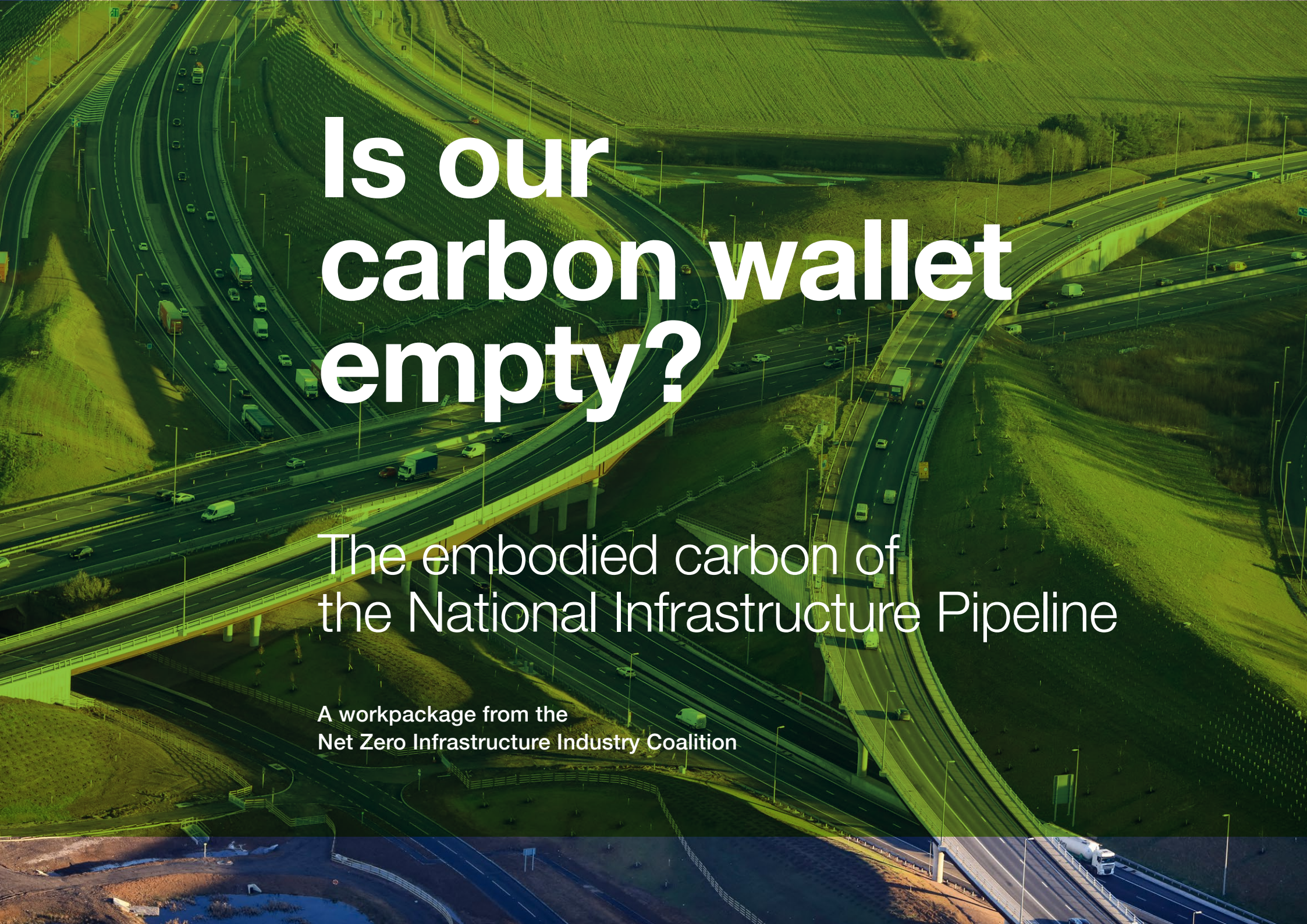


Is our carbon wallet empty?

The embodied carbon of the National Infrastructure Pipeline

A workpackage from the
Net Zero Infrastructure Industry Coalition


Unless we think big, we will never change. The time is not for tweaking the existing system, it's about changing our mindset, therefore accurately forecasting and understanding carbon data in infrastructure is critical to reaching net-zero.

Contents

Net-Zero by 2050?

This report highlights the challenges the infrastructure sector faces in addressing the UK's net-zero carbon commitment by 2050. Included is a manifesto for change, which will enable the infrastructure sector to measure, control and reduce carbon emissions.

The report is calling for urgent change in industry now to address the growing impact of carbon emissions on our planet. This report focuses on embodied carbon infrastructure projects. The urgency to change is that once the project is built, part of the wholelife carbon budget is spent. This can't be undone, and at the moment at our current rate of spend our carbon wallet will be empty before we know it.

The Net-Zero Infrastructure Industry Coalition harnesses the collective expertise of those who deliver and operate infrastructure at scale to work with the UK Government to determine how to build infrastructure needed to achieve net-zero. The Coalition believes that net-zero must become an industry-wide mission. This report provides a thorough audit of the existing embodied carbon measurement in the infrastructure pipeline, making recommendations on actions needed to make net-zero carbon emissions a reality. The potential systemic role of national infrastructure in catalysing the level of societal transformation required for a net-zero global economy cannot be overstated.

Whilst net-zero compatible national infrastructure cannot guarantee a net-zero economy, inaction or fragmented action on national infrastructure will all but guarantee that aspirations for a net-zero economy will not be achieved.

Knowledge of the level of carbon/greenhouse gas (GHG) emissions produced by UK infrastructure is incomplete because of a shortage of publicly available data. This is a significant issue because:

- Good data underpins good information. Good information is "data which has been filtered, integrated, assimilated, aggregated and contextualised to enable decisions". Good information enables good decision making. Therefore good carbon data is essential to inform enhanced understanding of how to plan, design, deliver, and operate net-zero infrastructure systems. Without understanding embodied carbon within a project, it is not possible to assess climate impact, and furthermore, we cannot understand the cumulative impact of the full infrastructure sector.
- While there is plenty of political commitment to drive down carbon consumption, the infrastructure sector lacks any consistent methods for measuring infrastructure projects' carbon impact. The will is there but the tools do not have consistent emissions factors applied across the sector leading to unreliable assessment and forecasting capability.
- If we cannot quantify our capital carbon usage in infrastructure, we cannot know the impact of infrastructure on the UK carbon budget. If we cannot create science-based targets for individual sectors, then how can individual projects and the wider infrastructure sector plan their journey without?

This project has found significant issues with data availability, quality, and transparency across all economic infrastructure sectors. This data shortfall needs to be addressed and requires urgent support and guidance, from the top-down and from the bottom-up. Our recommendations seek to address these shortfalls.

What needs to be done?

1. The industry must create a single, universally recognised, continuously managed, reviewed and updated, set of carbon emission factors, for the full range of construction products and building materials that are used in infrastructure projects. This comprises:

- Development of clearer, more consistent tools with standardised emission factors
- Clearer lifecycle footprints to enable engineers, designers and contractors to identify emission hotspots as opportunities for emission reductions
- Better benchmarks will help investors understand what good looks like and help governments make informed decisions and set appropriate direction

2. Planning framework guidance for carbon assessment in line with the Paris Agreement – We need agreement to define the methodology for carbon data measurement if we are to break the cycle of short-term solutions resulting from short timescales, short political cycles, and reactive solutions.

- The UK government must incorporate carbon accounting into the national planning policy framework (NPPF) to ensure net-zero is consistently included in all areas of national policy
- All asset owners must apply greater scrutiny of carbon impacts and promotion of net-zero carbon, which in turn will inform decision making
- Carbon data must be available to facilitate environmental impact assessments (EIAs), which now measure GHG emissions as a proxy for the impact of projects on the climate

3. A shared understanding of infrastructure's share of UK carbon budget – We need to develop common, long-term sector targets and trajectories, against which individual companies and projects can be measured. This requires collaboration and a collective industry effort to define the long-term role of the UK's infrastructure as an enabler of a net-zero UK Economy and a sustainable construction industry within a net-zero UK.

- We need better processes for future infrastructure project selection to define infrastructure purpose (outcomes), performance evaluation and the identification of performance gaps.

4. Carbon neutral design option for every asset – In order to move to this state of relationship across the industry, all stages of the process must collaborate to find the best net-zero carbon solutions to whole-life assets

- If the sector is to create net-zero carbon throughout the cycle we must ensure carbon neutral outline designs are provided, prior to planning and tender, by the asset owners.

We need to create a common carbon currency, so all specialisms can come together to understand the impact of infrastructure projects and systems on our collective carbon footprint and ability to achieve a net-zero UK. Upskilling our sector on carbon knowledge and what we need to do to achieve our goal is essential. The steps highlighted in the report are vital to create an industry that can address the challenge.

Introduction

Aims

The cumulative emissions impact of a net-zero infrastructure pipeline is not yet understood. Increased build rates will put upward pressure on UK territorial and international emissions. At the same time, UK industry has made big steps forward with the Infrastructure Carbon Review (ICR) and PAS 2080 carbon standard and these successes now must be stepped up across the whole infrastructure supply chain as urgently as possible.

In order to understand the locked-in carbon proposed in the infrastructure pipeline of works, and to be confident in a journey to net-zero by 2050, it is essential to understand the embodied carbon of those projects.

Coalition objectives for this report and future workstreams

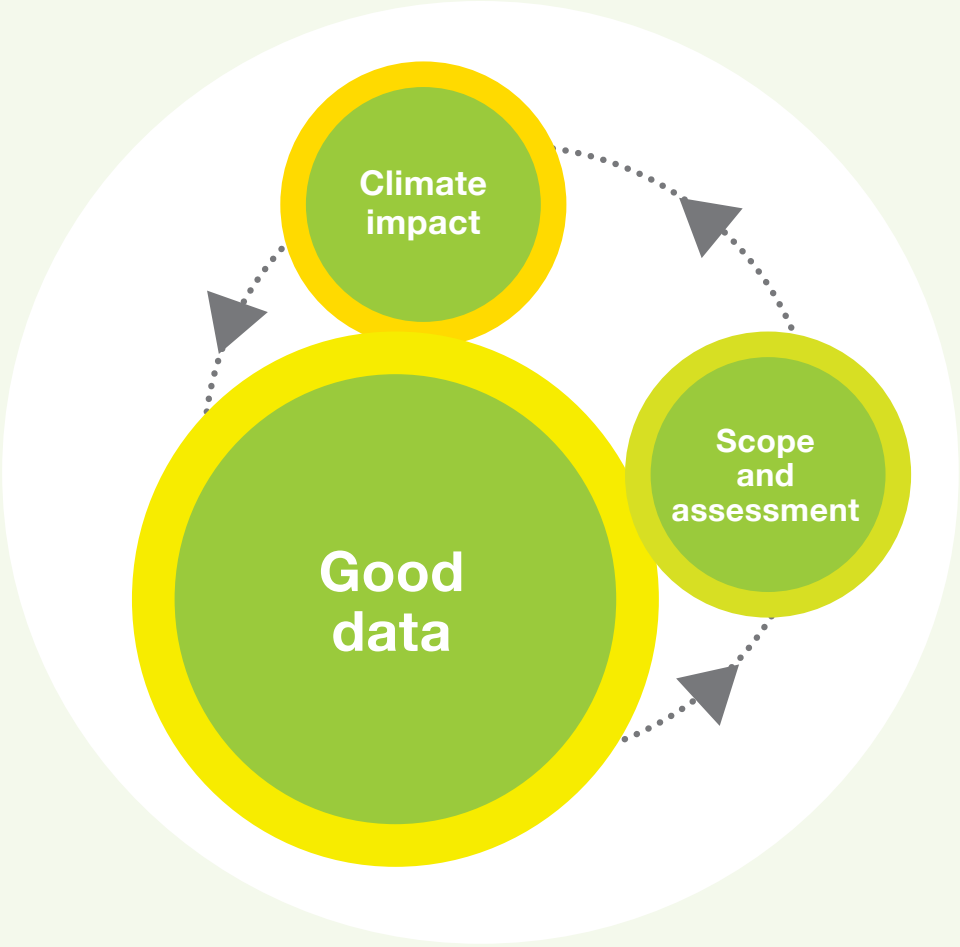
- Review the environment within which carbon in infrastructure sits, from political, social, and economic parameters
- Review the main decarbonisation of materials workstreams in the UK
- Collate and quantify available carbon data for assets included within the Infrastructure Pipeline Authority (IPA) list
- Review quality of data across the infrastructure sector; and
- Provide recommendations to support carbon assessment of infrastructure projects to align with the UK's carbon budget.

Overview

Good quality data underpins all decision making, and good carbon data is essential in understanding how to plan, design, deliver, and operate infrastructure. Without understanding carbon within a project it is not possible to assess climate impact, and furthermore, we cannot understand the cumulative impact of all projects.

This project has found significant issues with data availability, quality, and transparency across sectors that needs remedying from both top-down and bottom-up. It is with good quality data in mind that the recommendations have been developed. You can't manage and reduce what you can't measure.

Good data underpins all decision making.



1: Carbon in context

The political, social, and economic environment for infrastructure and carbon in the UK.

The Coalition's belief is that net-zero must become an industry-wide mission that transcends traditional relationships to become business as usual.

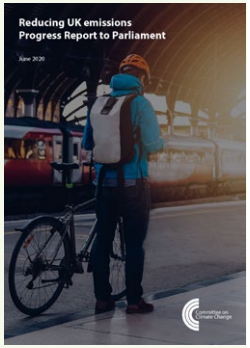
Affairs of state

The delivery of infrastructure projects has always been a political issue nationally and regionally.

Government policy shapes governing regulation, and planning processes are underpinned by a host of planning policy documents. Local authorities are required to comply with national and local policies in their decision making. This policy and regulation shapes the nature of available infrastructure. This in turn influences the way in which society functions, including the way in which people heat their homes and the available modes of transport. As a result, Government high-level policy around infrastructure has a significant influence on the UK public's carbon emissions, even at an individual level.

Investment too is often driven by Government policy, particularly for new and emerging technologies where the financial viability of a project could depend solely on a form of government subsidy or other financial incentive. In effect, politicians can drive a technology "winner" through investment. By way of example, the offshore wind industry has flourished as a result of significant Government backed subsidies whereas the tidal power industry has yet to get off the ground at least in part due to a lack of Government financial support.

In the next few years, as the Government attempts to battle the economic fallout from the Covid-19 pandemic, the role of politics in the delivery of infrastructure is only set to become more prominent.



Reducing UK carbon emissions Progress Report to Parliament.

"Short-term choices aimed at tackling unemployment and inequality, if poorly targeted, could lock in higher emissions in the long-term."
Committee on Climate Change (CCC)

The Government wants to "build build build" and the Government also wants to "build back better" and its ten point plan reinforces this. It is clear that in many cases, where new or replacement infrastructure is required, there is an opportunity to bring forward projects which are more sensitive to the environment than their predecessors. In other words, there is an opportunity to "build back better". When delivering on the "build build build" agenda however, care has to be taken to ensure continued compatibility with the Government's other climate and environmental policies.

Since the introduction of the Climate Change Act 2008 there has been clear and consistent Government policy in support of decarbonisation and the UK is now legally bound to achieve net-zero greenhouse gas emissions by 2050. The UK is also taking centre stage in the international climate change arena as the host of the next United Nations Climate Change Conference (COP26) in 2021, which is a real opportunity to show leadership on climate issues.

For the UK to achieve its net-zero by 2050 target it is clear there must be a step change in carbon emission reductions across all sectors.

Electrification must increase and more electricity must be sourced from renewables. Unabated fossil fuel consumption must become a thing of the past, for example through the introduction of carbon capture storage (CCS) and hydrogen production.

Importantly however, the UK economy and, in particular, the industries which support the delivery of infrastructure, are not yet decarbonised. When delivering on the "build build build" agenda therefore, there is a risk that the UK's climate objectives are diminished as a result of the scale and pace of anticipated infrastructure delivery.

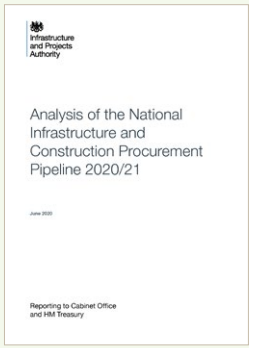
That risk is amplified given that the current driving force for infrastructure delivery in the UK is primarily economic stimulus. Infrastructure delivery which is politically motivated rather than a product of market or social need is likely to go beyond levels of investment that would normally occur. If we continue to deliver projects the way we've always delivered them, then higher than normal levels of investment are likely to lead to greater carbon emissions in the coming decades, associated with construction and operation. **On review, we as The Coalition believe that this path will not lead to our UK net-zero target.**

As the Committee on Climate Change (CCC) notes in its recent progress report, "Our pathway meets the Paris Agreement stipulation of 'highest possible ambition'. It is challenging but also hugely advantageous, creating new industrial opportunities and ensuring wider gains for the nation's health and for nature.."

There are opportunities to encourage development of low-carbon or net-zero carbon infrastructure, including by financial means, which are discussed in the next section. Another factor that could help ensure investment in infrastructure that aligns with net-zero is the introduction of a requirement for consideration of carbon earlier within the planning system. Whilst this analysis is undertaken on Nationally Significant Infrastructure Projects, there is no clear requirement for carbon cost control in development. Political support for consistent carbon analysis and changes to the planning system could facilitate lower-carbon development simply by requiring their consideration within the consenting regime.

The Sixth Carbon Budget – The path to net-zero recommended pathway requires a 78% reduction in UK territorial emissions between 1990 and 2035. It brings forward the UK's previous 80% target by nearly 15 years.

Managing our carbon budget


Infrastructure and Projects Authority

Analysis of the National Infrastructure and Construction Procurement Pipeline 2020/21

Reporting to Cabinet Office and HM Treasury

IPA Analysis 2020/21.

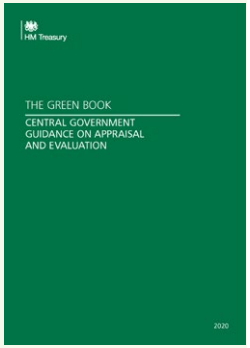
There are currently few economic incentives for developers to deliver infrastructure projects in a manner which seeks to minimise carbon emissions.

For many projects, the carbon associated with construction (or "CapCarb") is likely to be the largest source emissions (e.g. the embodied carbon associated with concrete and steel required for a flood barrier). For others, the carbon associated with operation (or "OpCarb") is by far the largest source (e.g. a new road or railway).

Projects committed to now will determine a locked in spend and associated carbon emissions to 2050 and beyond. Currently there is a £600bn pipeline of projects committed to be delivered in the next decade. However, the carbon footprint of those projects and the associated impact on meeting carbon budgets and crucially the net-zero by 2050 target is unknown.

The introduction of a carbon tax or other carbon pricing mechanism could be used as a lever to encourage developers to actively seek to reduce carbon emissions. To date there has been only fragmented economic regulation and carbon taxing on a sector by sector basis. Notwithstanding that increased financial levying could facilitate a drive towards lower carbon emissions, it is questionable whether this is feasible or desirable given the impetus for encouraging development is economic stimulus.

Given infrastructure projects often work with small margins, it is conceivable that levying a carbon tax or other financial disincentive on construction or operation of infrastructure would suppress market appetite and/or make the projects not financially viable. That is particularly the case in the current economic circumstances, with the UK heading into a recession as a result of Covid-19 and the changes expected from the European Union (Withdrawal Agreement) Act 2020.



The Green Book is guidance issued by HM Treasury on how to appraise policies, programmes and projects. It also provides guidance on the design and use of monitoring and evaluation before,during and after implementation.

HM Treasury

Instead, in the current economic climate, financial incentives such as a subsidy regime to support low-carbon initiatives may be more palatable than financial disincentives such as a carbon tax.

Providing industry with the political confidence and financial means to invest heavily in infrastructure which will allow it to operate in a decarbonised manner (e.g. the production of steel and concrete) is absolutely essential to ensure that economic growth, and the obligation to meet net-zero, are not mutually exclusive.

For example, the CCC urges Government to choose the preferred funding model and mechanism for delivering carbon infrastructure including CCS and to set out plans for awarding support. The CCC views the introduction of CCS as “a necessity, not an option” noting that current deployment levels remain very small. Clear political and economic support is required for CCS and other technologies (such as hydrogen production) to enable industry to decarbonise at the scale and pace required for net-zero, whilst continuing to contribute to the UK economy.

In addition to the current lack of financial incentive to decarbonise construction/operation of projects (at least at the scale and pace required), there is also a risk that the strive for economic stimulus means that projects which have a greater non-monetary value, such as natural capital and ecosystem services, are undervalued and overlooked.

Similarly, whilst the Government is supportive of delivery of green infrastructure, where its economic value (in terms of jobs etc.) is lower than carbon intensive infrastructure there is a risk that the immediate economic value is preferred to the longer term value from green infrastructure.

Given the social and economic cost of climate change is anticipated to be significant, an economic strategy with a longer-term outlook should be preferred.

Investors are increasingly viewing the climate agenda as a risk to capital deployment with a reluctance to invest in assets that may in the future become a financial liability as a consequence of net-zero related policies. As investors gain a greater understanding of the different aspects of an asset’s carbon footprint (e.g. over and above Scope 1 emissions) they may increasingly look to examine a project’s life-cycle carbon emissions (included the embodied carbon) when considering the attractiveness of an investment opportunity.

The Green Book doesn’t fully reflect the cost of the carbon impact. There is a rising social cost of carbon implied in calculations (greater value for future savings than CapCarb) currently rising to £350/tCO2e in the later half of the century.

Under any scenario, achieving net-zero requires substantial investment from industry, whether to deploy new technology or to retrofit existing schemes to make them less carbon intensive.

There should not be a risk that the Government and/or its priorities will change which will lead to support for green infrastructure being withdrawn. Clarity and consistency is essential.

Cross-party political support not just for achieving net-zero, but the mechanisms for doing so, is absolutely key to giving industry the confidence to deliver green infrastructure. INZCC

Our changing planet

CCC Evidence Report.

Undoubtedly the UK will have to adapt to climate change. That is particularly true in respect of infrastructure projects, given their nature and location.

The wider environmental effects of climate change, including increased flooding, storm events, warmer temperatures, fire risk and coastal erosion all have a significant ability to negatively impact infrastructure. The six priority areas identified by the Government are:

1. Flooding and coastal change risks to communities, businesses and infrastructure ('more action needed').
2. Risks to health, well-being and productivity from high temperatures ('more action needed').
3. Risks of shortages in the public water supply, and for agriculture, energy generation and industry, with impacts on freshwater ecology ('more action needed').
4. Risks to natural capital, including terrestrial, coastal, marine and freshwater ecosystems, soils and biodiversity ('more action needed').
5. Risks to domestic and international food production and trade ('more action needed').
6. New and emerging pests and diseases, and invasive non-native species, affecting people, plants and animals ('research priority').

Given the accelerated rate at which climate change is occurring, new infrastructure projects should be designed to be climate-resilient and to be capable of withstanding the worst case disruptive impacts of a 1.5 - 4°C global warming. Understanding and accounting for environmental factors in design scope should become commonplace, which may have a knock on impact on investment in and financial viability of some schemes. Whole life carbon costs of the development must be considered, with only the options which are most sustainable over the longer term being brought forward.

Projects should be designed not only to withstand the environment (including climate change) but to conserve and enhance it where possible. Designing projects in line with nature and prioritising construction and operation practices to reduce harmful impacts must become the norm. There is an increased recognition of the potential for infrastructure to make a positive contribution to the environment, e.g. by providing ecosystem services or natural capital management which should be encouraged at all levels of regulation and policy.

NEPC Royal Academy of Engineering Report.

Human connection and happiness

The UK public is generally becoming more environmentally conscious. There is a greater awareness of climate change and carbon issues, fostered by news coverage of localised flooding in the UK, reports on air pollution in towns and cities and world events such as the Amazon rainforest deforestation and Australian bushfires.

Awareness can and is leading to behavioural change. Consumers in the UK are increasingly making decisions based on carbon factors, for example purchasing renewable electricity and purchasing recycled goods. In the wake of the Covid-19 pandemic the Government is pushing a cultural shift towards public transport and cycling, and away from car centric place-making. Not only will this improve public health it will also help to improve the environment. At a local level, perhaps due to increased digitalisation, there is greater engagement in local issues.

This social awareness could be used to harness infrastructure which serves as a public good by developing and maintaining a demand for infrastructure which is sensitive to carbon issues and the environment more generally. For example, the National Engineering Policy Centre undertook a project to identify points of market intervention that could promote sustainable, low-carbon living places. As noted above, there is a clear link between Government policy and how sustainably the UK public lives their lives. For example, by incentivising the retrofit of homes to make them low carbon, the Government could in turn incentivise and enable people to live a more sustainable and less carbon-intensive lifestyle.

The opportunities are not limited to that one example, and the Government could play an active role in decarbonising society through the considered deployment of appropriate infrastructure. The public appetite for such an approach looks only set to increase.

The Covid-19 pandemic has dramatically changed the way in which people in the UK live and work, at least in the short term. It remains to be seen the true extent of any medium to long term cultural change which could lead to quite significant changes to the need for and location of infrastructure. For example, it is likely that there will be a higher usage of domestic infrastructure and a higher expectation of its quality, speed and reliability, particularly broadband, as more people are expected to work from home. A reliable broadband connection is increasingly seen as an essential human right and an enabler of social mobility.

Across other sectors, such as tourism, there may be a requirement for a change in infrastructure demand. Infrastructure connecting and facilitating UK holiday destinations may have to be improved as more people may decide to vacation in the UK rather than abroad.

Demographic factors could also drive changes in demand and expectations. The UK has an aging population and a younger generation of digital natives. The needs of this diverse population will have to be catered for, and is likely to move away from traditional city centric place-making. Work-related travel could reduce and/or diversify from the usual commuting corridors, which will have to be catered for in infrastructure delivery. Overall the UK could be headed to a decentralised system of infrastructure, with an increased market for sustainable projects.

2. The carbon data landscape

Carbon accounting in infrastructure

The Coalition's belief is that net-zero must become an industry-wide mission that transcends traditional relationships to become business as usual.

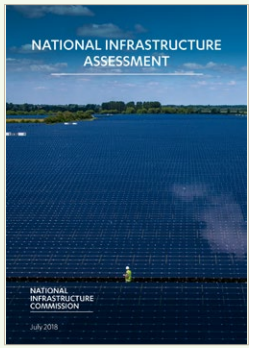
Building our future

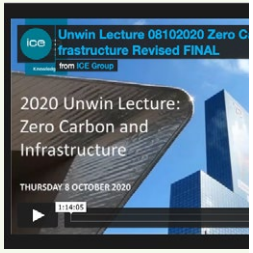
Public and private investment in infrastructure increased over the past decade. Although this investment has driven reductions in operational and user carbon associated with infrastructure assets, it has resulted in increased capital emissions. With continued increases in infrastructure spending expected out to 2050 we must reduce the associated capital carbon.

We can see this increase in real terms over the period since the global financial crisis of 2008. Office for National Statistics (ONS) output estimates, based upon surveys, suggest total annual new work on infrastructure increased by 90% in real-terms between 2008 and 2019.

Similarly, calculations by the National Infrastructure Commission suggest public sector capital expenditure on economic infrastructure has increased by 21% in real terms between 2013 and 2019.

Future demands for infrastructure, perhaps best articulated in the 2018 National Infrastructure Assessment and supporting evidence such as the National Needs Assessment, necessitate a continued increase in investment. This is required to deliver key objectives such as the nationwide rollout of full fibre broadband, decarbonisation of the electricity grid, and increased flood resilience. The National Infrastructure Commission (NIC) anticipate a sizeable increase in real terms expenditure on economic infrastructure assets, not just in the near term, but throughout the period to 2050.





1. Infrastructure Carbon Review
2. National Infrastructure Assessment
3. 2020 Unwin Lecture

Indeed, under the long term vision set out in the National Infrastructure Assessment anticipated annual expenditure in 2050 will be 27% higher than today's levels. This is consistent with the Commission's fiscal remit of continued gross public investment in economic infrastructure of 1-1.2% of GDP.

In May 2020 the NIC reviewed their recommendations in light of the national net-zero target adoption and determined that they were broadly consistent with the Committee on Climate Change's 'further ambition' scenario, though in some sectors action would need to be accelerated. However, despite considering operational and user carbon using a set of detailed system-of-system models, the NIC analysis did not include any assessment of the capital carbon associated with the anticipated investments.

The 2013 Infrastructure Carbon Review (ICR) was the first publication to articulate a baseline for capital, operational and user carbon emissions from UK economic infrastructure sectors. The ICR's underlying dataset estimated that collectively the construction, operation and use of infrastructure assets accounted for around half of the UK's carbon emissions in 2010. The dataset was updated by the ICE Carbon Project in 2020 using a comparable methodology – a summary of results can be viewed in the 2020 Unwin Lecture. The updated dataset revealed that, although infrastructure carbon emissions declined by 23% between 2010 and 2018, they still account for roughly half of the UK's carbon footprint.

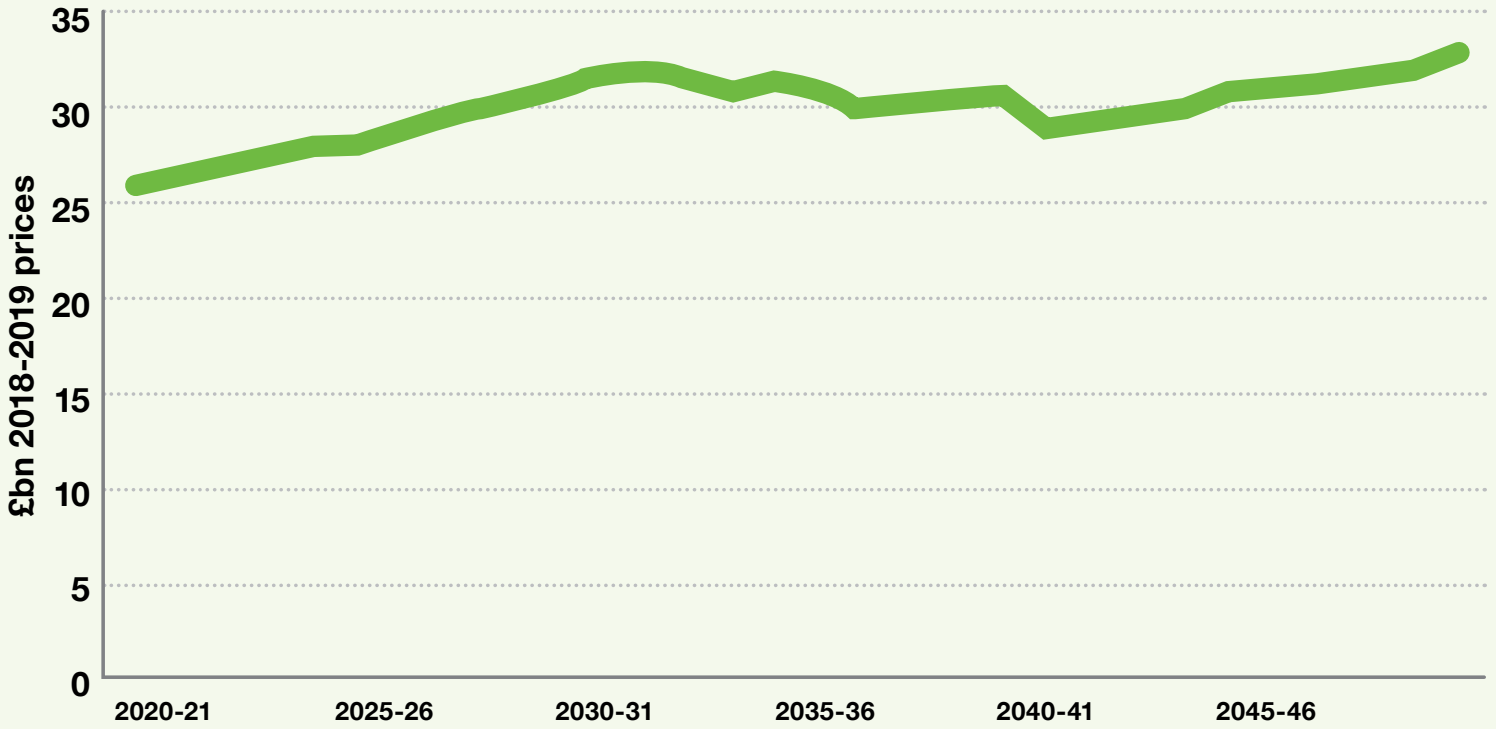
The bulk of this progress to date has been made by reducing the operational carbon emissions under 'control' of the industry, in particular within the energy and waste sectors. There has been little or no progress in reducing user carbon emissions associated with other sectors such as transport. Meanwhile, according to these calculations, capital carbon has increased by 60%.

The top down methodology underlying the calculation of capital carbon within the ICR and subsequent update is relatively crude, combining expenditure by sector with a single construction sector average carbon intensity. This average intensity is calculated by dividing the consumption based emissions associated with the UK construction sector by the total sector output for each year. This average intensity has increased marginally over recent years (to 325 gCO2e/£ output in the most recent year), meanwhile expenditure has increased substantially (as outlined in the preceding section). Collectively these two trends drive the estimated historic increase in capital carbon.

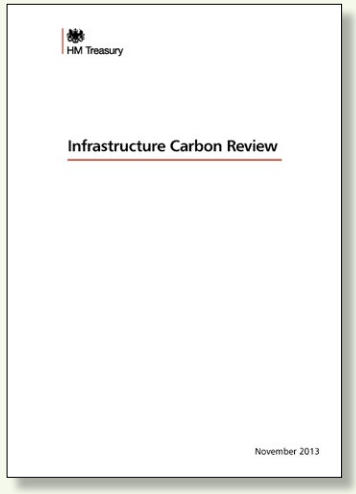
Though the expenditure data is a reasonably robust indicator of activity, the changes over time in sector average carbon intensity are more likely to be an indicator of the changing mix of projects undertaken by the industry than an indication of the effectiveness of efforts to decarbonise particular sectors or work types. Future versions of the dataset will be adapted to incorporate sector specific carbon intensities based upon best available data. Past reviews have identified a typical range of 100-900 gCO2e/£ across different sectors and projects types – with some work type designations falling below and above this range.

"...although infrastructure carbon emissions declined by 23% between 2010 and 2018, they still account for roughly half of the UK's carbon footprint."

Table 2.1 Anticipated spend on infrastructure 2020-2050 based upon National Infrastructure Assessment supplement to Table 7.1



Infrastructure carbon review



UK Carbon Footprint 773 $MtCO_2e$

Includes all impacts of UK consumption - both territorial & imported emissions

100%

Infrastructure emissions 419 $MtCO_2e$

54%

All other emissions 354 $MtCO_2e$

From other sources

46%

Control 99 $MtCO_2e$

The infrastructure industry has control over **capital & operational** carbon associated with the construction, operation and maintenance of infrastructure assets

13%

Influence 320 $MtCO_2e$

The infrastructure industry can influence emissions from end users, but typically action is also required by others to reduce emissions

41%

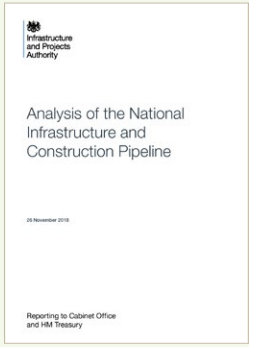
3. Our approach to future emissions

How to scope and calculate carbon data in infrastructure

The UK Project Pipeline published by The UK Infrastructure and Project Authority (IPA) provided a baseline for our thinking and subsequent project development. We developed a systematic approach to decide which projects from the pipeline should be included and which should be excluded.

Pipeline updates

The first 'national infrastructure and construction pipeline' was published in November 2011 alongside the National Infrastructure Plan to provide transparency, certainty and more long term visibility of planned infrastructure investments. The pipeline received numerous updates on a roughly annual basis until 2018. By then, the document had expanded to cover over £600bn of public and private investment in economic and social infrastructure over a 10 year period. Over half of this planned investment was from the private sector.



Analysis of the National Infrastructure Construction Pipeline.

Unfortunately, no annual update was produced in 2019 and in 2020 the IPA instead published the National Infrastructure and Construction Procurement Pipeline 2020/21. In contrast to prior editions, the 2020 pipeline only included planned public procurement within a single financial year. A direct comparison of the two pipelines is not possible, as planned public investments in the 2018 edition are not broken down by financial year. A revised pipeline is expected to be published in Spring 2021 following recent publication of the National Infrastructure Strategy. In the absence of an updated pipeline the 2018 edition provides the most granular indication of planned investments and served as the basis for analysis in this report. The cessation of regular pipeline publication, and the inconsistency of information provided in the most recent iteration, makes it challenging to accurately determine future investments and the associated carbon emissions. A return to regular publication with a consistent format would be welcomed.

Data sources

The data was limited to the projects listed in the 2018 IPA list, as this was the most recent version published at the time of the study and provides the most granular indication of planned. We noted that some major infrastructure projects did not appear in the list which was likely due to the timelines of those projects and the fact it is a voluntary disclosure.

The IPA captures information from a number of sectors but we have chosen to consider six specific sectors:

- Communications
- Energy
- Flood
- Transport
- Utilities
- Waste

These are further split into 21 sub-sectors, which were the basis of our data collection.

Data collection methods

A tiered approach was used according to data availability:

1. Direct access to project information
2. Planning information in the public domain
3. Industry contacts and experts

The first stage was to assess how many projects coalition member organisations had worked on as a consultant, contractor, or asset owner, and would therefore have access to project information. This included reviewing data held in the Mott MacDonald Moata Carbon Portal, Skanska's carbon dashboards, and information received from National grid, Transport for London, and others.

The next phase was to check what data currently exists in the public domain either in planning documents or other publicly available project information. In some cases, particularly for the larger sized projects, information on the estimated capital carbon impact was available online.

Finally, industry experts for some of the sub-sectors were contacted where publicly available data was not available. A data request was put together outlining the type of data needed to carry out a capital carbon calculation (high level material types and quantities and an outline of the project scope), and this was followed up by conversations with those individuals where possible.

If no specific project information was obtained through any of these approaches then we utilised carbon information from other similar projects (in terms of scope) that we did have data for and extrapolated using the average intensities.

Data analysis and carbon intensities

Carbon intensities for each sub-sector were estimated based on the data that was available to generate a carbon rate (tCO2e/CAPEX) that could be applied to the other projects in that sub-sector.

Where a sub-sector had very little or no data points, we utilised a carbon intensity from a similar sub-sector. Where there was no comparable sub-sector, we estimated an industry level carbon intensity across all sectors and this was applied to the projects in that sub-sector, again based on CAPEX.

Table 3.1 Overview of decision criteria used to filter IPA Pipeline Projects for inclusion in Scope of Project

Criteria name as taken from IPA pipeline	Decision	Rationale
Sectors and **Sub-Sectors**	Only Include projects linked to the economic infrastructures sectors and related sub-sectors in the NIC Remit/charter	Align analysis with the National Infrastructure Commission remit for National Infrastructure Assessment.
Start of works / Construction and date in service **(Projected)**	Only Include projects for which construction started in 2019 or later AND Date in service is post 2021	The UK Government set Net-Zero in 2019. The Net-Zero Coalition was established in 2019 This work is focused on Capital GHG emissions from the pipeline not those already built
Scheme Status	Not used to filter projects for inclusion	Criteria is secondary to those listed above
Sub-Group	Not used to filter projects for inclusion	Criteria is secondary to those listed above
ONS Region	Not used to filter projects for inclusion	The 2050 Net-Zero target is whole UK. All projects regardless of ONS region are in scope
Asset Ownership	Not used to filter projects for inclusion	All infrastructure projects produce Capital GHG emissions regardless of ownership, regulatory and funding model.
Economically Regulated Asset	Not used to filter projects for inclusion	
Funding Source	Not used to filter projects for inclusion	

Table 3.2 Overview of GHG Emission types included in the analysis.

Emission Type	Decision	Rationale
Greenhouse Gas (GHG) Emissions	Industry assumption that Capital Carbon includes all GHG types listed by the IPCC	UK Net-Zero target is for all GHG listed by the IPCC
PAS 2080 Emission Categories (see Table 3)	Focus initial analysis on only on the PAS 2080 category: Capital Carbon (all GHG emissions), sub-types: Creation - Use of Materials Creation - Use of Construction Plant Creation - Transport of Materials and Construction plant to construction sites	Capital Carbon refers to all GHG emissions that can be associated with the creation, refurbishment and end of life treatment of an asset (source PAS 2080, Section A2, p36). The IPA project pipeline focuses solely on the creation of new infrastructure. Analysis can be broadened to include other types and sub-types at a later stage
BS EN 15978 Lifecycle Stages	Limit initial Analysis of the GHG Emissions from projects in the Pipeline to the construction phase only. Use BS EN 15978 Product stage (A1-A3) and Construction Stage (A4-A5) categories to support methodology development.	Analysis is focused on GHG emissions from the construction of the projects in the Pipeline. It lays a foundation for subsequent stages of analysis focused on A Whole lifecycle perspective that includes GHG emissions associated with the Use Stage (BS EN 15978 B1-7) and end of life Stage (BS EN 15978 C1-4) and A Whole system perspective (possibly) that includes GHG emissions associated with aspects outside the lifecycle (BS EN 15978 D)
GHG Protocol Scopes 1, 2 or 3 Emissions (see Table 4)	Focus on PAS 2080 categories, and use BS EN 15978 to breakdown analysis by project lifecycle stage if needed. Do not break analysis down by GHG Protocol Scope 1 -3 at this stage	These categories are designed to apply to corporate supply chains. Therefore, are not directly applicable to a single infrastructure construction project. Application requires Further investigation.

4. Good data in = good data out

What does the data mean and why isn't it simple to understand where we are?

It became quickly apparent that there is a significant data gap in terms of publicly available capital carbon data for projects and sectors. For some sectors, no capital carbon data was available using the data collection methods employed as part of this work.

Additionally, it was not always clear how different organisations or projects had drawn their scope boundary for the data being collected e.g. what lifecycle stages were included, and what were the inclusions/exclusions.

Other challenges included understanding the scope of works associated with large programmes of investment and matching the naming conventions on the IPA list to publicly available information.

The Sixth Carbon Budget
The UK's path to Net Zero.

Carbon emissions from infrastructure

Although the progress update against the Infrastructure Carbon Review identified historic average reductions of around 3% per year in infrastructure carbon emissions, it does not include any estimates of future emissions. However, to be broadly consistent with the trajectory the Committee on Climate Change have set out for delivering net-zero, infrastructure emissions must reduce by at least 4% every year over the next decade.

With declining operational emissions, and no capacity to replicate past easy wins (such as the removal of coal from electricity generation), these reductions need to be driven by an increased focus upon reducing user and capital carbon emissions. Even in the shorter term, meeting the 5th Carbon Budget will require additional interventions beyond those anticipated in current DBEIS projections. The CCC published advice on the level of the 6th Carbon Budget on the 9th December.

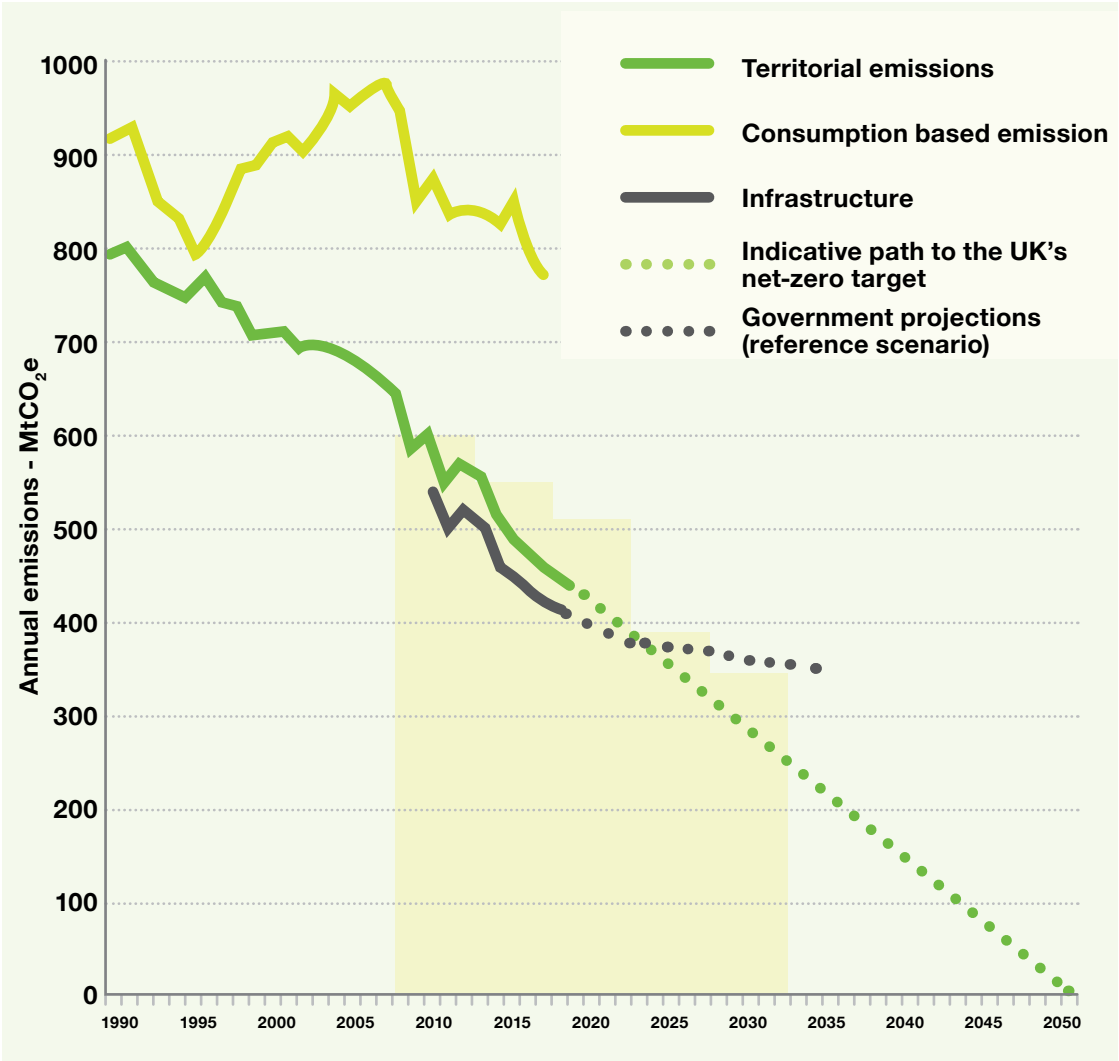


Fig. 4.1 Infrastructure emissions relative to national targets.

Scope of data and availability

The main issue with finding carbon data associated with the list is simply that a majority of the data is not publicly available. Where data was available it was difficult to make comparisons between different stages of the projects. Comparing the total Capex spend shows there is a paucity of data across the sectors and we were unable to draw any real conclusions from the data points gathered other than those regarding the limitations of the data.

When the data points were collated by Capex into sub-plots with three bands (<£1bn, £1-5bn, >£5bn) again there was no real correlation between Capex and capital carbon. It was therefore difficult to apply any statistical analysis to the carbon data which leads us back to the original issue of lack of data making it hard to manage our carbon.

Fig. 4.2 Capex of pipeline with actual (coloured), estimated (grey) and no carbon data.

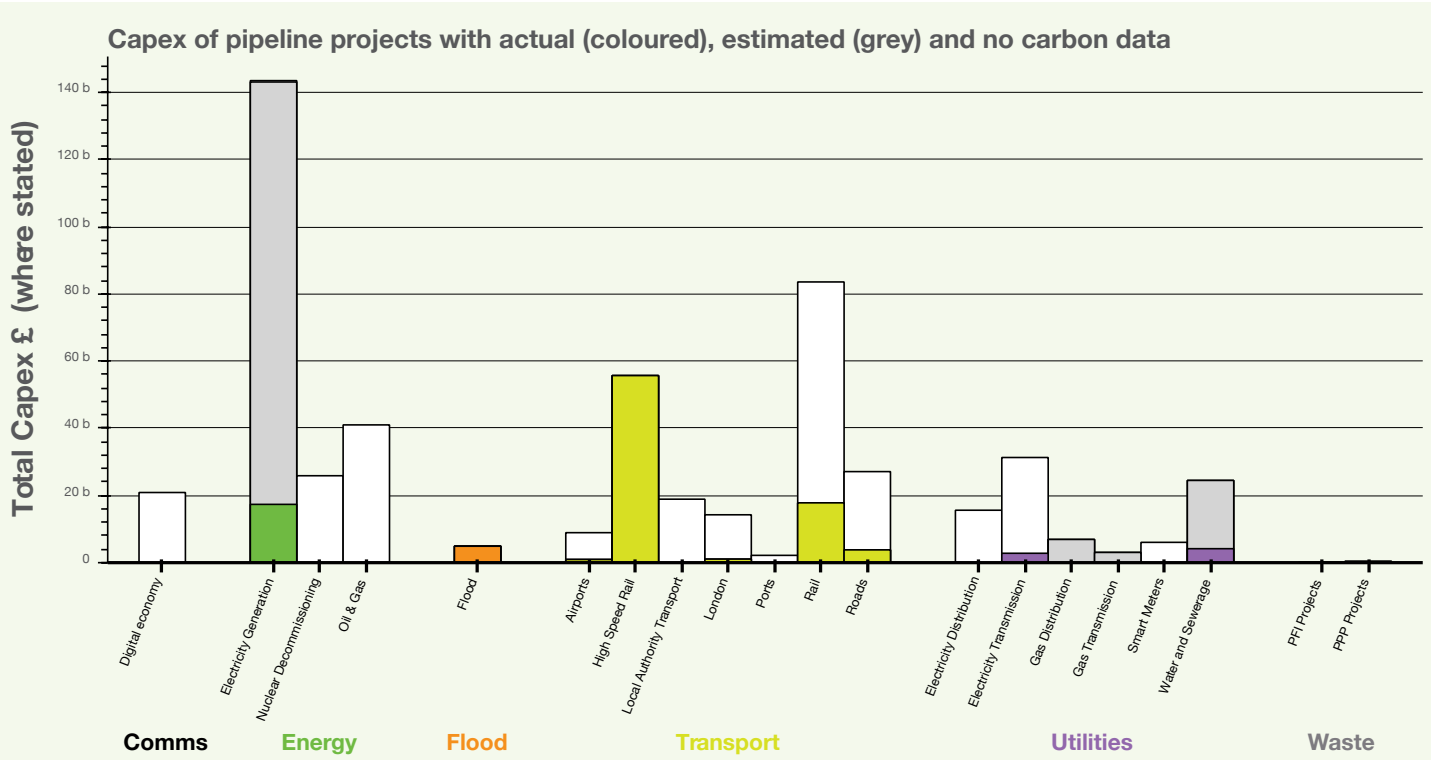


Fig. 4.3 Scatter Plot of data showing no correlation of Capex and carbon data available

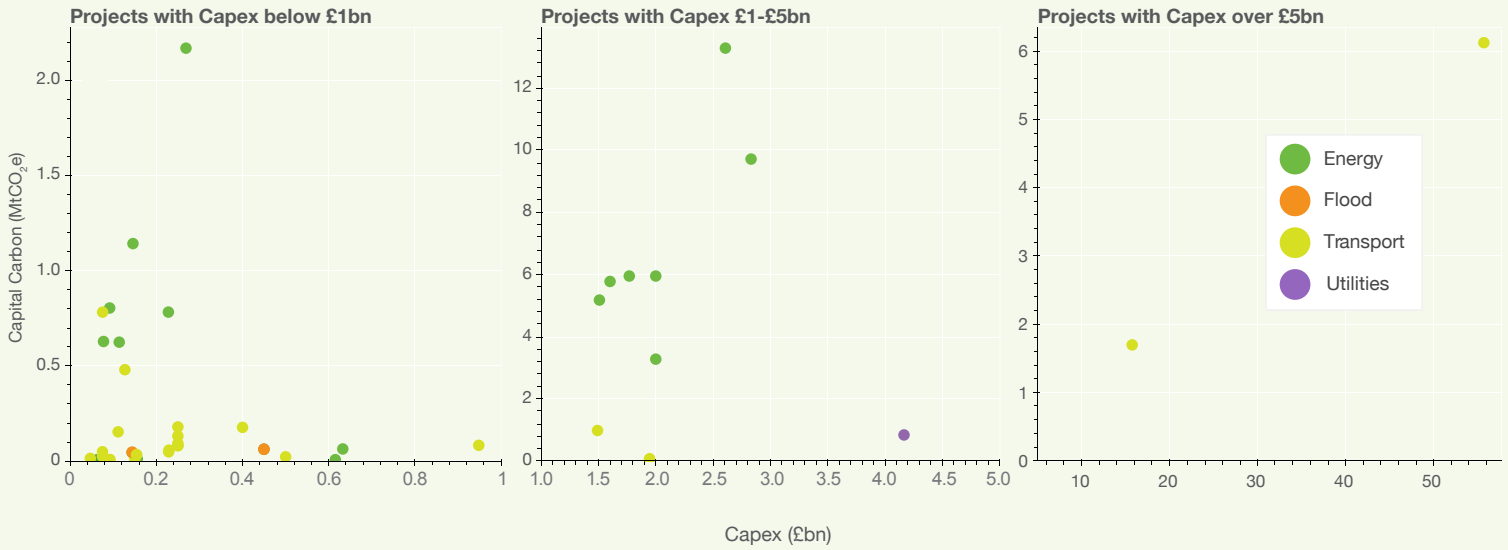


Fig. 4.4.

Chart B: Carbon data made available to the study

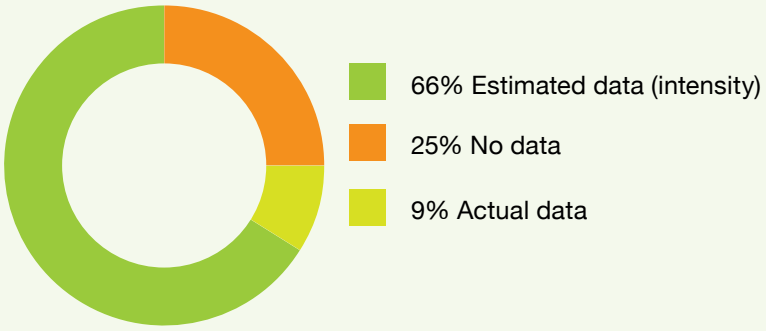
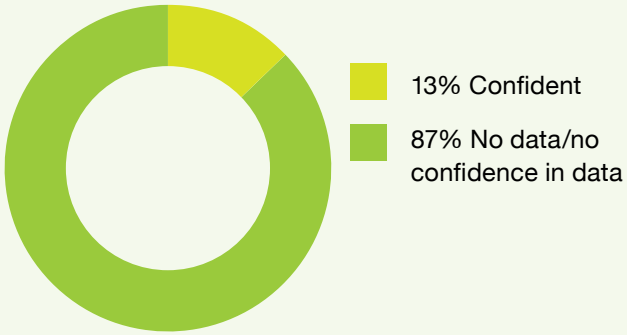


Chart A. Confidence in carbon data made available to the study (large error margins)



What the project found was in addition, the defined scope of each project either within the IPA list or from public data sources is not directly comparable because different scopes for the carbon assessments were used.

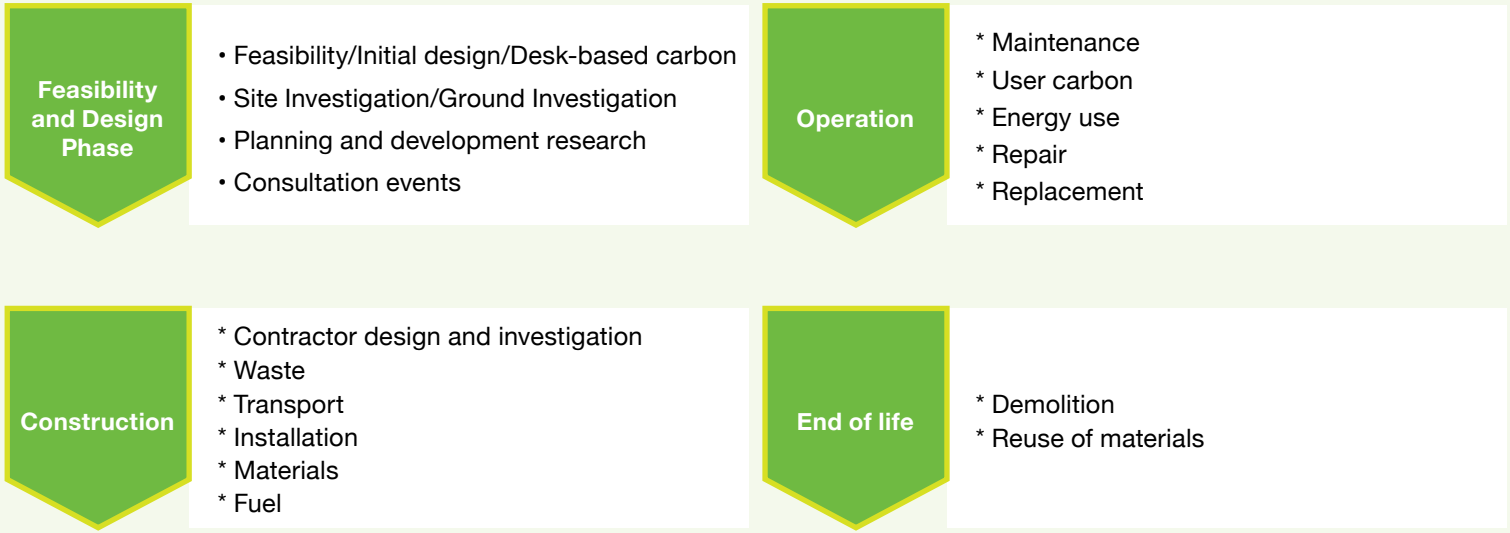
When capital carbon is used the stages that can be included are not standardised and form the basis of carbon assessment for project suitability in line with climate change targets.

Fig. 4.5 The following was found to have significant variations in both definition and assessment for the 9% of projects officially reported via the planning system as Nationally Significant Infrastructure Projects.

Data contacts/network with asset owners

The project participants come from a wide variety of industry and specialties. While the project does not assume to cover all aspects of infrastructure the contacts and resources available were not insignificant. Despite this, we were unable to gather data from large sectors of infrastructure, either due to the data not being available, there not being a clear point of contact for the asset owner data, or that the data was confidential in nature.

Not having direct public access to this data means that we cannot analyse where the information sits within the wider scope of the UK's carbon budget and in itself is a critical impact on how asset owners can plan their route to net-zero.



How, for example, are individual asset owners to know whether net-zero is good enough? If there are parts of our infrastructure that are unable to reduce carbon quickly due to technical specifications or safety of the infrastructure, shouldn't then other sectors be pushing for negative carbon in order to achieve net-zero across the industry?

Assumptive data – Can we use carbon intensity to estimate the pipeline of works?

A good question was, if we have data gaps, can we use the existing repositories to estimate intensities for the different sectors? On the face of it, the project thought it would be a straightforward assessment. However, in undertaking the investigative phase to look for scope of projects in line with their Capex reported via the IPA list, the project found that there was no definitive understanding of what data was being reported to the IPA.

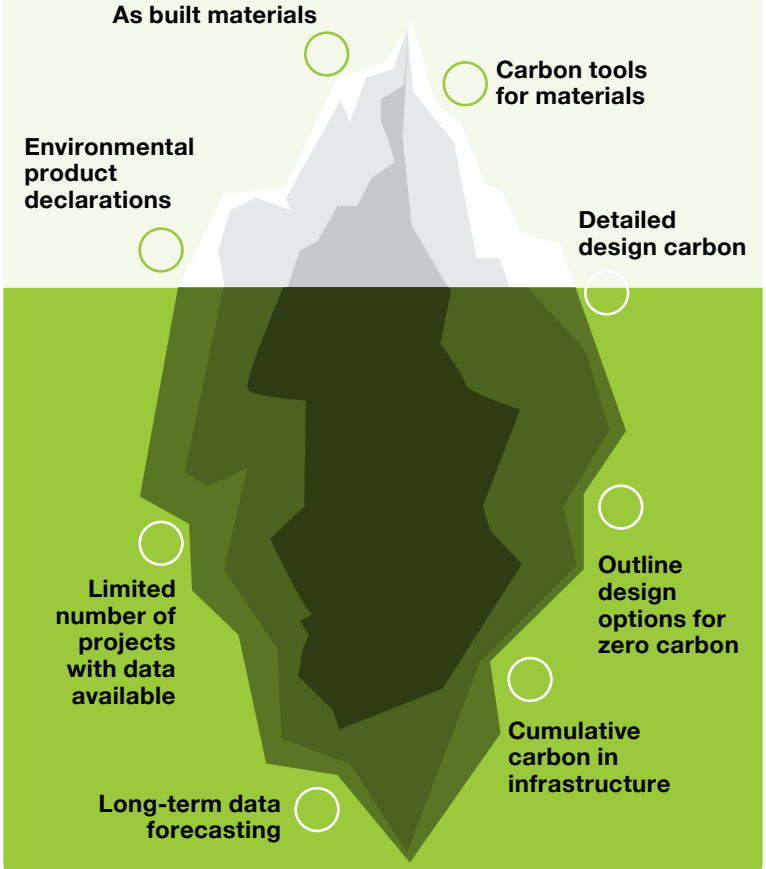
We were able make assumptions for a few projects, including the wind turbine sector as there was a large amount of data available to manipulate using the Mott MacDonald's Moata Carbon Portal.

For other sectors such as digital, we were unable to find transferable conversion factors from carbon per km to carbon per £spent, again because of a gap in publicly available data transparency and quality of project definitions given to the IPA.

Comparing data available in the environmental statement and calculated sector intensities gave little confidence in the intensity figure itself. To reduce carbon though, it is essential to have more granularity than the sector intensity can provide, so a detailed understanding of the carbon-cost for each project rather than using sector averages.

For other sectors such as digital, we were unable to find transferable conversion factors from carbon per km to carbon per £spent, again because of a gap in publicly available data transparency and quality of project definitions given to the IPA.

The carbon iceberg (what we don't know is hidden beneath the surface)



Carbon in materials

In order to better understand the embodied carbon of infrastructure schemes, a review of the IPA list was undertaken which was intended to provide a better understanding of the key components of embodied carbon in terms of materials.

However, we were generally unable to split the material types from the data obtained on individual projects or to say what each material type contributes to the overall embodied carbon. There is also the risk that a lack of data on individual materials from suppliers could in some cases be a contributory factor towards lack of understanding of embodied carbon in individual projects or sectors. Despite this lack of firm data our team's combined experience indicates that a significant portion of the overall pipeline embodied carbon can be accounted for by two materials, namely concrete and steel.

From the Coalition's own analysis of materials use in the last decade, we would suggest that steel comprises approximately 40% (Structural steel, steel and reinforcement) and concrete/ cement accounts for approximately 20% of overall construction material related emissions.

The infrastructure industry needs to take action to reduce the impact of these materials. In order to meet this challenge a cyclical approach to carbon reduction should be followed as set out within the Infrastructure Carbon Review. Once the opportunity to build nothing or build less has been ruled out, there is still opportunity to significantly reduce carbon by building smart. The diagram opposite shows the areas for reducing carbon at different stages of a project.

The Infrastructure industry needs to take action to reduce the impact of these materials. In order to meet this challenge a cyclical approach to carbon reduction should be followed as set out within the Infrastructure Carbon Review.

Good quality data

In order for everyone in the delivery value chain to be able to play their role in cutting lifecycle cost and carbon of the infrastructure projects (that are going to unlock the delivery of the UK's net-zero by 2050 target) we need to be able to create a robust, credible and verifiable lifecycle (CapCarb, OpCarb, UserCarb) carbon footprint baseline of infrastructure projects as we move from design brief through to detailed design and as-built.

From the baseline it is then possible to set measurable reduction targets that can drive the change that is needed. This challenge is increasingly recognised and many organisations, engineers/designers, infrastructure clients and main contractors are trying to address this. Whilst we have carbon footprint measurement standards and numerous measurement tools there isn't a single universally recognised, managed and continually improving source of carbon emission factors for the full range of construction products and building materials that are used consistently across all infrastructure projects.

The range of approaches currently being employed by those early adopters that are trying to make a difference has helped raise awareness of the urgency to address the issue. However, it has made comparing between asset owners and sectors difficult.

A key output of the embodied carbon project was an assessment of the UK's readiness to be able to baseline the whole-life carbon performance infrastructure assets to be able to set and deliver Paris-aligned reductions and in that way ensure the future UK infrastructure is future-fit to support a net-zero 1.5 degree world.

The range of approaches currently being employed by those early adopters that are trying to make a difference has helped raise awareness of the urgency to address the issue.

5. Taking action...now

1

Carbon Zero Definition and Scope for Assessment

As an industry we need to provide better, more accessible data to support the development of better tools that will allow for consistent quantification, better visualisation, analysis and optioneering.

2

Planning Framework Guidance for Carbon Assessment

There are some projects which are not accounted for in the planning system, including permitted development and other rights of statutory undertakers. It is therefore necessary to look beyond simply utilising the planning system for carbon accounting.

3

Understanding the Sector Share of UK Carbon Budget

If strategies only focus upon the achievement of short-term or interim carbon reduction goals, there is a risk that insufficient action will be taken in the coming decade and that emissions, infrastructure and technologies that are incompatible with the long-term objective will be locked in.

4

Net-Zero design option for every asset

Assuming we build, the only way to ensure that we can provide net-zero carbon assets throughout the cycle is to ensure that there is a net-zero carbon outline design provided prior to planning. This may mean that we collaborate earlier and design is supported by other organisations through tendering work prior to planning application.

1

Carbon Zero Definition and Scope for Assessment

As an industry we need to provide better, more accessible data to support the development of better tools that will allow for consistent quantification, better visualisation, analysis and optioneering. This will unlock the development of sector specific benchmarks that can be used to compare different types of infrastructure and assess the current performance of similar types of infrastructure.

Better lifecycle footprints will enable the more innovative engineers, designers and contractors to identify reduction hotspot opportunity areas within the common archetype 'building block' that make up a project. Accurate information will also help to develop both incremental and transformation challenge competitions for early supplier/contractor engagement to deliver incremental and transformational reductions.

Importantly, better benchmarks will also help investors understand what good looks like so as to unlock capital flows into solutions for the low carbon economy.

Finally, and equally importantly, benchmarking will allow governments to inform policy, and set standards and incentives.

Why CapCarb measurement must be improved

- OpCarb has been the historical focus, more recently UserCarb
- CapCarb has largely been ignored (mainly because it's hard to measure) – our view is that this needs to urgently change
- Recent analysis has shown that for certain infrastructure projects CapCarb can be 2/5th of 60yr lifetime carbon emission of that project
- With a full lifecycle perspective we can then make better comparisons between investments in different type of infrastructure investment both in terms of their environmental impact as well as how they create economic and social benefits i.e. growth, prosperity and enhanced quality of life

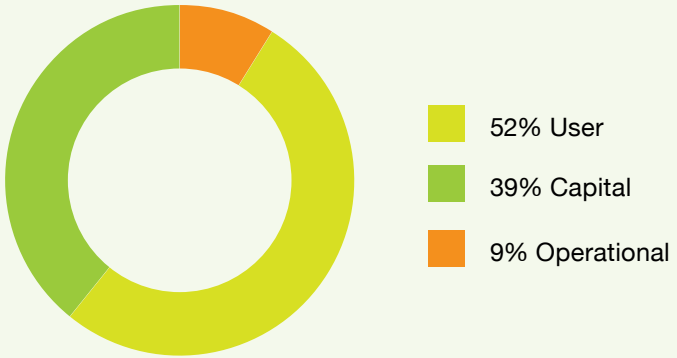


Fig. 6.1 Example from Lower Thames Crossing showing share of carbon across lifestages of a project

2

Planning framework guidance for carbon assessment in line with the Paris Agreement at local and national level

When we consider infrastructure development and climate change we find that a cycle has emerged of short-term solutions due to short timescales, short political cycles, and reactive solutions.

The planning framework allows for many projects to align to a specific regulatory process at an early stage in development. In a recent white paper the Government made clear that its policy is to ensure the planning system supports our efforts to combat climate change, and that it will amend the national planning policy framework (NPPF) to ensure that national policy targets those areas where a reformed planning system can most effectively play a role in climate change mitigation. We haven't yet seen the details of those proposals but they could incorporate some form of carbon accounting.

Ultimately however there are some projects which are not accounted for in the planning system, including permitted development and other rights of statutory undertakers. It is therefore also necessary to look beyond the planning system for carbon accounting.

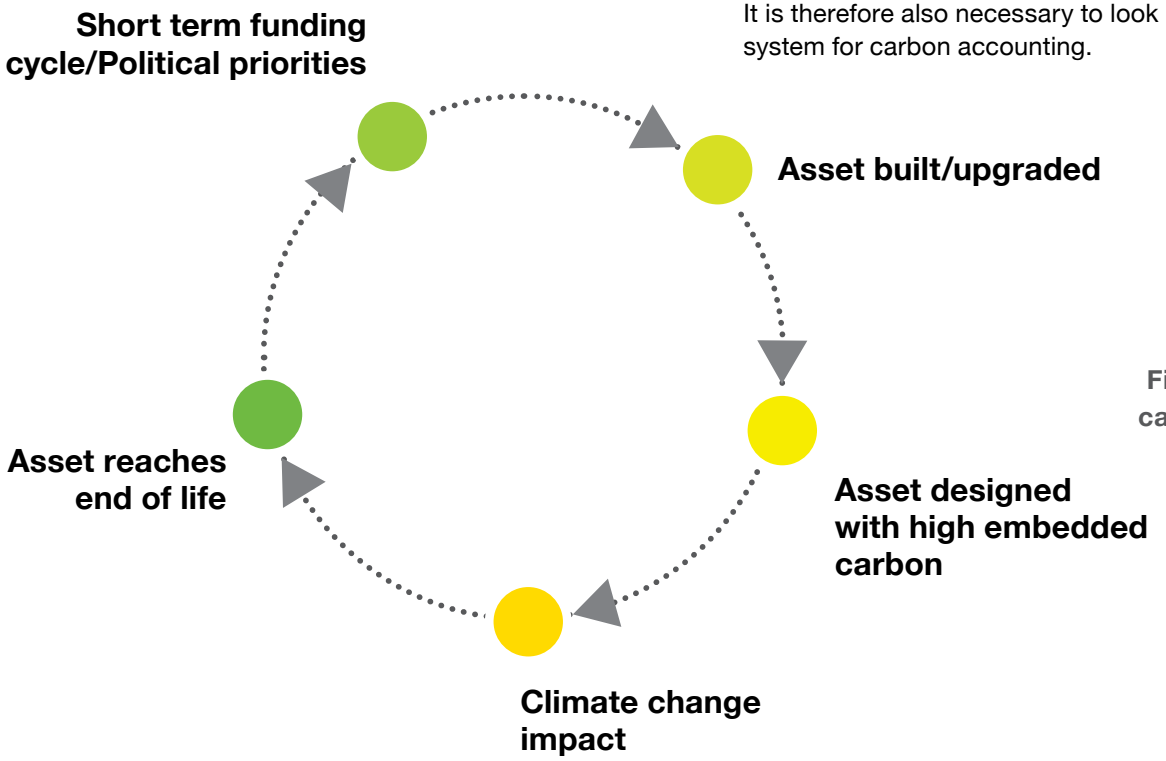


Fig. 6.2 Cycle of thinking in carbon management during the planning process

3

Understanding the sector share of UK carbon budget

Delivering against the UK's carbon budgets and subsequent net-zero target, requires that short term national, sectoral and company emission reduction targets are nested within longer-term pathways and strategies. In the years since the Paris Agreement, numerous UK built environment firms have sought to align their carbon reduction commitments through a diverse range of approaches including net-zero targets and Science Based Targets.

The UKGBC Climate Commitment Platform captures a broad range of such commitments. The sophistication of these approaches varies widely, and it is difficult to evaluate the consistency of these collective commitments with national targets. This is made particularly challenging by the lack of sectoral carbon budgets or trajectories and the incongruity between sector reporting and sectoral conventions used in national accounts and future pathways, such as those prepared by the CCC.

To rectify this problem there have been repeated calls within the industry for development of a common sector target trajectory from which commensurate targets for individual companies and projects can be derived. To this end, the UKGBC have recently announced plans to develop such a trajectory as part of a net-zero Whole Life Carbon Roadmap for the UK built environment ahead of COP26 in November 2021.

In the continuing absence of such a trajectory it is difficult for any individual asset owner or contractor to set short term carbon reduction targets that are consistent with both the near term Carbon Budgets and the UK's long term net-zero goal.

Construction of such a trajectory must overcome a number of challenges reflecting the unique characteristics of the sector's structure, product and reporting procedures, as well as its role in decarbonisation of the UK economy. It will also require collaboration, and a collective industry effort to depict the long term role of a sustainable construction industry within a net-zero UK. This will involve both deep mitigation and substantial deployment of negative emissions technologies. Recognising that complete mitigation of all Scope 1, 2 and 3 emissions from construction, operation and maintenance of the built environment within a few decades is highly unlikely, a portion of the UK's residual emissions post net-zero may need to be allocated to continuing construction activity.

Net-zero carbon buildings task group.

4

Net-zero design option for every asset

Assuming that 'build' is the option chosen, the best way to ensure that we can provide net zero carbon assets throughout the cycle is to ensure that there is a net-zero carbon outline design provided prior to planning. This may mean that we collaborate earlier and design is supported by other organisations through tendering work prior to planning application.

Assets are designed not only for their permanent structure, but for the construction and temporary works elements. Where a design is varied to accommodate for lower carbon alternatives the permanent structure does not necessarily show significant alteration from the standard. However, where we come across problems is within the scope of construction and temporary works. For example, a change to piling methodology could lead to significant changes in footprint required to store, construct, and install. There could be different water needs for the product as well as accessing the project from different locations. If a different construction is in place, then different preparations and safety precautions need to be met.

The cumulative impact of these is on the timescale and cost of a project, where most asset owners in infrastructure are beholden to the public wallet. All of the above come with different impacts to the environment and consideration of this from a risk, and legal planning permission need to be under consideration.

We have greater opportunity to achieve net-zero projects the earlier we apply the techniques in the carbon reduction hierarchy shown in the diagram opposite.

From this standpoint, a carbon neutral design alongside the impact assessment at feasibility is the most logical place for this to sit. In order to move to this state of relationship across the industry we need to consider changing our relationships to collaborative project work as opposed to transactional design and construction.

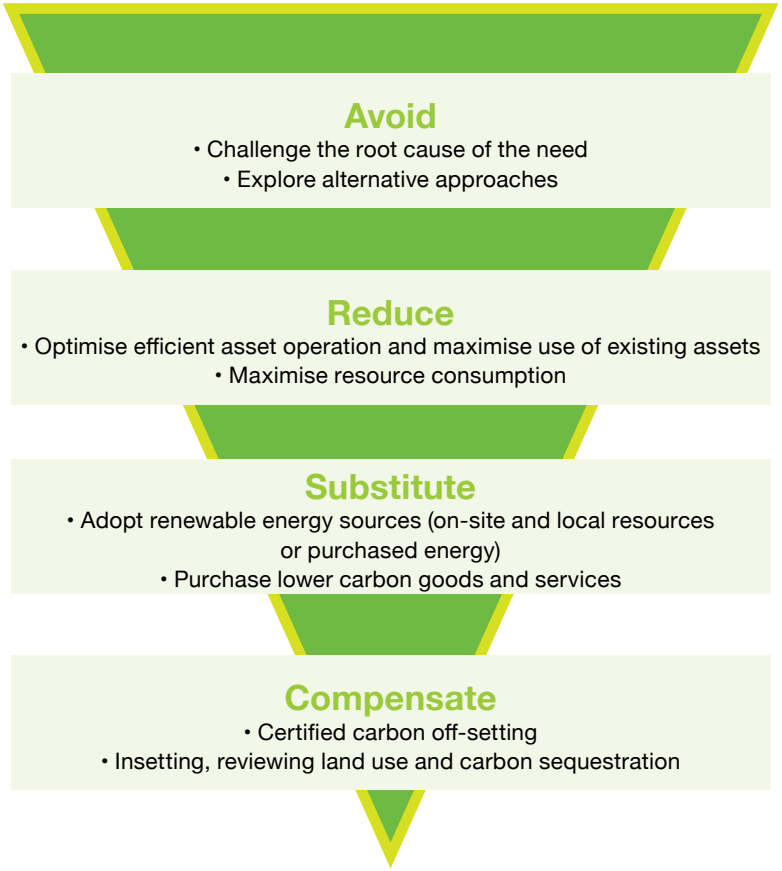


Fig. 6.3 Carbon reduction hierarchy

This report has identified a serious deficit in the understanding of embodied carbon across the infrastructure sectors, but even without this detailed understanding we know that collectively infrastructure input to carbon emissions is colossal.

Conclusion

There is a lot of pressure on asset owners to become net-zero in line with the Governments legislation and to evaluate carbon and climate change impacts, while also developing short, medium, and long-term solutions for infrastructure challenges. With so much going on, are we focussing too much on short-term outcomes from traditional transactional economics and not enough on a collaborative economic recovery?

Nobody is an expert in everything, yet we need all specialisms to come together to understand the impact of carbon. Upskilling a sector on carbon knowledge and how we need to reach the goal together is essential, and something that is being worked on around the industry.

This report has identified a serious deficit in the understanding of embodied carbon across the infrastructure sectors, but even without this detailed understanding we know that collectively infrastructure input to carbon emissions, as shown in the Sixth Carbon Report, is significant. Unless this deficit is addressed and unless a consistent, agreed approach is developed to managing and targeting embodied carbon across infrastructure sectors, we risk undermining all of our ambitions to achieve net-zero.

But we can do more than this – we have highlighted the positive steps that stakeholders (asset builders and operators, government, local authorities and others) can take to minimise the embodied carbon of individual projects but also to ensure our industry is collectively pulling in the right direction to achieve net-zero.

Unless we think big, we will never change. The time is not for tweaking the existing system, it's about changing our mindset, therefore accurately forecasting and understanding carbon data in infrastructure is critical to reaching net-zero.

What is the Net-Zero Infrastructure Industry Coalition?

The UK political system has shown genuine global leadership on climate change, but to turn ambition into reality demands equal levels of leadership from UK businesses, and from the UK infrastructure industry in particular.

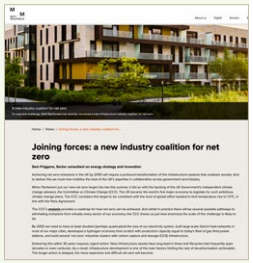
This report was produced as part of the work programme of the net-zero Infrastructure Industry Coalition, formed in 2019 in response to the UK government's 2050 net-zero greenhouse gas (GHG) emissions commitment. Our launch report, 'Building a net-zero economy: planning and practical action to transition our economic infrastructure for a net-zero future' is available at www.mottmac.com.

Coalition members include Mott MacDonald, Skanska, the UK Collaboratorium for Research on Infrastructure & Cities, UK Green Buildings Council, Anglian Water, Transport for London, Engie, Pinsent Masons, KPMG, Energy Systems Catapult, Carbon Trust and Leeds City Council.

The aim of our Coalition is to harness our collective expertise to support the delivery of UK net-zero. Our belief is that net-zero must become an industry-wide mission that transcends traditional business relationships to become a fundamental part of the way we all work, much like health and safety has over recent decades. Our vision is that the UK's engineering and infrastructure sectors rapidly mobilise to meet the net-zero challenge.

This workstream was led by Skanska with support from a working group that comprised: Skanska, Mott MacDonald. Pinsent Masons, The Carbon Trust, University of Leeds, UKCRIC, Leeds City Council, National Grid, and Transport for London.

Acknowledgements



Joining forces: a new industry coalition for net-zero.

SKANSKA

Ruth Finlayson
Environment and Carbon Manager (Infrastructure)

Chris Hayes
Sustainable Operations Director (Infrastructure)

David Mason
Technical Director (Environment)

Kathryn Tyley
Civil Engineering Intern

Mott MacDonald

Natalie Francis
Senior Carbon Consultant

Ross Ramsay
Senior Carbon Management Consultant

Ross McLean
Carbon Management Consultant

Dr Kim Yates
UK & Europe Sustainability & Climate Change Lead

Pinsent Masons

Stacey Collins
Energy & Infrastructure Partner

Amy Stirling
Energy & Infrastructure Associate

CARBON TRUST

Dominic Burbridge
Associate Director

University of Leeds

Dr Jannik Giesekam
Research Fellow in Industrial Climate Policy

UKCRIC

Dr Tom Dolan
Senior Research Associate

Leeds City Council

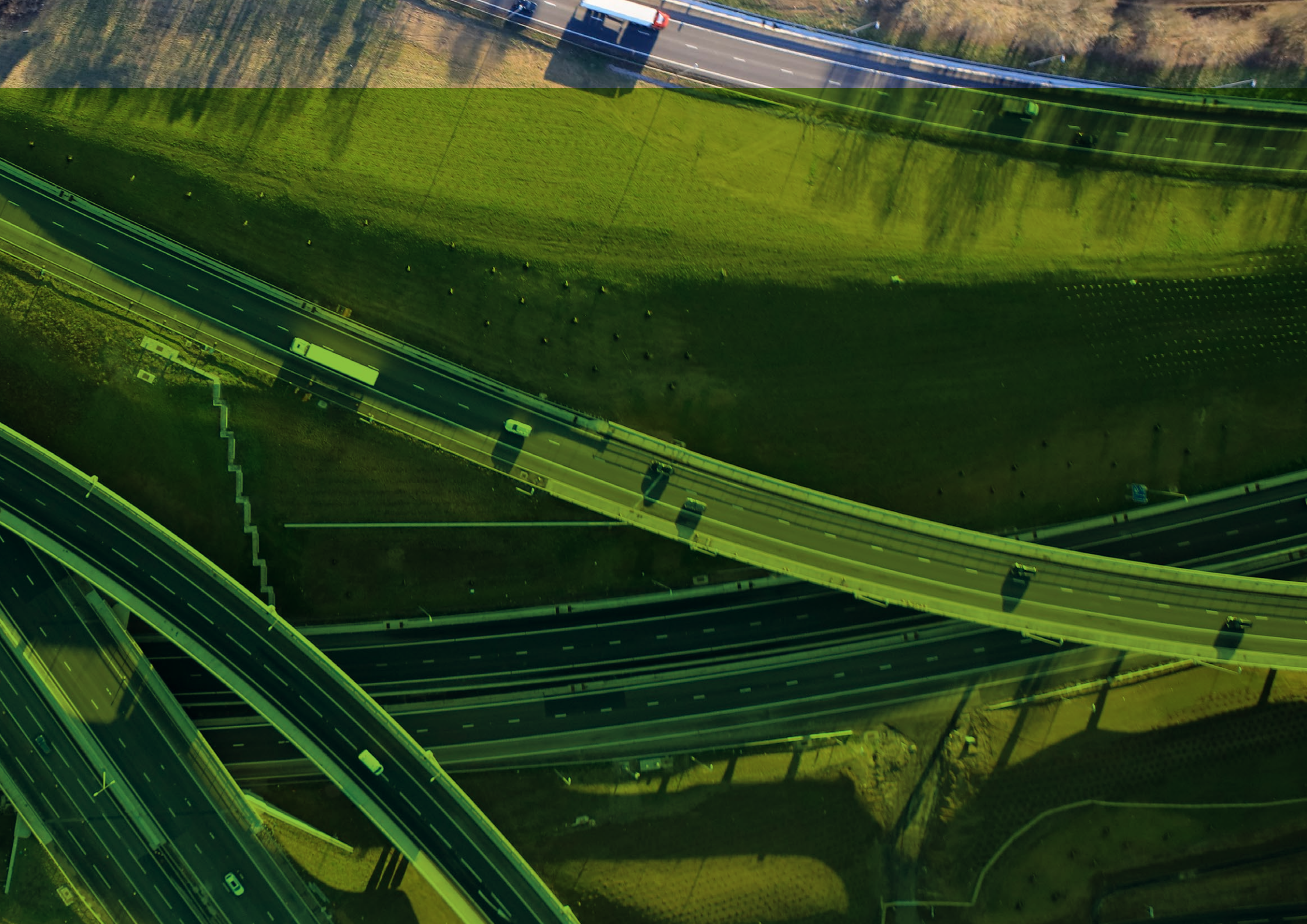
Thomas Knowland

National Grid

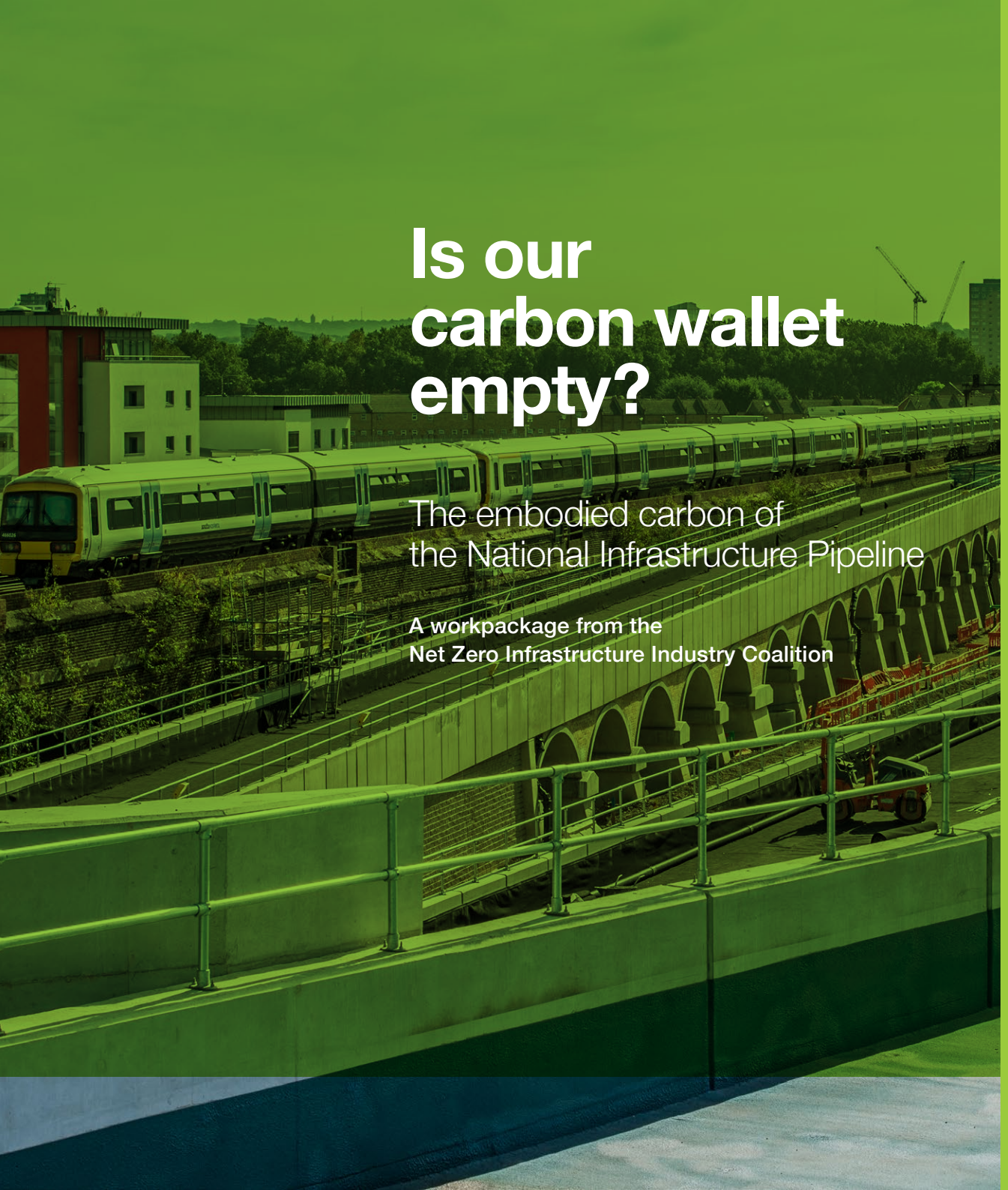
Christine Glew
Innovation & Sustainability Manager

Transport for London

James Ingram
Principal Policy Advisor



For the UK to achieve its net-zero by 2050 target it is clear there must be a step change in carbon emission reductions across all sectors.



Is our carbon wallet empty?

The embodied carbon of the National Infrastructure Pipeline

A workpackage from the Net Zero Infrastructure Industry Coalition

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Contacts

If you would like to discuss the contents of this report or the Net-Zero Coalition please contact:

Ruth Finlayson
Ruth.finlayson@skanska.co.uk
(Embodied carbon of the Infrastructure Pipeline workstream lead)

Georgina Phillips
Georgina.Phillips@mottmac.com
(Assistant Project Manager)

Natalie Francis
Natalie.Francis@mottmac.com
(Senior Carbon Consultant)

A number of additional reports by the Net Zero Infrastructure Industry Coalition are available:

- Building a net-zero economy
- The Path to Zero Carbon Heat
- A Place Based Approach to Net Zero