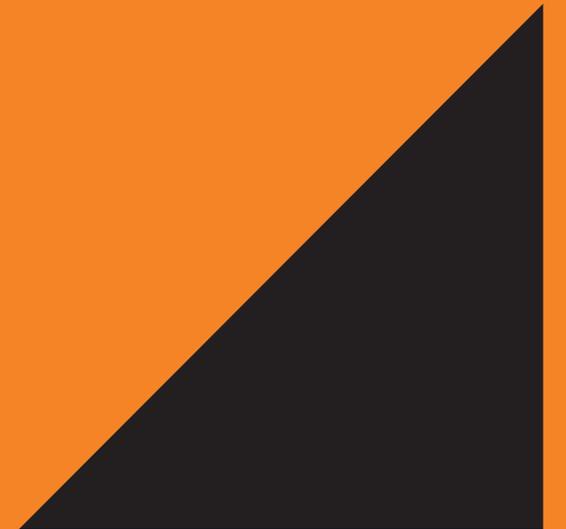
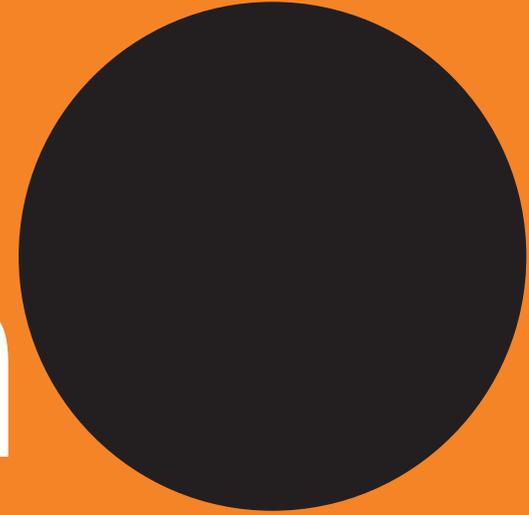


# NET ZERO CARBON

Stage	Concept		Investigate		Develop			Embed	
TRL	1	2	3	4	5	6	7	8	9
<b>Energy monitoring</b> Deploying energy sensors to monitor electricity consumption across different workspaces	100%	100%	100%	100%	100%	40%			
<b>Residential battery solutions</b> Develop partnerships with residential / consumer battery solutions (ie. PowerVault)	60%								
<b>Use of hydrogen for on-site energy</b> Exploring adoption of Hydrogen Cell Technology	100%	100%	40%						
<b>Clean energy on-site</b> Trial of a Glycerine fuel Hybrid Generator	100%	100%	100%	100%	20%	20%			
<b>Geothermal piles</b> Use of Hiperpiles to reduce embodied carbon & trial geothermal energy source	100%	100%	100%	100%	100%	40%			
<b>Concrete emission measurement</b> Real time data on concrete carbon emission though production & curing	100%	100%	60%						
<b>Circular economy - material reuse</b> Materials donation platforms	100%	100%	40%						
<b>Hybrid Excavators</b> Hybrid Excavators to reduce diesel on-site	100%	100%	100%	100%	100%	100%	100%	80%	
<b>Water leak detection</b> Monitoring of temporary / permanent water supplies for early detection of leaks	100%	100%	100%	100%	100%	100%	100%	40%	
<b>Electric plant</b> Electric dumper (Multiple)	100%	100%	100%	100%	100%	100%	100%	100%	80%
<b>Graphene Green Concrete</b> Explore acceleration of cement / concrete reduction through new materials ie. graphene	40%								
<b>Commercial duct sealant</b> Reduce energy through improving performance of commercial duct (reducing air leakage)	100%	40%							



# Construction to production



Our 2026 Business Strategy places construction to production (C2P) at the heart of our delivery approach.

At Mace, we have been advancing this approach to prefabrication and off-site assembly for over 20 years to deliver better for our clients and communities. Not only does C2P give us the ability to achieve efficient, high quality, right first-time construction, it also allows us to run processes in parallel – manufacturing off-site while building on-site, significantly reducing our programmes and carbon footprint.

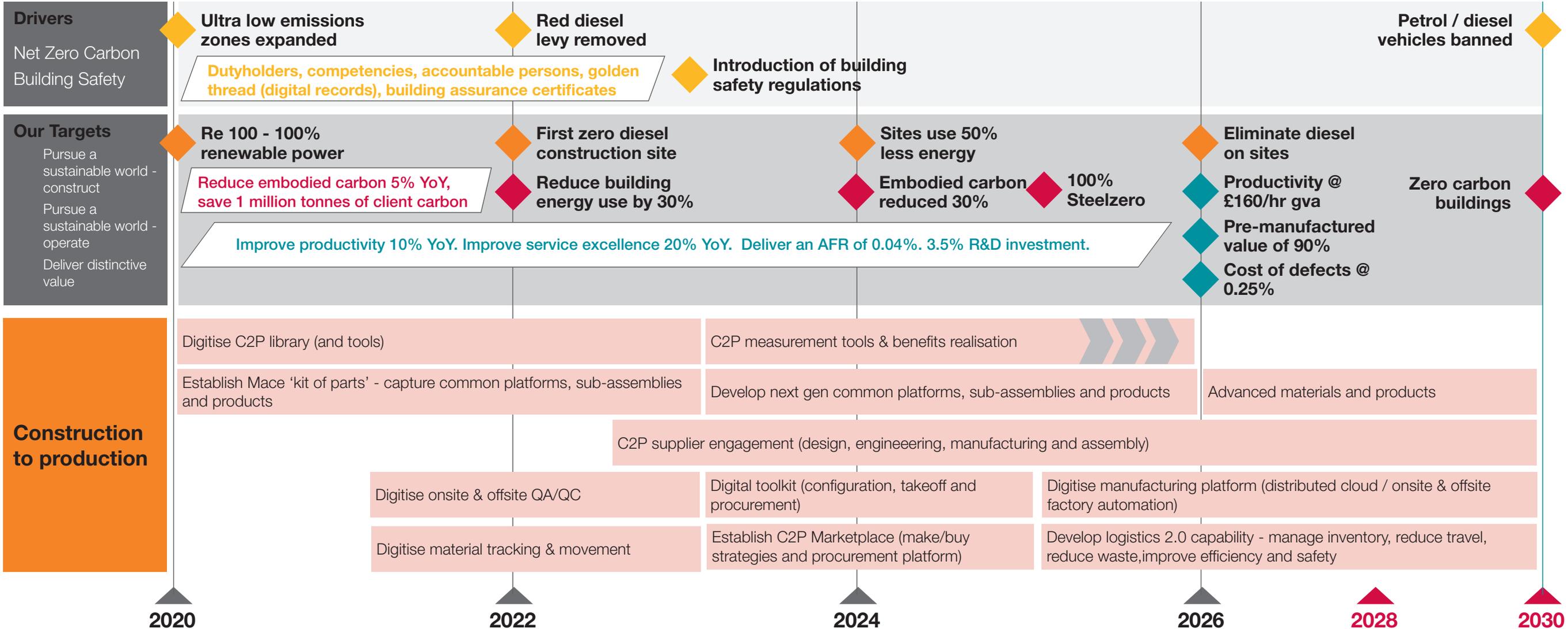
The roadmap sets out how we will build capability to achieve our ambitious goals and transform how we build with a digitally driven construction to production approach that will drive greater efficiency across our projects and deliver better value for our clients.

### Strategic innovation priorities:

- Developing a business-wide approach, kit-of-parts and library for the delivery of C2P across every relevant project and programme at Mace by 2023
- Digitise the movement and tracking of all materials on Mace projects by 2023
- The creation of a digitised manufacturing platform for Mace by 2026

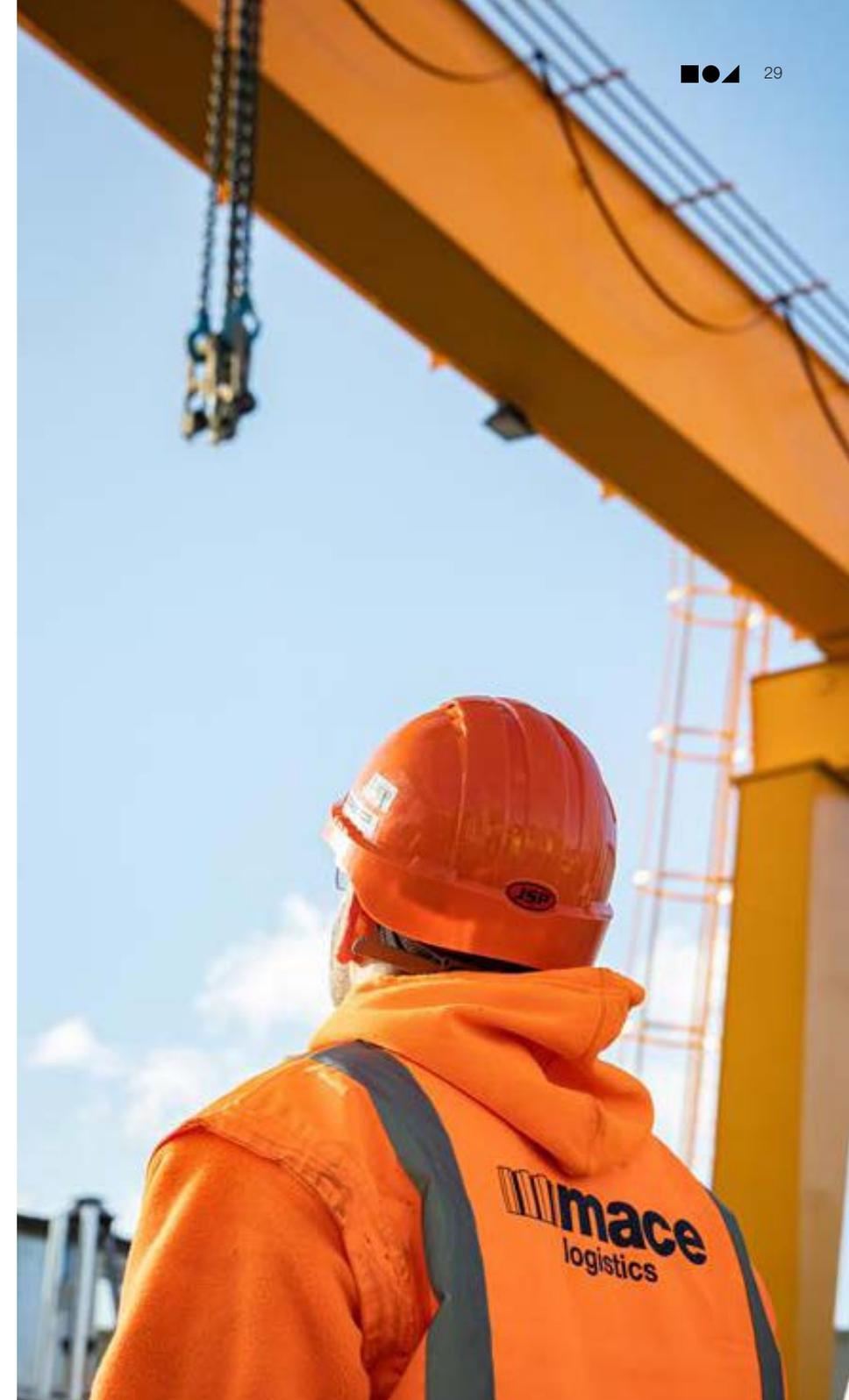


# CONSTRUCTION TO PRODUCTION



# CONSTRUCTION TO PRODUCTION

Stage	Concept		Investigate		Develop			Embed	
	1	2	3	4	5	6	7	8	9
<b>Rapid Modular Datacentre</b> Design, manufacture & assembly of entire RMD modular datacentre	100%	80%							
<b>Unitised façade panels</b> Built-up Facades	60%								
<b>Structural system - concrete / steel</b> Low Carbon Cassettes	100%	100%	100%	40%					
<b>Fitout - Wiring looms</b> Precut wiring harnesses in loom for quick installation	100%	100%	100%	100%	60%				
<b>Ceiling cassettes</b> Roof cassette with structure integrated (Mace Interiors)	100%	100%	100%	100%	100%	40%			
<b>LV Switch Rooms</b> Prefabricated LV Switch Rooms	100%	100%	100%	100%	100%	80%			
<b>Multi service MEP modules</b> Multi service modules combined with raised access floor. Multi service MEP modules with MEP services and integrated flooring support frames	100%	100%	100%	100%	100%	100%	100%		
<b>Prefabricated risers</b> Three storey vertical risers	100%	100%	100%	100%	100%	100%	100%	80%	
<b>Prefabricated utility cupboards</b> Modular Utility Cupboards (COR)	100%	100%	100%	100%	100%	100%	100%	40%	
<b>Site accommodation</b> Prefabricated site accommodation units assembled as large volumetric office building (Multiple BUs - BAU)	100%	100%	100%	100%	100%	100%	100%	100%	80%
<b>Airport Pier</b> KOPPIer product design manual with Aecom	100%	40%							
<b>On-site fabrication</b> On site prefabrication facility for production of sub assemblies (PREACH)	100%	100%	100%	100%	100%	40%			



# Digital and data



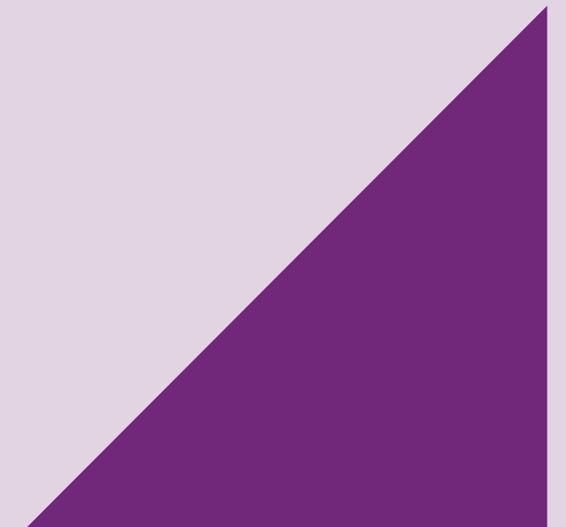
Across all of our Engines and Mace's corporate services, we're rapidly scaling up the effective capture of the right data and using it to generate insights that are transforming how we do business and how we deliver projects.

The scope of opportunity here is huge – if we can effectively capture delivery data against more of Mace's projects and programmes around the world we'll be able to use predictive analytics and AI to improve productivity and delivery certainty.

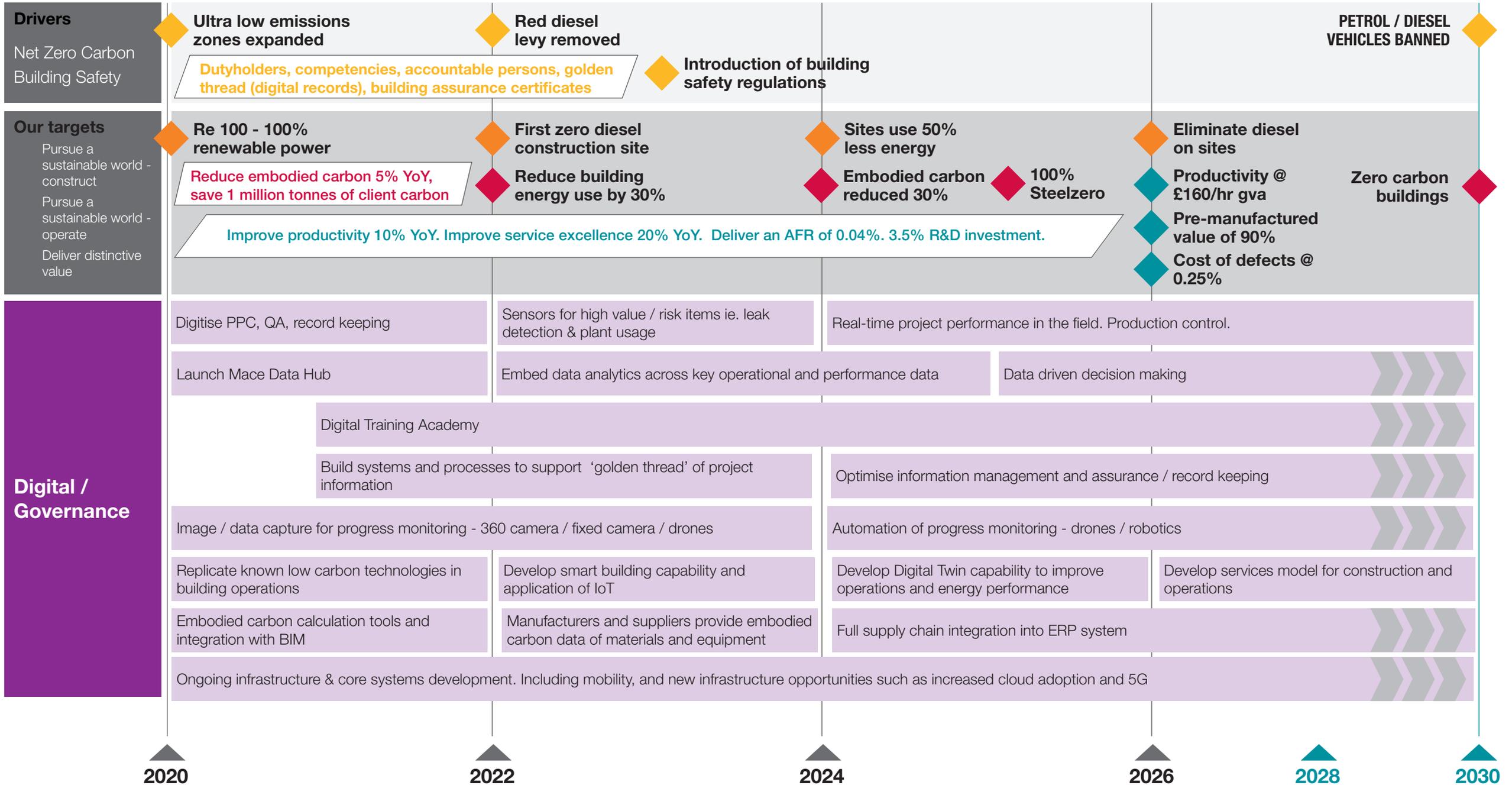
We're already delivering tangible benefits to our clients across Construct, Consult and Operate driven by our use of data, and as we invest in new technology over the next four years we'll see those impacts multiply.

## **Strategic innovation priorities**

- Building on the successful launch of the Mace Data Hub to provide authoritative, live data on Mace operations across our business.
- Enhanced use of analytics to track and measure construction delivery and building performance by 2024.
- Deliver automated progress monitoring of project delivery through drones and robotics by 2026.



# DIGITAL AND DATA



# DIGITAL AND DATA

Stage	Concept		Investigate		Develop			Embed	
TRL	1	2	3	4	5	6	7	8	9
<b>Automated / robotic laser scanning</b> Trial of Boston Dynamics 'Spot The Dog' and Trimble laser scanner to capture progress on site	100%	100%	100%	100%	60%				
<b>Capturing the Golden Thread</b> Digitalise the buildings regulations / Golden Thread tool for ease of application / data capture on sites (Disperse v Autodesk)	100%	100%	40%						
<b>On-site worker data</b> Wearables (watches / tags) to record safety / tool time - Mafic / Humananalytics / Plinx /	100%	40%							
<b>Production Control Room</b> InnovateUK-funded programme creating a standard, repeatable control room & data integration across key Mace software systems (3DRepo / Evifile / MissionRoom)	100%	100%	100%	100%	80%	60%			
<b>Design change measurement tool</b> Use of software solution to compare drawings and automate / highlight changes / provide reliable reporting to construction teams	100%	100%	100%	100%	100%	100%	60%		
<b>Short term collaborative planning</b> Use of technology to improve the frequency and value of short term collaborative planning, linked to aspirations for PPC implementation	100%	100%	100%	100%	100%	100%	100%	40%	
<b>BIM 360 Build</b> Model development / federation / QA/QC / Site Diaries / Commissioning (BIM360 Build)	100%	100%	100%	100%	100%	100%	100%	100%	80%
<b>Quantification output (BOQ) &amp; visual progress tracking tool</b> Use of BIM360 Assemble for quantification output (BOQ) & visual progress tracking tool through delivery -	100%	100%	100%	100%	100%	100%	100%	80%	
<b>Concrete strength monitoring</b> Using monitors in concrete to assess curing times and improve cycle times	100%	100%	100%	100%	100%	100%	100%	40%	
<b>C2P library / decision matrix</b> Build a library to hold key C2P information and a decision matrix to use for all project start up / bids	100%	100%	80%						

