# Reducing construction carbon: a planning, procurement and leadership method

**Alistair Kean, Andrew Kidd and Lucy Hayes** **describe how the Lower Thames Crossing project implemented a groundbreaking approach to carbon reduction by making this goal a central part of the procurement and contract management process.**

## Introduction

Reducing carbon emissions from major infrastructure projects is essential if the UK is to transition to an economy with low carbon emissions. As well as being the largest roads project in the UK for 30 years, the Lower Thames Crossing (LTC) has been designated as a pathfinder project for National Highways to consider how best to encourage the supply chain to reduce whole-life emissions from materials, manufacturing, temporary works, construction processes, and also maintenance and replacement[1].

A significant breakthrough came in 2018–19 with the realisation that incorporating the client's desire for a low-carbon outcome into the procurement and contract management process could be the key to unlocking significant carbon emission reductions. This article examines how emissions were predicted, what was done to make emissions control an important selection criterion during procurement, and how it was built into the contracts for delivery.

Like any other project in the UK, LTC also had to present a planning submission, in this case a development consent order (DCO), and the use of the procurement approach to carbon during the submission is also discussed. The lessons learned are applicable to any other construction project.

## Emissions reduction

It is more than 10 years since the UK's Infrastructure Carbon Review was published by HM Treasury[2]. Although this showed why the UK construction industry must focus on emissions reduction and how it should be done, surprisingly little has changed in the industry, despite the report's conclusion that saving carbon reduces costs.

However, climate targets are under pressure, and the UK's Climate Change Committee has recommended that the UK's Nationally Determined Contribution be changed to reducing territorial greenhouse gas emissions by 81% from 1990 to 2035[3]. Civil engineering projects will increasingly be challenged to reduce emissions.

Further pressure for change has been created by repeated challenges, often in court, to the substantial emissions that arise from the use of traditional steel, cement and diesel in major infrastructure projects. Perhaps most famously, the blocking of plans for Heathrow Airport's third runway in 2020 following a Court of Appeal emissions challenge showed that change was long overdue[4]. While the Supreme Court ultimately overturned the Court of Appeal ruling, it was too late to resurrect the project at that time. The Heathrow expansion experience demonstrated that climate has become a strategic risk to project success.

## Lower Thames Crossing: an overview

The proposed LTC project **(Figure 1)** comprises a new twin-bore tunnel carrying a six-lane highway under the River Thames, linking the London orbital motorway to the main road to the Channel ports by 23km of new road.

Initial calculations of potential construction emissions using a simple model suggested a total well in excess of 2Mt$CO_2$e. This demonstrated both the sheer size of the project and the likelihood that, given the UK's carbon budgets, the figures would be closely scrutinised by the Planning Inspectorate and campaign groups during the consenting process.

National Highway's project leadership team realised in 2020 that a new approach was required if its flagship LTC was to gain planning approval through the challenging DCO system. Support from senior leaders is essential for most successful sustainability initiatives.

## Carbon and the DCO

Preliminary estimates suggested that the cumulative emissions from the construction and maintenance of the LTC could be in excess of 2.5Mt$CO_2$e. During 2019–20, the project began developing a model of the embodied carbon emissions in the preliminary design. Unusually for the time, this carbon model included the embodied carbon in preliminary works, temporary works, construction processes (largely diesel fuel), operational emissions arising from long-term replacements

### Lesson 1. Comprehensive modelling of the preliminary design

Knowing at an early stage where a project's carbon hotspots are indicates where future savings will come from. Without this, substantial carbon reduction is unlikely to happen. National Highways was transparent with the model contractually, and gave the bidders access to the detailed version so they could assess future savings. Using a continuously updated model, the hotspots will change through time as emissions are progressively driven out.

and maintenance, following the completion of construction, and, finally, a provision for potential emissions from risk events.

This calculation will form the basis of much of the future strategy making and was critical to both the DCO and procurement approaches. Note that most of the emissions were from three key components: steel, cement and diesel fuel **(Figure 2)**.

At this time, another major UK project, HS2 (a planned high-speed rail route between London and Birmingham), was experimenting with carbon accounting and PAS 2080, the standard for carbon management in infrastructure[5]. The LTC team was quick to recognise that a well-managed approach to carbon reduction on such a complex project would be essential. Placing the PAS 2080 approach at the centre of both the DCO process and the future procurement was another key decision. A robust approach to carbon management is a necessity if any control over emissions is to be successful.

PAS 2080 requires the creation of a carbon management plan, so for LTC it was decided that this document would also be secured (i.e. made legally binding) as part of the DCO application, to demonstrate the seriousness with which National Highways was tackling emissions reductions[6]. Note that PAS 2080:2023 is equally applicable to buildings projects.

The carbon model was repeatedly amended to reflect changes in the preliminary design, as intended, helping to promote efficiency in design. It was decided to adopt a number of carbon reductions in the preliminary design, but not to go too far in specifying low-carbon materials as the tendering contractors would have their own ideas for reductions. In the early stages, the biggest savings come from minimising material use through high-quality, efficient design and envisaging the most efficient construction techniques. Over-specification of materials in the preliminary design could stifle innovation, or risk mandating a material that may turn out to be unsuitable or unavailable when the time comes to construct. Finally, a figure of 1.76MtCO$_2$e was agreed upon for the DCO submission and can be referred to as the 'carbon cap'.

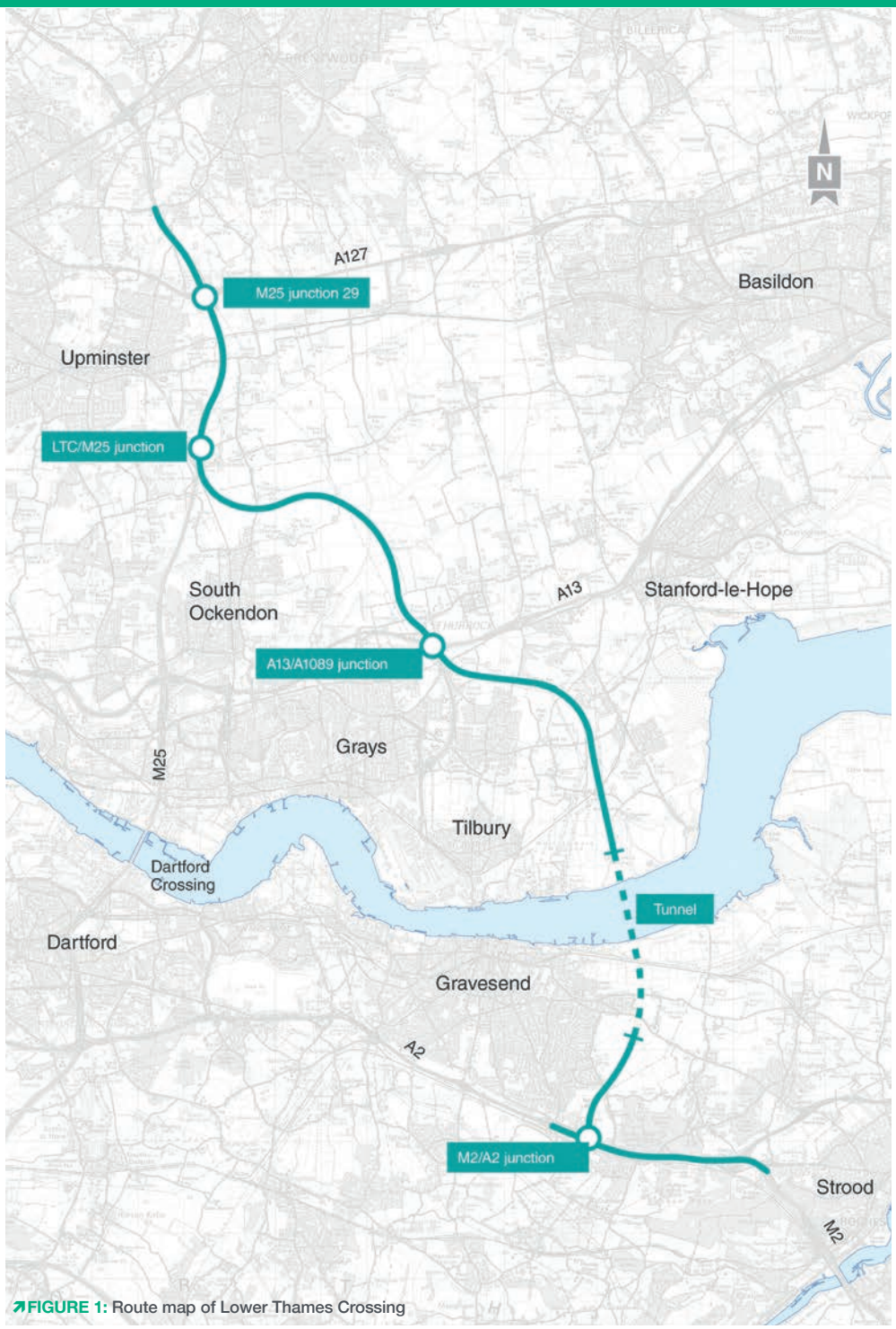


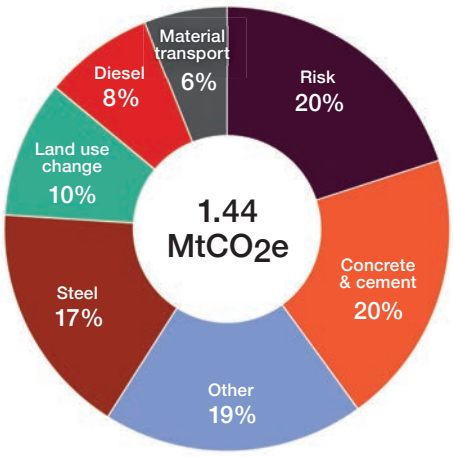

**FIGURE 1:** Route map of Lower Thames Crossing

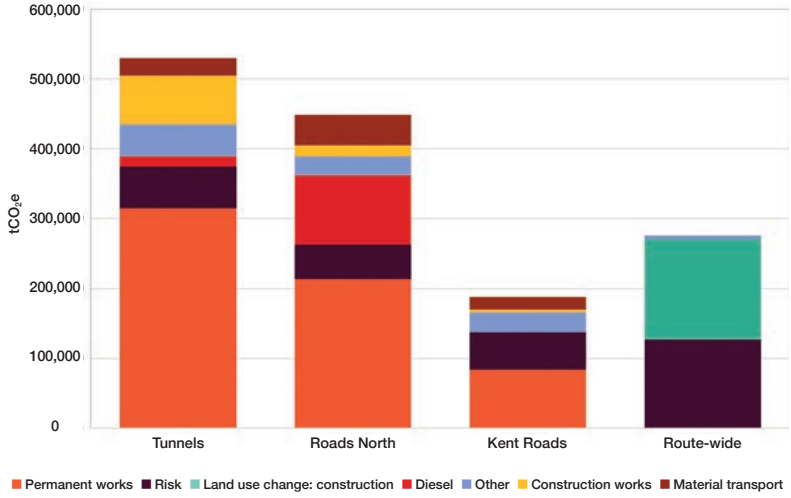
## Lesson 2. Mandate PAS 2080

PAS 2080 sets a common standard for managing carbon in infrastructure projects. It standardises approaches to early collaboration on carbon reduction, defined roles for staff, integrated decision making and whole-life carbon analysis. Experience is showing that adopting PAS 2080 is a way of mandating value engineering and that, in many cases, costs are reduced by engineering for low emissions.

LTC comprises three separate contracts: Roads North (largely in the county of Essex), the tunnel under the River Thames, and Kent Roads, leading from the tunnel, south to the motorway. For this reason, the 1.76MtCO$_2$e construction total had to be split into the three contract subtotals and allocated to each in turn.

As detailed in the Carbon and Energy Management Plan and the LTC Planning Statement[7], some reductions were achieved in the model by allowing for low-carbon concrete mixes, steel fibre reinforcement in the tunnel lining rather than rebar, and various elements of value engineering. These were not mandated though, as the contractors were at liberty to adopt whatever approach they wished, as long as the total emissions could be shown to be less than their portion of the 1.76MtCO$_2$e.




↗**FIGURE 2:** Lower Thames Crossing emissions forecast, post-procurement

## Carbon in procurement

In devising a procurement approach, the intention was to create a balance between incentivising carbon reduction, cost-effectiveness and focusing on efficiency. Contractors bidding for work will balance emissions reductions with cost, aiming for a competitive bid. Clients have the option to incentivise further reductions if they wish. The market for low-carbon construction was relatively immature at this time and the tender was designed to avoid over-commitment to unrealistic targets that could cause commercial friction during delivery.

Tender responses had to commit to being below the carbon cap and, at that stage, further reductions were up to the tenderer. National Highways wanted to select partners ready to work with it on the carbon-reduction journey, while recognising inherent uncertainty, but also willing to commit to what they could do initially (short-term measures) and with a compelling approach to developing what they could not fully commit to yet (long-term measures).

Tenderers were sent the full carbon model for their section of the project, and required to assess it, mark up where they had made changes, within certain defined parameters, and commit to completing the project with lower emissions than the cap. In this way, National Highways was very transparent about what was required.

A set of carbon questions was created for the tender to test both the contractor's ambition for making significant short-term reductions, and also how they might go on making further cuts to emissions during the construction process. With a 70:30 quality/price split in the tender points, it was decided to award up to 10 points for an excellent carbon response (14% of the quality total), but that only one point could be accrued if the response was above the carbon cap (i.e. the contract portion of the 1.76Mt).

In their 30-page responses, the contractors had to consider:

- →| their short- and long-term actions to reduce construction emissions
- →| how their wider corporations were delivering carbon reduction in other projects
- →| their plans for working with the supply chain on emissions reduction and for utilising PAS 2080
- →| how their carbon performance would be continually improved during the contract
- →| how they might deliver the project's Lowest Carbon Strategy, which covered nine specific elements under the headings of material, supply chain and management
- →| their commitment to the carbon cap, and how they would achieve greater reductions.

### Lesson 3. The market is ready to be challenged on low-emission engineering

Placing carbon at the heart of the procurement process isn't a risk, it's a necessity. By encouraging contractors to focus on potential savings in a carbon model, incentivising good results and encouraging innovation, significant carbon savings can be made. When contractors are challenged to reduce emissions, costs are far more likely to go down than up. Low-carbon design means efficiency, less material and, consequently, lower cost.

Carbon has been shown to be an effective differentiator in procurement. If tenderers failed to commit to a solution below the cap, they could only score one tender point for the carbon question. Being below the cap gave access to the full 10 question points.

Responses had to be written in contractual language (i.e. meaningful 'we will' commitments that could be measured later) and would become part of the final contract. Despite some concern about the market being ready for this, excellent responses were returned.

It is believed that this is the first public contract in the UK to put carbon at the centre of the procurement process and represents current best practice. Perhaps increasing the tender score for carbon would achieve even better results.

## Carbon in contracts

Contractual requirements were written into a sustainability section of the General Requirements document. These were designed to achieve a number of aims for reducing emissions over the construction of the project and included:

- →| a requirement for National Highways' published net-zero plan[1] to be adopted
- →| a requirement for contractors to be compliant with and certified to PAS 2080, the latter within one year of appointment. The same also applied to subcontractors, with the contractors responsible for compliance
- →| a series of requirements relating to the contractor's version of the Carbon and Energy Management Plan, its submission to the project and, as the document was secured by the DCO, submission of a copy to the Secretary of State for Transport for approval
- →| a requirement to not exceed the contracted carbon cap, i.e. the contractors' own estimates at the time of procurement as to the

emissions from their element of the works
- requirements dealing with corrective action plans and the need for a recalculation with every compensation event
- details of the carbon tool to be used, when quarterly and annual reports were required, and the need to comply with a separate technical document that was prepared to describe the overall carbon management process
- an additional requirement for contractors to submit, with each design, reasoning for their choices of construction materials and processes, particularly if the lowest-carbon option was not selected. Furthermore, a report was to be submitted outlining the environmental product declarations for the 10 most emitting materials to demonstrate that the emissions levels were below the European average
- low-carbon requirements for site compounds collated into one clause and covering the need for the provision of extensive electric vehicle charging, zero-carbon transport on site and from transport hubs, renewable energy provision and manufacture on site, and the use of generators with zero tailpipe emissions
- a clause requiring monthly carbon collaboration workshops to encourage innovation and inter-contract efficiency, given that there were three main contracts on the project
- separate requirements for a per-tonne $CO_2e$ reduction financial incentive and for what was termed 'carbon enhancements'.

Carbon reductions that save money or are cost neutral are encouraged with a flat rate £/t$CO_2e$ incentive payment. This is set at a relatively low level, reflecting the fact that such savings are also supported by the core cost reward mechanisms in the contract.

Carbon reductions that come with incremental cost or risk are assessed on a business-case basis. If the business case is supported, the client will generally pay the additional costs and the flat-rate incentive payment or another bonus that recognises the value to the client of the carbon reduction.

No additional carbon can be accrued to a design until the corresponding compensation event has been approved. Any approved additional carbon would be allocated to the carbon risk allowance mentioned above, in the same way that a cost overrun can be allocated to a risk fund.

This is thought to comprise the most comprehensive set of carbon requirements yet utilised on a major UK infrastructure project.

## Lesson 4. Carbon requirements for complex contracts

There is no need to wait for special contract requirements to be published. It is perfectly possible to write contract-specific requirements that will achieve the desired carbon reduction aims, by making the contractor responsible for identifying and sticking to reductions.

Competitive dialogue was used for the tunnel contract, and it was felt that this was very helpful with respect to carbon.

## Lesson 5. PAS 2080 is easily achieved and a powerful tool for change

If your organisation is used to operating management systems, adopting PAS 2080 is straightforward. Experience also shows that civil and structural engineers learn how to count carbon very easily, and good solutions flow from identifying where the highest emissions lie.


tse@istructe.org

@IStructE
#TheStructuralEngineer

#TheStructuralEngineer

## PAS 2080 verification

A central theme across the LTC approach has been the adoption of PAS 2080 by the Lower Thames Crossing Project, National Highways and, during the progress of the project, by the contractors and subcontractors constructing the project.

While PAS 2080 is an essential part of the carbon-reduction mechanism, it is only part of the process, being the management system which underlies all the other components, such as procurement, contract requirements, detailed emission-reduction requirements and so on. The following section sets out how PAS 2080, rolled out across the supply chain, in combination with these other factors, is a very powerful tool for achieving major reductions in construction emissions.

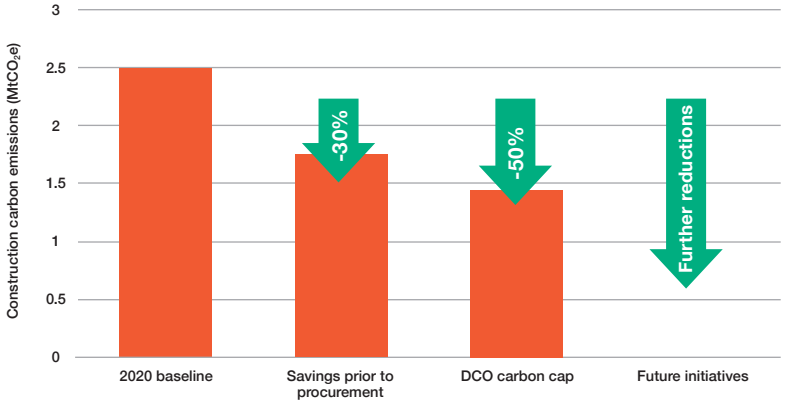
Verification to PAS 2080 is not an overly onerous process for any organisation used to working with audited management systems. Its power comes from aligning language and carbon accounting approaches, making it easier to integrate carbon management across a multiparty contract. Assessing emissions in detail and finding the hotspots is simple, the key is to do something about it. In combination, carbon in procurement, carbon contract requirements, incentives and enhancements become a very powerful tool for change.

## Results during procurement

As a consequence of the high profile carbon was given in the tender process, the creation of National Highways' Lowest Carbon Strategy and the detailed set of carbon requirements in the contract, the procurement process led to significant reductions below the 1.76Mt contract cap. The new post-procurement cap was 1.445Mt$CO_2e$ **(Figures 2 and 3)**.

As the procurement process completed at the same time as the DCO process was in the hearing phase, it was decided to update the legal commitment in the DCO to reflect the best reduction the market could commit to. The legal commitment is now back to back with the delivery partners' contractual commitment. This further saving of over a third of a million tonnes brought the total carbon saving versus a 'do nothing' approach to well over 40%, with further savings to come from the continued focus on emissions reduction.

The delivery partners for LTC are Roads North, Balfour Beatty Civil Engineering Ltd.; Tunnels and




↗**FIGURE 3:** Graphical representation of emissions reductions achieved to date on Lower Thames Crossing

approaches, Bouygues Travaux Publics – Murphy joint venture; Kent Roads, Skanska Construction UK.

This saving of nearly a third of a million tonnes was achieved without recourse to out-of-specification special materials, untested innovations or predictions of low-carbon fuels that weren't yet available. Most of the carbon savings come from the contractor's design efficiency, careful selection of materials with low emission factors, procuring locally and minimising transport distances. All these parameters are in the control of the contractor and can be difficult and risky for designers to specify.

## What next?

At the time of writing, the Construction Leadership Council had just launched the Five Client Carbon Commitments[8], which are to:

- →| procure for low-carbon construction and provide incentives in contracts
- →| set phase-out dates for fossil fuel use
- →| eliminate the most carbon-intensive concrete products
- →| eliminate the most carbon-intensive steel products
- →| adopt PAS 2080 as a common standard.

These five commitments are largely based on the LTC work and are a great way for clients to communicate what they want to the construction supply chain. They can be used for both long-term market signalling and for establishing requirements in contracts today.

Further reductions will become possible as low-carbon innovations come to market, such as very low-emission cements, innovative fibre reinforcements, very low-carbon steel, electrical and hydrogen-powered plant.

COWI engineers have written previously about the importance of measuring carbon intensity[9], such as the carbon intensity of a bridge expressed as construction emissions per square metre of deck area. Being able to compare against good practice elsewhere will help to drive emissions down and identify where poorly performing designs exist.

In future contracts, carbon standards could be set before procurement to encourage good behaviours. These could include maximum emission factors for cement, steel and fuel. National Highways and the other signatories of the Five Client Carbon Commitments will be leading the way. The use of hydrotreated vegetable oil as a diesel replacement is an example of the kind of solution whose acceptability should be clarified in the contract[10].

Incentivising carbon reduction in the way described above may on its own be a sufficient force to create the net-zero-compliant industry we require. However, further impetus could be gained by changing our approach to procurement. What if we demanded greater quality in major projects, against a preset cost range? This would allow sustainability, whole-life-benefit, quality and environmental considerations to be central to procurement, rather than lowest cost. That could really incentivise innovation[11].

### Lesson 6. Setting a cap on emissions

Setting a cap on emissions, demonstrating that the project's management will concentrate attention on PAS 2080, continued emissions reduction, while rewarding good behaviours through incentives and enhancements, is an effective and low-risk policy. Incentive and enhancement requirements will complement the PAS 2080 management process and give the client control over what they choose to pay for.

> **VERIFICATION TO PAS 2080 IS NOT AN OVERLY ONEROUS PROCESS FOR ANY ORGANISATION**

**Alistair Kean**
Alistair was Head of Sustainability at Lower Thames Crossing from 2016–24 and is Director for Sustainability at COWI in the UK, with 39 years in the construction industry.

**Andrew Kidd**
Andrew is the Lower Thames Crossing Director of Environmental Sustainability. He has more than 20 years' experience in the development and delivery of transport infrastructure.

**Lucy Hayes**
Lucy is the Net Zero Lead at Lower Thames Crossing. She has 20 years' experience of managing carbon and sustainability aspects of projects.

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