

Carbon Crunch: The road to a zero carbon UK



The zero carbon agenda is a valuable opportunity for innovation and reward.

We must adapt to the new carbon context

By committing the country to becoming a zero carbon economy by 2050, the government has created a new carbon context in the UK.

While all sectors need to up their game on carbon reduction, infrastructure lags behind, with faster progress needed to move the industry on to a trajectory that will ensure we meet national targets.

Momentum is slowly but steadily building. We accept we need to make a change to drive carbon down from project solutions. So we are now debating the 'inertia of organisational change' rather than the inertia to change itself.

The Infrastructure Carbon Review showed that carbon is a good proxy for cost. Those who have been most successful in cutting carbon have unleashed innovation and enjoyed financial returns as a result. This is independent from national regulation requirements or governmental

incentivisation mechanisms. It is primarily based on visionary and committed leadership.

Our Carbon Crunch event in 2015 saw a debate around PAS 2080, a new standard on carbon management for infrastructure. Companies across the industry are developing their own in-house tools to measure and manage carbon. And clients are beginning to demand action from their suppliers in support of their low carbon ambitions.

The financial benefits of cutting capital and operational carbon are becoming clearer to more players – spurring additional companies to focus on carbon management.

Dr Jannik Giesekam, research fellow in energy, materials and climate policy at the University of Leeds, explains in his report overleaf that a growing UK population requires massive investment in infrastructure development. As the UK

economy transitions in support of its zero carbon ambitions, the money will go to those who can deliver these assets as efficiently as possible. Four such organisations – Anglian Water, National Grid, Yorkshire Water and Costain – share their stories and recommendations in this publication.

Improving collaboration across the industry and within the value chain is the common theme promoted by these successful companies, as is the need to share innovation and adopt best practice to drive down capital and whole-life carbon emissions.

Now more than ever, it's time to embrace carbon management.

Davide Stronati
Global sustainability
leader, Mott MacDonald

Building a zero carbon economy will be challenging – but rewards are available for those who help get us there.

The role of low carbon construction

The UK's decision to sign up to the Paris Agreement has changed the carbon reduction game for infrastructure investment, design and construction.

Ambitions to restrict the global temperature rise to 'well below 2°C' above pre-industrial levels has seen current targets for an 80% reduction in carbon emissions by 2050 supplemented by a determination that the UK will be a net zero emissions nation shortly after the middle of the century.

For the infrastructure industry, this means that assets in planning now have to be designed to operate in a net zero emissions future.

Decisions made by today's infrastructure professionals will fundamentally determine the viability of our national and global targets. It is no longer a distant problem. We all need to ask ourselves: where does my current project fit on this roadmap to zero emissions? Are the assets I'm designing now fit to operate in a net zero nation? Any emissions not designed-out now will have to be offset in future with expensive – and unproven at scale – 'negative

emissions technologies' such as biomass energy with carbon capture and storage (BECCS).

Construction has fallen behind

Construction 2025 set a target of halving built environment emissions over the next decade to around 113MtCO₂e. Meanwhile the Green Construction Board's Low Carbon Routemap for the Built Environment set out the steps required to achieve an 80% reduction by 2050. However, the latest Green Construction Board figures show that built environment emissions totalled 202MtCO₂e in 2012, up from 188MtCO₂e in 2009, meaning the sector is well behind the target trajectory.

So the sector is behind on its targets – that's the bad news. The good news is that individual firms which are seriously pursuing carbon reduction have achieved more impressive results than originally thought possible by the authors of the Low Carbon Routemap. This is because effective alignment of the supply chain is delivering innovations that were not previously envisaged.

This tells us that it is possible to get back

on the required low carbon trajectory, but it requires greater effort and collaboration from the rest of the industry.

And there is certainly a business incentive. The National Needs Assessment predicts a UK population of 75M by 2050 requiring construction of 300,000 homes a year, traffic growth of up to 50% and a potential increase in energy demand to between 900 and 1200TWh/year. Those who can deliver this infrastructure in accordance with the UK's zero carbon ambitions will be best placed to win work over the next three decades.

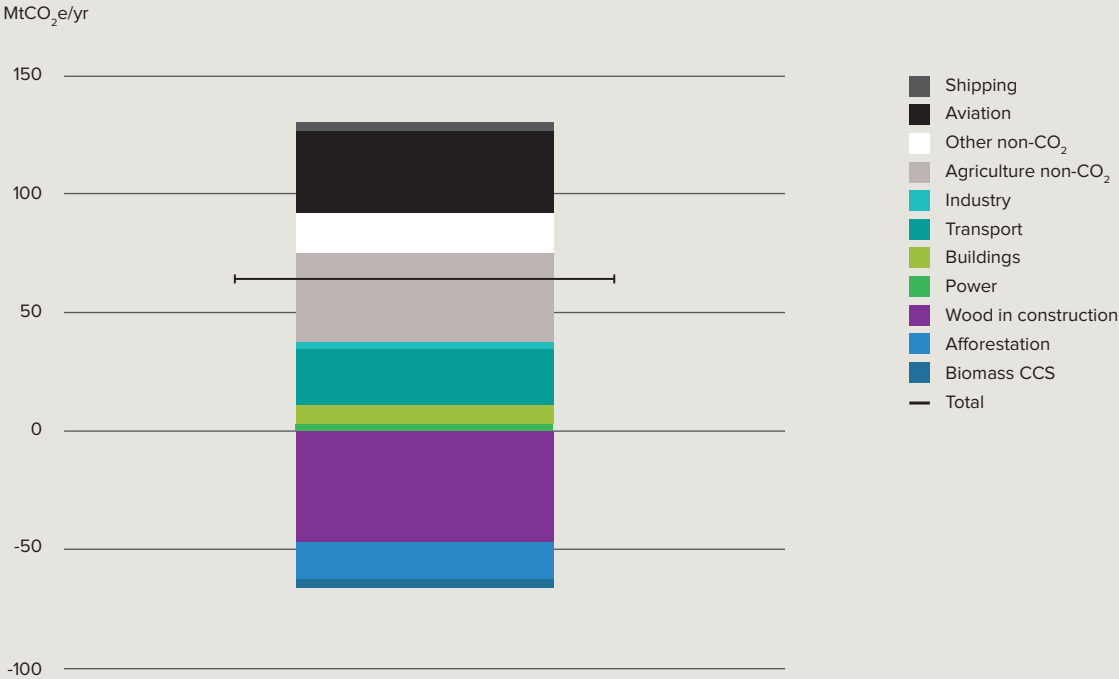
Current figures reveal reductions in operational carbon are being offset by increased capital carbon. The bulk of capital carbon is found in construction materials and onsite activity. There is significant scope for reductions through low carbon materials but many suppliers say few designers are specifying them.

What could the UK’s carbon economy look like in 2050?

Achieving net zero carbon emissions in the UK will be a major challenge which will require:

- Development of all identified mitigation options
- Deployment of negative emissions technologies (up to a max of 100MtCO₂e/yr)
- Further offsetting elsewhere

Residual UK greenhouse gas emissions in 2050 under max deployment across all sectors



CCC (2016) UK climate action following the Paris Agreement

Momentum is growing on climate mitigation

The Paris Agreement commits signatories to limiting “the increase in the global average temperature to well below 2°C above pre-industrial levels and to pursue efforts to limit the temperature increase to 1.5°C.”

The UK must be at net zero CO₂ emissions in 40-60 years’ time for a more than 66% chance of meeting Paris Agreement targets to limit the global temperature rise to 2°C. Aiming to limit the temperature rise to 1.5°C would mean the UK becoming zero carbon before 2050.

A growing need for innovation

CIEMAP (Centre for Industrial Energy, Materials and Products) recently modelled 27 capital carbon emission scenarios based on different demand and construction projections up to 2030. These were not ‘extreme’ scenarios; rather, they were based on estimates provided by various government departments and represent the range of forecasts the country is planning for.

Given that carbon budgets are absolute, the modelling revealed that if the UK wants to build more than it did during the global recession, if CCS is financially unviable for materials producers, or if grid decarbonisation occurs more slowly than expected, then design teams may face the need for radical carbon cuts as early as the late 2020s if the industry is to remain on track (see diagram opposite).

What is happening now?

The UK government’s latest Construction Strategy acknowledges the need to focus on whole-life carbon emissions but offers no substantive drivers, preferring to defer interventions until the next parliament.

However, the leading firms are getting on with it. More than 50 have signed up to the principles set out in the government’s Infrastructure Carbon Review, over 30 are targeting embodied carbon in buildings and a number of local authorities are taking an interest in whole-life carbon.

New guidance, including the infrastructure industry standard on carbon management, PAS 2080, is potentially game changing, but too many businesses are still dependent on outdated products and datasets and are yet to engage with the low carbon agenda.

Carbon mitigation is a challenge... and an opportunity

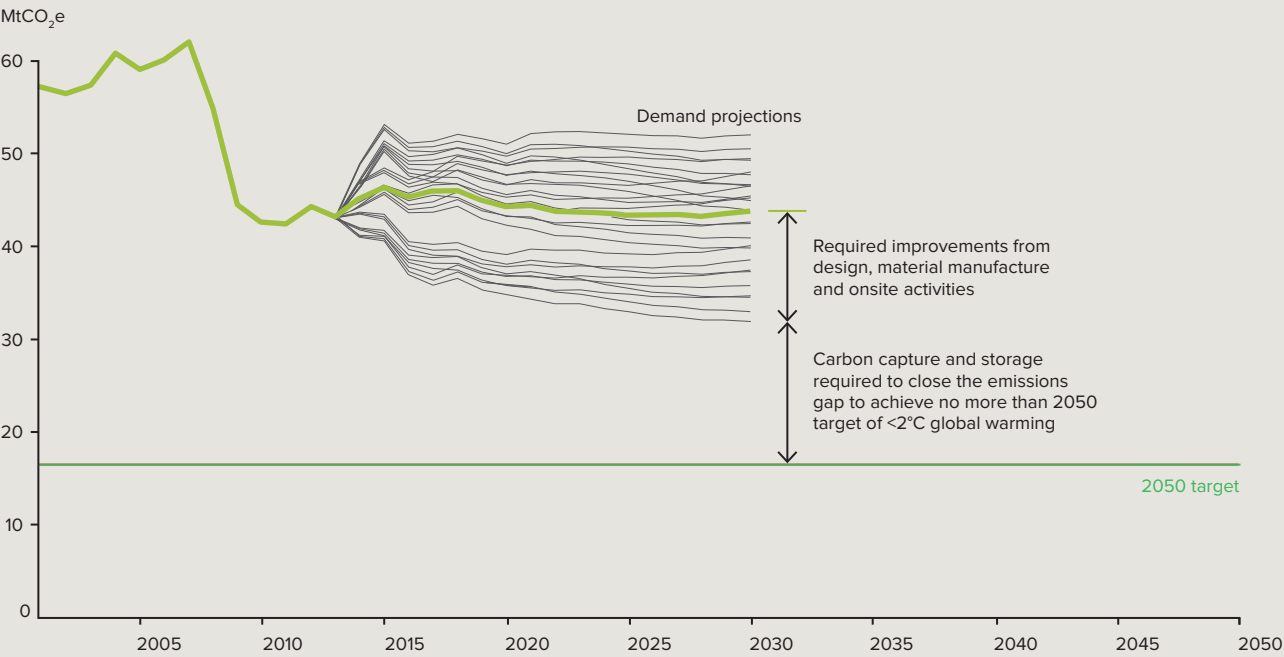
Carbon reduction and control is a growing business. Projects around the world in countries such as France, Germany, the Netherlands, Sweden, Norway, Australia, the US, Canada, and even some in Qatar, are targeting whole-life carbon reductions, and foreign product manufacturers and designers are developing low carbon solutions. The UK is still a leader in this field but some countries, such as the Netherlands, are now moving ahead of us, by implementing stronger reporting requirements, targets and regulation. Most of these countries will also be pursuing net zero emissions on similar timeframes, so the export opportunity is enormous if we raise our game.

Dr Jannik Giesekam
Research fellow in energy, materials and climate policy at University of Leeds

Required reductions in CapCarb
Anticipated embodied emissions of UK construction 2001-2030

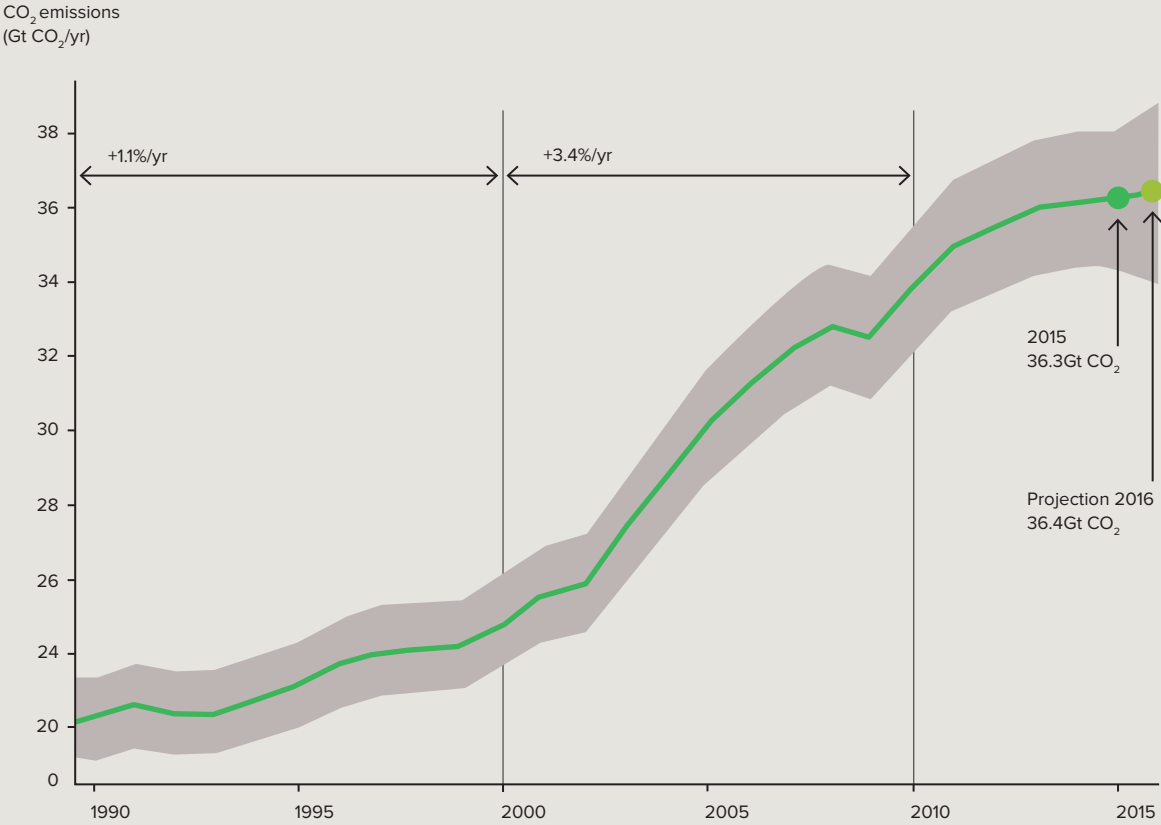
27 scenarios using UK Buildings and Infrastructure Embodied Carbon model Including improvements in grid intensity from DECC (2014)

Green Construction Board Routemap Targets (against a 2010 baseline)



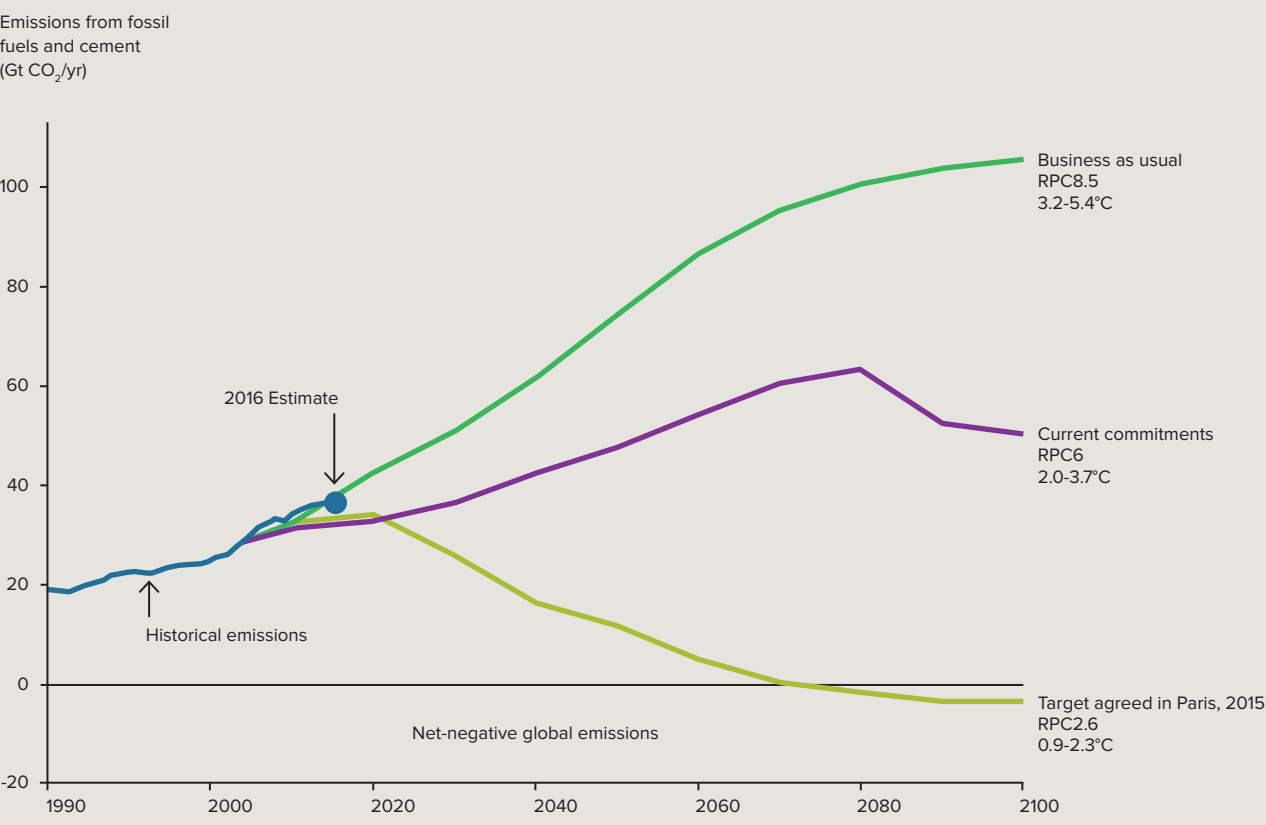
Giesekam et al.
Scenario analysis of embodied greenhouse gas emissions in UK construction

Global emissions trend



Data: CDIAC/GCP/BP/USGS
Global Carbon Project (2016). Carbon budget and trends 2016 – globalcarbonproject.org/carbonbudget

Emissions scenarios to 2100



Data: CDIAC/GCP/IPCC/Fuss et al 2014
Global Carbon Project (2016). Carbon budget and trends 2016 – globalcarbonproject.org/carbonbudget

Use PAS 2080 to steer your carbon cutting programme.

PAS 2080 will support effective carbon management and encourage innovation in asset design

Disruptive change can be a good thing and used effectively, standards can play an important part in achieving it. For example, when the PAS 1192 series of standards on building information modelling (BIM) was introduced in 2013 it facilitated a step change in the UK industry uptake of BIM.

PAS 2080 – the world's first carbon management standard for infrastructure – is set to do the same for carbon, providing the guidance the sector needs to effectively manage greenhouse gas emissions while driving down cost.

Getting started

PAS 2080 provides guidance on how to initiate and embed low carbon efficiency.

Driving innovation

The focus on carbon will stimulate new ways of thinking about infrastructure creation and management.

Establishing a common language

PAS 2080 paves the way for a consistent approach to methods, measurements and reporting which makes it easier to talk about carbon and cost right across the supply chain.

Non regulatory

PAS 2080 is a voluntary standard. This allows businesses to find their own way to best practice, minimising the need for regulations. Clients can specify PAS 2080 as they choose.

Complementing existing standards

PAS 2080 complements the existing suite of codes focusing on carbon management (including PAS 2050 for products, PAS 2060 for processes, and PAS 2070 for cities).

Prospects for a global standard

In its role as the UK national standards body, BSI provides the infrastructure for UK industry experts to work on international, European and national standards within a process that meets the UK obligations under the WTO principles of full stakeholder engagement, open public consultation and consensus. Given the UK's dependence on international trade, around 95% of BSI's work is international, helping UK experts to shape what global or European best practice looks like (such as the Eurocodes). Given its provenance as a BSI document, PAS 2080

could in time become the global standard as an ISO on carbon management. Being PAS 2080-compliant will give firms an 'early mover advantage' in global markets.

Until recently, businesses have had to steer their own carbon cutting agendas, using the example of leading clients who have cut costs by cutting carbon.

The BSI's PAS 2080 standard will provide much needed guidance to help all asset owners make the most of carbon management. For most, complying with PAS 2080 will lead to a complete rethink of 'business as usual'. But as always, it will be businesses at the vanguard of change which reap the rewards.

Scott Steedman

Director of Standards, BSI

The whole industry needs to take carbon reduction seriously.

Let's establish a cross-infrastructure approach to carbon

Over the last seven years, Anglian Water has made huge progress in driving down capital carbon. By setting strict targets on carbon reduction we not only unleashed innovation in the design and construction of our assets, we also realised huge cost savings too.

Our teams have now developed an intuitive understanding of the need to focus on carbon, and we worked effectively with our supply chain to realise our ambitions, such that our goal of 50% reductions in capital carbon for the period 2010-2015 has now been raised to 60% for 2020.

However, the carbon reduction message is yet to reach some parts of the industry, and if we are to meet the UK's goal of being a zero carbon economy, then the whole industry needs to be on board.

This requires massive change to long established ways of working, from the way we collaborate to finding low carbon replacements for the most commonly used materials. And it is far

better that we start making these changes now, rather than being left stranded by the disruptive change that is surely coming.

Integrate the whole team to drive innovation

There is an increasing understanding that innovation comes not from clients or certain parts of the supply chain, but from the network as a whole. Instead of bringing new parties into the process when the solution has already been decided with little scope to add value through innovation, the whole team must be integrated from the beginning.

Challenge engineering standards

Clients can be reluctant to move away from tried and tested solutions, but some are increasingly adopting minimum asset standards that allow even the simplest components to benefit from new thinking. For example, we previously specified exactly how one of our air valves should be constructed with little room for innovation.

The result was a valve that weighed 25kg. By using minimum asset standards and by allowing our supply chain to innovate

in design, they are now made of recycled plastic and weigh just 1kg – a carbon cut of 95% and a cost reduction of 35%.

Set challenging targets

Bold, audacious targets will drive collaboration. Anglian Water is part of the Infrastructure Client Group and we are tracking our progress against our targets to halve carbon emissions by 2025, producing annual maturity assessments in line with the Infrastructure Carbon Review. By 2020 we aim to be fully compliant with PAS 2080, the industry standard on carbon management in infrastructure.

Carbon reduction is a challenge to all of us, but it's crucial the whole industry gets involved.

Dale Evans
Director, Anglian Water's @one Alliance, and member of the Institution of Civil Engineers' Infrastructure Client Group

Carbon cutting success stories

By rethinking two common components in our assets and working closely with our suppliers we realised substantive cuts in both carbon and costs.

Biological filters:

At one point we decided to stop using these filters as they are expensive to build and high in capital emissions, though low in operational carbon. The solution was to make them using largely recycled plastic requiring little civils work in the ground and in a modular, scalable pack for easy assembly. Results: 30% less capital cost; 45% less capital carbon.

Water sampling kiosks:

Traditionally these would have been built on site in brick or steel. They are now a standard product built offsite with modular on site assembly. They are solar powered; as well as eliminating emissions associated with energy use, this means there is no need for trenching or cabling, slashing capital carbon and costs. Results: 10% less operational carbon; 11% less capital carbon.

A strong start to our low carbon journey has put the right structures in place for continued progress.

Reap the benefits of change

National Grid decided to tackle carbon efficiency head-on, setting tough targets and working with our supply chain. Here's what we've learnt:

Be clear on the benefits of carbon reduction

Cut costs

A low carbon design will cascade cost savings to the whole value chain.

Meet stakeholder expectations

Today the whole value chain understands the value of cutting carbon. Client expectations are high – do your best to surpass them.

Unlock innovation

Approaching problems through a carbon lens will lead to new and exciting solutions.

Improve decision-making

The assets we build today will still be there in 40-60 years' time. A focus on the whole-life carbon footprint supports long-term, holistic investment decisions.

Mitigate risk

Low carbon assets are the result of a more stringent design process that leads to better, more sustainable assets.

Benefit the environment

There are reputational and financial benefits to ensuring a positive impact too.

Strive for culture change

Adopting new ways of working is never easy, and we recognised that carbon reduction is as much about change management as anything else.

It starts with strong leadership

It's not just about inspiring rhetoric; leaders need to commit people, resources, time and budget to reducing carbon, even though the payback may not be immediate.

An initiative is only as good as the people behind it

The success of your carbon reduction programme depends on the enthusiasm and engagement of the people charged with delivering it.

Tenacity is crucial

Your team needs to be prepared to ramp up its efforts if success is initially elusive.

Quantify your targets and your achievements

But don't hold up the process by trying to nail everything down to the last kilogram of carbon.

Feed expertise across your business:

Embed knowledge and best practice as business as usual.

Can you measure it?

The mantra 'if you can measure it, you can manage it' applies as much to carbon reduction as anything else. National Grid has developed a carbon interface tool with associated data for various asset types so we know where our hotspots are. Concrete, steel and aluminium are the obvious ones, but what's as interesting is finding out which areas need less focus. For example, for us, transport has a relatively small impact, despite its importance in the wider carbon economy. That's not to say we don't try and reduce carbon and costs in all areas.

Have targets and stick to them

We have set ourselves the stretching target to reduce the carbon intensity of capital projects by 10% year on year. We beat this target in 2015/2016 and are on track to do so again.

Work with suppliers

In 2015 we got our supply chain involved in helping us to cut carbon. We work with our suppliers, sharing

with them our carbon interface tool and driving a two-way conversation to unlock innovation in design and specification. What this says to our supply chain is that we are serious about reductions and that suppliers must keep this in mind when they bid to work for us. The result has been a significant improvement in the quality of tenders and, most importantly, demonstrable cost and carbon reductions.

Steven Thompson
Sustainability manager,
National Grid

An ambitious carbon reduction programme means challenging established business practices.

Make carbon a catalyst for change

Cutting carbon will be at the heart of Yorkshire Water's ambitions when the AMP7 investment period starts in 2019. As well as capital carbon, we will target whole-life emissions to truly reduce the impact of our assets and play our part in helping the UK meet its carbon reduction targets.

This builds on the six key carbon commitments we made in 2015 (see box), which helped us achieve great progress during the current investment period. Here are the key lessons we learnt:

If you can measure carbon, you can cut it

We established our carbon baseline in 2015 so we knew broadly where the carbon was, enabling us to measure reductions against it. Although it isn't perfect – and we are working to improve it – it provides us with a starting point and has allowed us to identify key areas to focus on.

Embed carbon efficiency throughout the business

We want to realise carbon savings across our asset management lifecycle, not just at the construction phase. Although we have enthusiastic early adopters, the challenge is to create a new 'business as usual' approach, so we are working to embed sustainability and carbon efficiency into the decision-making process.

Use the latest software to support carbon reduction

Modelling and measurement tools will help you to visualise where the carbon is in order to drive it out. Dynamic visualisation tools are especially crucial as we want to push the thinking to focus on whole-life costs.

Heather Sheffield
Wastewater networks
strategic asset manager,
Yorkshire Water

Yorkshire Water's six carbon commitments

1. Measure and monitor carbon emissions to inform operational and investment decisions.
2. Complete a sustainability risk assessment, including the supply chain.
3. Explore integrated water management and innovative assessment management.
4. Use Asset Management Standard ISO 55001 to embed sustainable business processes.
5. Continue to reduce operational carbon emissions and maintain certification to the Carbon Trust Standard.
6. Halve carbon emissions in new assets by 2020 (from a 2015 baseline).

Don't be afraid to develop new ways of working in order to realise your low carbon ambitions.

Embed carbon reduction across your business

To make a real difference on carbon emissions, we realised we had to make carbon reduction a key outcome of our work, standing alongside the traditional factors of cost and time. This entailed changing our internal processes, finding new ways to collaborate with the supply chain, and developing a new in-house tool to make carbon front and centre of our thinking.

Recognise where the carbon really is

Some years ago we realised that our target to halve capital carbon by 2020 was virtually meaningless when compared to the whole-life carbon emissions of our assets. For example, in a lifecycle assessment of our London Bridge Station project we worked out that in the first year, 81% of the carbon was embodied in materials, with the contracting footprint fairly minimal at just 8%. But by the time the station had been in operation for 60 years, 80% of emissions would be operational, with our footprint even lower at just 1% of the total. Knowing this changes your whole view of where to focus your efforts.

Make carbon reduction work for you

By designing-out carbon in construction materials we:

- Cut costs for our clients
- Became more competitive
- Saved money ourselves
- Brought savings to the supply chain through shared value mechanisms

Challenge suppliers to find carbon savings

If you bring suppliers into the project early, they can work with you to drive down carbon emissions. We saw the benefits of this while working on the £125M Heysham M6 scheme, where we set principal supplier Tarmac a target of a 20% reduction in embodied carbon. Our design team worked with the company to eliminate any over-specification in the scheme, as well as substituting for low carbon materials where possible. Altogether, we saved 5018t of carbon emissions – a quarter of the CO₂ envisaged in the original bid, and cut costs by £2.73M too.

Develop new processes

One key problem was that carbon was disconnected from our delivery processes. With no commercial data available it was hard to make the business case for reduction, difficult to track progress and assess the cost impact of low carbon solutions, and the environment teams were getting involved too late to make an impact. So we restructured our processes at the planning, estimating and design phases and developed an in-house software tool to help us make intelligent choices with carbon reduction a key outcome.

Estimate carbon alongside cost

By storing data on carbon emissions per unit, carbon is automatically quantified as the estimator builds a cost profile. This means that during optioneering we can rank elements in terms of carbon impact, and work to further reduce emissions. And because carbon is a good proxy for cost there is an incentive for designers and suppliers to reduce both.

Calculate the impact on scheduling

We established a link between our estimating and planning software so that time – a factor that is paramount for contractors – is an integral part of the process, allowing us to consider the scheduling impact of all options.

Use design for continuous enhancement

We bring carbon values right into our BIM models, allowing us to identify the areas of high impact and challenge our suppliers to make savings.

Where next?

Our approach and the software tool we developed are being applied to all new bids, realising savings both to us and our clients. We hope to make our tool open-source in due course – the more challenges it deals with, the more robust it will be, and the more the whole construction supply chain can be aligned around low carbon outcomes.

Damien Canning
Head of technical sustainability, Costain

The first BIM-enabled carbon calculator will help clients cut costs and spearhead innovation.

The Carbon Portal will become a key enabler of low carbon design

While PAS 2080 provides guidance to those who want to cut carbon in infrastructure delivery, quantifying carbon to establish a baseline is one of the crucial first steps. This is where the Carbon Portal comes into play – the first carbon calculator to directly measure the capital and operational carbon footprint of BIM-designed assets. The Carbon Portal has been developed by Mott MacDonald using the infrastructure industry's most comprehensive carbon data.

Key aspects of the Carbon Portal include:

Focus on assets, not materials

Quantity surveyors are already able to add up the tonnage of individual materials and calculate carbon accordingly. However, innovation comes from engineers, and by providing carbon calculations for BIM objects and entire assets the Carbon Portal provides essential information at the planning and design stages where savings can be made.

Rapid calculations

Carbon assessment undertaken by specialist teams using an Excel spreadsheet can take hours or even days. Using the Carbon Portal reduces this to as little as 30 seconds.

Enables 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 Carbon 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 for quantity to provide immediate calculations.

Cross-sectoral

The tool works for water, transport and power assets, and will be progressively expanded to cover further sectors.

Can be used internationally

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

Carbon is a proxy for cost, and using carbon as a performance metric encourages creative design and construction solutions. The Carbon Portal can play an important role in showing the value of innovation. Although unable to replace strong leadership or engineering talent, it will become a key enabler allowing alternative designs to be easily tested, compared and value engineered.

As the importance of carbon management gains ground, we expect carbon to become fully embedded alongside scheduling and cost details as the sixth dimension of BIM, with automated carbon assessments informing the design process. This will take time, but will be driven by the many benefits clients are already enjoying by cutting carbon.

If you want an early glimpse of what the future holds in store, contact us directly and we will be happy to demonstrate how the Carbon Portal can help you and your organisation cut costs by cutting carbon.

Terry Ellis
Global carbon management practice leader, Mott MacDonald
Kim Yates
Principal sustainability and carbon specialist, Mott MacDonald

Opening opportunities with connected thinking.

For more information contact davide.stronati@mottmac.com
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