Less is more

If cost efficiency is not reason enough to cut carbon, investors are starting to divest from companies that aren’t aligned with the Paris Agreement's goal of net-zero emissions by 2050, and favouring those that are.

Time for change

Business efficiency should be reason enough to embark on decarbonisation. But climate change provides an increasingly powerful impetus.

“Cut carbon, save cost” said the UK government’s Infrastructure Carbon Review (ICR), published in 2013. Because carbon is a proxy for resource use, focusing on ways to reduce it drives more efficient planning, design, construction and management of assets, and improves bottom line performance.

Contents

The 2019-2020 Australian bushfire season has burned an estimated 18.6Mha, destroyed over 2500 buildings and killed 35 people as of 10 March 2020.

Challenges and opportunities

Challenges and opportunities frequently go together, and the response to climate change is no exception. Businesses must address five key challenges and gain benefit from doing so.

1.

Reduce emissions

2.

Prolong asset integrity and maintain asset value

3.

Provide high quality and continuous service

4.

Safeguard customers, employees and supply chains

5.

Protect business continuity, reputation, revenue and profit

Commercial and competitive

Radical carbon reduction requires innovation in all areas of business activity, which creates cost efficiencies and new market opportunities. Resilient organisations gain market advantage by surviving acute and chronic climate change impacts better than less adapted competitors.

Financial and fiduciary

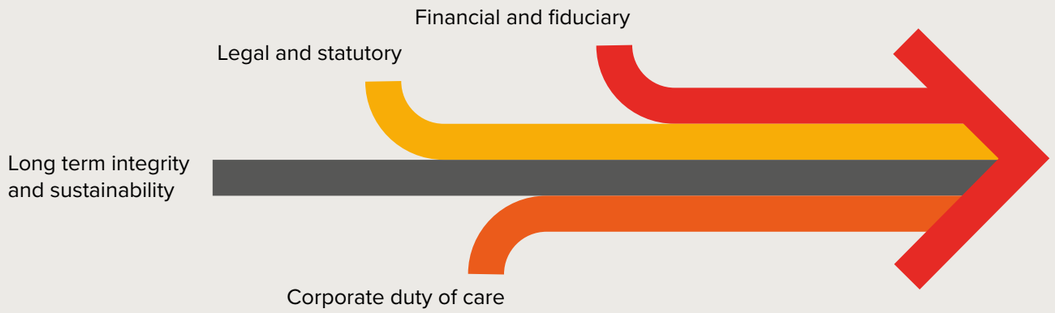
The financial industry is taking account of organisations' exposure to and management of climate change risks when making investment decisions. Increasingly, carbon reduction and resilience are determining factors in access to capital and the management of investment returns. Supporters of the Task Force on Climate-related Financial Disclosures (TCFD), established by the G20's Financial Stability Board in 2015, want to see carbon actively managed and are increasingly likely to penalise those that fail to do so.

Legal and statutory

Since December 2015, some 1500 pieces of legislation and policy have been enacted by signatories of the Paris Agreement to keep temperatures well below 2°C, requiring organisations to be vigilant regarding regulatory and legal compliance. In 2019, the UK government passed into law its target to bring all greenhouse gas emissions to net zero by 2050.

Corporate responsibility

Cutting carbon and building resilience are morally 'the right thing to do', but also part of each organisation's corporate duty of care.



With you every step of the way

We'll work with you to develop a cost-effective transition pathway to achieve long-term business sustainability and continuity. Looking at where you are now and where you want to be, together we'll develop a series of steps to get you there.

Our approach is transferable across sectors and geographies. It addresses:

- **Capital carbon** – the emissions associated with creating, enhancing or extending an asset – adding together the emissions arising from materials extraction and processing, the manufacturing of components, transport and construction activities.
- **Operational carbon** – the emissions from operation and maintenance activities over the lifetime of an asset.

What motivates you?

We start by understanding your business, the operational challenges you face and what infrastructure needs these create. The next step is to identify where low carbon interventions will make the biggest difference.

Costs, benefits and carbon

A big part of any project is understanding the costs and benefits of different options. We bring carbon into that discussion, helping you develop options that have the most carbon savings for your investment. We carry out a 'baselining' exercise to calculate current emissions and work with you to set targets and an action plan for achieving them.

Capital carbon
Looking at capital carbon, the first question we ask is: do you need to build anything at all? Can a need be met by changing the way existing assets are operated, or by addressing the situation that has given rise to the need in the first place?

Operational carbon
Today, with fossil fuels still accounting for a large part of the energy mix, operational carbon is usually the larger contributor to total emissions over the lifetime of an asset. This will change as low- and zero-emission generating technologies grow their market share. But in the near-term, operational energy savings are important for carbon reduction. In the long-term, they will remain important for saving cost. Operational carbon and cost savings come from managing load and achieving efficiency in the handling of those loads. It's where skilled asset management makes all the difference:

- Understanding and influencing demand
- Knowing how assets are performing in real-time
- Gaining insight from historic patterns and trends
- Tuning the performance of assets to conditions
- Identifying when and where maintenance or repair is required before it becomes a problem
- Seeing where targeted investment can make the biggest difference

A new lens

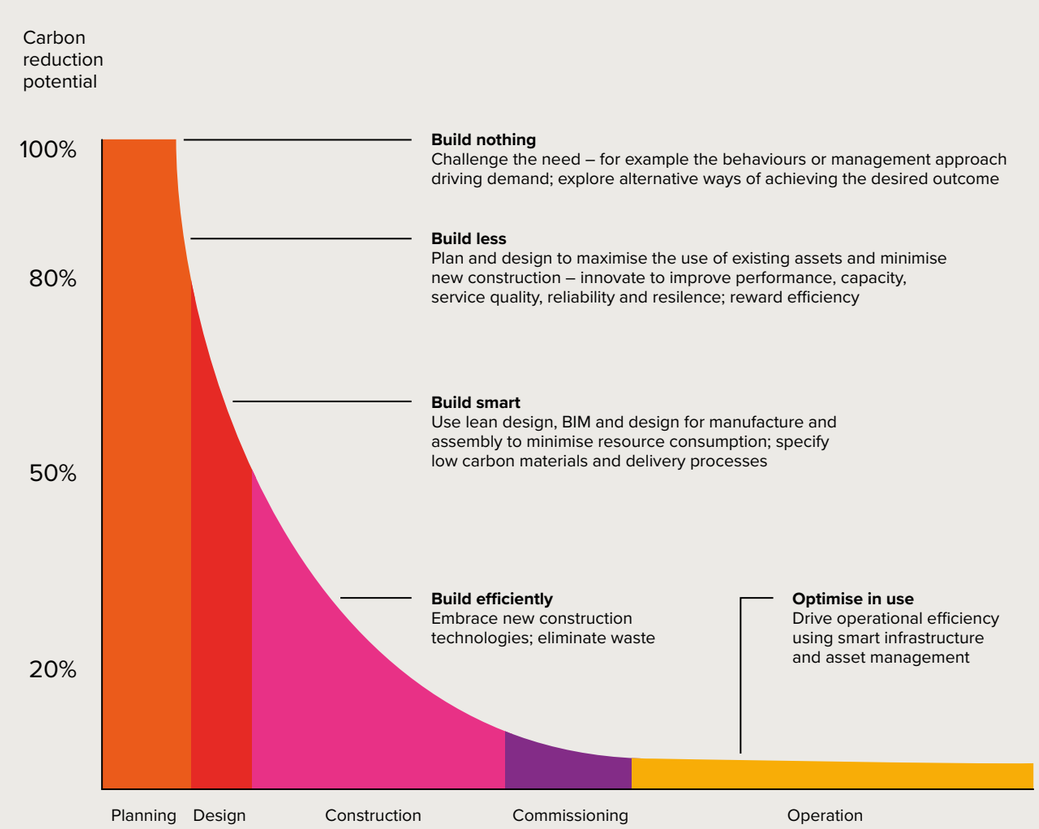
We don't claim to have all the answers, but we're here to help our clients to look at what they do through a new lens – helping see the carbon hotspots and start the process of removing them. We like to involve others in our clients' supply chains. Collaboration helps to ensure that the right questions are asked, the correct challenges set, necessary capabilities and management systems are put in place, and opportunities for innovation recognised at the right time. It's about ensuring that solutions are the best they can be and work for everyone involved in a project over its lifetime.

Sharing best practice, ensuring compliance

Carbon best practice translates readily between sectors. Rail, aviation, flood defence, power, highways and water may be very different industries, but they face common challenges in terms of the materials, delivery methods and asset management strategies they use. We can provide guidance on best practice carbon management and tailor it for your sector and your organisation. While doing so, we'll advise on alignment with relevant guidelines and specifications, ensuring you are on the front foot in both addressing obligations and seizing opportunities.

Carbon emissions reduction hierarchy

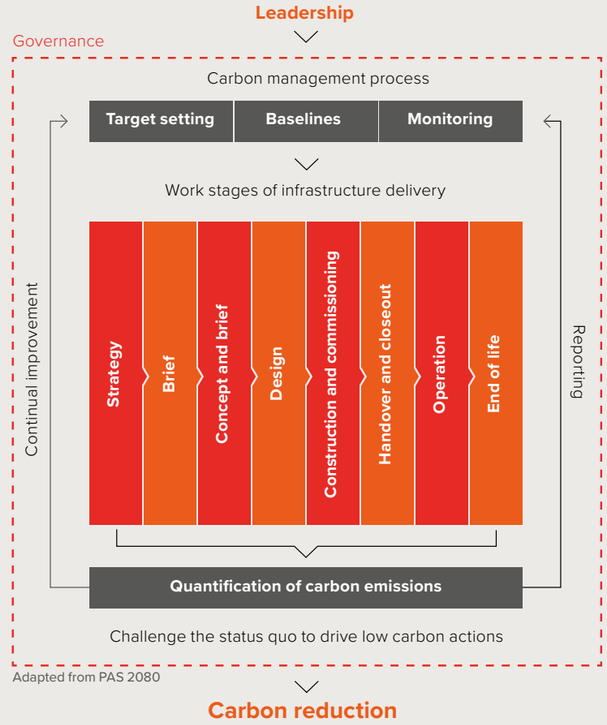
Opportunities for cutting carbon
Our carbon reduction hierarchy guides critical decision-making through all stages of a project. The approach, developed as part of the Infrastructure Carbon Review and PAS 2080, encourages constructive challenge and innovative thinking. This is particulary critical in the earliest stages, where the biggest opportunities for carbon and cost reduction lies.



Tried and tested

With our clients, we've been cutting cost and carbon for over two decades with the tried and tested principles:

1. Set ambitious targets
2. Specify the outcomes you want to achieve, not outputs and processes
3. Engage your supply chain before you've made the important decisions
4. Encourage competition
5. Pursue co-benefits and efficiencies of scale
6. Be committed in your low carbon leadership



PAS 2080

We were lead authors of the Infrastructure Carbon Review. One of the recommendations of the ICR was the creation of a new industry standard and we were subsequently appointed as lead author of PAS 2080, the world's first carbon management standard for infrastructure. Launched in 2016, PAS 2080 addresses whole-life carbon (capital and operational greenhouse gas emissions) and provides practical 'how to' guidance on implementing the ICR recommendations.

No red tape

PAS 2080 is a voluntary standard, which means businesses can specify it in the way that works best for them and increase their maturity in carbon management, no matter what stage they are at. It provides a consistent approach to methods, measurement and reporting for companies across the supply chain – asset owners, managers, designers, constructors, and product and material suppliers.

It is compatible with BSI standards for building information modelling (BIM) and information management to aid integration of carbon management with other infrastructure planning, delivery and management processes.

What's the value of PAS 2080?

Accreditation will help you reassure your board, shareholders, investors, insurers and regulators that carbon is being effectively managed and targets are being achieved.

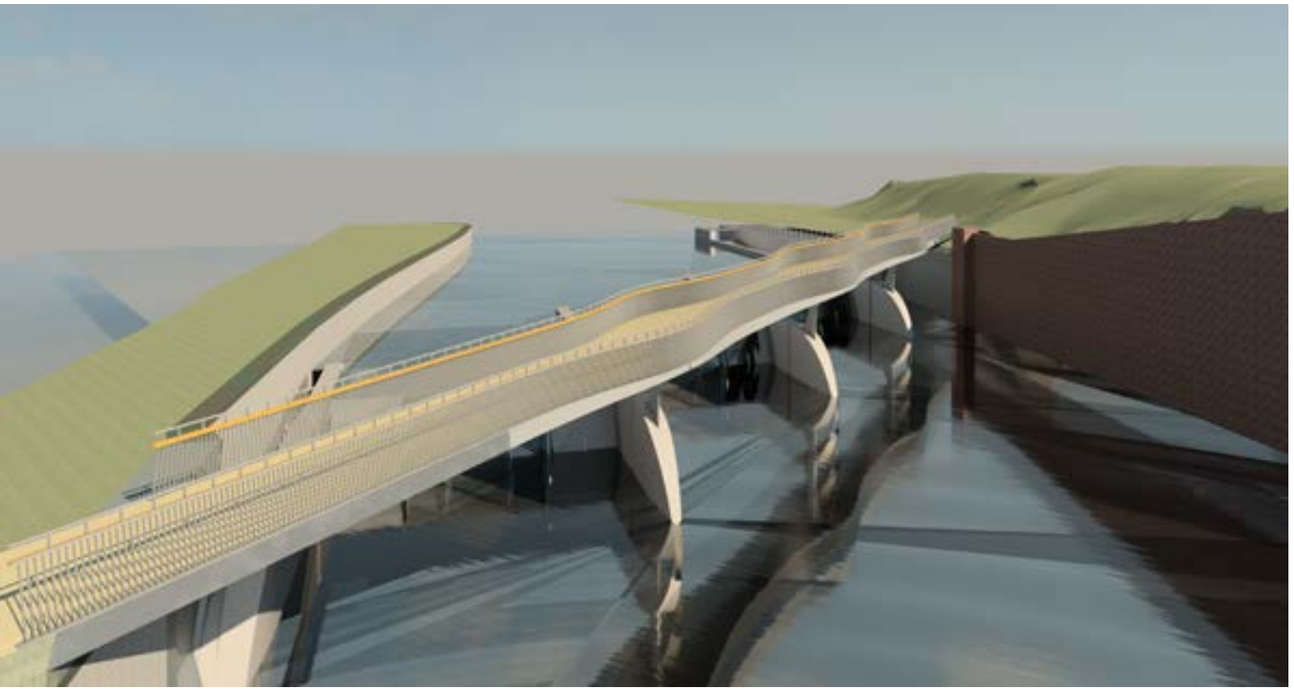
Theory and practice

As well as our experience helping clients to manage and minimise their carbon, we were the first consultancy to be independently certified to PAS 2080. Having written it and been through the process of earning PAS 2080 accreditation ourselves, we know what it takes and are well placed to support you.

MOATA Carbon Portal

MOATA Carbon Portal is a tool for modelling the capital and operational carbon of new assets. It enables designers to find carbon hotspots during the optioneering phase of a project, when decision-making is most flexible. Carbon Portal is built on the infrastructure industry's most comprehensive carbon database and is integrated with BIM, enabling the carbon impacts of design changes to be visualised as they are made.

Carbon Portal sits within our technology platform, MOATA, which integrates multiple products and services, providing joined-up solutions.



Key aspects of the Carbon Portal:

Focus on assets, not materials
By calculating carbon for BIM objects and entire assets, the portal provides essential information as to where savings can be made at both planning and design stages.

Rapid calculations
Carbon assessments using spreadsheets can take hours or even days. The portal reduces this to as little as 30 seconds.

Optioneering
Users are able to quickly calculate the capital and operational carbon footprint of competing designs and to see the impact of design modifications across the entire project.

Ease of use
The portal is based on a drag-and-drop system which is intuitive to all software users. BIM data can be easily imported, with users adjusting quantity to provide immediate calculations.

Cross-sectoral
The tool works for water, transport and power assets, with plans in place to cover further sectors in the future.

International use
The portal is populated with UK data that already supports optioneering in all markets. Datasets are being continually refined and tailored to key regions worldwide.

99.9% carbon-free

An innovative approach to assessing the condition of Digley Reservoir's dam enabled Yorkshire Water to avoid major engineering work and associated cost and carbon emissions.

A safety report had highlighted potential water seepage through the clay core of the dam. Seepage is a problem that, if left unchecked, can lead to structural problems – assurance was needed that the core was watertight.

Conventionally, this would have been achieved through a physical intervention, such as localised grouting of the clay core or full replacement with a slurry trench.

Instead, we set out to ascertain whether seepage really was taking place. We used temperature-sensing fibre optics to send pulses of light to the core. By reading temperature changes from the top to the bottom of the embankment, and from one end to the other, we were able to gauge whether water was passing through the core.

The fibre optic probes allowed the project team to follow up with targeted geotechnical investigations in clearly identified potential problem areas. Analysis of the results of all investigations showed that the dam was in satisfactory condition and that no remedial works were required.

Avoiding repair or replacement of the dam core followed the principles of 'no build' and 'build less'. It was estimated to save 700tCO_2e – a 99.9% carbon reduction compared to full replacement.

It was the first time fibre optic technology had been used on a major reservoir project. The probe system has now been installed permanently, enabling Yorkshire Water to keep an eye on the dam in real time for years to come.

Project
Digley Reservoir Dam Assessment

Location
Yorkshire, United Kingdom

Client
Yorkshire Water

Expertise
Condition investigation, carbon assessment

700t

CO_2e saved

Building less, building better for Anglian Water

At the start of the last decade, the population of Lincolnshire was growing rapidly.

A boom in economic development transformed the formerly quiet port town of Boston into a magnet for people seeking work opportunities and a place to settle down.

But this surge in population put a strain on the town's water supply. In the unlikely event of an extended outage, residents could have been left without water.

To protect Bostonians, the area's supplier, Anglian Water, set out to build a new 60km-long pipeline that would connect the town to a reservoir and water treatment works in Covenham, at an initial estimated cost of £40M.

However, the client set a number of tight delivery targets, including reducing capital costs by 19%, and cutting embodied and operational carbon by 50% and 20% respectively. We knew from the outset that building the pipeline using traditional methods would not meet these ambitious targets.

We started by undertaking detailed network modelling and assessment of existing assets. This revealed that 40% of the required water could be supplied from south of the town through existing pipelines, enabling us to significantly reduce the size of the new pipeline, from 600mm to 500mm diameter for the first 40km, and to 400mm for the last 20km. The next step was deciding what material would be most suitable and least carbon-intensive. Minimising the use of concrete across the project would reduce carbon the most, so a polyethylene pipe was installed. Not only did it have the lowest embodied carbon, it was also the cheapest. The material was also flexible enough to vary the thickness of the pipeline walls and to better follow the natural terrain than iron or steel, which helped to limit the number of joints, bends and route diversions. By using longer, 18m pipe sections, the number of lorry deliveries to the construction site was 30% less compared with a conventional steel pipeline. Our innovative approach to planning, manufacturing and building led to a 57% carbon saving and 25% cost saving over the entire project. Through discussions with Anglian Water's board of directors, we realised that using current low carbon best practice across the UK infrastructure sector – just like our team demonstrated on this project – would bring a £1.5bn-a-year economic benefit to the country.

Today, the green eastern plains under which the vital pipeline snakes is a picture of pristine, undisturbed countryside. But thanks to our collaborative work with Anglian Water and our partners, thousands of Boston residents will now enjoy a secure, resilient supply of drinking water for many years to come.

Project
Covenham Water Treatment Works to Boston Transfer

Location
Lincolnshire, United Kingdom

Client
Anglian Water Services

Expertise
Feasibility study and investigation

57%
carbon saving

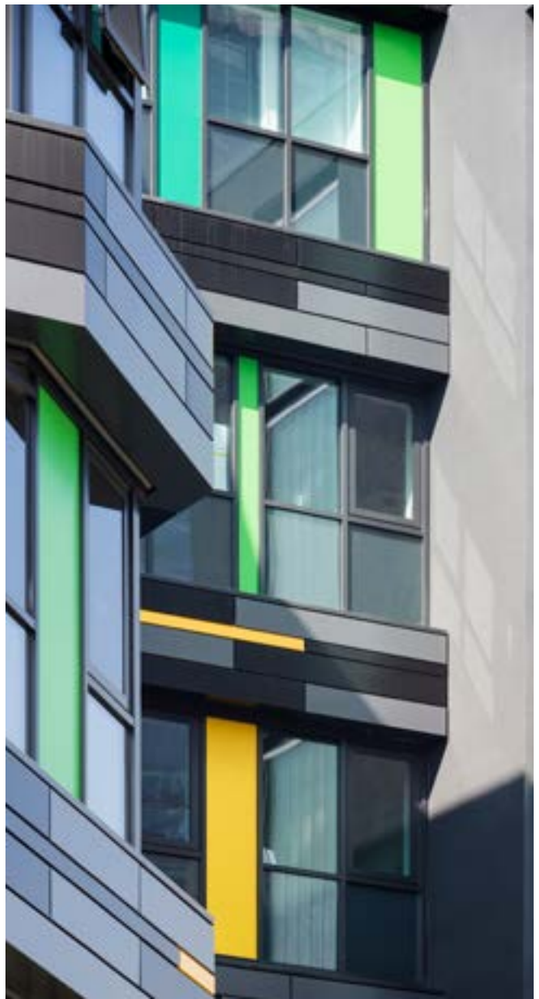
25%
cost saving

Project
Queen Mary University,
Fogg Building Upgrade

Location
London, United Kingdom

Client
Queen Mary University of London

Expertise
Feasibility study and investigation, design, supervision of construction



Retrofit for the future

Building a brand-new facility for the 70 staff and 1300 students of Queen Mary University's biological and chemical sciences faculty would have been hugely expensive, so we looked at ways to improve their existing home.

The seven-storey 1960s GE Fogg Building had a leaky façade, poor insulation and suffered from extreme solar thermal gain.

Our cost-effective solution included high performance glazing, better insulation on the walls and solar photovoltaic panels on the south and southeast-facing roofs. New windows were sized to provide the right balance between natural lighting, heat transmission and ventilation. Tight seals on the new cladding and windows cut the volume of air leaking from the building by 35%, improving wintertime heat retention.

With a budget of just £3.95M, this university in east London gained a facility matching the performance of the best new build projects at a fraction of the cost. Energy consumption for heating, cooling and ventilation was cut by 70%.

Our design solutions cut carbon emissions on the project by

46%

Project
A303 Sparkford to
Ilchester Stage 2

Location
Somerset, United Kingdom

Client
Highways England

Expertise
Feasibility studies, design, project management

Driving down emissions

The A303 is a vital trunk road in southern England, running between Basingstoke in Hampshire and Honiton in Devon.

Most of the 150km route is dual carriageway, but some is single carriageway, including a 5.6km stretch between Sparkford and Ilchester in Somerset. It was often congested, and poor junction alignment and visibility increased the risk of accidents. Highways England proposed to turn this section into a dual carriageway to solve these issues.

It chose our Carbon Portal for the project over its own carbon assessment tool to assess carbon emissions associated with construction and to inform the scheme's environmental impact assessment (EIA).

Our tool enabled carbon hotspots to be identified and targeted, and low-carbon alternatives to be implemented. Our design solutions cut carbon emissions on the project by 46%.

One of the main ways this was achieved was by widening the existing single carriageway stretch to dual status, instead of building an entirely new stretch of dual carriageway through surrounding countryside. Since the A303 upgrade, all our projects in the south-west for Highways England use the portal.

Going further on the Northern Line

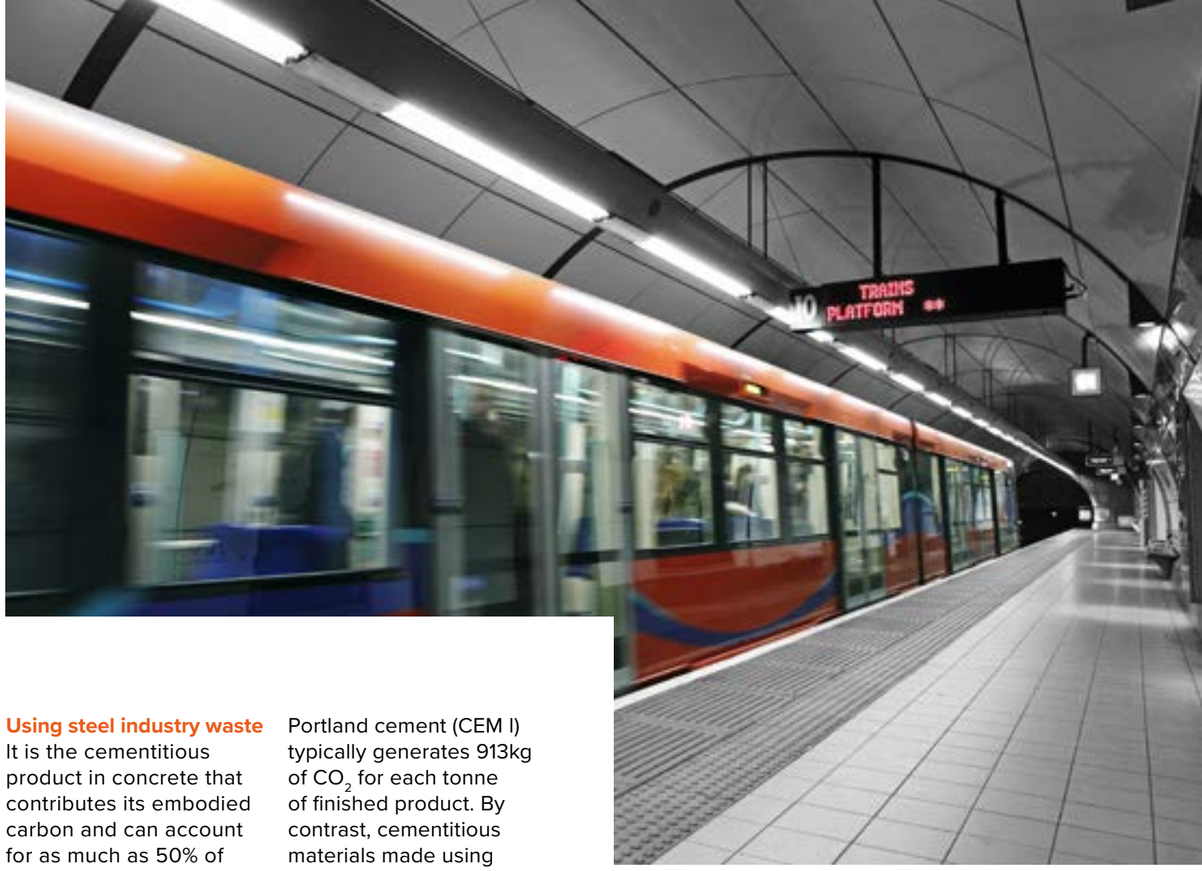
Mott MacDonald was appointed lead designer for FLO, the joint venture between Ferrovial Agroman and Laing O'Rourke delivering the Northern Line extension (NLE), a 3.2km addition to the London Underground network targeted for completion in 2020.

Project
Northern Line Extension
Nine Elms to Battersea

Location
London, United Kingdom

Client
Ferrovial-Laing O'Rourke
Joint Venture

Expertise
Design



The project consists of two new subterranean stations – one at the iconic former power station at Battersea and another to the east, at Nine Elms – and two ventilation shafts in Kennington, as well as bored and SCL (sprayed concrete lining) tunnels and SGI (spheroidal graphite iron) turnouts. Overall, about 50,000m^3 of concrete will be poured to build the line and stations. With cement manufacture a major source of greenhouse gas emissions, our work focused on finding ultra-low carbon alternatives to Portland cement, which is traditionally used in concrete.

"Construction that is less damaging to the environment must push the boundaries."

Ian Gibb
Technical principal, Mott MacDonald

Using steel industry waste

It is the cementitious product in concrete that contributes its embodied carbon and can account for as much as 50% of total emissions over the lifetime of a building, bridge or tunnel. Adding industrial waste products such as fly ash and ground granulated blast-furnace slag (GGBS) is a tried and trusted way of significantly reducing the carbon footprint of concrete. This is because they are by-products from coal-fuelled electricity power stations and steel manufacture respectively, and the main carbon emitted is from grinding the waste into a powder and hauling it to a mixer. To put the potential savings into perspective, Portland cement (CEM I) typically generates 913kg of CO_2 for each tonne of finished product. By contrast, cementitious materials made using limestone, fly ash or GGBS (CEM II), generates between 615 and 859kg of CO_2, depending on the amount added.

According to the Cementitious Slag Makers Association, GGBS typically replaces about 50% of the Portland cement component in concrete, and sometimes up to 70%. We went much further on the NLE, raising the proportion to 95% for the secant piling concrete, reducing the CO_2 equivalent content compared with the CEM II mix by more than 80%.

Future-proofing New Zealand's Watercare

Project
Carbon Baseline Asset Plan 2020–2024

Location
Auckland, New Zealand

Client
Watercare Services

Expertise
Advisory, oversight, peer review

Auckland is regarded as one of the most desirable places in the world to live, and it is now home to more than 1.5M people.

Over the next 30 years, that number is expected to jump to 2.5M. This rapid growth is putting pressure on organisations to ensure infrastructure is resilient, reliable and sustainable.

Watercare, the local government-owned organisation that operates Auckland's water and wastewater infrastructure, is aware and prepared for this challenge. Over the next 10 years, it plans to invest NZ$5.5bn in water and wastewater infrastructure for the city.

At the same time, the organisation has set an ambitious target to reduce carbon in construction by 40% by 2024.

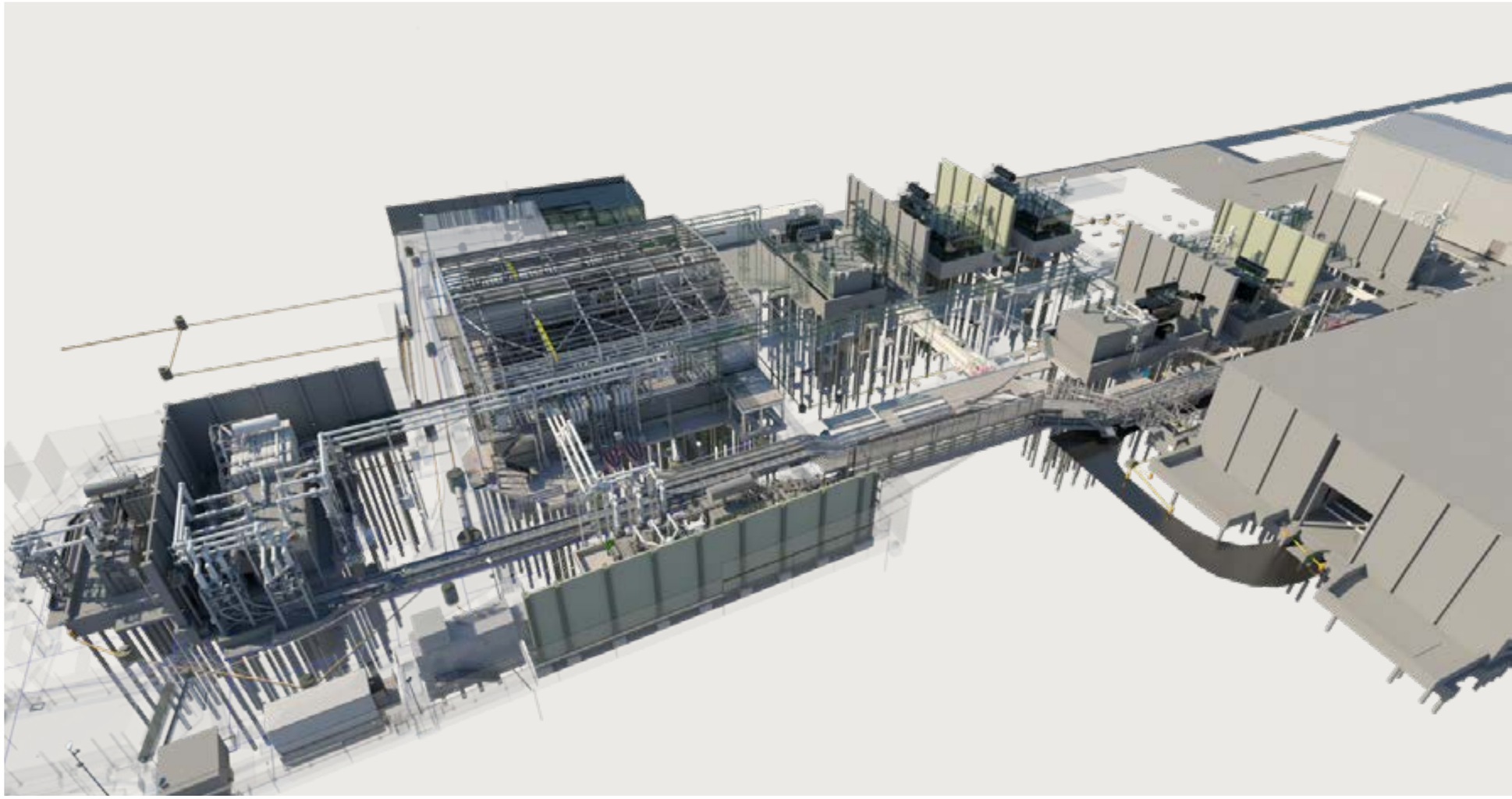
To help Watercare achieve its goals, we carried out the Infrastructure Carbon Baseline project to assess the anticipated capital carbon embodied in its five-year asset management plan for construction projects, which has an approximate total value of NZ$1bn. We were also in charge of the design of the NZ$63M expansion of the Rosedale wastewater treatment plant on Auckland's north shore.

Our work has provided Watercare with insight into where its hotspots and areas of greatest carbon impact are, enabling it to focus on how best to reduce capital carbon at both the project and programme level. Watercare will use this to challenge its design and contract partners and its suppliers to drive that 40% reduction in capital carbon by 2024.

Watercare has a

40%

capital carbon reduction target by 2024



Project
Wimbledon 400kV substation

Location
London, United Kingdom

Client
National Grid

Expertise
Design

Cutting carbon through BIM

In 2011, National Grid kicked off a major seven-year project to upgrade the electrical infrastructure underneath London and build a number of new substations to meet the capital's growing power demand.

Part of this project was the upgrade of a 400kV substation in the densely populated borough of Wimbledon, to serve the south east of London, and the London Underground and National Rail networks.

Building the Wimbledon substation replacement in a highly congested area with minimum disruption, while sticking within time and budget constraints was a challenge. But National Grid also wanted us to achieve major carbon and cost savings in keeping with its target to cut greenhouse gas emisssions by 45% before 2020 and 80% by 2050, compared with 1990 levels.

During the tender stage, a critical 5% weighting was awarded to carbon reduction efforts, setting the tone for what would be a very ambitious construction project. The Wimbledon substation would be the client's first project to embed carbon reduction at every stage of the design and build.

We supported main contractor Laing O'Rourke to develop a 3D digital engineering model to solve spatial and site access puzzles, optimise design for operation and maintenance, and aid construction.

The modelling software managed to reduce the carbon footprint by 23% –the equivalent of taking 7600 cars off the road for a year – and cut the total cost of the project by £3M.

Using BIM allowed a common data environment to be created, where every user had access to shared information. Carbon data was derived from this and could be quantified, visualised and reviewed.

National Grid has since replicated the process over the rest of its seven-year programme of works, focusing on the carbon hotspots of in situ and precast concrete and steel.

MottTRAIN: a powerful rail simulator

When it comes to the development or upgrade of a rail line, balancing efficiency and sustainability is a tricky task.

Rolling stock fleet size, scheduling of train services, energy consumption and electrical traction system parameters must all be determined before a rail system can function properly.

MottTRAIN is applicable for both the alternating current (AC) and direct current (DC) rail networks, and can also be used to analyse net efficiency comparisons between AC and DC systems.

The software is used for scoping traction power upgrades, optimising or validating traction power system designs, assessing the impact of new technologies, and forecasting traction energy consumption under a variety of scenarios.

Higher capacity rolling stock and increased services are typically considered when renewing or upgrading an existing rail line.

Electrical substations on a DC line are usually between 2.5km and 5km apart. By using MottTRAIN, we are able to model the exact number of trains running per hour, as well as different parameters for each one, to calculate the optimal number of substations that need to be built.

In Victoria, Australia, a preliminary model from the rail operator specified 21 substations to be installed or upgraded on a 40km railway line. We analysed the model and found that only 14 were required for the introduction of new rolling stock and planned upgrade to services. This resulted in cost as well as carbon savings.

Larger diameter overhead cable is another element often associated with service level uplifts and more power intensive rolling stock. This has a knock-on effect on the structures that hold up the cable and requires more copper, more steel and more construction activities.

MottTRAIN can model the thermal behaviour of overhead conductor lines to potentially change the way the systems are analysed, minimising the requirement to upgrade overhead conductor lines.

Boiling down the numbers

How do you solve a problem like climate change? A three-year, £3M programme launched in 2019 is helping participating countries to find answers.

Most of us recognise we must cut our carbon emissions, but few know where to direct effort for greatest effect – or the associated costs or benefits of doing so.

A powerful modelling tool developed by the UK government to set long-term climate targets is designed to help with that. It was first developed to support the implementation of the UK Climate Change Act in 2008 to identify pathways to meeting the world's first legally binding greenhouse gas target – an 80% reduction in CO_2e emissions by 2050.

Known as the 2050 calculator, it could answer questions, such as:

- How much energy can be supplied by different technologies?
- Which sectors can achieve the largest reductions, and at what cost?
- How much energy is needed in each sector, and how can this be changed?
- What are the impacts of different pathways on air quality and land use?

The tool was so successful in engaging policymakers, business leaders and the general public about the trade-offs between sectors and technologies that 2050 calculators were developed in more than 30 countries. In 2015, a Global 2050 Calculator was developed to assess pathways to achieve the temperature goals of the Paris Agreement.

In all its iterations the calculator illustrates the connections between emissions and diverse aspects of economic activity and daily life. It helps national governments, local authorities, businesses and even individual citizens examine scenarios and identify where urgent action is required. It enables them to see where the greatest carbon reductions can be achieved and what the economic impacts are – helping guide policy, planning and action.

Calculators have been adopted by more than 25 countries, as well as in states, provinces and cities, enabling them to trial different options for reducing emissions.

Users can create their own energy and emissions reduction pathways, and see the impact of different choices and trade-offs.

Users can create their own energy and emissions reduction pathways, and see the impact of different choices and trade-offs. Three versions are currently in use: a full model built in Excel allowing expert users to examine pathways in detail; a user-friendly, interactive web tool for policy makers and stakeholders; and an interactive game version aimed at the public, particularly school children.

Under the UK Department for Business, Energy & Industrial Strategy's (BEIS) International 2050 Calculator Programme, launched in 2019, the calculator will be rolled out to five new countries. The programme will also update existing national calculators to make them more useful for policymakers and other stakeholders. We are BEIS's delivery partner, managing the programme and a consortium of technical experts from Imperial College, Ricardo Energy and Environment, and Climact.

Shaping policy around the world

The 2015 Paris Agreement marked a historic shift in how most of the world's nations think and act on climate. Signatories were required to submit 'nationally determined contributions' (NDCs) to global greenhouse gas (GHG) reductions. Every five years countries must increase their ambition and strengthen their NDCs, ratcheting the world towards net-zero emissions.

The Czech Republic's climate change policy and long-term strategy for the United Nations Framework Convention on Climate Change (UNFCCC) was developed using the calculator. The Indian government is using it to set targets under its national energy policy, tackling the challenge of improving energy access for millions of households while raising the share of renewables in the mix.

Belgium created scenarios using the calculator to inform its national debate on carbon pricing. The model is now being used to update and enhance the country's NDC and keep it in line with the EU's wider climate commitments.

In Vietnam, authorities employed the model to take stock of GHG emissions produced by the most polluting sectors, leading to a decarbonisation plan to tackle these sectors first.

Local change for a global impact

Cities consume more than two-thirds of the world's energy and account for about 70% of global CO_2 emissions. Urbanisation is exacerbating the rate at which cities contribute to climate change – but they are also part of the solution.

City leaders can use the calculator to steer a course to net-zero. C40 is a network of the world's megacities committed to addressing climate change. It is hoped use of the calculator will spread across the C40 network to help properly inform decision-making.

Combating the causes and effects of climate change.